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**Agricultural Economics and Rural Development**

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# Assessing the Competitive Advantage of Ecuador's Shrimp Industry in the Global Market Using the Balassa Index for 2018–2022

## Evaluación de la ventaja competitiva de la industria camaronera de Ecuador en el mercado global mediante el índice de Balassa para el período 2018-2022

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**Abstract:** Increased shrimp production in Ecuador might significantly boost the nation's economic development while allowing for the sustainable exploitation of its natural resources. Business owners in Ecuador still require diagnostic tools for investment, marketing, and production planning. Therefore, this study aimed to evaluate the competitive position of Ecuador's shrimp industry and direct competitors in the global shrimp market. Export data on shrimp from the International Trade Centre and Ecuador's National Chamber of Aquaculture were used for the top five shrimp-exporting countries. The period 2018–2022 was chosen as the information was available at the start of the research. Balassa's methodology was employed for the competitiveness analysis, and statistical analysis was conducted to validate the findings. The results show Ecuador has a significant competitive edge compared to its main rivals, Argentina, India, Indonesia, and Vietnam. This analysis indicates that Ecuador has the potential to win bigger market shares in the global shrimp trade despite being placed 70th and 97th, respectively, in the 2017–2018 Global Competitiveness Index and the 2018 Logistics Performance Index. Therefore, it is necessary to establish strategic production plans for Ecuadorian shrimp enterprises to adapt to the global shrimp trade demands and to advance production and supply chain technology so that Ecuador can access additional worldwide markets.

**Keywords:** Competitiveness, exports, imports, relative advantage, shrimp.

**Resumen:** El aumento de la producción de camarón en Ecuador podría impulsar de manera significativa el desarrollo económico de la nación y permitir la explotación sostenible de sus recursos naturales. Con respecto a la inversión, comercialización y planificación de la producción, se requieren herramientas de diagnóstico que ayuden a los empresarios camaroneros en el Ecuador. El propósito de este estudio fue evaluar la posición competitiva de la industria camaronera de Ecuador y sus rivales directos en el mercado mundial. Se utilizó los datos de exportación del International Trade Centre y de la cámara nacional de acuacultura de Ecuador de los cinco principales países exportadores de camarón. Se escogió el período 2018-2022 que tenía la información disponible al momento de empezar la investigación. Para el análisis de competitividad se utilizó la metodología de Balassa y se realizó un análisis estadístico para validar los hallazgos. Los resultados demostraron que Ecuador tiene una ventaja competitiva significativa en comparación con sus principales rivales, Argentina, India, Indonesia y Vietnam. El análisis muestra que Ecuador tiene el potencial de ganar mayores participaciones de mercado en el comercio mundial de camarón, a pesar de ocupar el puesto 70 y 97 respectivamente en el Índice de Competitividad Global 2017-2018 y el Índice de Desempeño Logístico 2018. Es necesario establecer planes estratégicos de producción para las empresas camaroneras ecuatorianas con el fin de adaptarse a las demandas del comercio mundial y avanzar en la tecnología de producción y cadena de suministro para que Ecuador pueda acceder a mercados mundiales adicionales.

**Palabras clave:** camarón, competitividad, exportaciones, importaciones, ventaja relativa.

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## Introduction

From 2018 to 2022, global shrimp exports climbed from USD 17,5 billion to USD 22,6 billion. With 70 % of the global market, Ecuador, India, Vietnam, Indonesia, and Argentina are the top five shrimp exporters. In contrast, the top shrimp importers are the United States, China, Japan, Spain, and France, which account for nearly 66 % of the market (International Trade Centre [ITC], 2023).

After crude oil, shrimp, bananas, and flowers comprise Ecuador's three most important exports. The top give nations by average shrimp exports from 2018 to 2022 are Ecuador (Thousands of USD 4,616,730), India (Thousands of USD 4,533,388), Vietnam (Thousands of USD 2,085,699), Indonesia (Thousands of USD 1,402,765), and Argentina (Thousands of USD 1,046,354). The following percentages are reached by shrimp exports as a percentage of the five countries' overall exports: Argentina (2 %), Ecuador (18 %), India, Vietnam, and Indonesia (1 % per country) (ITC, 2023).

