Article

Not peer-reviewed version

Diversification and Competitiveness Patterns in International Shrimp and Prawn Trade: Evidence from Ecuador, India, Viet Nam, and Indonesia

Jose Carlos Montes Ninaquispe *, Luisa Angelica Orejuela Guerrero, Francisco Elias Rodriguez Novoa, Pedro Ramiro Mendoza Ocaña, Anggie Melissa Sánchez Yarleque, Carlos Enrique Mendoza Ocaña, Fanny Lileth Pairazaman Lam, Luis Ignacio Gutiérrez Albán, Marcos Marcelo Flores Castillo, Yerson Paul Semillan Rosales

Posted Date: 13 January 2026

doi: 10.20944/preprints202601.0924.v1

Keywords: NRCA; HHI; destination diversification; shrimp and prawn exports; revealed competitiveness

Article

Diversification and Competitiveness Patterns in International Shrimp and Prawn Trade: Evidence from Ecuador, India, Viet Nam, and Indonesia

Jose Carlos Montes Ninaquispe [1,*], Luisa Angelica Orejuela Guerrero [2], Francisco Elias Rodriguez Novoa [2], Pedro Ramiro Mendoza Ocaña [3], Anggie Melissa Sánchez Yarleque [4], Carlos Enrique Mendoza Ocaña [5], Fanny Lileth Pairazaman Lam [3], Luis Ignacio Gutiérrez Albán [3], Marcos Marcelo Flores Castillo [6] and Yerson Paul Semillan Rosales [6]

[1] Universidad de San Martín de Porres, Chiclayo 14001, Perú
[2] Escuela de Ingeniería Industrial, Universidad Nacional de Trujillo, Trujillo 13700, Perú
[3] Institute for Research in Science and Technology, César Vallejo University, Campus Chepén, Trujillo 13001, Peru
[4] Facultad de Humanidades, Universidad Tecnológica del Perú, Campus Piura, Perú
[5] Escuela de Ingeniería Industrial, Universidad Privada del Norte, Campus Trujillo, Perú
[6] Facultad de Humanidades, Universidad Nacional de Frontera, Piura, Perú
* Correspondence: jmontesn@usmp.pe; Tel.: +51-979985261

Abstract

This study aimed to jointly characterize destination diversification and revealed competitiveness in the international shrimp and prawn trade of Ecuador, India, Viet Nam, and Indonesia during 2020–2024. A quantitative, descriptive–comparative approach was applied using annual FOB values at the exporter–destination level obtained from Trade Map (ITC). Destination diversification was proxied by the Herfindahl–Hirschman Index (HHI), while market-level competitiveness was measured through the Normalized Revealed Comparative Advantage (NRCA). Results show that Ecuador expanded exports while maintaining persistently high destination concentration. India exhibited broad revealed comparative advantage across multiple markets, yet remained highly concentrated, with episodes of deconcentration that were not sustained. Viet Nam recorded relative stagnation, moderate concentration, and heterogeneous competitiveness across destinations. Indonesia experienced contraction with extremely high concentration, characterized by a pronounced advantage in the United States alongside disadvantages in alternative markets. Overall, a positive NRCA did not necessarily imply a low HHI, and vulnerability increased when competitive advantage aligned with a small set of anchor markets, constraining adjustment capacity under shocks. The study recommends institutionalizing integrated HHI–NRCA dashboards, strengthening destination-specific market intelligence and early-warning systems, setting operational deconcentration targets, and implementing differentiated market strategies—consolidating advantages where robust, converting near-neutral positions into sustained advantages, and redesigning entry into unfavorable markets through improvements in quality, traceability, and logistics efficiency.

Keywords: NRCA; HHI; destination diversification; shrimp and prawn exports; revealed competitiveness

1. Introduction

Contemporary discussions of export competitiveness have shifted from static explanations toward frameworks that jointly consider specialization, diversification, and resilience to shocks.

