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Digital Transformation, Cocoa Downstreaming and Export Competitiveness

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Abstract: The global cocoa industry is changing dramatically, with the supply chain facing disruptions, climate change challenges, sustainability demands, and an increasing demand for technology-enabled processing and value-added products. Indonesia must improve its cocoa export competitiveness by shifting away from raw commodity exports to higher-value processed products. The current study analyzes comparative advantage, export market dynamics, and downstreaming of Indonesian cocoa exports, focusing on cocoa beans (HS 1801) and cocoa butter, fat and oil (HS 1804) in selected European markets. The research adopts a quantitative descriptive approach using international trade data from the United Nations Commodity Trade Statistics Database (UN Comtrade) and the International Trade Center (ITC) Trade Map. To measure the comparative advantage of cocoa beans and cocoa butter, Revealed Symmetric Comparative Advantage (RSCA) is used, and Export Product Dynamics (EPD) is used to measure their market position in the Netherlands, Belgium, France, and Germany. A Downstreaming Index measures the proportion of cocoa butter exports to total cocoa bean and cocoa butter exports. Results suggest that cocoa butter has a stronger comparative advantage than cocoa beans in some European markets, while EPD shows different market positions across destination countries. The Downstreaming Index indicates a transition from raw cocoa beans to cocoa butter. Processing enabled by technology, digital traceability, quality management, and supply-chain integration may enhance downstream competitiveness and help to comply with sustainability-oriented market demands, the findings suggest. The study emphasizes the importance of the integration of cocoa downstreaming, technological upgrading and sustainable value chain development to improve Indonesia's position in the global cocoa trade and sustainable international markets.

Keywords: Digital transformation, Cocoa downstreaming, Cocoa industry

Introduction

Cocoa is a strategic plantation commodity in world agricultural trade, and it plays an important role in value addition, export revenue, and food industry development. However, the global cocoa industry is currently undergoing increasingly complex structural changes, driven by climate change, supply chain disruptions, price volatility, sustainability demands, and growing international market requirements. Such conditions stimulate cocoa-producing countries to focus not only on increasing the production of raw materials but also on improving supply chain efficiency, product quality, added value, and the ability to meet sustainability standards. Recent trends in the global cocoa market have highlighted the significance of supply chain resilience. The International

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Cocoa Organization (ICCO) said global cocoa production was well below demand in the 2023/2024 season while cocoa prices were at very high levels on the back of supply constraints and erratic weather conditions. These conditions create opportunities for producing countries, such as Indonesia, to improve their position in the global cocoa value chain via productivity improvements, processing, product diversification, and the ability to improve export competitiveness.

Conversely, the cocoa trade is increasingly fueled by demand for sustainability and more transparency in the supply chain. One of the most important and, at the same time, hardest markets is the European market, which places increasing importance on traceability, product origin, and compliance with ecological standards. With the entry into force of Regulation (EU) 2023, the EU Deforestation Regulation (EUDR) has increased the need for commodity exporters, such as cocoa producers, to provide traceability information to ensure that products placed on the market are deforestation-free and meet legality requirements. As a consequence, the competitiveness of cocoa in the European market is not only related to the price and volume of exports but also to the ability of the business actors to establish a transparent and well-documented supply chain that meets the criteria of sustainability. These changes make technology increasingly important in the development of the cocoa industry. Post-harvest processing technology, fermentation, quality control, digital traceability systems, supply chain management, and market information exchange can support efficiency improvements while also producing higher value-added products. In the context of international trade, technological transformation allows producing countries to shift from raw material suppliers to higher-value processing activities. Therefore, cocoa's competitiveness in a sustainable economy must be understood as a combination of the ability to produce competitive products, carry out value-added processing, meet quality standards, and respond to market demands that are increasingly technology- and sustainability-based.

Indonesia is one of the world's biggest cocoa producers and holds a strategic position in the global cocoa trade. However, the Indonesian cocoa sector has traditionally exported raw cocoa beans that have a relatively lower economic value compared to processed cocoa products. The Indonesian government has acknowledged this limitation and has ramped up downstream industrialization policies to enhance domestic value addition and to reduce reliance on raw commodity exports. Simultaneously, national cocoa development programs have focused on the rehabilitation and replanting of plantations, as many cocoa plantations are run by smallholder farmers with aging trees and decreasing yields. Better planting material, improved cultivation technology, and modern processing systems can be used to support sustainable production and industrial development (Ministry of Agriculture of Indonesia, 2024).

In response to these conditions, the Indonesian government has promoted cocoa downstreaming policies to boost domestic processing and reduce dependence on raw-material exports. These policies have changed the structure of Indonesia's cocoa exports. Zikria et al. (2019) found that after the policy change in 2010, Indonesia's cocoa bean exports decreased, while processed cocoa exports increased and showed greater expansion potential than cocoa beans. This indicates that downstream processing can be an important instrument for increasing domestic value addition. However, an increase in the share of processed products does not automatically mean Indonesia has gained strong and sustainable competitiveness in every target market. In other words, structural downstreaming needs to be distinguished from the success of downstreaming in creating sustainable export competitiveness. Recent studies show that sustainable cocoa production systems combining technological innovation and agroforestry practices have the potential to improve ecological and environmental performance and market competitiveness (Schroth et al., 2024; FAO, 2023).

Based on this gap, this research analyses the competitiveness and dynamics of Indonesian cocoa exports by comparing two product groups, namely cocoa beans (HS 1801) as the upstream product and cocoa butter, fat, and oil (HS 1804) as the processed product. The analysis covered four European markets: the Netherlands, Belgium, France, and Germany. Revealed Symmetric Comparative Advantage (RSCA) identifies comparative advantages more symmetrically, while Export Product Dynamics (EPD) identifies product positions based on market share developments and demand dynamics. The Downstreaming Index complements both approaches by illustrating changes in the export structure from cocoa beans to processed products. This approach allows the research to answer not only whether Indonesian cocoa has a comparative advantage but also whether that advantage persists in developing markets and whether changes in export structure indicate a greater orientation toward downstreaming. The analytical framework aligns with the research design in the article, which specifically compares HS 1801 and HS 1804 using RSCA, EPD, and the Downstreaming Index. Thus, the contribution of this research lies in the integration of comparative advantage, market dynamics, and downstream structure within a single framework for analysing Indonesian cocoa exports. Unlike previous studies that primarily assessed competitiveness or the impact of downstream policies separately, this research compares the performance of upstream and downstream products while considering the characteristics of the European target market. The

subsequent analysis results are interpreted in the context of technological transformation, value addition, traceability, and sustainability demands. With this approach, the research is expected to provide a more comprehensive understanding of whether Indonesia's shift from exporting raw materials to processed products has resulted in a tangible and sustainable export upgrading.

Based on this background, this research aims to (1) analyze the comparative advantages of Indonesian cocoa bean and cocoa butter exports in the European market, (2) identify the dynamics and positions of both products in the Dutch, Belgian, French, and German markets, and (3) measure the development of downstream orientation through the Downstreaming Index. The research results are expected to inform downstream policy development, strengthen processing technology, improve quality and traceability, and support strategies to enhance the competitiveness of Indonesian cocoa in international trade, which is increasingly oriented toward sustainability.

Method

Research Design

This study employed a quantitative descriptive approach to analyze the competitiveness and market dynamics of Indonesian cocoa exports in the context of global economic transformation and technology-driven downstream industrialization. The analysis focused on cocoa beans and processed cocoa products exported by Indonesia to the international market. Secondary data were obtained from the United Nations Commodity Trade Statistics Database (UN Comtrade) and the International Trade Centre (ITC Trade Map), which provide comprehensive international trade statistics. The study utilized annual export data covering the period 2014–2024 for cocoa products classified under the Harmonized System (HS).

Research Framework

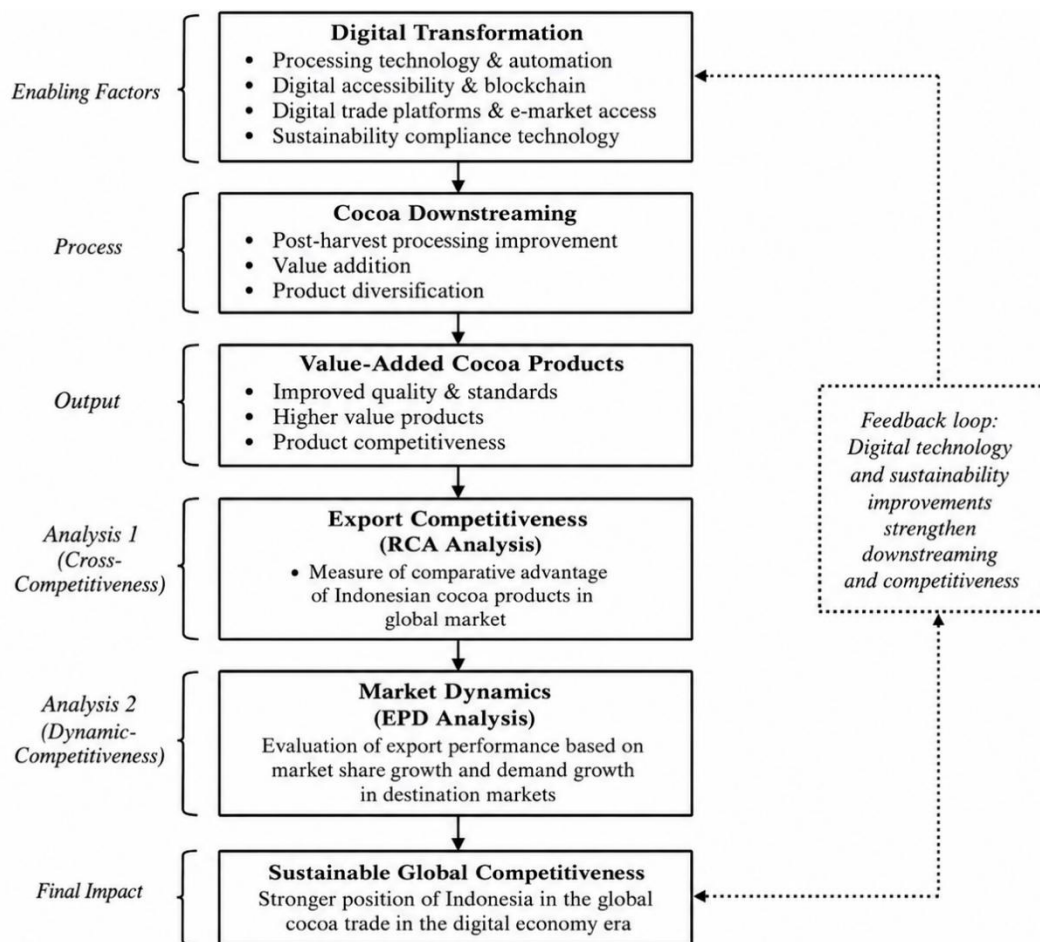


Figure 1. Research framework

This study adopts a quantitative descriptive approach to examine Indonesia's cocoa export competitiveness within the context of digital transformation, cocoa downstreaming, and sustainable agro-industrial development. The study is based on the premise that technological advancements in post-harvest processing, digital trade systems, supply chain management, and sustainability compliance contribute to the creation of higher-value cocoa products, which in turn affect export competitiveness and market dynamics.

The analytical framework assumes that digital and processing technologies do not directly determine export performance; rather, they facilitate downstream industrialization, increase value addition, improve product quality, strengthen traceability systems, and enhance access to international markets. These improvements are expected to be reflected in higher comparative advantage and stronger market positioning of processed cocoa products compared to raw cocoa beans.

Data Source

This study uses secondary data obtained from the United Nations Commodity Trade Statistics Database (UN Comtrade) and the International Trade Center (ITC) Trade Map. The analysis focuses on Indonesia's cocoa exports to selected European markets, namely the Netherlands, Belgium, France, and Germany, classified according to the Harmonized System (HS). The study specifically examines cocoa beans (HS 1801) as the primary raw cocoa product and cocoa butter, fat and oil (HS 1804) as the processed cocoa product. Export value data are collected for each product and destination market over the 2014–2024 observation period. The data are used to assess comparative advantage, export market dynamics, and the structural shift from raw cocoa beans toward processed cocoa through the Revealed Symmetric Comparative Advantage (RSCA), Export Product Dynamics (EPD), and Downstreaming Index approaches. The 2014–2024 period captures changes in Indonesia's cocoa export structure during the development of downstream industrialization and the growing adoption of digital trade and supply chain systems. Data from UN Comtrade provide the primary basis for international trade values, while ITC Trade Map is used as a complementary source for cross-checking and validating export statistics.

Data Analysis

To evaluate export competitiveness, the study applied the Revealed Comparative Advantage (RCA) index developed by Balassa (1965). RCA measures the comparative advantage of a country's export commodity relative to global trade performance. An RCA value greater than one indicates that the commodity possesses a comparative advantage and is internationally competitive.

$$RCA_{ij} = (X_{ij}/X_i) / (X_{wj}/X_w)$$

where X_{ij} represents Indonesia's export value of cocoa product j , X_i is Indonesia's total export value, X_{wj} denotes world exports of cocoa product j , and X_w represents total world exports.

In this study, RCA is employed not only to evaluate competitiveness but also to identify whether downstream cocoa products demonstrate stronger comparative advantages than raw cocoa beans. Higher RCA values for processed products are interpreted as evidence of successful value addition supported by technological upgrading and industrial processing capabilities. However, the RCA index has several weaknesses, including: the values are not symmetrical; the comparisons between countries or between commodities are not proportional/unbalanced. In addressing the issue, the symmetric comparison index has been used. The RSCA index is formulated as follows :

$$RSCA_{ij} = \frac{RCA_{ij} - 1}{RCA_{ij} + 1}$$

Explanation: RCA_{ij} = RCA Index for country i , commodity j . Interpretation of RSCA Value: $RSCA > 0$, The country has a comparative advantage in that commodity; $RSCA < 0$, The country does not have a comparative advantage; $RSCA = 0$, Neutral (threshold point of advantage).

To complement the competitiveness analysis, Export Product Dynamics (EPD) was employed to examine the dynamics of Indonesia's cocoa export position in the global market. EPD evaluates export performance based on growth in export market share and product demand in destination markets. The results are classified into four

categories: *Rising Star*, *Falling Star*, *Lost Opportunity*, and *Retreat*. This method enables the identification of market opportunities and the strategic positioning of cocoa products in international trade. EPD evaluates export performance using two dimensions: Growth of Indonesia's export market share. Growth of product demand in destination markets. Based on these dimensions, products are classified into four categories:

Y-Axis: Growth of Market Share

$$\frac{\sum_{t=1}^t \left(\left(\frac{X_{ij}}{W_{ij}} \right)_t \times 100\% - \left(\frac{X_{ij}}{W_{ij}} \right)_{t-1} \times 100\% \right)}{T}$$

Explanation: X_{ij} = total export value of Indonesia to the European Union market; W_{ij} = total world export value to the European Union market.