The topic of business competitiveness already has a certain amount of literature, which supports a more detailed analysis of the shrimp sector, either from a business perspective or from a national standpoint. However, there is a lack of robust competitiveness studies in the shrimp sector for decision-making purposes. Examining the Ecuadorian shrimp business and its place in the global shrimp market is the focus of this article. To do this, we compare Ecuador's competitive advantages to those of the other major shrimp exporters at the moment, including India, Vietnam, Indonesia, and Argentina (Alghamdi, 2023; Idris et al., 2022; Sergi et al., 2021). Assessing a country's or industry's export competitiveness is vital for understanding its position in the global market and informing strategic decisions. Various indices and analytical methods have been employed to evaluate export advantage, competitiveness, and trade performance across different sectors and regions.

Competitiveness in shrimp aquaculture is crucial in several countries such as Taiwan, Japan, China, and Malaysia. A comparative study of competitiveness among Taiwan, Japan, and China revealed that Japan is the least competitive, while China has gained an advantage over Taiwan in recent decades (Lee et al., 2003). Similarly, Malaysia's competitive position in shrimp production within the Association of Southeast Asian Nations (ASEAN) has been investigated, and Malaysia and Thailand maintain their competitiveness in different segments of the shrimp market (Ismail & Abdullah, 2013).

Competition in aquatic product trade between China and ASEAN has also been analyzed, demonstrating significant differences in the competitive advantage of their aquatic products (Luo et al., 2017). Additionally, the feasibility of Indonesia exporting aquaculture products internationally has been explored, identifying shrimp, algae, tilapia, and grouper as products with a comparative advantage (Oktopura et al., 2020).

Regarding competitiveness in Atlantic salmon production, marked differences are observed among the main producing countries, with Chile and the Faroe Islands standing out for significant changes in their production costs (Iversen et al., 2020). On the other hand,


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competition between China and Indonesia in the US tilapia market has been studied, highlighting Indonesia's superior performance in recent years (Dai et al., 2020).

In the specific context of shrimp production in Ahome, Mexico, aquaculture clusters can enhance regional competitiveness through better coordination among companies and increased knowledge transfer (Carrazco-Escalante et al., 2012). Similarly, the competitiveness of China's freshwater aquaculture industry has been evaluated, identifying key factors such as technological development capacity and support from related industries (Zhu et al., 2022). Conversely, in Michoacan, Mexico, the possibility of forming an aquaculture cluster to enhance regional competitiveness has been explored (Peñaloza-Talavera et al., 2022).

In Sri Lanka, the competitiveness of frozen shrimp and finfish exports has been analyzed, identifying challenges in market expansion and export diversification (Bandara et al., 2020). Additionally, in Kien Giang province, Vietnam, several factors affecting the competitiveness of marine product exporting companies have been identified, emphasizing the importance of strategic management and innovation in products and services (Nguyen & Khoa, 2020).
Competitiveness in the shrimp industry is crucial for its sustainable development and contribution to the economy and the environment. A recent study examined the competitive evolution of marine aquaculture in nine provinces and cities in China, using the vertical and horizontal dispersion method to analyze the dynamic trend and spatial imbalance of competitiveness level. Regional and staged characteristics were found in marine aquaculture, with an observable gradient effect and a general decrease in differences, suggesting a movement towards regional synergistic development in the industry (Cao & Shen, 2023).

Furthermore, the impact of regulatory costs on US tilapia farms and their effect on national production has been investigated. Results from a national survey revealed that regulatory costs accounted for 15 % of total production costs on these farms, with national direct costs of USD 4.4 million. Regulations on effluent discharge, predatory bird control, international export policies, water, and energy were identified as problematic. Lost sales revenue due to regulations amounted to USD 32 million annually, indicating that the regulatory framework has limited the growth of tilapia production in the US. Improving regulatory efficiency, researching new technologies, and understanding consumer preferences are key to increasing this industry's competitiveness (Engle et al., 2023).