 doi:10.20944/preprints202601.0924.v1

Analytically, revealed comparative advantage became a standard empirical approach to infer specialization patterns from observed trade flows, with Balassa's classical formulation interpreting a country's relative export share as evidence of sectoral advantage [1]. Subsequent research highlighted distributional asymmetry, scale dependence, and sensitivity to country size, motivating adjustments to improve comparability and statistical properties [2]. In this context, the Normalized Revealed Comparative Advantage (NRCA) was proposed as an additive and cross-country comparable alternative for assessing relative specialization while reducing biases associated with total export size [3]. In parallel, export diversification research argues that performance should also be assessed through the distribution of exports across destinations, because concentration increases vulnerability to demand shifts, price changes, and regulatory barriers [4]. Within this approach, the Herfindahl–Hirschman Index (HHI) is commonly used as a concentration measure: values close to one indicate strong dependence on a small number of markets, whereas values near zero reflect greater diversification. Recent macroeconomic evidence further suggests that diversification can buffer external volatility, although effects are heterogeneous and depend on the diversification type, productive structure, and the synchronicity of shocks across markets [5].

The shrimp and prawn literature adds sector-specific evidence on how competitiveness is built in intensive production systems exposed to biological, environmental, and market risks. Penaeid aquaculture is frequently described as one of the most dynamic processes in global food expansion, characterized by transitions from extensive to intensive systems, technological reconfiguration, and shifts in commercially dominant species—especially the consolidation of whiteleg shrimp (Litopenaeus vannamei) across multiple exporting countries [6]. For Ecuador, technical and empirical studies document high yields and input-intensive production, alongside regional heterogeneity and efficiency gaps that shape costs and the ability to sustain market shares [7]. Competitive advantage in shrimp, however, depends not only on physical productivity but also on global value-chain governance, food safety requirements, certification regimes, and traceability capabilities, which can operate as mechanisms of market access or exclusion in high-value destinations [8]. Environmental certification, often presented as an improvement instrument, does not necessarily change local production practices and may function more as a commercial filter than as technological transformation, according to comparative evidence on certification and trade [9]. The competitive landscape is also influenced by trade defense measures and dumping disputes, which heighten uncertainty and alter destination-diversification incentives by increasing the costs of reliance on one or two dominant markets [10]. Overall, accumulated evidence indicates that shrimp export competitiveness reflects a combination of productive efficiency, institutional quality, chain governance, regulatory compliance, and market strategy; therefore, jointly examining NRCA and HHI can provide a more complete reading of performance and risk.

Analyzing diversification and NRCA together in shrimp and prawn exports is particularly relevant given the product's strategic role in coastal economies and the sector's sensitivity to external disturbances. Leading exporters can experience broad macroeconomic and social impacts when international prices shift or when sanitary restrictions emerge in key destinations, since specialization and market concentration create high external exposure. In Ecuador, shrimp consolidated as the main non-oil export, representing 28% of total non-oil exports in 2024, which heightens exposure to demand fluctuations and policy changes in predominant markets [11]. In India, the shrimp sector plays a central role in seafood exports and sustains employment and processing chains, so changes in the main market can affect coastal incomes and jobs [12]. In Viet Nam, the recent export recovery has been interpreted as evidence of strategic adjustment and market recomposition, making it pertinent to assess whether this recovery coincides with changes in destination concentration [13]. In Indonesia, recent public evidence shows how dependence on the U.S. market becomes an immediate risk when tariffs or restrictive measures are applied, prompting diversion toward China and other destinations [14].

Global shrimp and prawn trade has expanded over the long run, but recent volatility has been linked to supply shocks, cost variation, and demand deceleration in certain destinations. For example,

 doi:10.20944/preprints202601.0924.v1

the cancellation of Peru's anchoveta fishery in 2023 increased feed costs. Market prices also fluctuated, moving from US$5.80/kg to US$5.00/kg during the pandemic and falling further to US$5.00/kg by July 2023 due to oversupply and slow demand, particularly in key exporting contexts such as Ecuador and India [15]. This volatility is compounded by demand concentration in a limited number of markets, creating an environment in which leading exporters compete for shares in specific destinations, intensifying price pressure and the risk of trade defense actions [10].

For Ecuador, official evidence simultaneously confirms export scale and destination dependence. In 2024, the five main shrimp destinations accounted for 91% of total exports, indicating high geographic concentration and potential vulnerability to shocks affecting any one of these markets [16]. These figures point to an apparent paradox: sectoral growth and international leadership may coexist with substantial destination concentration. India also operates at global scale with exports strongly tied to specific destinations, particularly the United States, which is expected to remain the main market; consequently, dependence on a small set of buyers introduces commercial risk despite large export volumes [17]. Viet Nam exhibited a notable rebound: in the first eleven months of 2024, shrimp exports reached nearly US$3.6 billion, increasing 22% year-on-year, suggesting demand recomposition and potential destination reconfiguration, although risks remain due to trade measures and price competitiveness relative to other suppliers [18]. Indonesia's central challenge is heavy reliance on the U.S. market, which increases vulnerability to non-tariff barriers, rivalry among exporters, and shifts in trade policy.