X-Axis: Growth of Export Share

$$\frac{\sum_{t=1}^t \left(\left(\frac{X_{aj}}{W_{aj}} \right)_t \times 100\% - \left(\frac{X_{aj}}{W_{aj}} \right)_{t-1} \times 100\% \right)}{T}$$

Explanation: X_{aj} = the export value of cocoa commodities (beans/processed) from Indonesia to the European Union market; W_{aj} = the export value of cocoa commodities (beans/processed) from the world to the European Union market. Based on these dimensions, products are classified into four categories:



Figure 2. Export product dynamics (EPD) matrix

Within this study, the EPD classification is interpreted within the framework of digital transformation and cocoa downstreaming. Products classified as *Rising Star* indicate that Indonesia has successfully increased its market share in expanding markets through value-added processing, technological innovation, and improved product quality. *Falling Star* products suggest that Indonesian cocoa products remain competitive despite declining market demand, reflecting the industry's ability to maintain market presence through efficiency and technological adaptation. *Lost Opportunity* products indicate that the industry has not fully captured growing market potential, highlighting the need for further technological upgrading, innovation, and market responsiveness. Meanwhile, products categorized as *Retreat* reflect declining competitiveness in shrinking markets, underscoring the need to strengthen downstream industrialization, digital integration, and sustainable production systems to improve future export performance.

Interpretation of Digital Transformation and Downstreaming Effects

The combined application of RCA and EPD provides a comprehensive assessment of both static competitiveness and dynamic market performance. Furthermore, the results were interpreted within the broader framework of cocoa downstreaming, technological transformation, and sustainable agro-industrial development to evaluate how value-added processing contributes to Indonesia's export competitiveness in the global sustainable economy. The results of RCA and EPD are subsequently interpreted within the framework of digital economic transformation

and sustainable cocoa industrialization. Rather than measuring technology directly, this study uses competitiveness and market dynamics as outcome indicators of structural changes associated with technology adoption.

A higher competitiveness level of processed cocoa products relative to cocoa beans is interpreted as evidence that technological upgrading in processing activities, quality management, traceability systems, and supply chain efficiency contributes to strengthening Indonesia's position in global cocoa markets. Furthermore, the EPD results are used to identify whether downstream products benefit from evolving market preferences associated with sustainability standards, digital traceability requirements, and environmentally friendly production systems. The X-Model Potential Export Products method is a method that combines the results of the Vollrath Index with the Export Product Dynamic (EPD) results to generate a grouping of potential export products to specific countries. Here is the clustering of the X-Model Potential Export Product.

Table 1. Combination of RSCA and EPD matrix

RSCA	Export Product Dynamic (EPD)	X-Model
RSCA > 0	Rising Star	Optimistic Market Development
	Lost opportunity	Development of Potential Markets
	Falling star	Development of Potential Markets
	Retreat	Development of Less Potential Markets
RSCA < 0	Rising Star	Development of Potential Markets
	Lost opportunity	Development of Less Potential Markets
	Falling star	Development of Less Potential Markets
	Retreat	Development of Non-Potential Markets

Source : Nurhayati *et al.* (2019)

Downstreaming Index

This study proposes a Downstreaming Index (DI) to quantify the downstreaming level of Indonesia's cocoa exports by calculating the ratio of processed cocoa butter exports to total cocoa beans and cocoa butter exports. The index captures the structural shift from upstream raw cocoa beans (HS 1801) toward a higher value-added processed cocoa product, namely cocoa butter, fat, and oil (HS 1804). The Downstreaming Index is calculated using the following formula:

$$DI_{ct} = \frac{X_{1804,ct}}{X_{1801,ct} + X_{1804,ct}}$$

where denotes the Downstreaming Index of Indonesia's cocoa exports to the destination country in year ; denotes the export value of cocoa butter, fat, and oil (HS 1804) from Indonesia to the destination country in year ; and denotes the export value of cocoa beans (HS 1801) from Indonesia to the destination country in year . Export values are expressed in US dollars and sourced primarily from UN Comtrade, with the ITC Trade Map used for complementary data validation.

The index ranges from 0 to 1 and can also be expressed as a percentage. A higher DI indicates that a larger proportion of Indonesia's combined exports of cocoa beans and cocoa butter consists of the processed product (HS 1804), indicating a stronger downstream orientation in the destination market. Conversely, a lower DI indicates that exports are relatively more concentrated in cocoa beans (HS 1801), reflecting a stronger upstream orientation.

For example, a DI value of 0.75 indicates that 75% of Indonesia's combined exports of cocoa beans and cocoa butter to a particular destination in a given year consist of cocoa butter. The index is calculated for each destination market—Netherlands, Belgium, France, and Germany—and for each year during the 2014–2024 observation period. The resulting index is subsequently used to describe changes in Indonesia's cocoa export structure and to complement the analysis of comparative advantage and export market dynamics.

Results and Discussion

Comparative Advantage of Indonesian Cocoa Products

The RSCA analysis highlights the difference in competitiveness between cocoa beans (HS 1801) and processed cocoa products. The results indicate that in the case of processed cocoa products, positive RSCA values are consistently greater than the raw cocoa bean which indicates a greater comparative advantage in international markets. The research results showed that the competitiveness of Indonesia is more to the in value-added value-added cocoa products, not primary commodity. This study is to analyze the comparative advantage of Indonesian cocoa products in the international market with Revealed Symmetric Comparative Advantage (RSCA) index.

Compared to the conventional Revealed Comparative Advantage (RCA) index, RSCA symmetrically scales the RCA values in the range of $[-1, +1]$. This avoids asymmetry, and provides a better comparison of commodities against each other, and over time. Positive values of the RSCA suggest a comparative advantage while negative values of the RSCA suggest a comparative disadvantage. These results provide some empirical evidence on structural transformation of cocoa sector in Indonesia. One example of how downstream industrialization policies are being applied to increase the domestic value added and improve export competitiveness is the shift from exporting raw cocoa beans to processed cocoa products. Industrial upgrading can help countries to move up the global value chains by moving from exporting primary commodities to higher value-added processing activities (Gereffi & Fernandez-Stark, 2016).

The competitive advantage of processed cocoa products is closely linked to technological upgrading in the cocoa value chain. The competitiveness of processed cocoa products is closely linked to the technological upgrading of the cocoa value chain. Technological upgrading in the cocoa value chain is an important factor in the competitive advantage of processed cocoa products. Modern processing technologies, quality assurance systems, digital traceability and innovations in the supply chain allow companies to produce products that satisfy the increasingly demanding requirements of the international market. As global buyers seek greater transparency, sustainability and quality of products, these technologies have become important. The RSCA analysis has been applied to cocoa beans (HS 1801) and several processed cocoa products in an effort to identify the structural shifts of the export competitiveness of Indonesia during the period of observation. The analysis compares the comparative advantages of raw and processed cocoa products to provide insights on the effectiveness of cocoa downstream strategies and how far value-added activities could help to strengthen Indonesia's position in the global markets. The results of RSCA are shown in Figure 3.

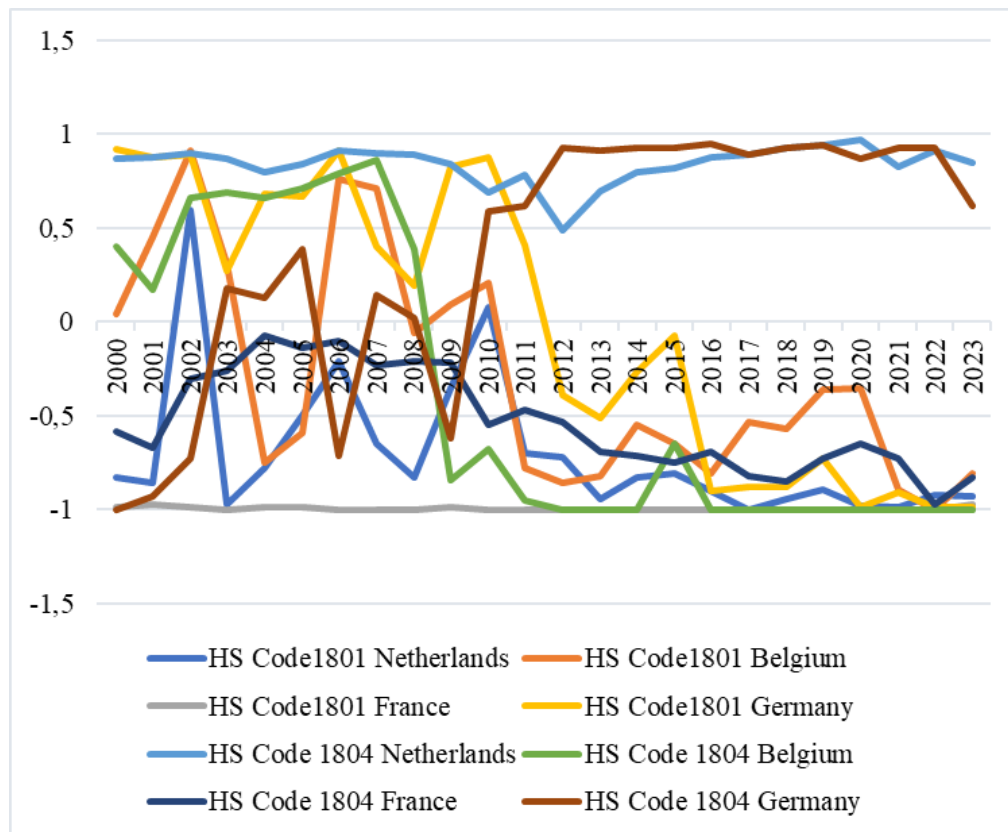


Figure 3. Graph of RSCA main destination countries for Indonesian cocoa

The RSCA analysis shows that in most of the destination markets in Europe, cocoa butter (HS 1804) has a higher comparative advantage than cocoa beans (HS 1801). The continued positive values of the RSCA of cocoa butter showed that Indonesia has built a more competitive position in processed cocoa products compared to raw cocoa exports. The finding suggests that downstream processing activities and value-added production are at the heart of the export competitiveness of the country.

The shift from cocoa bean exports to cocoa butter exports is one example of a more general transformation in global agricultural value chains. According to Amfo et al. (2023) the competitiveness of the agricultural commodity markets is increasingly determined by a country's ability to develop value-added products rather than the export of primary commodities. Usually, agricultural products are more profitable and less sensitive to fluctuations in world commodity prices.

The higher comparative advantage of cocoa butter also points to the successful implementation of the downstream industrialization strategy in Indonesia. Indonesia can increase its share of value creation in the cocoa value chain by increasing domestic processing capacity. Similar findings were reported by Effendy et al. (2019) that agro-industrial upgrading significantly contributes to export competitiveness by increasing product diversification, industrial productivity, and market adaptability.

Cocoa butter performance has improved through improved processing technologies, quality management systems, and industrial innovations. Making cocoa butter is more difficult than producing raw cocoa beans. It requires extraction technologies. It needs to be quality-standardized. High industrial processing efficiency. One of the most important determinants of the competitiveness of agro-processing industries is technological upgradation. It helps companies to be more efficient, lower the cost of production, and comply with international quality standards (Ndlovu & Thamaga-Chitja, 2023).

Cocoa butter's competitiveness is closely related to the digital transformation of agricultural value chains. Overseas buyers are increasingly driving demand for digital traceability, transparency in supply chains and verification systems for sustainability. Digital technologies enable the tracking, certification and dissemination of information along the supply chain, and improve market access and consumer confidence. Digitalization is becoming increasingly important for the improvement of transparency and competitiveness of global agri-food systems, especially in export-oriented sectors (Kamilaris et al., 2021).

Furthermore, the declining comparative advantage of cocoa beans in European markets may reflect a changing pattern of demand in the world cocoa market. Chocolate manufacturers are using semi-processed or processed cocoa inputs and this is reducing transaction cost and improving the efficiency of production. Similar trends have also been reported by Voora et al. (2023) who indicate that value capture in the current cocoa markets is increasingly concentrated in downstream segments where processing, branding, quality differentiation and sustainability certification are located. The decline of comparative advantage of cocoa beans in some European markets may be another indication of changing structures of demand in the world cocoa industry. "We are seeing more and more chocolate makers going into semi-processed, processed cocoa inputs. These commodities cut down the transaction price and efficiency in the production. Voora et al. (2023) further note these trends, citing the current cocoa markets are characterized by an increasing concentration of value capture in the downstream segments, where processing, branding, quality differentiation and sustainability certification take place.

These results are especially relevant for the implementation of sustainability-oriented regulations such as the EU Deforestation Regulation (EUDR). Exporting countries need to demonstrate traceability, transparency and sustainable sourcing practices to be able to comply with EUDR. Historically, these requirements have favored countries with more advanced technology capabilities and more integrated supply chain systems. Sustainability requirements are increasingly becoming a major competitive advantage in global agricultural value chains, especially for commodities going to European markets (Tröster and Staritz 2023).

Overall, the results of RSCA show a gradual shift of comparative advantage in Indonesia from exports of raw cocoa to exports of processed cocoa products. The empirically higher RSCA values of cocoa butter from the global cocoa market demonstrate that competitiveness is increasingly determined by downstream industrialization, technological upgrading, digital transformation, and sustainability compliance.

This finding is consistent with the study by Neilson, Wright, and Aklimawati (2020) who argue that the creation of value in agricultural commodity chains depends more and more on the integration of technology, quality standards and market governance mechanisms. Moreover, Aung and Chang (2014) illustrate that traceability

systems and technology innovations play a significant part in increasing competitiveness by increasing product quality, food safety and market access.

Higher RSCA values of processed cocoa products further support recent evidence that downstream processing creates more economic benefits than raw commodity exports. Fold and Neilson (2016) argue that by participating in higher stages of agricultural value chains, producing countries can capture more value and reduce their vulnerability to fluctuations in global commodity prices. Thus, the comparative advantage of Indonesian processed cocoa products could be interpreted as the outcome of successful downstream industrialization, supported by technological development and value-added production.

Export Product Dynamics (EPD) of Indonesian Cocoa Exports in the European Market

The Export Product Dynamics (EPD) analysis was conducted to assess the dynamic position of Indonesian cocoa exports to four major European destination markets, namely the Netherlands, Belgium, France and Germany in the period 2000-2023. EPD is a popular tool for evaluating export performance by combining two dimensions of market attractiveness and business strength. The resulting matrix classifies export performance in four categories: Rising Star, Falling Star, Lost Opportunity and Retreat. The best position is Rising Star, which means that a country's export market share is increasing in a growing market. The EPD matrix indicates that the Netherlands and France belong to the Rising Star quadrant, while Belgium and Germany are in the Falling Star quadrant.

The Netherlands is in the Rising Star quadrant." Indonesia has managed to win its share of the export market in an expanding market. This is evidence that the Netherlands is one of the biggest cocoa trading and processing centers in Europe. The country has a large cocoa processing industry and is one of the main entry points for cocoa into the European Union through the Port of Rotterdam. The increasing share of Indonesian cocoa products in the Dutch market shows that Indonesian cocoa products are still competitive and relevant in the European value chains. Fold and Neilson (2016) obtained similar results, and stressed the importance of integration into global value chains for the competitiveness of agricultural commodity exports. Moreover, competitiveness on international cocoa markets is increasingly determined not only by production capacity but also by the ability to meet the quality standards, traceability requirements and sustainability criteria imposed by European buyers (Voora et al., 2019).