Moreover, sustainable innovation management has been uderscored as a crucial factor for competitiveness in shrimp production in Guasave, Mexico. A recent study evaluated entrepreneurs' perception of this management through surveys of owners and managers of six shrimp farms. The results indicate a favorable attitude towards sustainable innovation, with high percentages agreeing to foster innovation, invest in new equipment and methods, and participate in markets. The significant correlation between indicators reinforces the importance of sustainable innovation management for social and environmental well-being in the region (Beltrán-Lugo et al., 2023).

These studies underline the diverse range of indices, analytical methods, and data sources employed to assess export competitiveness, trade performance, and comparative advantage across various industries and products within the global market. In summary, competitiveness in the shrimp aquaculture industry is influenced by a variety of factors, including production


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costs, technological development, government regulations, market strategies, sustainable management, and the ability to adapt to changing regulations. Understanding and effectively managing these factors are critical for maintaining and enhancing the competitive position of shrimp producers globally.

However, Ecuadorian shrimp businesses still require an up-to-date picture of the global and domestic shrimp markets, which they can use to plan their production, make investments, and create and implement marketing strategies. This would also be helpful as a tool for the Ecuadorian government to implement a wide range of policies meant to achieve its economic goals, including measures linked to business, transportation, employment, agriculture, etc. Therefore, this study aimed to evaluate the competitive position of Ecuador's shrimp industry and its direct competitors in the global shrimp market. Based on this, the following research question was formulated for the study: What is Ecuador's competitiveness in the shrimp industry compared to its chief competitor countries? The methodology developed by Balassa was employed to answer the research question, along with the application of statistical analysis to validate the results.

## Material and Methods

The researchers assessed the level of competitiveness of shrimp exports from various countries by calculating the Balassa index. The study covered five years and relied on data obtained from ITC (product code 030617) and national statistical agencies such as the National Chamber of Aquaculture of Ecuador. The main objective was to calculate and compare the competitiveness of the shrimp sector in Ecuador, India, Vietnam, Indonesia, and Argentina to measure the comparative advantage of exporting this product. The variables analyzed included total exports, shrimp exports, total imports, and shrimp imports from these countries in US dollars. Additionally, the existence and scope of correlations between the obtained trade indices were examined. Analysis of variance (ANOVA) was applied to determine if the differences between the indices were statistically significant. The calculated indices were evaluated to examine the extent to which they related to comparative advantages. Using Pearson's evaluation test, the aim was to find covariation between paired samples, that is, how much the values of the Balassa index obtained for different countries varied.

Comparative advantage is typically calculated in the literature using Balassa's methods (Balassa, 1965; Fojtíková, 2018). To conduct our analysis, we computed a variety of indices for Ecuador and the five leading nations that export shrimp (Ecuador, India, Vietnam, Indonesia, and Argentina), as suggested by Balassa:

Equation 1 illustrates that the the relative advantages of exports (RXA) is one of the indices measured.

$$RXA = \frac{\frac{X_{ij}}{X_{it}}}{\frac{X_{nj}}{X_{nt}}} \quad (1)$$


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Where $X_{ij}$ represents the exports of product j by nation i; $X_{it}$ represents the total exports by nation i; $X_{nj}$ represents the total exports of product j globally; and $X_{nt}$ represents the total exports worldwide.

A competitive advantage exists for the country under investigation in its exports of product j, as shown by an RXA value greater than 1. To put it differently, a country has a comparative advantage in exporting product j if its share of global exports $\left(\frac{X_{ij}}{X_{it}}\right)$ is greater than the share of global exports of that product $\left(\frac{X_{nj}}{X_{nt}}\right)$.