Taken together, these patterns describe a problem context characterized by high exposure to a few markets and intense price competition. This raises the relevance of testing whether revealed comparative advantage (NRCA) is sustained under concentrated destination structures or whether it is accompanied by diversification that reduces vulnerability. The problem is further amplified by the role of standards and non-tariff barriers in food trade. Empirical evidence in fisheries trade shows relationships between tariff changes and the use of non-tariff measures—proxied through sanitary notifications—implying that market access depends on regulatory dynamics as well as cost-based competitiveness [19].

1.1. Literature Review

The literature broadly agrees that export concentration increases exposure to external shocks, but it differs in how diversification is conceptualized, what drives it, and how it evolves with development. A central point of departure is the evidence of nonlinearity: Imbs and Wacziarg [20] show that diversification does not follow a monotonic path but rather a U-shaped pattern in which economies diversify at early stages and later re-specialize at higher income levels. This contribution reframes concentration not as a permanent "failure" but as a potential outcome of structural transformation, implying that HHI-based diagnostics must account for turning points and structural heterogeneity. By contrast, macro-performance studies often treat diversification as a channel for sustained improvement, while qualifying its strength by development stage. Using a broad dynamic panel with endogeneity controls, Markakkaran et al. [21] report a positive effect of diversification on GDP per capita growth, while acknowledging that the relationship may vary across development stages—consistent with the nonlinearity highlighted by Imbs and Wacziarg [20]. The key difference is the analytical focus: Imbs and Wacziarg emphasize structural sectoral evolution with income, whereas Markakkaran et al. position diversification as a growth- and learning-related driver in a global sample.

A complementary line examines diversification as an outcome of trade policy and international integration, with results that are strongly context-dependent. Osakwe et al. [22] find that, across developing countries, greater openness is associated with more diversified structures and that tariff liberalization correlates positively with diversification; however, less favorable patterns emerge for Sub-Saharan Africa, suggesting that openness does not operate uniformly and that productive and institutional capacities mediate outcomes. Applied to shrimp and prawns, this implies that HHI-

 doi:10.20944/preprints202601.0924.v1

measured diversification may reflect policy change, demand shocks, sanitary events, or logistics disruptions, making it methodologically important to distinguish among channels.

Another major divergence concerns the expected "outcome" of diversification: higher growth, lower volatility, or reduced vulnerability. Haddad et al. [23] argue that trade openness can be associated with lower growth volatility when export structures are more diversified, whereas concentration constrains this stabilizing potential. This shifts the emphasis from export size to export composition as a condition for stability. In a related risk-centered approach, Mano and Combary [24] focus on economic vulnerability and find that higher diversification is associated with lower vulnerability in WAEMU countries. Although Haddad et al. focus on growth volatility and Mano and Combary on structural exposure, both converge on the conclusion that export concentration amplifies risk and diversification acts as a buffer. For sensitive products such as crustaceans, destination concentration measured by export value through HHI therefore captures not only structure but also exposure to sanitary shocks, regulatory changes, and logistics disruptions.

Methodologically, the literature further notes that diversification depends on measurement choices and aggregation level. Barbieri et al. [25] show that HHI-based indices applied to geographic and sectoral diversification—and computed at different aggregation levels—reveal that more diversified territories are more resilient to pandemic-type shocks. Their contribution differs from country-average macro studies by emphasizing how aggregation can conceal specialization and how analytic scale affects inference on export resilience. This is particularly relevant for shrimp and prawns, where destination diversification can evolve in ways that materially affect export continuity and competitiveness diagnostics.

In parallel, export competitiveness research debates how to measure revealed comparative advantage. Hinloopen and van Marrewijk [26] show that the traditional Balassa index exhibits distributional problems, asymmetry, and extreme values, which can bias comparisons across countries and products. Subsequent work proposes more symmetric and comparable alternatives. Foster [27] develops an expanded Ricardian foundation for comparative advantage measurement and reports improved stability and symmetry relative to the traditional approach, while Stellian and Danna Buitrago [28] review normalized variants reinterpreted as contributions to the trade balance and demonstrate that indicator choice can alter competitiveness inferences.