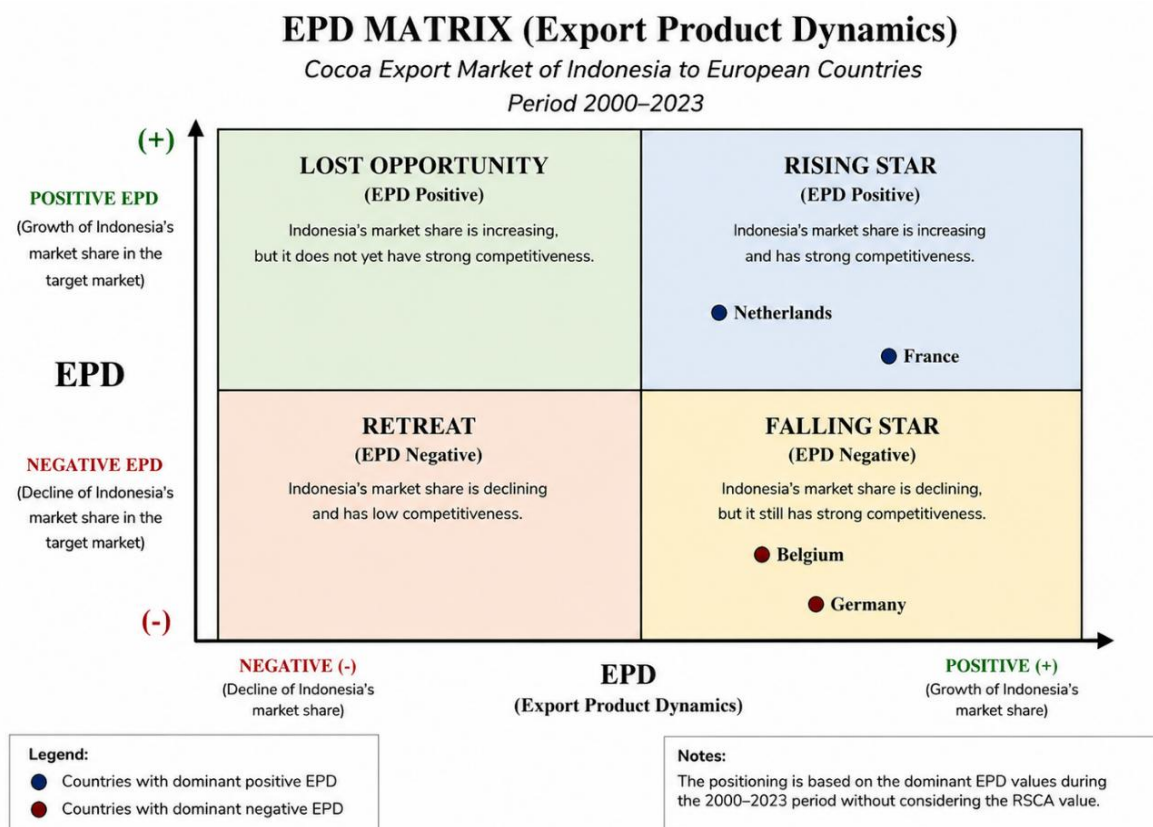


Figure 4. EPD matrix for HS code 1801

France also displays a similar pattern and is also considered a Rising Star market. The dominance of this category proves that Indonesian cocoa exports have been able to take an increasing share of the market with rising demand. This is especially important as France is a high-value consumer market with increasing demand for premium chocolate and sustainably sourced cocoa products. The positive performance in France can be explained by better product quality, a greater involvement in downstream processing of cocoa and a growing adaptation to changing consumer preferences. “European cocoa markets are increasingly driven by sustainability, product differentiation and traceability requirements, which create opportunities for exporters able to provide higher value-added products (Lambin et al., 2023).” The rising star position of France has seen Indonesian cocoa exporters relatively successful in responding to these market transformations.

By contrast, Belgium is mostly categorized as a Falling Star market. This position suggests that the Indonesian cocoa market position is still relatively strong, but its market share growth has slowed relative to overall market developments. Belgium is one of the world’s leading countries in cocoa processing and chocolate manufacturing, making it a highly competitive destination market. A Falling Star position could imply Indonesian cocoa is facing increasing competition from big producers like Ivory Coast, Ghana and Ecuador, which together make up the global cocoa exports. West African countries still dominate the world’s supply of cocoa beans, which means that there is fierce competition for supplies in the main European processing markets (International Cocoa Organization (ICCO, 2024). Therefore, to increase the export figures in Belgium more differentiated strategies are needed, particularly through sustainability certification, quality improvement and the export of processed cocoa.

Belgium, however, is mainly classified as a Falling Star market. The position shows the position of Indonesian cocoa market is still strong enough, but the growth of the market share is slowing down along with the development of the whole market. Belgium is one of the world's leading countries in processing cocoa and manufacturing chocolate, which makes it a very competitive destination market. The position of a Falling Star may mean Indonesian cocoa is having a hard time with the increasing competition from the big producers like Ivory Coast, Ghana, and Ecuador, which are the world’s cocoa exporters. West African countries continue to dominate the global supply of cocoa beans, so there is a fierce competition for supplies in the major European processing markets (International Cocoa Organization (ICCO, 2024). Therefore, more differentiated strategies are needed to increase export figures in Belgium, especially through sustainability certification, quality improvement, and export of processed cocoa.

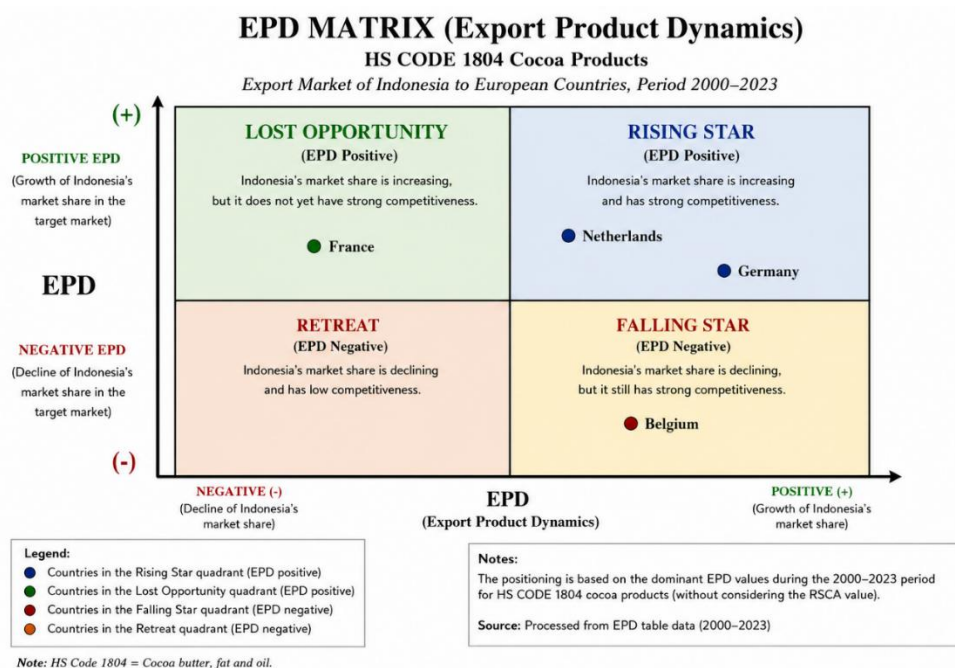


Figure 5. EPD matrix for HS code 1804

Overall, EPD results show that the competitiveness of Indonesian cocoa exports in the European destination markets is uneven. The Rising Star positions in the Netherlands and France are opportunities for market expansion, while the Falling Star positions in Belgium and Germany indicate the need for strategic measures to preserve the export performance. These results are consistent with the proposition that the long-term competitiveness of the

global cocoa market increasingly depends on moving beyond raw commodity exports to higher value-added processed products, sustainability certification, and integration into global value chains (Kaplinksky & Morris, 2016; Voora et al., 2019). From a policy standpoint, the emphasis for Indonesia should be on market consolidation strategies in the Netherlands and France by enhancing trade partnerships, broadening downstream cocoa exports, and guaranteeing compliance with European sustainability standards. At the same time, efforts to restore market dynamism in Belgium and Germany should focus on more product differentiation, promotion of certified sustainable cocoa and productivity improvements along the entire domestic cocoa value chain. Such measures are expected to build up Indonesia's resilience and competitiveness in the increasingly demanding European cocoa market.

The Export Product Dynamics (EPD) analysis of Indonesian cocoa butter (HS Code 1804) reveals heterogeneous market dynamics for the main European destination countries in the period 2000-2023. The Netherlands and Germany are in the Rising Star quadrant according to the prevalent EPD classifications, Belgium is in the Falling Star quadrant, and France is in the Lost Opportunity quadrant. These results show that the performance of Indonesian cocoa butter exports differs significantly between European markets, reflecting differences in market attractiveness, competitive positions, and the ability of Indonesian exporters to respond to changing market demands.

Indonesia's position in the Rising Star quadrant indicates that Indonesian cocoa butter exports have been successful in gaining market share in a fast-growing market. This finding is in line with the strategic position of the Netherlands as the largest European importer and processor of cocoa. The Dutch cocoa industry is an important gateway for cocoa products into the EU, due to sophisticated logistics infrastructure, significant processing capacity, and a high degree of integration in global value chains. Thus, the Rising Star position indicates that Indonesian cocoa butter has been able to improve its competitiveness and at the same time, it has also benefited from the expanding market demand. This supports the argument of Fold and Neilson (2016) that participation in global value chains is a key determinant of export competitiveness in agricultural commodity markets. In addition, the Netherlands has emerged as a center for value-added processing of cocoa, providing opportunities for exporters who can provide semi-processed cocoa products such as cocoa butter, instead of raw cocoa beans (Voora et al., 2019).

A similar story is apparent in Germany, another Rising Star market. Germany is one of the largest consumers and processors of cocoa products in Europe and has a well-developed confectionery and chocolate manufacturing industry. The Rising Star position shows that Indonesia has not only maintained but gained market share in a market with positive growth. This shows that German processors have accepted Indonesian cocoa butter which could be due to improvements in the quality of the product, continuity of supply and growth of the domestic cocoa-processing industry in Indonesia. Demand for processed cocoa products in Europe has continued to grow, particularly among manufacturers seeking to source reliable cocoa ingredients to produce high-value chocolate (International Cocoa Organization, ICCO, 2024). Positive performance in Germany therefore reflects the growing importance of Indonesia's downstream cocoa sector in international markets.

In contrast, Belgium is positioned in the Falling Star quadrant, indicating that although Indonesian cocoa butter continues to maintain a presence in the market, its market share growth has not kept pace with overall market developments. Belgium is globally recognized as one of the leading chocolate-producing countries and hosts numerous multinational chocolate manufacturers. The Falling Star classification suggests that Indonesian cocoa butter faces increasing competitive pressure from major cocoa-processing countries and suppliers, particularly those with stronger integration into European supply chains. Previous studies have demonstrated that competitiveness in processed cocoa markets is increasingly influenced by factors beyond price competitiveness, including product quality, sustainability certification, traceability, and compliance with environmental standards (Lambin et al., 2018; Araujo et al., 2023). Therefore, maintaining and expanding Indonesia's position in Belgium will require stronger efforts to enhance value-added production and compliance with sustainability requirements.

Meanwhile, France is in the Lost Opportunity quadrant, which indicates that although the market is growing positively, Indonesia has not been able to fully capitalize on the increasing demand. The finding points to a latent export potential in the French market. Lost Opportunity conditions are usually identified when market demand rises but exporters are unable to increase their market share because of limited competitiveness, lack of market penetration or poor adaptation to consumer preference. "France is one of the largest premium chocolate markets in Europe where consumers increasingly seek sustainability, product origin, quality assurance and ethical sourcing practices. Fountain and Huetz-Adams (2020) find that European consumers are increasingly sensitive to sustainability-related attributes in cocoa and chocolate products with challenges and opportunities for exporting countries. Thus, the Lost Opportunity position of France implies that Indonesia has not fully exploited the market

developments, given the favorable demand conditions. Meanwhile, France is in the Lost Opportunity quadrant, which indicates that although the market is growing positively, Indonesia has not been able to fully capitalize on the increasing demand. The finding points to a latent export potential in the French market. Lost Opportunity conditions are usually identified when market demand rises but exporters are unable to increase their market share because of limited competitiveness, lack of market penetration or poor adaptation to consumer preference. “France is one of the largest premium chocolate markets in Europe where consumers increasingly seek sustainability, product origin, quality assurance and ethical sourcing practices. Fountain and Huetz-Adams (2020) find that European consumers are increasingly sensitive to sustainability-related attributes in cocoa and chocolate products, with challenges and opportunities for exporting countries. Thus, the Lost Opportunity position of France implies that Indonesia has not fully exploited the market developments, given the favorable demand conditions. More broadly, the EPD results indicate that downstream industrialization is becoming more important for increasing Indonesia’s export competitiveness. As a semi-processed product, cocoa butter has a much higher value-added content and is more integrated in global manufacturing networks than raw cocoa beans. The rise of the Netherlands and Germany as Rising Star markets shows that Indonesia’s cocoa-processing policies have had positive effects, by increasing its share in the higher stages of the cocoa value chain.

Finally, the EPD analysis shows that Indonesian cocoa butter exports have developed better market dynamics than traditional raw cocoa exports in some European markets. The Rising Star statuses for the Netherlands and Germany indicate good opportunities for further growth. Conversely, the Falling Star and Lost Opportunity positions of Belgium and France point to potential areas for strategic intervention. In an effort to maintain its competitiveness over the long term, Indonesia needs to keep strengthening its cocoa processing industry, improve the quality of its products, broaden the scope of sustainability certification schemes and enhance compliance with new European regulations such as the European Union Deforestation Regulation (EUDR). These measures are expected to improve market penetration and strengthen Indonesia’s position in the global cocoa value chain.

Cocoa Downstreaming and Export Structure

To study the degree of the shift in the direction of Indonesia from exporting primary cocoa commodities to higher-value processed cocoa products, the downstreaming structure of Indonesian cocoa exports is evaluated. In this study, the relative contribution of cocoa butter, fat and oil (HS 1804) to the total exports of cocoa beans (HS 1801) and cocoa butter is measured using the Downstreaming Index (DI) . A higher DI implies a larger share of processed cocoa products in the export structure, suggesting a higher level of downstream processing, whereas a lower DI implies a greater dependence on raw cocoa bean exports. It provides an important insight into the upgrading of Indonesia’s exports by complementing the analysis of comparative advantage and the dynamics of export markets. The change in the Downstreaming Index in the selected European markets is shown in Figure 6.