Equation 2 illustrates how the relative advantages of imports (RMA) is determined similarly. A country is comparatively more vulnerable to the availability of imports of product j (compared to its entire economy) when the proportion of product j in the country's total imports $\left(\frac{M_{ij}}{M_{it}}\right)$ is larger than the proportion of product j in the world's total imports $\left(\frac{M_{nj}}{M_{nt}}\right)$. This is how RMA can be interpreted symmetrically to the RXA equation.

$$RMA = \frac{\frac{M_{ij}}{M_{it}}}{\frac{M_{nj}}{M_{nt}}} \quad (2)$$

The difference between the import and export comparative advantage indices is used to compute the relative trade advantage (RTA) index (Algieri et al., 2018; Ignjatijevic et al., 2014; Pocol et al., 2017 ; see Equations 2 and 3).

$$RTA = RXA - RMA \quad (3)$$

Another index was created utilizing the natural logarithm (ln) of RMA and RXA to assess comparative advantage more precisely (Vollrath, 1991)This may make the contrasts between the countries under investigation apparent. Equation 4 calculates the relative competitiveness (RC) index by deducting the relative advantage of imports from that of exports.

$$RC = lnRXA - lnRMA \quad (4)$$

The RC index expresses a nation's business competitiveness, productive performance, and level of export specialization (Bojnec & Fertő, 2019; Liu & Gao, 2019).

The revealed comparative advantage (RCA), also known as the Balassa index, is a measurement used to analyze a country's comparative advantage in manufacturing specific commodities and services compared to other nations. It is determined by comparing the proportion of a nation's exports of a particular good to the proportion of the same good exported globally (Fojtíková, 2018; Gnangnon, 2020). A nation's comparative advantage over its rivals with respect to the product under consideration is gauged by the RCA index. The comparative advantage increases with the value of RCA. Those above were computed using Equation 5). It should be observed


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that when the ln is applied to the ratio of a product's exports to imports, a smaller value is generated when the ratio of exports to the total imports of the nation is multiplied:

$$RCA = \ln\left[\frac{X_i}{M_i}\right] x \left[\frac{\sum_{i=1}^{n} X_i}{\sum_{i=1}^{n} M_i}\right] \quad (5)$$

If index i denotes the sector, Mi is the import value, and Xi is the export value.

The RCA index scores for the primary shrimp exporters in 2018–2022 are displayed in the RCAs, which are the equation's findings. They define the researched countries' competitiveness.

The RCA aids in identifying the goods that a nation produces and exports with a comparative advantage over those it does not. Policymakers, companies, and investors can utilize this information to inform their trade and investment decisions (Algieri et al., 2018)

Lastly, to determine if there was a statistical difference between the indices, we ran an ANOVA. Additionally, this study examined the breadth of the correlations between the trade indices—which provide insight into the strength or degree of association between the indices—and their existence. A t-test was employed to confirm if there were any statistical distinctions in the Balassa index amongst the five nations that export shrimp (Lind et al., 2019).

## Results and Discussion

The main achievement of this research was to evaluate the competitiveness of Ecuador's shrimp industry compared to the leading shrimp-exporting countries, using Balassa's methodology.

### Shrimp Exports from the Main Exporting Countries

Ecuador exhibited the greatest average growth rate of 27.7 % in terms of annual export growth rates in value. Even with such a high figure, Ecuador could not produce noteworthy outcomes in absolute terms; as a result, the average annual export was USD 4,616 million, with notable annual fluctuations. On average, Ecuador was exporting shrimp valued at USD 4,616 million, which was a faster annual growth rate than that of India, Vietnam, Indonesia, and Argentina.

### Shrimp Importing Countries

China exhibited the highest average annual growth rate of 42.9 % in import data, with average annual imports of USD 3,558 million. With a significant rise in imports over the previous few years, the USA had the largest average value of imports, at USD 5,376 million.

### Comparative Advantage of Ecuador's Shrimp Exports

The findings of the RCA are then organized into Table 1, which lists the top exporters of shrimp in order of comparative advantage.