Within this debate, NRCA is particularly relevant because it supports both cross-sectional and intertemporal comparison. Yu et al. [3] propose NRCA as an additive alternative with improved properties for longitudinal and panel analysis, directly addressing the concerns raised by Hinloopen and van Marrewijk [26]. Accordingly, when the aim is to relate competitiveness to destination concentration (HHI), NRCA aligns with the recommendation to use indicators with stronger comparability to avoid conflating competitiveness changes with measurement artifacts, as noted in studies applying these indicators separately in descriptive settings [29–34].

Sector specificity in shrimp and prawns also requires accounting for technological, logistical, and governance constraints that shape both diversification and competitiveness. Asche et al. [35] argue that, for perishable seafood products, distance and infrastructure (cold chain, delivery times, spoilage risk) shape trade's spatial structure, favoring regionalization or dependence on logistics capabilities that can limit destination expansion. For this reason, counting markets can be misleading, whereas value-based indices such as HHI more effectively capture true dependence in crustacean trade. Relatedly, using microdata, Straume et al. [36] show that apparent diversification at the country level may coexist with high firm-level concentration, where a small number of firms dominate export value. This distinguishes national geographic diversification from effective diversification at the firm level and suggests that destination-based HHI may obscure exporter power concentration—echoing Barbieri et al.'s [25] aggregation warning, but at the micro-enterprise scale.

Competitiveness in crustaceans can also be affected by production fragmentation and reliance on imported inputs, which complicates interpretations based solely on gross exports. Seung [37] shows that competitiveness measures can change when value added and global value chains are considered, and that imported-input dependence may overstate competitiveness if only gross exports

 doi:10.20944/preprints202601.0924.v1

are used. This does not invalidate NRCA, but it requires interpreting revealed competitiveness alongside productive structure, especially where exports embed imported components or re-export processes. Historical and applied shrimp research likewise indicates that competitiveness is dynamic and responsive to market conditions and policy. Ling et al. [38] apply revealed comparative advantage in key markets to compare producers and detect leadership changes; Yu et al. [39] systematize performance metrics and document heterogeneous trajectories in the U.S. market; and Khan et al. [40] find that macroeconomic and policy determinants correlate with competitiveness changes over time. These contributions differ in explanatory depth: performance-comparison approaches emphasize rankings and positional shifts, whereas Khan et al. explicitly incorporate macro and policy correlates, framing competitiveness as sensitive to both domestic and external environments.

Taken together, these studies suggest that NRCA performance and HHI concentration may respond to standards, certifications, and environmental restrictions in addition to demand or price changes. The literature converges on the link between diversification and better macro outcomes (higher growth, lower volatility, or reduced vulnerability) but diverges on three critical aspects: the dynamic path of diversification over development [20], the conditioning role of institutional and productive context in the openness–diversification link [22], and the sensitivity of diagnostics to territorial, sectoral, and firm-level aggregation [25,36]. These contributions justify an integrative approach in which export-value concentration and competitiveness are treated as complementary metrics: HHI approximates exposure and commercial resilience, while NRCA assesses whether market insertion reflects persistent advantages or transitory outcomes—helping identify whether competitiveness is built alongside sustained diversification or under dependence on a small set of destinations.

1.2. Theoretical Framework

In international trade, diversification is understood as the expansion and balancing of a territory's export portfolio across a broader set of destinations, thereby reducing dependence on a limited number of markets [41]. This concept aligns with a resilience perspective in which a less concentrated export basket supports more stable export levels under disturbances by spreading commercial risk and enabling faster reallocation across market segments. Barbieri et al. [25] synthesize this reasoning by treating export diversification as both a shock-mitigation mechanism and a proxy for the productive and geoeconomic capabilities underlying export performance under crisis conditions.