(a)

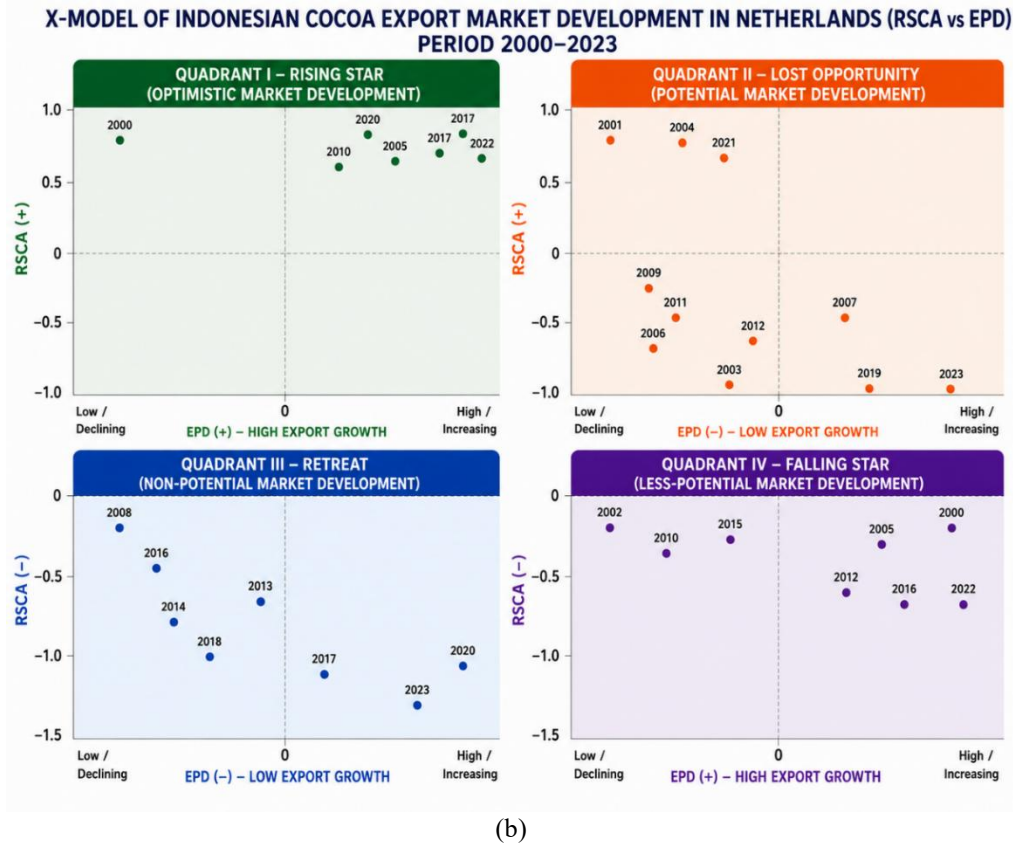


Figure 6. X-model of Indonesian cocoa export market development in the Netherlands, 2000–2023

Figure 6(a) shows the dynamic position of Indonesian cocoa exports in the Netherlands during 2000–2023 based on the interaction of Revealed Symmetric Comparative Advantage (RSCA) and Export Product Dynamics (EPD). The position map shows substantial changes in the competitiveness of Indonesia during the observation period. Indonesian cocoa has been moving in all four categories of the EPD, namely Rising Star, Lost Opportunity, Falling Star and Retreat. The result suggests that Indonesia's competitiveness in the Dutch cocoa market has been dynamic rather than persistent. This is in agreement with the proposition that export competitiveness must be assessed not only through the lens of comparative advantage, but also in terms of the ability of a product to maintain or improve its position in a dynamic international market. Fahmid et al. (2022) also show that for Indonesian cocoa, the comparative advantage and market position could be significantly different across destination markets. Thus, the competitiveness of Indonesia's cocoa is very market-specific.

The Rising Star quadrant is the most favorable competitive position because it has positive RSCA and positive EPD. This means that Indonesia has a comparative advantage and the related export market is growing. Indonesian cocoa was the Rising Star in 2002, 2004, 2005 and 2010 in the Netherlands. Among the observations, 2002 has a relatively high positive RSCA, indicating a stronger comparative advantage, while the observations for 2004 and 2005 remain positive but at a more moderate level. The 2010 observation is close to the RSCA threshold, indicating that the good position was quite fragile by then. These periods show that there were times when Indonesia was able to combine export specialization with positive market dynamics. Such a position is strategically important as it provides the opportunity to convert the existing comparative advantage into sustainable export growth through technological upgrading, quality improvement and value addition. Here, Gehl Sampath and Vallejo (2018) argue that participation in global value chains is not a sufficient condition for technological upgrading; instead, technological and innovation capabilities must be developed to be able to convert trade participation into higher-value export activities.

But the good Rising Star job didn't go all the way. For the years 2001, 2008, 2011, 2015, 2021 and 2022, observations are in the Lost Opportunity quadrant with positive EPD but negative RSCA. The Dutch market was doing well in terms of export. But Indonesia was at comparative disadvantage. These observations are especially significant as the RSCA values of the observations in 2015, 2021 and 2022 are well below zero, indicating the widening gap between market growth and Indonesia's comparative advantage. Therefore, Indonesia is in a situation where market opportunities exist but have not been translated into competitive gains enough. This is important because an increase in export growth in a destination market does not necessarily imply an increase in

competitiveness. Fahmid et al. (2022) also found that the relative competitive advantage of Indonesian cocoa is relatively low compared to other cocoa-producing countries, but there is still potential to develop the market in several destination countries. “This shows the need to upgrade product quality and downstream processing and not just rely on the existing export capacity.”

2006, 2009, 2012, 2014, 2016 and 2017 with a positive EPD but a negative RSCA fall into the Falling Star quadrant. The position shows that Indonesian cocoa had relatively favorable market dynamics but no corresponding comparative advantage. Several Falling Star observations suggest that Indonesia experienced periods of market expansion, but these opportunities were not paralleled by a sufficient strengthening of export specialization. Economically, it might be a transient market opportunity rather than a structurally competitive advantage. In this sense, the results are in line with the findings of Yemima and Novianti (2020), who found that processed Indonesian cocoa can have a comparative advantage and at the same time can have an EPD position in the less advantageous categories, which shows that comparative advantage and market dynamics do not necessarily go in the same direction. That is to say, to be able to form a sustainable competitive position, market expansion must be accompanied by improvements in productivity, product quality, processing capacity and market access.

The Retreat quadrant is the weakest position compared to the standard, as both RSCA and EPD are negative. This third quadrant includes Indonesian cocoa in the years of 2003, 2007, 2013, 2018, 2019, 2020 and 2023. The clustering of observations in this quadrant toward the latter part of the study period is of particular importance. The observations show that in 2018, 2019, 2020 and 2023 Indonesia has a comparative advantage in the Netherlands, but also an unfavorable market dynamic. In particular, 2023 is the lowest RSCA position in the figure, which shows that Indonesia’s relative advantage had substantially deteriorated at the end of the period of observation. This pattern suggests that the competitive position of Indonesia was not automatically maintained and that the structural characteristics of the cocoa export sector may have constrained the ability to maintain market competitiveness.

The decline in the latter period is linked to the structural problems of the Indonesian cocoa industry, particularly the challenges related to productivity, quality and limited value capture from downstream activities. In addition to improvements in the quality of cocoa beans, including fermentation, also required to improve the competitiveness of cocoa in Indonesia is the strengthening of downstream processing industries (Fahmid et al., 2022). Their findings indicate that there are still opportunities for market development, but Indonesia’s comparative competitiveness in cocoa beans and processed cocoa lags well behind several rival producers. Thus, the Retreat-positions observed in the Netherlands should not be interpreted as a temporary decrease of exports, but as a sign of the need for a structural upgrading of the Indonesian cocoa value chain.

The overall distribution of observations reveals a clear shift from relatively favorable competitive positions in the earlier period toward less favorable positions in the later period. The period 2002–2010 includes several Rising Star observations, whereas after 2010 the observations increasingly appear in Lost Opportunity, Falling Star, and Retreat categories. In particular, the period from 2018 to 2023 is marked by negative RSCA positions, where 2018, 2019, 2020, and 2023 are classified as Retreat, and 2021–2022 as Lost Opportunity. This pattern indicates that the challenge for Indonesia in the Dutch market is not only the absence of market demand, as several years still show positive EPD, but also the difficulty of translating the opportunities in the market into sustained comparative advantage.

This finding provides an important basis to understand the role of cocoa downstreaming in strengthening Indonesia’s export competitiveness. Downstream processing of cocoa beans into processed products may improve the value captured in the domestic cocoa value chain but does not necessarily lead to upgrading. Van Huellen and Abubakar (2021) demonstrate that cocoa processing offers opportunities for functional upgrading in the Ghanaian cocoa sector, although these may be limited by the structure and concentration of global value chains. To summarize, processing capacity needs to be complemented with stronger technological capabilities, market access, and control over higher-value functions to increase the value added from cocoa exports.

The structure of the world cocoa trade is a good example of downstreaming. It is estimated that seven transnational traders’ control 62% of global cocoa export volumes, revealing a highly concentrated global cocoa trade system and uneven traceability and sustainability commitments across the supply chain (Parra-Paitan et al., 2023). This concentration may limit the ability of producing countries to capture more value and may increase the importance of technological, institutional, and traceability capabilities to access higher value international markets. The Netherlands’ fall in position on the map therefore indicates that Indonesia has to shift from a comparative

advantage based mainly on the availability of raw materials to value-added processing, quality upgrading, digital traceability, and supply-chain integration.

Overall, the Netherlands position map shows that Indonesian cocoa competitiveness is dynamic, market-specific, and not automatically maintained by comparative advantage. The presence of Rising Star positions in several past years indicates that Indonesia has the potential to achieve a favorable mix of comparative advantage and market growth. But the later move into Lost Opportunity, Falling Star, and especially Retreat indicates that these advantages have not consistently translated into continued market competitiveness. Thus, the results support the strategic importance of downstreaming as one of the strategies to improve Indonesia's cocoa export. Indonesia needs to move beyond just increasing the volume of cocoa exports and instead process more cocoa and move into higher-value cocoa products while also improving quality, traceability and sustainability performance. This direction is consistent with the direction taken by Fahmid et al. (2022) who acknowledge downstream processing and industrial development as important parts in strengthening Indonesian cocoa competitiveness in international markets.

Figure 6(b) presents the dynamic export position of Indonesian cocoa butter, fat and oil (HS 1804) in the Netherlands from 2000 to 2023 as a function of the interaction between Revealed Symmetric Comparative Advantage (RSCA) and Export Product Dynamics (EPD). The position map shows that the competitive position of Indonesian cocoa butter changed significantly over the period of observation, with observations falling into the Rising Star, Lost Opportunity, Falling Star and Retreat categories. The distribution shows that the Dutch market has not been a uniformly good competitive environment for Indonesian cocoa butter, despite the potential of the product as a higher-value derivative of cocoa beans. This result is in line with the general evidence that Indonesia's processed cocoa products have better export potential after the downstream processing policy of the country, but competitiveness depends on market conditions and product differentiation (Zikria et al., 2019).

The most favorable export position is the Rising Star quadrant, which has positive RSCA and positive EPD. In the Netherlands this number shows observations for 2000, 2006, 2007, 2009 and 2010 related to this quadrant. The periods indicate that Indonesian cocoa butter enjoyed comparative advantage and favorable export-market dynamics at the same time. The relatively high RSCA positions during 2006 and 2007, imply especially strong comparative advantage during these periods. However, the observations for 2009 and 2010 are positive, but are closer to the RSCA threshold.

The presence of several Rising Star observations is important because cocoa butter is a processed cocoa derivative, not a primary commodity. Thus, a favorable position for HS 1804 means that Indonesia has at times been able to turn its capacity to process cocoa into an internationally competitive export product. This interpretation is also supported by Zikria et al. (2019) who found that the export potential of Indonesia's processed cocoa products is higher than that of cocoa beans after the 2010 policy shift toward downstream processing. Their results also suggest that the policy reduced the share of expenditure on cocoa beans and increased the share of processed cocoa in world demand, indicating a structural shift toward higher value cocoa products.

This finding is also in accordance with the evidence from the Indonesian cocoa agro-industry that HS 1804 has continued to maintain comparative advantage in the international markets. One of the Indonesian cocoa products having a comparative advantage is cocoa butter, as stated by Dianawati et al. (2023). The product is at the commercial maturity stage, which means that the product has shifted from an emerging export activity to a more mature position in international trade.

The Lost Opportunity quadrant is a situation where EPD is positive, and RSCA is negative. In the figure, observations belonging to this quadrant are 2001, 2004, 2008 and 2012. This position suggests that the Dutch market had relatively good growth dynamics, but that Indonesia did not have a positive comparative advantage in cocoa butter at the same time. This implication is important in our interpretation of the export performance of Indonesia. A growing market does not necessarily mean that you are more competitive. Indonesia may have been exposed to increasing demand for cocoa butter but may have had limitations in capturing that demand versus competing suppliers. This can happen when exports are not growing fast enough to increase the relative specialization of the product, or when competitors are expanding faster.

This is especially important for processed cocoa. Competitiveness is not only determined by the availability of cocoa beans, but also by the efficiency of processing, quality of the product, its consistency, and the ability to meet the requirements of the buyer. Dianawati et al. (2023) mentioned that Indonesian cocoa products faced challenges in terms of quality, food safety, environmental standards, market access, and supply-chain efficiency.

The availability of downstream processing capacity does not guarantee sustained competitiveness in international markets.

The Falling Star quadrant combines negative RSCA with positive EPD and suggests that the product is experiencing relatively favorable market dynamics despite Indonesia's weak comparative advantage. The observations associated with this position in the figure are 2002, 2005, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 and 2023. Interestingly, most observations are concentrated in this category, especially in the later years. It means that although Indonesian cocoa butter was still available in the Dutch market, the market dynamics were not always in a coupling with the positive comparative advantage. This can be read as a market opportunity that has not yet been fully converted into structural competitiveness.

This pattern also points to the need to decouple the issue of the presence of exports from the issue of export competitiveness. Indonesian cocoa butter is not competitive with other exporting countries but can be a major processed export commodity. Recent evidence shows this with Indonesian cocoa derivative products such as cocoa butter and cocoa powder being very competitive in the major destination markets. But the level of competitiveness varies quite a lot across countries and products. RCA value for Indonesian cocoa butter is high in some major destination markets, indicating strong competitive potential of the product. The market performance is destination-dependent. The worst position is the Retreat quadrant where both RSCA and EPD are negative. In the figure some observations in this category are shown, especially in the second half of the observation period. This pattern is indicative of periods of weak relative specialization and adverse market dynamics of Indonesian cocoa butter in the Netherlands.

In particular, the increasing number of observations in the lower right part of the map is noteworthy. The observations show that Indonesian cocoa butter had to deal with both decreasing comparative advantage and negative market development. This pattern is more worrying than a temporary Falling Star position because it indicates that Indonesia was not only weak relative to competing exporters but also was operating in an unfavorable market environment.

The result indicates that downstreaming should be combined with a continuous process of upgrading technology and organization from a value chain perspective. Cocoa beans are processed into cocoa butter which is exported at a higher value. But for the cocoa processing industry to be competitive, it needs to improve the entire value chain. According to Dianawati et al., the Indonesian cocoa agro-industry can enhance its competitiveness through a good supply chain, market access, regulatory support, and stakeholder coordination. The position map shows that there is a potential for Indonesian cocoa butter to be competitive in the Netherlands, but this potential did not bring about a consistently good market position over the entire period 2000–2023. The presence of Rising Star observations indicates that Indonesia has the right combination of comparative advantage and positive growth in the market. The high number of observations for both Falling Star and Retreat in the later period suggests that HS 1804 was struggling more to compete.

This finding is very important especially for the downstream strategy of Indonesian cocoa. The evidence from Zikria et al. (2019) suggests that processed cocoa has more potential for export expansion than cocoa beans, which supports the strategic rationale for moving toward downstream products. However, the current EPD-RSCA results indicate that downstreaming per se may not be sufficient to ensure sustainable export competitiveness. The processed product must also have a comparative advantage, and respond to the specific growth dynamics of the destination market.

Therefore, the Netherlands is a market for Indonesian cocoa butter which has proven to have competitive potential, but this must be kept up with ongoing upgrades. Better processing technology, consistent product quality, supply chain efficiency and compliance with international technical and environmental requirements could help turn periods of market opportunity into more enduring Rising Star positions. This interpretation is in line with the global value-chain view of Indonesian cocoa, where competitiveness is not only determined by the processing activities, but also by the capability of domestic firms to effectively integrate into international production networks and meet the growing demands of the market (Dianawati et al., 2023).

Figure 7(a) shows the dynamic export position of Indonesian cocoa beans (HS 1801) in the Belgian market in 2000–2023 based on the interaction of Revealed Symmetric Comparative Advantage (RSCA) and Export Product Dynamics (EPD). The position map shows large swings in Indonesia's competitive position with the observations scattered across the Rising Star, Lost Opportunity and Retreat positions. Generally, the figure shows that Indonesia possessed relatively strong comparative advantage at different times in the early 2000s, but this advantage declined significantly in the subsequent years. The pattern is consistent with evidence that Indonesian cocoa has

enjoyed comparative advantage in European markets in the past, but that this has tended to diminish over time. For instance, Anggoro and Widyastutik (2016) found that the RCA value of Indonesian cocoa exports to European destinations was generally above one, but showed a downward trend, indicating that the existence of comparative advantage did not necessarily guaranty its persistence.