We used production, export, and import data from 2018 to 2022 from the United Nations Comtrade and the ITC to analyze the global shrimp market. Here, we concentrate on the relative


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market share, global distribution, development, and medium-term trends of shrimp products, as well as the major areas of exchange (exports and imports). The RCA index value exceeded 4 in Ecuador, Argentina, and Indonesia. In all three nations, the shrimp export value can be regarded as high compared to the low value of imports. The index results show that Ecuador, Argentina, and Indonesia are net shrimp exporters with a significant competitive advantage.

**Table 1.** Main Shrimp Exporting Countries Ranked by Comparative Advantage Level

| | | |
|---|---|---|
| Comparative disadvantage | $0 < \text{RCA index} \leq 1$ | |
| Weak comparative advantage | $1 < \text{RCA index} \leq 2$ | Vietnam |
| Medium comparative advantage | $2 < \text{RCA index} \leq 4$ | India |
| Strong comparative advantage | $4 < \text{RCA index}$ | Ecuador, Argentina, and Indonesia |

Source: Prepared by the authors based on Hinloopen and Van Marrewijk (2001).

The RCA indices for the investigated nations—Ecuador, Argentina, Indonesia, India, and Vietnam—are displayed in Table 2. Vietnam has a weak comparative advantage since its RCA index fluctuates between 1 and 2. Ecuador, Argentina, and Indonesia all had RCA index values greater than 4, placing them in the nations with "strong comparative advantage." The RCA index for Ecuador as a whole is more than 4. Ecuador's score of more than 4 is comparable to those of Indonesia and Argentina. As a result, three nations are net shrimp exporters, with a near to one ratio between their total exports and total imports. Based on the information in Table 3 and the two Asian nations under study, India falls into the category of "medium comparative advantage," with an RCA index value that is between 2 and 4, while Vietnam's results indicate that it has a weak comparative advantage, with a value between 1 and 2.

Considering the results from Table 1 and following Hinloopen and Van Marrewijk (2001), the RCA rankings of the nations (Table 2) place Ecuador, Argentina, and Indonesia, three of which have RCA index values higher than 4, in the "strong comparative advantage" category.

India's Balassa index score, which is 2 RCA Index > 4, places it in the "medium comparative advantage" group (Table 1). The difference between India and Ecuador is that, despite the fact that both nations are net exporters of shrimp, their total imports and exports are not equal in India, while they are in Ecuador. India's total imports are significantly higher than its total exports.

Conversely, Vietnam received an index value that falls within the low interval (1 RCA index 2), indicating that it has a weak comparative advantage. Vietnam is ranked third in shrimp export value but imports about 400 million dollars worth of shrimp annually. Because of this, when we


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apply the first part of equation 5, we get a result of around 1.8. The exports, however, account for more than 100 % of the value of imports when its total imports are split by its total exports. Because multiplying both terms yields a Balassa index of less than 2, this nation is categorized as having a "weak comparative advantage."

**Table 2.** RCA Index Scores for the Leading Shrimp Exporters in 2018–2022

| | RCA | | | | |
|---|---|---|---|---|---|
| **Year** | **Ecuador** | **India** | **Vietnam** | **Indonesia** | **Argentina** |
| 2018 | 11.18 | 3.28 | 1.67 | 5.27 | 5.19 |
| 2019 | 13.47 | 3.61 | 2.28 | 4.27 | 7.42 |
| 2020 | 12.29 | 4.00 | 2.14 | 5.07 | 7.21 |
| 2021 | 9.87 | 3.67 | 1.90 | 4.55 | 7.15 |
| 2022 | 9.06 | 3.16 | 2.06 | 4.98 | 6.11 |

Source*:* Authors' calculation from ITC (2023). Note*:* Revealed comparative advantage (RCA) index.

These indicated that Ecuador enjoys a strong comparative advantage among its direct competitors: Argentina, India, Indonesia, and Vietnam. Despite Ecuador being ranked 70th and 97th globally in the 2017–2018 Global Competitiveness Index and the 2018 Logistics Performance Index, respectively, our research indicates that Ecuador has the potential to capture larger market shares in the international shrimp trade.