Theoretically, diversification is linked to structural change and capability accumulation. When an economy expands its export portfolio, it not only changes quantities but also reveals—and may accelerate—the development of technological, organizational, and institutional capabilities needed to produce and place new goods in international markets [42]. Recent evidence also supports diversification as a buffer against macroeconomic vulnerability in economies highly dependent on natural resources [43]. Studies report that export concentration is associated with greater economic vulnerability, reinforcing the idea that diversification is not merely "more variety" but a reduction of systemic risks derived from narrow specialization [44]. Complementary analyses discuss diversification and structural transformation in regions with low export sophistication by comparing productive transformation dynamics and diversification patterns [45]. Satnarine-Singh et al. [46] further examine these interactions by analyzing how export structure and productive transformation condition the margins of diversification and external performance.

Operationalizing diversification via the HHI is consistent with the conceptual definition that "lower concentration equals higher diversification," because the index summarizes, in a single value, how export shares are distributed across destinations and the extent to which a few categories dominate total exports [47,48]. Recent applications use HHI-based indices to measure sectoral and geographic diversification in industrial exports as representations of portfolio breadth and, by extension, underlying capabilities supporting export performance. Barbieri et al. make this explicit

 doi:10.20944/preprints202601.0924.v1

by proposing HHI-based indices to approximate diversification across sectoral and territorial dimensions [25,49–52].

External competitiveness in international economics is typically defined as the relative ability of a country or sector to sustain and expand its presence in international markets, often proxied through revealed comparative advantage indicators derived from observed export patterns [53,54]. The classical reference is Balassa's revealed comparative advantage, which interprets relative export performance as an empirical signal of specialization. Balassa (1965) formalizes this approach by arguing that observed export structures can "reveal" comparative advantages even when technological determinants or factor endowments are not directly observed, making it a widely used basis for measuring product–country competitiveness [1].

Yu et al. (2009) introduce NRCA to improve precision and intertemporal and intersectoral comparability, allowing competitiveness to be interpreted as a relative position whose sign and magnitude indicate advantage or disadvantage and its intensity [3]. This feature is particularly useful when competitiveness must be compared across multiple markets or tracked over time without distortions driven by scale or bounds typical of non-normalized measures.

Diversification and competitiveness can be coherently integrated within a capabilities-and-structural-transformation framework, in which the observable export structure reflects accumulated capabilities and simultaneously conditions the formation of new comparative advantages [55]. In this perspective, a positive and larger NRCA suggests that capabilities, costs, and institutional conditions have converged toward effective specialization in a product [56]. Applied evidence shows that these indicators are often used jointly to characterize external performance and export structure; for example, Mabeta and Smutka (2023) treat NRCA as a core competitiveness metric that links revealed advantage dynamics to structural and orientation shifts in trade [57].

Under this framework, lower destination concentration (lower HHI) is expected to be associated with stronger conditions for sustaining aggregate or sectoral competitiveness over time through two complementary mechanisms. First, from a resilience perspective, a less concentrated structure reduces vulnerability to product- or destination-specific disturbances [58]. Second, from an upgrading and learning perspective, diversification can facilitate cumulative capability-building processes that, in the long run, raise export quality or complexity and improve competitive positioning [59].

2. Materials and Methods

This study followed a quantitative, descriptive–comparative design aimed at characterizing (rather than explaining causally) the joint behavior of destination diversification and revealed competitiveness in global trade of shrimp and prawns. The empirical strategy was intentionally non-causal: the indicators were used to document patterns, co-movements, and cross-country differences across time and destinations, and the interpretations were therefore limited to descriptive associations observed in the trade data. The analysis focused on four leading exporters—Ecuador, India, Viet Nam, and Indonesia—over a five-year window (2020–2024). The unit of analysis was the annual export flow by exporter–destination pair, measured in value FOB.

Export data were obtained from Trade Map [60], using the platform's annual export records for the shrimp and prawn product category, reported in FOB values (current USD) by destination market. For each exporter and year, the full destination breakdown available in Trade Map was downloaded and harmonized into a country–destination–year structure to ensure consistent computation of concentration and competitiveness metrics.