Figure 7. X-model of Indonesian cocoa export market development in Belgium, 2000–2023

The Rising Star quadrant is the best position to be in, with positive RSCA and positive EPD. This number places 2000, 2002, 2006, 2007, 2009 and 2010 in this quadrant in the Belgian market. Among these observations, 2002, 2006, and 2007 exhibit relatively high positive RSCA values, indicating a particularly strong comparative advantage in Indonesian cocoa beans. The observations for 2009 and 2010 remain positive but are considerably

closer to the zero line, suggesting that the strength of comparative advantage was already weakening toward the end of this favorable period. Thus, the early part of the observation period represents a period in which Indonesia was relatively successful in combining specialization in cocoa beans with favorable market development.

The Rising Star position is particularly important considering that Belgium is a major European hub for cocoa processing and chocolate production. Note that Belgium was a large exporter of chocolate and a large importer of cocoa beans at the same time. Cocoa beans are an important raw material to European processing industries. Their analysis also indicated that the relative competitiveness of Indonesia for cocoa beans was weaker than that of major producing countries, but there were opportunities in European markets. Hence, the Rising Star observations of Indonesia in Belgium point to periods in which its cocoa beans could tap on the demand created by Belgium's processing-oriented cocoa market.

2001, 2012, 2015, 2016 and 2022 form the Lost Opportunity quadrant. This position has a positive EPD but a negative RSCA. Thus, the Belgian market was still offering relatively attractive growth opportunities but Indonesia did not have a corresponding comparative advantage. The observations from 2015, 2016 and 2022 are of special interest because they combine relatively strong positive EPD with clearly negative RSCA. This implies that the problem was not so much the absence of market opportunities, but rather the inability of Indonesia's cocoa beans to translate those opportunities into a sufficiently strong relative competitive position.

This distinction is important because market growth and comparative advantage are not equivalent concepts. A product may be traded in a growing market while simultaneously losing relative competitiveness against competing suppliers. The Indonesian cocoa sector has faced precisely this type of challenge. Anggoro and Widyastutik (2016) found that Indonesian cocoa exports to Europe were affected by economic conditions, exchange rates, tariffs, and non-tariff barriers, while Indonesian cocoa competitiveness in European destinations tended to decline. Such restrictions may account for an inability to convert favorable market dynamics into improved comparative advantage.

The Retreat quadrant, where RSCA and EPD are negative, is the least desirable position. In this quadrant, we find 2003, 2004, 2008, 2011, 2018, and 2021 (see Figure). The results point to a low comparative advantage and discouraging market dynamics for Indonesian cocoa beans in Belgium. The subsequent observations, especially those from 2018 and 2021, are relevant because they suggest that the loss of competitiveness was not limited to the first part of the period but continued in the more recent years.

The Retreat position points to a problem of structural competitiveness and not just to a dip in export performance. Indonesia's cocoa sector has experienced problems related to productivity, quality and the structure of its export composition. A change in government policy on downstream processing has reduced incentives to export cocoa beans and has encouraged domestic processing. While this policy can increase value addition in the domestic front, it can simultaneously reduce the relative competitiveness and export presence of raw cocoa beans. Research on Indonesian cocoa competitiveness also shows that the downstreaming policy has been associated with a decrease in cocoa-bean exports and an increase in processed cocoa exports.

This point is particularly important for interpreting the negative RSCA values after 2010. RSCA for HS 1801 is declining, but that doesn't automatically mean that Indonesia's cocoa sector as a whole has failed. However, some of the decline might be a structural shift from exporting cocoa beans to processed cocoa products. This interpretation is supported by the German market evidence, where Indonesian cocoa beans had a weaker comparative advantage after the implementation of the export-duty policy, while processed cocoa products became more prominent. Thus, the declining competitiveness of HS 1801 may be partly due to downstreaming rather than only a decline in production capability.

However, the EPD results reveal that this structural transition constitutes a competitiveness challenge on markets where raw cocoa beans are still strongly demanded. The cluster of later observations in negative-RSCA positions suggests that Indonesia must ensure that adequate gains in higher-value processed products offset the decline in raw-bean exports. Thus, the loss of competitiveness in HS 1801 is economically significant only if it is not compensated by gains in competitiveness in HS 1804 and other processed cocoa products.

Figure 7(b) shows the dynamic export position of Indonesian cocoa butter, fat and oil (HS 1804) in the Belgian market from 2000 to 2023, considering the intersection of Revealed Symmetric Comparative Advantage (RSCA) and Export Product Dynamics (EPD). The distribution of observations in the position map shows that Indonesia's position in terms of competitiveness in cocoa butter has changed significantly over time. The earlier period shows a number of observations in the Rising Star quadrant, suggesting the simultaneous presence of competitive

advantage and a favorable market dynamic. However, the increasing number of observations with negative RSCA in the latter period indicates that Indonesia has had difficulties to maintain its relative competitive position in the Belgian market. This pattern suggests that the emergence of processed cocoa exports should not be seen only in terms of processing capacity, but also in relation to the organization and governance of the wider cocoa value chain.

The Rising Star observations, particularly those located in the upper-right area of the figure, indicate periods when Indonesian cocoa butter achieved both comparative advantage and favorable market dynamics. This is an important result because HS 1804 represents a processed cocoa product and therefore reflects a higher degree of value addition than cocoa beans. The existence of Rising Star positions demonstrates that Indonesia has been able to compete in a processed cocoa segment rather than relying exclusively on exports of primary cocoa commodities. Nevertheless, the subsequent movement away from this quadrant indicates that the competitive advantage was not automatically sustained.

One reason is that competitiveness of processed cocoa is dependent on coordination across the different stages of the value chain. Making cocoa butter is a combination of a good supply of quality cocoa beans, good processing, quality control, logistics and stable relationships with the buyers.” Awafo and Owusu (2022) in their study on the cocoa value chain, reveal that processing is one of the links in a broader chain of production, post-harvest handling, certification, marketing and industrial activities and significant resources are needed in all these areas. They find that “positive changes in one part of the cocoa chain are not able to offset inefficiencies elsewhere in the system.

The Lost Opportunity observations are especially relevant because they indicate that there were periods of favorable market development in Indonesia which were not translated into corresponding comparative advantage. This pattern suggests that there were opportunities for the expansion of cocoa butter exports in the Belgian market but Indonesian exporters were not always able to take advantage of such opportunities in relation to competing suppliers. This means that market attractiveness is not enough to generate sustained competitiveness. Product quality, supply reliability, buyer relationships and ability to meet destination-market requirements can determine if an expanding market translates into greater export specialization.

This interpretation is consistent with Codjoe et al. (2023), who show that cocoa value chains are characterized by differences in bargaining power between upstream and downstream actors. Their study finds that direct connections with external buyers are not sufficient by themselves to create bargaining power; strong internal governance, cooperative leadership, and sustained engagement with buyers are also required. For Indonesian cocoa butter, this suggests that improving export competitiveness requires stronger organizational and commercial linkages rather than relying exclusively on domestic processing capacity.

Also important are those observations that are in the negative-RSCA region later period. The positions suggest that Indonesia's relative specialization in cocoa butter exports decreased over time. This should not be taken as evidence that downstream processing was unsuccessful. Instead, it suggests a distinction between structural downstreaming and long-term downstream competitiveness. Indonesia may be processing more cocoa beans and exporting more cocoa butter, while losing relative competitiveness in a specific destination market. As such, an increase in processed exports should not automatically be seen as a sign of successful export upgrading.

Another explanation for this pattern is the governance of European-linked cocoa value chains. Ingram et al. (2018) argue that cocoa value chains linked to European markets are increasingly governed by mechanisms that consider ecosystem services, such as certification, market-based mechanisms, multi-actor platforms and public regulation. These mechanisms mean that exporters competing in European markets increasingly work within a system where environmental and sustainability attributes may shape relationships among producers, processors, traders and buyers. Therefore, Indonesian cocoa butter must compete not only on price and processing ability but also on the broader sustainability attributes of its supply chain.

This is especially the case for the interpretation of the weaker positions at the end of the observation period. Sustainability is changing the way European cocoa is governed, from cocoa bean processing to the origin and conditions of cocoa cultivation. For example Busquet et al (2021) show that social issues in cocoa production are not just at farm level but are embedded within the wider global value chain. They emphasize the multi-dimensionality of cocoa value chains and the need to take into consideration relationships between upstream producers and downstream market actors.

The Retreat-type observations, characterized by negative RSCA and negative EPD, therefore are the most difficult periods for Indonesian cocoa butter in Belgium. These observations indicate that Indonesia suffered from a weak

comparative advantage and unfavorable market dynamics. From an export strategy perspective, such a position implies that simply holding on to market presence may not be enough. Indonesian exporters should work on product differentiation, processing efficiency, quality consistency, and supply chain coordination to prevent temporary market weaknesses from becoming permanent competitive disadvantages.

The combination of Rising Star and negative-RSCA positions also indicates that market and time specificity is the competitiveness of Indonesian cocoa butter. Indonesia has proven that it can compete in the Belgian market, but it has not been able to sustain this advantage. This underscores the necessity of a dynamic assessment of competitiveness rather than a static comparative-advantage measure. Therefore, EPD component is very important in this study because it shows that Indonesia's comparative advantage is accompanied by good market growth.

The results can be better understood from the perspective of downstream cocoa processing in the Indonesian strategy. Cocoa butter is worth more than cocoa beans. Selling only processed exports will not magically make you more competitive internationally. Providing value through integration of upstream supply, organisational governance, buyer relationships and sustainability requirements. Organisational governance and direct engagement with buyers are also important in strengthening the bargaining power of cocoa value chain actors as pointed out by Codjoe et al. (2023). More and more, Europe needs governance mechanisms for sustainable commodity chains (Ingram et al., 2018).

Therefore, the Belgium–HS 1804 results suggest that Indonesian downstreaming should evolve from processing-oriented downstreaming toward value-chain-oriented upgrading. Processing cocoa beans into cocoa butter is an important step, but sustaining competitiveness requires improvements in the entire chain, including raw-material quality, processing efficiency, market coordination, certification, traceability, and relationships with international buyers. The sustainability dimension is particularly relevant because European-linked cocoa chains increasingly incorporate governance mechanisms that extend beyond the conventional price and volume dimensions of international trade.

To summarize, the figure indicates that the competitive potential of Indonesian cocoa butter in Belgium has been proven, but has not been consistently maintained over the 2000–2023 period. Early Rising Star observations are linked to successful specialization and market expansion periods, while negative-RSCA later positions are linked to mounting competitive pressure. The finding suggests that Indonesia's downstreaming strategy has created an important platform of value addition, but that more needs to be done to translate processing capacity into sustained competitiveness in destination markets.

The result also provides an important basis for interpreting the Downstreaming Index (DI). If the DI increases over time while the RSCA–EPD position of HS 1804 weakens, this would indicate that Indonesia has achieved structural downstreaming without fully achieving sustained market competitiveness. Conversely, if a higher DI is accompanied by persistent positive RSCA and favorable EPD positions, the evidence would be stronger that downstreaming has contributed to genuine export upgrading. Thus, the DI and RSCA–EPD results should be interpreted jointly rather than independently.

Figure 8(a) shows the dynamic export position of Indonesian cocoa beans (HS 1801) in the French market (2000–2023) based on the interplay of Revealed Symmetric Comparative Advantage (RSCA) and Export Product Dynamics (EPD). The position map shows a relatively weak and unstable competitive position, compared to the more favorable positions found in some of the periods in other European markets. There are a few observations in the Rising Star quadrant, but the concentration is higher in the negative-RSCA region. This pattern shows that Indonesian cocoa beans have quite a challenge to maintain comparative advantage in France, especially in the latter period of observation. This is in line with evidence that there are structural constraints in Indonesia's cocoa sector on productivity, output prices, input costs and production efficiency that impact its sustainability of competitiveness in international markets (Fahmid et al., 2018). The most favorable position is the Rising Star, which combines positive RSCA with positive EPD. In the French market, there are few observations in this quadrant, especially in 2001 and 2005. The low number of observations for Rising Star indicates that Indonesia was only able to combine comparative advantage and strong market growth in France at the same time on rare occasions.

The early Rising Star positions show that Indonesia was able to compete in the French cocoa-bean market under specific market conditions. But the lack of persistence for this position suggests that the advantage is not structurally strong. The interpretation is in line with the findings of Fahmid et al. (2018) that Indonesian cocoa farming has a competitive advantage at the farm level, but it has weaknesses in comparative efficiency, productivity, output prices, and input costs. They see improvements in productivity and price as important requirements to strengthen the competitiveness of Indonesian cocoa.

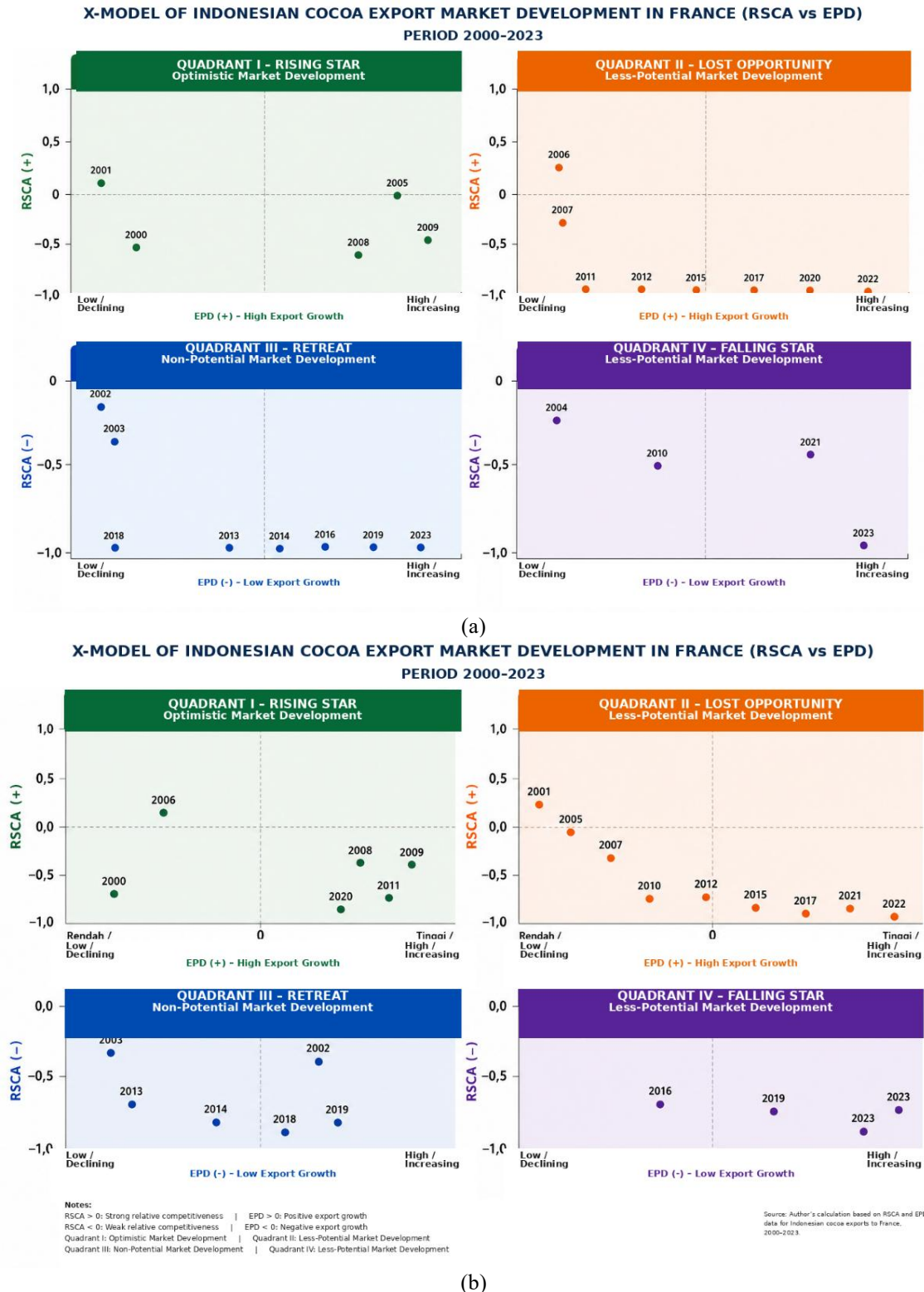


Figure 8. X-model of Indonesian cocoa export market development in France, 2000–2023

The result suggests that the early favorable market positions of Indonesia in France must be viewed as episodic competitiveness, not sustained competitive advantage. That is, the Indonesian cocoa sector managed to benefit in some years from market conditions that proved to be advantageous but not to establish a persistent position in the French market. There are a large number of observations in the Lost Opportunity quadrant, with positive EPD and negative RSCA. The figure in this region has observations like 2006, 2007, 2011, 2012, 2015, 2016 and 2022. This condition indicates that the French market had good development, but Indonesia was not in a more advantageous position in cocoa beans during the same period. This is an important finding as it shows that the

weakness of Indonesian cocoa in France cannot be simply explained by the lack of market opportunities. “There were still growth periods in the market, but Indonesia was not competitive enough to take advantage of it. The difference between EPD and RSCA implies that market attractiveness and export competitiveness were not in line.