A comparative analysis of studies on competitiveness in the aquaculture industry sheds light on significant trends and disparities. For instance, research comparing eel aquaculture competitiveness in Taiwan, Japan, and China delineates shifting dynamics over time. Lee et al. (2003) assert that while Taiwan led in the 1990s, it later ceded ground to China due to various factors, including domestic resource costs. On the contrary, Malaysia and Thailand maintain competitiveness in shrimp production, whereas Indonesia excels in preserved shrimp export (Ismail & Abdullah, 2013). Moreover, Luo et al. (2017) reveal distinct differences in aquatic product competitiveness between China and ASEAN, underlining the necessity of recognizing market-specific strengths for strategic development. Examining production costs in Atlantic salmon aquaculture across five countries, Iversen et al. (2020) highlight Norway's notable cost efficiency, positioning it as a leader. In contrast, the tilapia industry in China and Indonesia faces challenges due to shifts in US market demand, with Indonesia exhibiting relatively stronger export performance (Dai et al., 2020). Carrazco-Escalante et al. (2012) emphasize the advantage of aquaculture clusters in enhancing competitiveness, while Engle et al. (2023) underscore regulatory costs' impact on tilapia production in the United States, signaling the imperative of improving regulatory efficiency.

Furthermore, innovation management emerges as a pivotal factor, with studies emphasizing its role in improving competitiveness and sustainability. Beltrán-Lugo et al. (2023) highlight the significance of sustainable innovation in the shrimp industry in Sinaloa, Mexico. Bandara et al. (2020) stress the need for market diversification to bolster Sri Lanka's frozen shrimp export competitiveness. Finally, Nguyen and Khoa (2020) identify strategic management as crucial for marine product exporting companies in Kien Giang, Vietnam, within global economic integration. These findings underscore the multifaceted nature of competitiveness in the

aquaculture industry, necessitating nuanced policy interventions and strategic initiatives to foster innovation, sustainability, and competitiveness on national and international fronts.

**Statistical Validation of Results**

Five indices—the RCA, RC, RMA, RTA, and RXA—were used to analyze comparative advantage in Ecuador's shrimp exports. The indices for every year examined are displayed in Table 3. According to the analysis, all five indices have an excellent comparative advantage. Table 3 displays the findings of an empirical study on Ecuador's comparative advantage in exports for 2018–2022.

The comparative advantage of Ecuador's shrimp exports study's findings indicates that each of the five indices has reached a positive value. Relative export advantage has reached its maximum, producing a solid positive relative trade advantage. The relative import advantage is relatively small, but it is positive and indicates some quantities of imports and negative tendencies.

**Table 3.** Descriptive Statistics for RXA, RMA, RTA, RC, and RCA Indices of Shrimp Exports from Ecuador in 2018–2022

| | *N* | Minimum | Maximum | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|
| RXA | 5 | 149.30 | 237.62 | 33.31 | 33.31 | 1109,68 |
| RMA | 5 | 0.00 | 0.05 | 0.02 | 0.02 | 0.00 |
| RTA | 5 | 149.30 | 237.57 | 33.29 | 33.29 | 1108,36 |
| RC | 5 | 8.37 | 13.50 | 1.98 | 1.98 | 3.91 |
| RCA | 5 | 9.06 | 13.47 | 1.78 | 1.78 | 3.17 |

Source: Prepared by the authors.

We analyzed the variance to determine whether the mean variables varied among the groups (Table 4). The empirical F value in the Ecuadorian example is 115.93, with a *p*-value of 1.5457E-13, suggesting statistical significance in the differences between the indices.