For presentation purposes in the descriptive export tables, the largest destination markets were reported explicitly and the residual set of smaller markets was grouped under an "Others" category. However, to avoid mechanical distortions in diversification and competitiveness measurement, the computation of the indices relied on the complete destination list (i.e., without collapsing destinations into "Others"), so that concentration and competitiveness reflected the exporter's true distribution of export value across markets.

 doi:10.20944/preprints202601.0924.v1

Destination diversification was proxied through the Herfindahl–Hirschman Index (HHI) computed on the distribution of export values across importing markets. Let $X_{c,d,t}$ denote exports (FOB value) from exporter c to destination d in year t. The destination share was defined as:

$$s_{c,d,t} = \frac{X_{c,d,t}}{\sum_d X_{c,d,t}} \qquad (1)$$

HHI was then calculated as the sum of squared shares, expressed on the conventional 0–10,000 scale:

$$HHI_{c,t} = 10{,}000 \sum_d s_{c,d,t}^2 \qquad (2)$$

Higher values indicate greater destination concentration (lower diversification). For interpretability, concentration regimes were read using standard thresholds: HHI < 1000 (low concentration/diversified), 1000–1800 (moderate concentration), and HHI > 1800 (high concentration).

Competitiveness was measured using the Normalized Revealed Comparative Advantage (NRCA) at the destination level, which captures whether an exporter's observed exports to a specific market exceed (or fall short of) the value expected under a neutral benchmark given the exporter's overall scale and the destination's overall absorption. Using standard notation, $X_{c,d,t}$ represents exporter c's exports to destination d; $X_{c,*,t}$ is exporter c's total exports across all destinations; $X_{*,d,t}$ is world exports to destination d; and $X_{*,*,t}$ is total world exports of the product. NRCA was computed as:

$$NRCA_{c,d,t} = \frac{X_{c,d,t} - \left(\frac{X_{c,*,t}\, X_{*,d,t}}{X_{*,*,t}}\right)}{X_{*,*,t}} \qquad (3)$$

NRCA values were interpreted by sign and magnitude: NRCA > 0 indicates revealed comparative advantage (stronger relative competitiveness in that destination), NRCA < 0 indicates revealed comparative disadvantage, and values near zero reflect near-neutral positioning.

The empirical workflow proceeded in a strictly descriptive sequence. First, annual export values by destination were summarized for each country to document growth trajectories and the degree of market anchoring. Second, HHI was computed by country and year to classify the destination structure and identify episodes of tightening or loosening concentration over time. Third, NRCA was computed at the exporter–destination–year level to map market-specific competitiveness and evaluate whether competitiveness was broad-based across destinations or concentrated in a subset of markets.

The indicators employed are descriptive indices and do not identify causal mechanisms; results are therefore discussed as observed patterns consistent with destination concentration and revealed competitiveness dynamics, without attributing effects to policy, shocks, or supply-chain factors not explicitly modeled.

3. Results

3.1. Ecuador

In Table 1, Ecuador's shrimp and prawn exports exhibit a sharp expansion followed by a visible normalization, with a clear dominance of one destination that nevertheless does not move in lockstep with the total. The trajectory is characterized by a pronounced surge into the middle of the period and a subsequent retrenchment that still leaves exports structurally above the initial level. At the same time, the "Others" aggregate gains relative weight toward the end of the period, indicating that growth was not exclusively driven by the largest buyer and that secondary markets contributed non-trivially to the overall export base. This pattern is consistent with a sector that is commercially successful yet exposed to demand and pricing swings in its principal market, because the total is highly sensitive to movements in the leading destination. The partial rebalancing toward additional markets suggests some room for resilience, but the export profile remains vulnerable insofar as a single importer continues to anchor performance. Strategically, the evidence aligns with the

 doi:10.20944/preprints202601.0924.v1

interpretation that Ecuador's shrimp exports combine strong market penetration with a concentration risk that could constrain bargaining power and amplify the transmission of external shocks to export revenues.

Table 1. Exports of Shrimp and Prawns from Ecuador (in millions of USD).

Importers	2020	2021	2022	2023	2024
China	1853	2263	4247	3865	3234
United States of America	654	1182	1510	1364	1463
Spain	242	332	399	383	361
Italy	140	174	231	266	326
France	184	280	269	200	247
Others	554	859	1115	1013	1244
Total	3627	5090	7769	7093	6875

Note. Data taken from International Trade Center (2025).

In Table 2, the HHI levels place Ecuador's shrimp and prawn exports firmly in the high-concentration range throughout the period, indicating persistent dependence on a narrow set of destination markets. The sequence suggests that concentration is not stable but rather episodic: it tightens notably around the middle of the period and then relaxes toward the end, without crossing into even moderate concentration. This implies that diversification gains, when they occur, are incremental and reversible, reflecting a structure where shifts in one or two large markets can quickly re-shape the overall distribution of export value. The implication is that Ecuador's export resilience is constrained by structural concentration, even when headline performance is strong. The late-period reduction in concentration is meaningful because it signals a potential pathway to risk mitigation through wider market absorption, yet the continued high HHI indicates that the export system remains highly exposed to importer-specific disruptions.