An alternative is the integration of Indonesian cocoa into international price and market mechanisms. Izaati et al. (2020) demonstrated that the prices of Indonesian cocoa-beans were integrated with some international markets in the long run, but there was limited price transmission with some importing markets. Such differences in price transmission may cause difficulties for Indonesian cocoa exporters to fully transmit international market conditions into domestic export prices and incentives.

This provides a useful interpretation of the observations of Lost Opportunity. Even if the French demand conditions had been favorable, Indonesian exporters might not have been able to respond competitively to them due to differences in price transmission, production costs, exchange rate conditions, or supply-side constraints. The Retreat quadrant is in the most negative position as both RSCA and EPD are negative. There are relatively many observations in this region in the figure, such as 2002, 2003, 2013, 2014, 2018, 2019, 2023, etc. The concentration of observations in the lower region of the map is especially striking because it shows that the negative comparative advantage was not a short-term phenomenon.

The latter findings are especially disturbing. A number of points for the post-2010 period are close to the lower edge of the RSCA axis, which means a significant drop in Indonesia’s relative specialization in cocoa beans. The position of 2023 is still very negative, which means that Indonesia had not regained its comparative advantage in the French cocoa-bean market at the end of the observation period. The persistence of negative positions is in line with the broader structural problems of Indonesian cocoa production. Fahmid et al. (2018) found that cocoa productivity in Indonesia was relatively low and the costs of production, particularly those related to labor and land, represented important components of the production structure. They analyzed that to increase the competitiveness of Indonesian cocoa, productivity improvement, better output prices and more efficient input management are needed.

Thus, the Retreat positions in France can be interpreted as evidence that the competitiveness problem extends beyond export-market conditions. Indonesia’s ability to compete in the French market is also linked to the underlying efficiency and productivity of its domestic cocoa production system. The lower-right observations in the figure, including points around 2004, 2010, 2021, and 2023, require particular attention. Based on the mathematical definition of the RSCA–EPD framework, observations with negative RSCA and negative EPD correspond to the Retreat position, rather than Falling Star. A Falling Star position should have positive RSCA and negative EPD.

This distinction matters because the lower-right observations indicate that Indonesian cocoa beans experienced both weak comparative advantage and unfavorable market dynamics. Therefore, they represent periods in which Indonesia was not only relatively less specialized but was also operating in a less favorable market environment. The increasing appearance of such negative positions toward the end of the period reinforces the conclusion that the French market has become increasingly challenging for Indonesian cocoa beans. This pattern contrasts with the earlier Rising Star observations and suggests a gradual deterioration in the competitive position of the raw cocoa-bean export segment.

Overall, the France–HS 1801 position map shows a predominantly weak and unstable competitive trajectory for Indonesian cocoa beans during 2000–2023. Unlike a market characterized by persistent Rising Star positions, France shows only limited periods in which Indonesia simultaneously achieved comparative advantage and favorable market development. A much larger proportion of observations is associated with negative RSCA, particularly after 2010. These results confirm recent evidence in terms of cocoa competitiveness in Indonesia. The EPD and other indicators of competitiveness of Indonesia’s cocoa export performance are influenced by productivity, price, exchange rates, destination-country GDP, and comparative competitiveness (Setiawan et al., 2025). They demonstrate that the impact of such factors may be different in the short and long run, as cocoa markets are subject to volatility and structural constraints. The French case thus points to a problem which is not only one of market access. Instead, Indonesia needs to improve the basic competitiveness of its cocoa supply, including productivity, quality, pricing and responsiveness to the demand of destination markets. The interpretation is particularly important, as France is a major European market for the consumption and processing of chocolate. Thus for Indonesian cocoa to continue to have access to this market, it must be able to compete not only in terms of availability, but also in terms of quality and consistency.

Figure 8(b) shows the dynamic export position of Indonesian cocoa butter, fat, and oil (HS 1804) in the French market during 2000-2023 from RSCA and EPD. Figure shows that the competitive position of Indonesian cocoa butter is relatively unstable with few observations located in the favorable Rising Star area, and most observations are located in the negative RSCA positions. Early observations (notably 2006) suggest a relatively good combination of comparative advantage and market development while several later observations are placed well below the RSCA threshold. This pattern shows that Indonesia has been able to compete in the French processed-cocoa market, but this has not been sustained consistently. The evidence also shows that cocoa butter is one of the stronger products of cocoa derivatives in Indonesia, but its competitiveness varies in the market (Nurwansyah et al., 2023).

The distribution of observations in the Lost Opportunity and Retreat areas is of particular interest. Negative RSCA over several years such as 2001, 2005, 2007, 2010, 2012, 2015, 2017, 2021 and 2022 suggest that market opportunities in France were not always translated into comparative advantage despite relatively favorable EPD positions. Data for 2013, 2014, 2018, 2019 and 2023 point, in parallel, to a less favorable position when the negative comparative advantage is combined with unfavorable market dynamics. This divergence between comparative advantage and market development is in line with the research on Indonesian processed cocoa, which suggests that products of processed cocoa can maintain comparative advantage and at the same time have less favorable EPD positions. This implies that structural competitiveness does not necessarily translate into market growth (Yemima & Novianti, 2020).

The downward trend of HS 1804 in the second period also indicates that downstream processing alone cannot guarantee sustained competitiveness. The competitiveness of cocoa butter still depends on the availability and quality of cocoa beans as processing inputs and the efficiency of the downstream industry. Research on the export of Indonesian cocoa butter shows that upstream factors, namely the supply of cocoa beans, are important for the development of cocoa butter exports. The competitiveness downstream cannot be separated from the performance of the upstream cocoa sector (Hermawan, 2019). This is especially true in France, where cocoa is a major industrial input: France imported some 439 000 tons of cocoa per year on average between 2012 and 2021, of which some 15 percent of its cocoa imports was cocoa butter.

Overall, the results from France-HS 1804 suggest that Indonesian cocoa butter has export potential but has not been a consistently strong competitive position in 2000–2023. The limited observations on the Rising Star suggest that Indonesia has the potential to achieve favorable competitiveness under certain market conditions, but the dominance of negative RSCA positions in later years indicates the need for stronger product quality, processing efficiency, supply-chain integration and market adaptation. This result strengthens the argument for examining the Downstreaming Index: a rising proportion of cocoa butter exports would indicate structural downstreaming, but its combination with weak RSCA–EPD performance would suggest that downstreaming has not yet been fully translated into durable competitiveness in the French market.

The dynamic export position of Indonesian cocoa beans (HS 1801) in the German market in 2000-2023 based on the interaction between RSCA and EPD is presented in Figure 9(a). The results show a relatively strong competitive position in the early period, where 2000, 2009, 2010 and 2006 are located in the Rising Star quadrant. Positive RSCA values during 2000, 2009 and 2010, in particular, indicate that Indonesian cocoa beans had comparative advantage, while enjoying favorable market dynamics. But later the situation tilted toward negative RSCA which means that the initial competitive advantage was not sustained through the observation period.

In the Lost Opportunity quadrant there are several observations, such as 2001, 2002, 2004, 2007 and 2015, that indicate a period when the German market was relatively favorable in terms of dynamics, while Indonesia's comparative advantage was already declining. It implies that Indonesia did not fully exploit market opportunities although Germany is a major European destination for cocoa products. Recent research that specifically examines the German market finds that Indonesian cocoa competitiveness is affected by international cocoa prices and export-duty policy, while processed cocoa products have shown significant competitive potential in the market (Udayana & Setiawina, 2023). However, the Retreat positions show times with weak comparative advantage and unfavorable market development at the same time, especially during the 2011–2016. The clustering of negative RSCA values in the later period shows that raw cocoa bean competitiveness in Germany became more and more vulnerable. This pattern can be partly linked to the structural change of Indonesia from raw-bean exports into processed cocoa after the implementation of the downstreaming-oriented export policies. Indonesia's exports of cocoa beans declined after the 2010 policy change, but its processed cocoa exports increased, suggesting a structural shift to higher-value products (Zikria et al., 2019). On the supply side, productivity, output prices, and input cost are also important determinants of Indonesian cocoa competitiveness, which are still important determinants of the sector's international competitiveness (Fahmid et al., 2018).

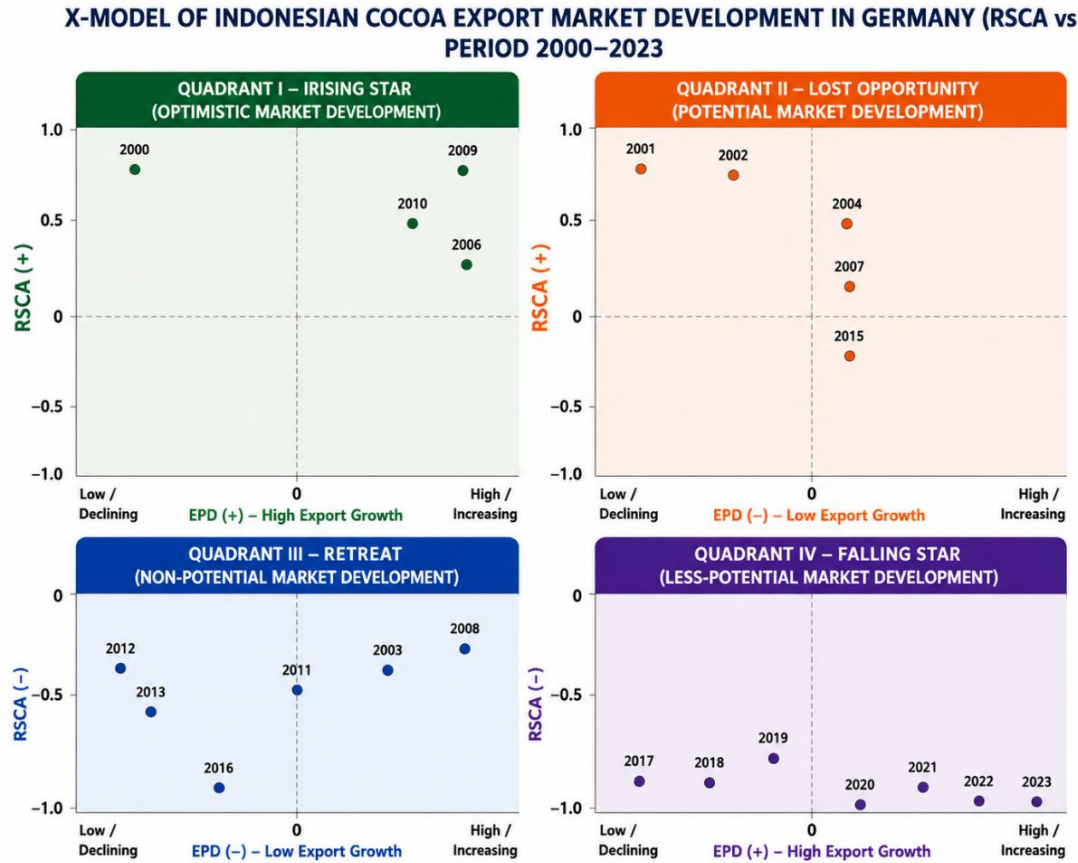
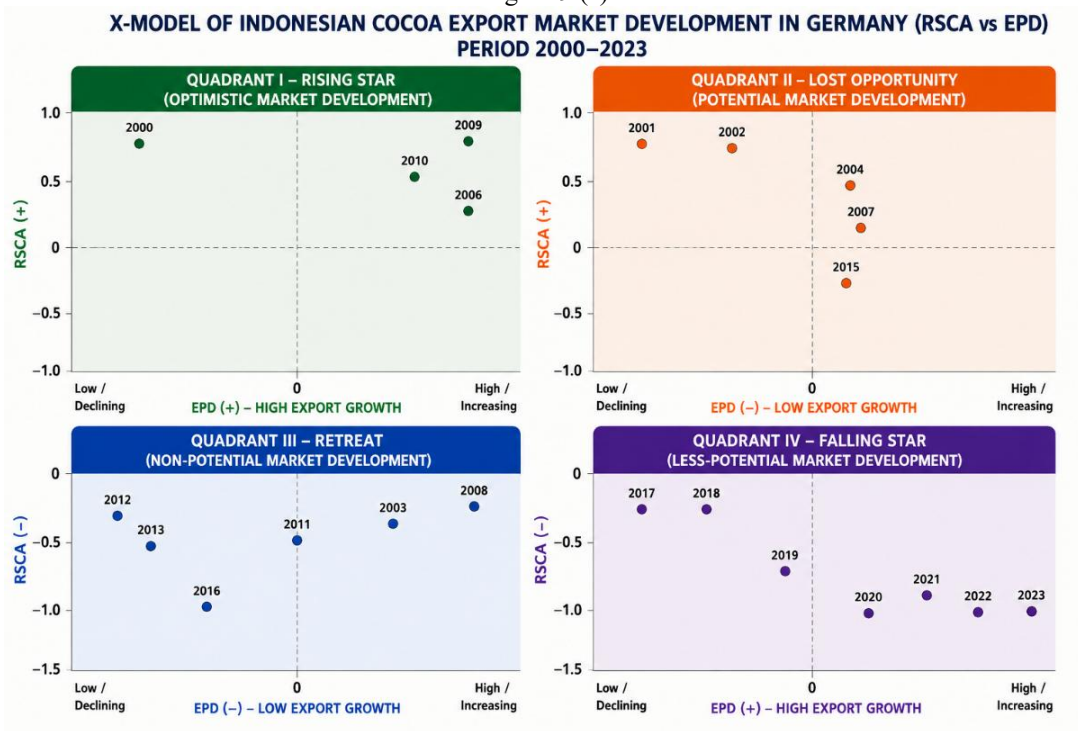


Figure 9 (a).