**Table 4.** ANOVA and One Sample Test for Ecuador's RXA, RMA, RTA, RC, and RCA Indices from 2018 to 2022

| ANOVA | | | | | | | Indexes | t (Dt=4) | Sig. (2 tailed) | Mean difference |
|---|---|---|---|---|---|---|---|---|---|---|
| | SS | Df | MS | F | p-value | F critic | RXA | 12.93 | .00 | 192.62 |
| Between groups | 206,366.30 | 4 | 51,591.57 | 115.93 | 1.457E-13 | 2.87 | RMA | 1.44 | .22 | 0.01 |
| Within groups | 8,900.49 | 20 | 445.02 | | | | RTA | 12.94 | .00 | 192.60 |
| | | | | | | | RC | 12.23 | .00 | 10.81 |
| Total | 215,266.79 | 24 | | | | | RCA | 14.03 | .00 | 11.17 |

Source: Prepared by the authors.

In accordance with studies completed, we also looked at how closely the indices connected to the identification of competitive advantages by performing a correlation analysis of the derived


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indices (Table 5). We have demonstrated a correlation between ten paired simples, or how much the RCA index values covariate, through the Pearson (rp) and Spearman (rs) correlation tests. We may conclude that there is a correlation and that the variables covariate for Ecuador because there is one pair with a strong positive correlation and one with a *p*-value <0.01. We may conclude that there is a correlation and that the variables covariate based on the results of the Spearman formula Test of Connection of the Balassa index, which reveals a correlation in two pairs with *p*-values below 0.01 and six pairs below 0.05. It is interesting to note that there is a positive correlation between the relative export advantage and the relative trade advantage, as well as between the comparative advantage and the found competitiveness. These findings suggest that an increase in shrimp exports will positively impact the expansion of the exports' comparative advantage.

**Table 5.** Pearson ($r_p$) and Spearman ($r_s$) Correlation Tests on the Indices for Ecuador

| | | **Pearson Correlation** | | | | | **Spearman´s correlation** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RXA | RMA | RTA | RC | RCA | RXA | RMA | RTA | RC | RCA |
| RXA | Pearson Correlation | 1 | .857 | 1.000** | -.831 | -.654 | 1.000 | .900* | 1.000** | -.900* | -.700 |
| | Sig. (bilateral) | | .063 | .000 | .081 | .231 | | .037 | | .037 | .188 |
| | N | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| RMA | Pearson Correlation | .857 | 1 | .857 | -.816 | -.784 | .900* | 1.000 | .900* | -1.000** | -.900* |
| | Sig. (bilateral) | .063 | | .064 | .092 | .117 | .037 | | .037 | | .037 |
| | N | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| RTA | Pearson Correlation | 1.000** | .857 | 1 | -.831 | -.654 | 1.000** | .900* | 1.000 | -.900* | -.700 |
| | Sig. (bilateral) | .000 | .064 | | .081 | .232 | | .037 | | .037 | .188 |
| | N | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| RC | Pearson Correlation | -.831 | -.816 | -.831 | 1 | .905* | -.900* | -1.000** | -.900* | 1.000 | .900* |
| | Sig. (bilateral) | .081 | .092 | .081 | | .034 | .037 | | .037 | | .037 |
| | N | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| RCA | Pearson Correlation | -.654 | -.784 | -.654 | .905* | 1 | -.700 | -.900* | -.700 | .900* | 1.000 |
| | Sig. (bilateral) | .231 | .117 | .232 | .034 | | .188 | .037 | .188 | .037 | |
| | N | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |

**. The correlation is significant at the 0.01 level (bilateral).

*. The correlation is significant at the 0.05 (bilateral).

Source: Prepared by the authors.

We have demonstrated the correlation between ten matched samples using the Pearson (rp) and Spearman (ra) correlation tests (Table 5). We can determine that correlation exists, and the



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variable is covariate for India because there are three pairs with a solid correlation and *p*-values less than .01.

In our additional research, we sought to ascertain the significance and utility of the variation in the RCA indices for each of the five nations. In this sense, the variance analysis displays the following: The empirical F value of 70.75 and $p$ = 1.623E-11 indicate statistical significance in the differences between groups.

Additional analysis findings indicate that the degrees of comparative advantage in exports between Ecuador, India, Indonesia, Vietnam, Argentina, and other countries have a statistically significant difference (Table 6). This is especially true if we consider that Argentina, Ecuador, India, Indonesia, Vietnam, and other countries produce excess shrimp for the global market.