(b)

Figure 9 (b) X-model of Indonesian cocoa export market development based on RSCA and EPD in Germany, 2000–2023

Overall, the Germany–HS 1801 results indicate that Indonesia's cocoa beans have experienced a transition from relatively favorable competitiveness toward a weaker and more unstable market position. The persistence of negative RSCA in the later period suggests that maintaining competitiveness through raw-bean exports alone may

be increasingly difficult. This provides an important rationale for examining HS 1804 and the Downstreaming Index: if processed cocoa demonstrates stronger competitiveness than HS 1801, the decline in raw-bean competitiveness can be interpreted as part of Indonesia's export upgrading process rather than simply a deterioration of the cocoa sector. However, the transition needs to be supported by improvements in productivity and the quality of domestic cocoa supply.

Figure 9(b) depicts the dynamic export position of Indonesian cocoa butter (HS 1804) in the German market in 2000–2023. The result showed that Indonesian cocoa butter had strong competitive position in the early period with 2000, 2006, 2009 and 2010 located in Rising Star quadrant. These observations suggest that Indonesia managed to combine a positive comparative advantage with a favorable market development. However, the later clustering of observations in negative-RSCA positions indicates that this advantage became less stable over time.

The positions of Lost Opportunity observed in 2001, 2002, 2004, 2007 and 2015 suggest that favorable market dynamics were not always matched with comparative advantage. But, the lower-quadrant observations after 2010 show a more persistent weakening of Indonesia's relative position. This pattern is interesting because after the abolishment of export duties, Tupamahu and Apituley (2022) found that cocoa butter was still one of the Indonesian cocoa products with high comparative advantage, though the competitiveness of cocoa beans and some other derivatives declined. Thus the weaker RSCA–EPD position found specifically for Germany may reflect destination-market differences rather than a general loss of competitiveness in Indonesian cocoa butter.

The negative positions indicate that competitive advantage does not always result in good market dynamics. Syarif et al. (2022) stated that Indonesian processed cocoa has a comparative advantage and competitive advantage, but the position in the market is very different between the destination countries. Moreover, the quality of cocoa beans, especially low fermentation, was identified as one of the important barriers to the competitiveness of processed cocoa in Indonesia. This explains a likely reason for the change in the position of HS 1804 in Germany. Downstream processing can add value but export performance is still dependent on stable quality of raw materials and the ability to meet destination market requirements. Map Position Germany HS 1804 shows that Indonesian cocoa butter has large competitive potential but has not been able to maintain a sustainable market position in the period 2000-2023. The early Rising Star periods show Indonesia's success in competing in this processed segment, and the later negative-RSCA positions indicate rising competitive pressure. Therefore, Indonesia's downstreaming strategy must be supported by increasing the quality of raw materials, processing efficiency, product differentiation and market adaptation to specific destinations. The result also confirms the importance of the comparison between HS 1804 and HS 1801: if cocoa butter still remains more competitive than cocoa beans, the change toward processed exports can be considered as a feature of export upgrading, although the competitiveness of HS 1804 remains market-specific.

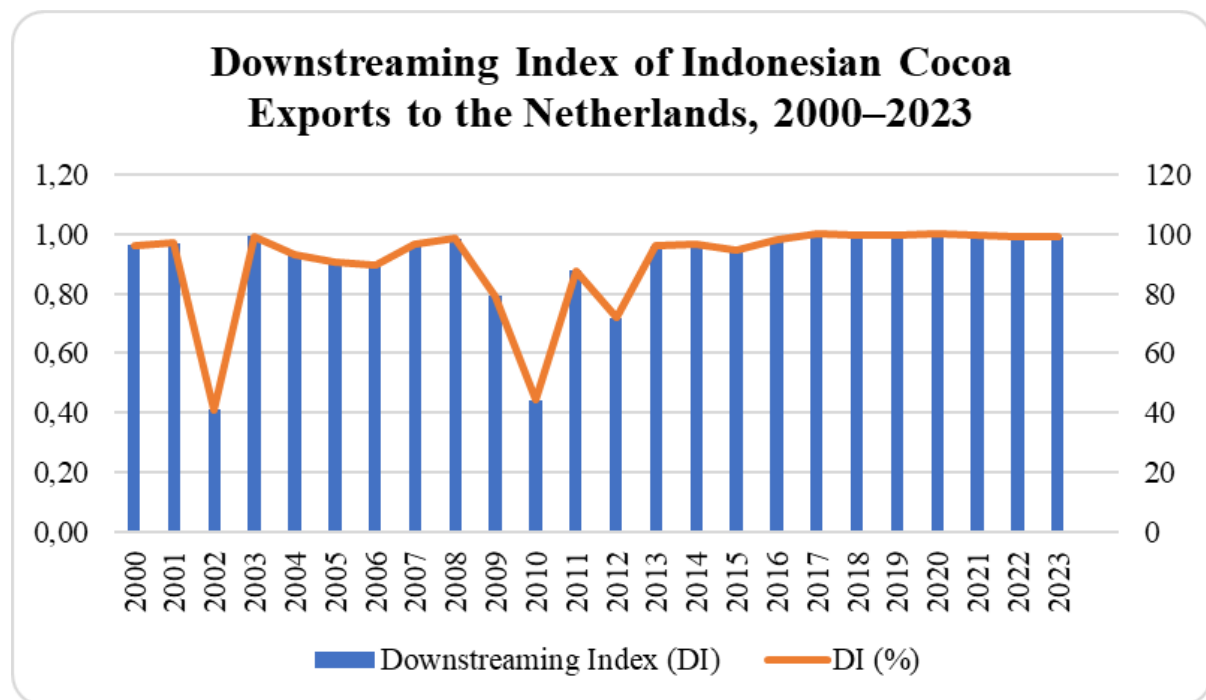


Figure 10. Downstreaming index of Indonesian cocoa exports to the Netherlands, 2000-2023

In analyzing export competitiveness, it is not only about Indonesia's ability to maintain its position in the international market, but also about the extent to which the export structure has shifted to higher value-added products. An important indicator of successful downstreaming is an increasing share of processed cocoa products in the cocoa sector. This can reduce dependence on cocoa bean exports and increase the economic value generated from exported cocoa. Therefore, the development of Indonesia's cocoa export orientation toward processed and higher value-added products, especially in the Netherlands market is reflected in the Downstreaming Index (DI). The higher the DI, the higher the orientation to processed cocoa products and the higher the value addition in the export structure.

Figure 10 shows the development of the Downstreaming Index (DI) of Indonesian cocoa exports to the Netherlands in 2000–2023. In general, the DI stayed quite high during the whole observation period, but there were some remarkable fluctuations in the early and mid-part. The DI is relatively high at the beginning of the period, at around 0.95 in 2000–2001 and declines sharply to around 0.40 in 2002. The index then rebounded sharply in 2003, reaching close to 1.00, and remained relatively stable around 0.90–1.00 in the years that followed.

Between 2009 and 2012, there was another significant fluctuation period. The DI declined from around 0.98 in 2008 to around 0.77 in 2009 and a low of around 0.43 in 2010. The index then recovered in 2011 before falling back to around 0.71 in 2012. These fluctuations suggest that the downstream orientation of Indonesian cocoa exports to the Netherlands did not develop in a fully linear way. Changes in the DI may reflect changes in the composition of exported cocoa products, in particular the relative contribution of primary cocoa products and processed cocoa products.

From 2013 onward, the DI rebounded substantially and remained high, mostly between 0.95 and 1.00. Most importantly, the index stayed very close to 1.00 between 2017 and 2023, suggesting a high degree of stability. The pattern suggests a strong and continued downstream orientation of Indonesia's cocoa exports to the Netherlands. The DI, which is increasingly stable and high, shows that Indonesian cocoa exports are increasingly characterized by processed or value-added cocoa products, rather than being dominated by primary cocoa commodities exclusively.

Overall, the DI trend during 2000–2023 indicates that, despite several periods of decline, the long-term direction points toward stronger downstreaming of Indonesian cocoa exports. The sustained DI values close to 1.00 during 2017–2023 are particularly important, as they suggest that Indonesia has strengthened its orientation toward exporting cocoa products with higher levels of processing and value addition to the Netherlands. This finding complements the export competitiveness analysis by demonstrating that Indonesia's competitiveness is not only associated with its ability to maintain market performance, but also with its capacity to transform the export structure toward higher value-added cocoa products.

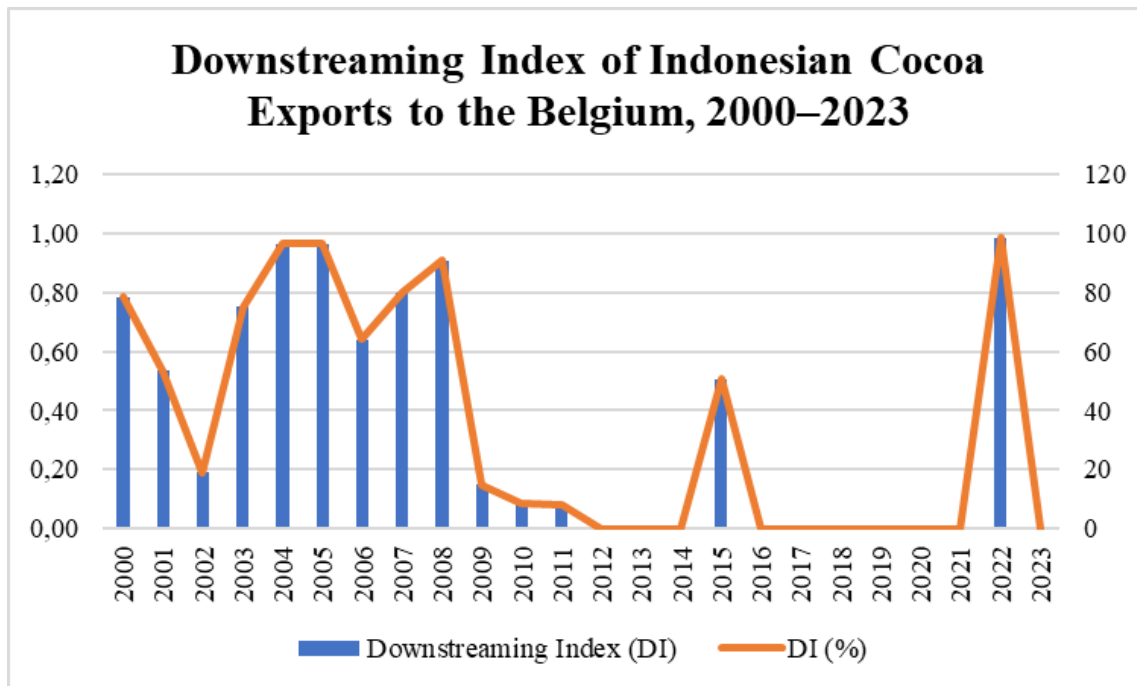


Figure 11. Downstreaming index of Indonesian cocoa exports to the Belgium, 2000-2023

The pattern of the Downstreaming Index (DI) of Indonesian cocoa exports to Belgium for the period 2000-2023 is very fluctuating compared to the Netherlands. The DI was quite high in the first period (around 0.80 in 2000) and then fell to around 0.20 in 2002. Then the index rose to about 0.95 in 2003-2005, indicating a greater orientation toward downstream or value-added cocoa products. But the DI fell again to around 0.65 in 2006, and then rose to 0.80-0.90 in 2007-2008. A big drop then, after 2008. The DI fell to a very low 0.15 in 2009 and remained at a very low level in 2010-2011. The DI was close to zero in the period 2012-2014, which implies that the downstreaming orientation measured by the index was very weak in this period. The DI temporarily recovered to around 0.50 in 2015, but this recovery was not sustained, and the index returned to almost zero in the period 2016-2021. In 2022, the DI rose significantly, but this was a transient effect. It leaped to near 1.00, the strongest downstream position seen in the period. But the spike was short-lived, and by 2023 the index was back to about nothing. The downstreaming pattern is rather stable and high in the Netherlands, but volatile and discontinuous in Belgium. The results of the study show that for a long time the structure of Indonesia's cocoa exports to Belgium has not been strongly downstream oriented. There are several periods with high DI values, especially 2003-2005, 2007-2008 and 2022. But these gains were short-lived with large declines thereafter. The long periods of very low or zero DI indicate that the downstream performance of Indonesian cocoa exports to Belgium is still erratic. This finding suggests that the Belgian market may need to improve its diversification of value-added products, stable supply of processed cocoa products and market penetration strategies to be able to successfully sustain the downstreaming gains over time.

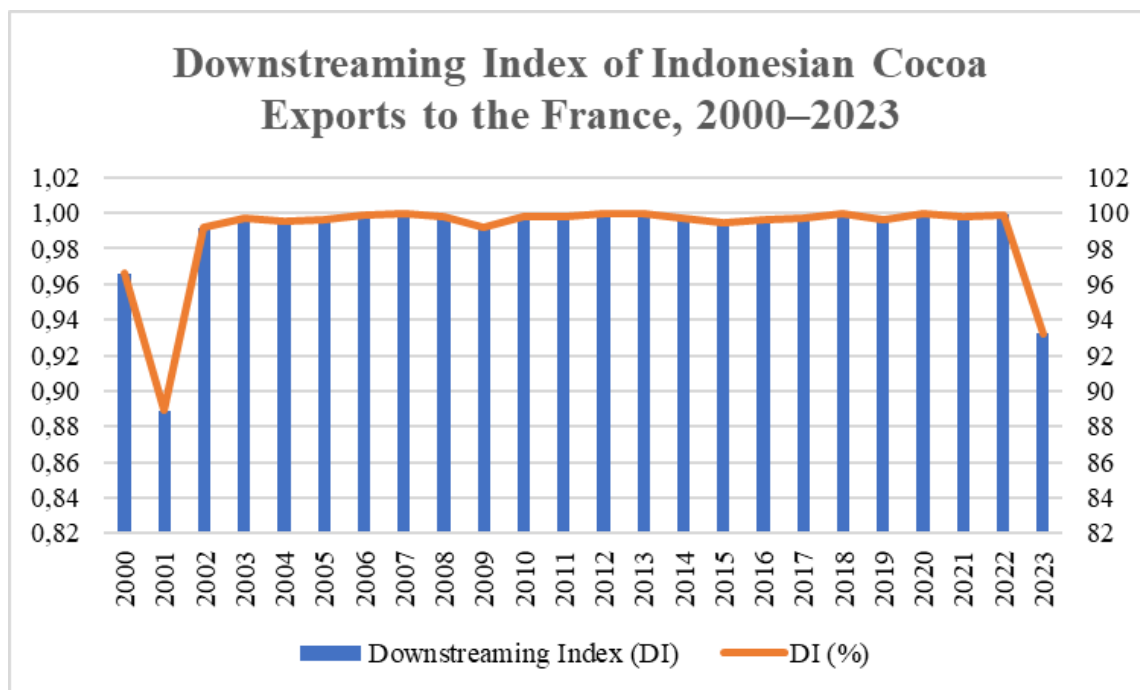


Figure 12. Downstreaming index of Indonesian cocoa exports to the France, 2000-2023

The Downstreaming Index (DI) of Indonesian cocoa exports to France in the period 2000-2023 is very high and stable and has a downstream orientation compared to Belgium. The DI was already very high in 2000 at about .97 and declined to about .2001: 89. There was a small dip (DI around 0.99) before a sharp rebound in 2002. The index from 2002 to 2022 was around 1.00, which means that the tendency of Indonesian cocoa exports toward downstream or added-value products in the French market is quite stable. During this period, there are some minor fluctuations, notably in 2009, 2015-2016, and 2018. These are, however, very small changes and do not alter the overall pattern. The overall DI was 0.98-1.00, which indicates that the composition of Indonesian cocoa exports to France tended to be relatively stable and biased toward processed or value-added cocoa products. The most significant change occurred in 2023, when DI fell to about 0.93. The index was still very high, but down from near-maximum levels seen earlier. Of all the markets studied so far, the French market shows the most marked and regular downstreaming pattern. For the last twenty years, the DI values of Indonesia have been stable at around 1.00 which indicates the success of Indonesia in maintaining a highly downstream-oriented structure of cocoa exports in France. The stability indicates that the French market is a quite well established destination of value added cocoa products from Indonesia. However, the French market should give a more solid basis for the Indonesian strategy in terms of the exports of value added products and development of downstream industries. In 2023 there has been a fall which must be watched to see if it is a transitory variation or the beginning of a structural change in the composition of exports.

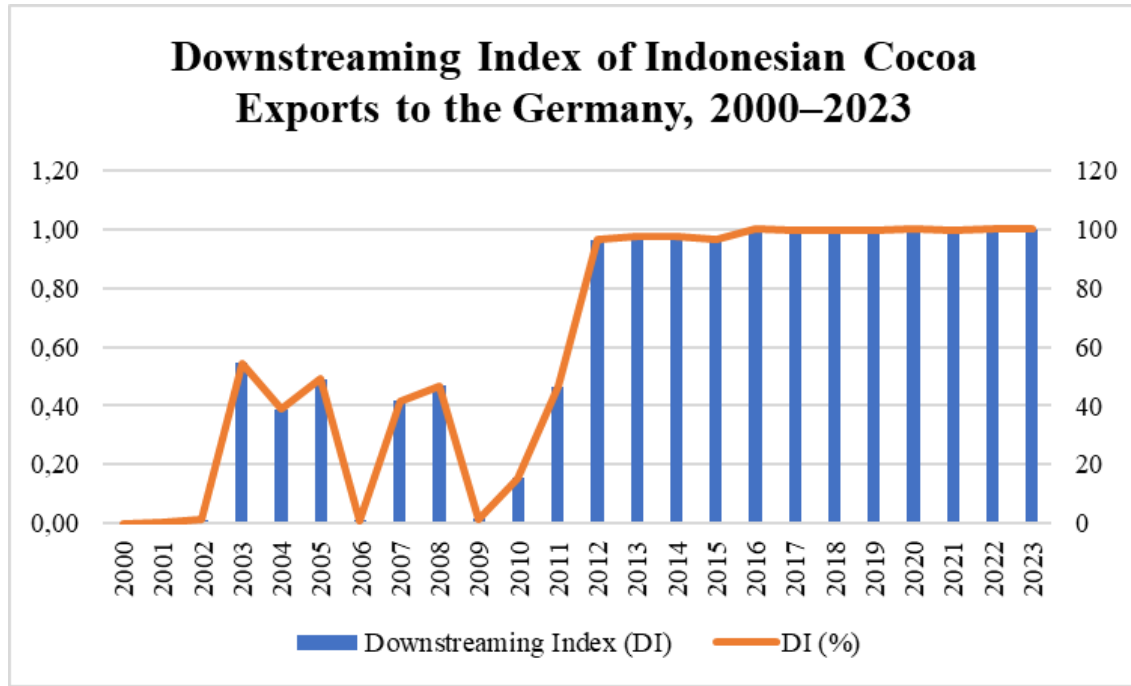


Figure 13. Downstreaming index of Indonesian cocoa exports to the Germany, 2000-2023

The Downstreaming Index (DI) of Indonesian cocoa exports to Germany over the period 2000–2023 clearly shows a shift from a very volatile downstreaming pattern in the early period to a consistently high and stable level after 2012. The DI was close to zero during 2000–2002, showing that Indonesia’s cocoa exports to Germany were very little downstream oriented. The index rose substantially in 2003 to approximately 0.55, but declined to approximately 0.40 in 2004 and rose again to approximately 0.50 in 2005. 2006–2011 saw continued considerable volatility. The DI dropped to near zero in 2006, bounced back to around 0.40–0.45 during 2007–2008 and then dropped again to near zero in 2009. The index recovered gradually in 2010–2011 and then increased sharply to about 0.95 in 2012. The sharp structural change indicates a significant turning point in the downstreaming performance of Indonesian cocoa exports to Germany. Between 2012 and 2023, the DI was consistently high, often between 0.95 and 1.00 with very small fluctuations. In particular, from 2016 the index was almost constantly around or very close to 1.00. This shows that the orientation of Indonesian cocoa exports to Germany strongly to processed and value-added cocoa products. The downstream structure is maintained for a long time. In general, the data suggest a strong structural shift in the German market toward downstream orientation in Indonesian cocoa exports. This period after 2012 is characterized by a persistent DI close to 1.00 unlike the highly volatile pattern during 2000–2011. Thus, Indonesia has shifted its positioning in Germany from primarily a supplier of primary cocoa commodities to a provider of value-added cocoa products. The continued high DI also suggests that the downstreaming process in the German market is relatively well established and can be an important foundation for improving Indonesia’s export competitiveness through higher value cocoa products.

Conclusion

The study found that there has been a structural shift in the Indonesia cocoa export competitiveness from the export of raw cocoa beans to the export of higher value added processed cocoa products. The analysis of the RSCA shows that processed cocoa products, in particular cocoa butter (HS 1804), have continued to have stronger comparative advantages than cocoa beans (HS 1801) in the main European markets. The results underscore the increasing importance of downstream industrialization, technology upgrades, and value-added processing as drivers of Indonesia’s competitiveness in the global cocoa trade.

The analysis of EPD shows that the dynamics of Indonesian cocoa exports are different among destination markets. Cocoa bean markets in the Netherlands and France are Rising Star markets, while Belgium and Germany are Falling Star markets. Meanwhile, the Netherlands and Germany are identified as the Rising Star markets for cocoa butter products, Belgium as a Falling Star, and France as a Lost Opportunity. The results show that processed cocoa products tend to perform better in the market and have more favorable growth dynamics than raw cocoa exports.

The results also show the growing importance of sustainability standards, digital traceability systems and supply chain efficiency for export competitiveness. Demand for environmentally sustainable production systems, transparent supply chains and technology-based monitoring mechanisms is being driven by the adoption of international regulations such as the European Union Deforestation Regulation (EUDR). This implies that competitiveness in the global cocoa industry is no longer solely a matter of volume of production but increasingly of technological capacities, efficiency of processing, compliance with sustainability standards and participation in higher stages of global value chains.

Overall, this study confirms that cocoa downstreaming and digital transformation contribute positively to strengthening Indonesia's position in the global sustainable economy. The transition toward processed cocoa exports provides greater opportunities for value creation, market expansion, and long-term competitiveness in international markets.

Recommendations

The government and industry players need to keep speeding up policies on cocoa downstream industrialization by expanding the capacity of domestic processing and encouraging increased production of value-added cocoa products to bolster Indonesia's position in the global cocoa market. The switch from exporting raw cocoa beans to exporting processed cocoa products is more powerful in building up comparative advantages and in generating better market dynamics, especially in the major European markets. Therefore, strengthening the downstream sector is important to increase export value, improve industrial competitiveness, and reduce reliance on primary commodity exports. In addition, technological innovation and digital transformation should be a top priority for the cocoa industry in Indonesia. Advanced processing techniques, digital traceability systems, quality assurance systems, and integrated supply chain management are increasingly important in meeting the requirements of international markets. These technological improvements may enhance the production efficiency, product consistency, and transparency of the cocoa value chain, and thereby increase the competitiveness of Indonesian cocoa products in global markets. Indonesia needs to develop governance of sustainability and compliance with environmental regulations across the cocoa sector, especially with the enforcement of international regulations such as the European Union Deforestation Regulation (EUDR). The promotion of sustainable cocoa farming, agroforestry systems, and environmentally friendly production practices is necessary to maintain long-term market access and improve the reputation of Indonesian cocoa products in sustainability-oriented markets. At the same time, the expansion of sustainability certification and traceability systems will serve to improve consumer confidence and bolster Indonesia's competitive position in European markets. Export promotion strategies should also aim to retain and increase market share in countries classified as Rising Star markets, such as the Netherlands and Germany, while at the same time enhancing competitiveness in Belgium and France through deeper market penetration, product differentiation and sustainability-oriented branding strategies. It is important to foster collaboration between government institutions, exporters, processing industries, and smallholder farmers to ensure consistency in the quality of products and continuous supply of products in international markets. Last but not least, with the majority of Indonesia's cocoa plantations being run by smallholder farmers, policies aimed at improving productivity should continue to be a national priority. To support sustainable cocoa production and strengthen the durability of Indonesia's cocoa sector in the era of digital economic transformation and sustainable global trade, it is important to implement programs related to plantation rehabilitation, replanting using superior planting materials, farmer capacity building, and access to modern cultivation technologies.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM Journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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References

- Adewopo, J. B., Nwafor, C. U., van der Fels-Klerx, H. J., & Oude Lansink, A. (2023). Sustainability challenges and opportunities in cocoa value chains: A systematic review. *Journal of Cleaner Production*, 398, 136529.
- Amfo, B., Aidoo, R., Mensah, J. O., & Maanikuu, P. M. I. (2023). Linkage between working conditions and wellbeing: Insight from migrant and native farmhands on Ghana's cocoa farms. *Heliyon*, 9(2), e13383.
- Aung, M. M., & Chang, Y. S. (2014). Traceability in a food supply chain: Safety and quality perspectives. *Food Control*, 39, 172–184.
- Effendy, Pratama, M. F., Rauf, R. A., Antara, M., Basir-Cyio, M., Mahfudz, & Muhardi. (2019). Factors influencing the efficiency of cocoa farms: A study to increase income in rural Indonesia. *PLoS ONE*, 14(4), e0214569.
- European Commission. (2023). *Regulation (EU) 2023/1115 on deforestation-free products (EUDR)*. Retrieved from https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en
- Fahmid, I. M., Wahyudi, Salman, D., Kariyasa, I. K., Fahmid, M. M., Agustian, A., Perdana, R. P., Rachman, B., Darwis, V., & Mardianto, S. (2022). “Downstreaming” policy supporting the competitiveness of Indonesian cocoa in the global market. *Frontiers in Sustainable Food Systems*, 6, 821330.
- Food and Agriculture Organization of the United Nations. (2023). *Sustainable cocoa initiative*. Retrieved from <https://www.fao.org/investment-centre/about-us/how-we-work/investmentplanningpolicy/sustainable-cocoa-initiative/en>
- Fold, N., & Neilson, J. (2016). Global value chains and global production networks in the changing international political economy: An introduction. In N. Fold & J. Neilson (Eds.), *Value chains and global capitalism: A multidisciplinary perspective* (pp. 1–19). London, England: Routledge.
- Gehl Sampath, P., & Vallejo, B. (2018). Trade, global value chains and upgrading: What, when and how? *The European Journal of Development Research*, 30, 481–504.
- Gereffi, G., & Fernandez-Stark, K. (2016). *Global value chain analysis: A primer* (2nd ed.). Durham, NC: Duke University, Center on Globalization, Governance & Competitiveness.
- Hermawan, R. (2019). Analisis pengaruh kebijakan bea keluar biji kakao, impor biji kakao, ekspor biji kakao dan harga cocoa butter terhadap ekspor cocoa butter. *Indonesian Treasury Review*, 4(3).
- Huetz-Adams, F., & Fountain, A. C. (2020). *Cocoa Barometer 2020*. Cocoa Barometer Consortium. Retrieved from <https://www.voicenetwork.eu/cocoa-barometer-2020>
- Humphrey, J., & Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies*, 36(9), 1017–1027.
- International Cocoa Organization. (2024). *Quarterly bulletin of cocoa statistics* (Vol. 50). International Cocoa Organization. Retrieved from <https://www.icco.org/icco-documentation/icco-publications/icco-publications/>
- Kamilaris, A., Cole, I. R., & Prenafeta-Boldú, F. X. (2021). Blockchain in agriculture. In C. M. Galanakis (Ed.), *Food technology disruptions* (pp. 247–284). Elsevier.

- Kaplinsky, R., & Morris, M. (2016). *A handbook for value chain research*. International Development Research Centre.
- Lambin, E. F., et al. (2023). Large gaps in voluntary sustainability commitments covering the global cocoa trade. *Global Environmental Change*, 81, 102696.
- Ministry of Agriculture of the Republic of Indonesia. (2024). *Agricultural statistics 2024 (Statistik Pertanian 2024)*. Jakarta, Indonesia: Center for Agricultural Data and Information Systems (PUSDATIN), Ministry of Agriculture.
- Ndlovu, P., & Thamaga-Chitja, J. M. (2023). Inclusive and sustainable agricultural value chains in developing countries: A review of challenges and opportunities. *Sustainability*, 15(8), 6502.
- Neilson, J., Wright, J., & Aklimawati, L. (2018). Geographical indications and value capture in the Indonesian coffee sector. *Journal of Rural Studies*, 59, 35–48.
- Nurhayati, N., Setyabudi, F. M. C. S., Marseno, D. W., & Supriyanto, S. (2019). The effects of roasting time of unfermented cocoa liquor using the oil bath methods on physicochemical properties and volatile compound profiles. *AgriTECH*, 39(1), 36–47.
- Nurwansyah, A., Nuraini, C., & Apriyani, D. (2023). Daya saing ekspor lemak kakao Indonesia di pasar internasional. *Forum Agribisnis*, 14(1), 50–58.
- Parra-Paitan, C., zu Ermgassen, E. K. H. J., Meyfroidt, P., & Verburg, P. H. (2023). Large gaps in voluntary sustainability commitments covering the global cocoa trade. *Global Environmental Change*, 81, 102696.
- Schroth, G., Figueiredo, M. G., Rocha-Santos, L., Mariano-Neto, E., & colleagues. (2024). *Management practices can improve yields of carbon-rich cocoa agroforests in Brazil*. Research Square.
- Tröster, B., & Staritz, C. (2023). Price-setting power in global value chains: The cases of price stabilisation in the cocoa sectors in Côte d'Ivoire and Ghana. *The European Journal of Development Research*, 35(4), 840–868.
- Udayana, H. P., & Setiawina, N. D. (2023). Comparative analysis and factors affecting the competitiveness of Indonesian cocoa commodities in the German market. *Jurnal Manajemen*, 14(2).
- Van Huellen, S., & Abubakar, F. M. (2021). Potential for upgrading in financialised agri-food chains: The case of Ghanaian cocoa. *The European Journal of Development Research*, 33(2), 227–252.
- Voora, V., Bermúdez, S., & Larrea, C. (2023). *Global market report: Cocoa prices and sustainability*. International Institute for Sustainable Development.
- World Bank. (2024). *Commodity markets outlook: October 2024*. Washington, DC: World Bank Group.
- Yemima, R., & Novianti, T. (2020). Competitiveness and determinant of Indonesian processed cocoa demand in the AANZFTA framework. *Jurnal Ilmu Ekonomi Terapan*, 5(1).
- Zikria, V., Takahashi, K., & Maeda, K. (2019). International competitiveness of Indonesia's cocoa sector: From the viewpoint of product differentiation. *Journal of the Faculty of Agriculture, Kyushu University*, 64(2), 407–413.

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