**Table 6.** Paired Samples test on the RCA index for Ecuador, India, Vietnam, Indonesia, and Argentina.

| | | Paired differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | Pair samples tests | Mean | Std. Desviation | Std Error Mean | 95% confidence interval of the difference Lower | Upper | | | |
| Pair 1 | RCA_ECU- RCA_INDIA | 7.63 | 1.62 | 0.73 | 5.61 | 9.64 | 10.51 | 4 | .00 |
| Pair 2 | RCA_ECU - RCA_VIET | 9.16 | 1.68 | 0.75 | 7.08 | 11.25 | 12.19 | 4 | .00 |
| Pair 3 | RCA_ECU - RCA_INDON | 6.34 | 1.96 | 0.87 | 3.92 | 8.77 | 7.25 | 4 | .00 |
| Pair 4 | RCA_ECU - RCA_ARG | 4.56 | 1.62 | 0.72 | 2.55 | 6.57 | 6.29 | 4 | .00 |
| Pair 5 | RCA_INDIA - RCA_VIET | 1.53 | 0.31 | 0.14 | 1.14 | 1.92 | 10.94 | 4 | .00 |
| Pair 6 | RCA_INDIA - RCA_INDON | -1.28 | 0.59 | 0.26 | -2.01 | -0.56 | -4.89 | 4 | .01 |
| Pair 7 | RCA_INDIA - RCA_ARG | -3.07 | 0.73 | 0.33 | -3.97 | -2.17 | -9.44 | 4 | .00 |
| Pair 8 | RCA_VIET - RCA_INDON | -2.82 | 0.58 | 0.26 | -3.54 | -2.10 | -10.84 | 4 | .00 |
| Pair 9 | RCA_VIET - RCA_ARG | -4.60 | 0.78 | 0.35 | -5.57 | -3.64 | -13.26 | 4 | .00 |
| Pair 10 | RCA_INDON - RCA_ARG | -1.79 | 1.28 | 0.57 | -3.38 | -0.19 | -3.11 | 4 | .04 |

Source: Prepared by the authors.

Among the limitations of the present study is the availability of variables to conduct the research and a lack of agreements between academia and the export sectors to generate robust data. For future studies, governments should make information on qualitative and quantitative variables available to researchers, which would allow the application of advanced statistical methodologies and provide more representative and applicable results. The development of logistics

performance and global competitiveness indices for the shrimp industry and other sectors can offer a broader and more precise vision for decision-making.

## Conclusions

Based on the study's purpose, research question, method, and results, the following conclusions can be formulated.

The analysis conducted by calculating Balassa (RCA) indices demonstrates that Ecuador possesses a robust competitive advantage in shrimp export compared to its main competitors: Argentina, India, Indonesia, and Vietnam. RCA index values exceeding 4 for Ecuador during 2018–2022 clearly place it under the "strong comparative advantage" category. This strength likely derives from Ecuador's favorable geographical and climatic conditions for shrimp cultivation. However, despite this advantage, Ecuador ranks low in the Global Competitiveness Index (70th place) and the Logistics Performance Index (97th place), suggesting opportunities for improvement in areas such as productivity, technology, and supply chains.

Additional statistical analyses validate Ecuador's strong comparative advantage results, including ANOVA, t-test, and correlation analysis. The differences in RCA indices between Ecuador and other exporting countries were statistically significant. Overall, the results indicate that Ecuador has significant potential to capture larger market shares in the global shrimp trade, but realizing this opportunity fully requires policies and strategies focused on enhancing productivity, adopting better international practices, improving domestic supply chain integration, diversifying export markets, and implementing traceability infrastructure technologies and sustainability certifications. Close collaboration between the public and private sectors will be key to designing and implementing these strategic initiatives.

## Ethical Implications

There are no ethical implications; all documentation was done through official sources with open-access information.

## Conflict of Interest

The researcher does not have any conflicts of interest.

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