Table 2. Market Diversification in Ecuador's Shrimp and Prawn Exports.

Years	2020	2021	2022	2023	2024
HHI in Value	3037	2619	3426	3402	2747

Note. Own elaboration.

In Table 3, the NRCA results indicate a robust and persistent comparative advantage in several destination markets, alongside a borderline-to-neutral position in at least one large market over time. The strongest feature is stability: key markets remain consistently in the comparative-advantage range, with only modest drift, which signals durable competitiveness rather than a temporary placement effect. By contrast, the United States moves from mild comparative disadvantage toward the intra-product trade corridor and eventually into a near-neutral/incipient advantage position, implying a gradual strengthening rather than abrupt repositioning. This configuration suggests that Ecuador's shrimp exports rest on a solid competitive core in specific markets, which can underpin export continuity even when total values fluctuate. However, the coexistence of strong advantage in some destinations and near-neutral positioning in a major market is consistent with segmented competitiveness, where market access, preferences, or competitive intensity may differ across importers. Strategically, the evidence supports the interpretation that Ecuador has room to consolidate and deepen advantage where it is already strong while building a more resilient portfolio by converting near-neutral markets into sustained advantage positions, thereby reducing over-reliance on a narrow set of high-impact buyers.

Table 3. NRCA for Ecuador's Shrimp and Prawn Exports.

Importers	2020	2021	2022	2023	2024
China	0.53	0.52	0.51	0.50	0.52

 doi:10.20944/preprints202601.0924.v1

United States of America	-0.14	-0.02	-0.18	-0.11	0.02
Spain	0.43	0.40	0.28	0.33	0.28
Italy	0.21	0.24	0.27	0.30	0.37
France	0.58	0.58	0.52	0.45	0.49

Note. Own elaboration.

3.2. India

In Table 4, India's shrimp and prawn exports exhibit a high level of market anchoring alongside pronounced cyclical sensitivity in aggregate performance. The trajectory features a sharp expansion followed by a correction and subsequent stabilization, indicating that growth impulses were not fully consolidated into a higher long-run plateau. Across destinations, the United States remains the dominant absorber, while a secondary tier of Asian markets provides additional scale without overturning the hierarchy; the "Others" aggregate also retains material weight, suggesting some breadth but not enough to offset the system's reliance on a few core outlets. This configuration implies an export profile that is commercially strong yet exposed to demand or price fluctuations in its principal markets. The persistence of a leading destination supports revenue continuity and bargaining familiarity, but it also concentrates negotiation and compliance risks, making performance more vulnerable to shifts in procurement cycles or buyer-side standards in those hubs. The meaningful contribution of secondary markets and the residual "Others" category offers a platform for risk distribution, yet the observed inability to sustain the post-expansion peak suggests that resilience would depend less on marginal market additions and more on deepening and broadening demand across multiple destinations simultaneously.

Table 4. Exports of Shrimp and Prawns from India (in millions of USD).

Importers	**2020**	**2021**	**2022**	**2023**	**2024**
United States of America	1811	2580	1888	1812	1883
China	572	744	872	763	752
Japan	308	351	331	269	281
Viet Nam	184	258	291	249	245
Belgium	106	132	174	157	187
Others	813	1082	1240	1072	1033
Total	3793	5149	4797	4321	4381

Note. Data taken from International Trade Center (2025).

In Table 5, the HHI levels consistently place India's shrimp and prawn exports in a highly concentrated structure (well above the 1800 threshold) throughout the period, despite a partial easing after the initial rise. The pattern indicates that concentration intensified early and then retreated, but without transitioning into a moderately concentrated range. The post-peak decline suggests some incremental diversification, yet the rebound afterward signals that dispersion gains were not self-reinforcing, pointing to a structure that remains highly sensitive to the relative pull of the largest markets rather than steadily broadening over time. Sustained high concentration implies that India's export performance is structurally conditioned by a limited set of destination markets, which amplifies exposure to market-specific shocks and buyer power dynamics. The temporary improvement in diversification does not appear to have matured into a durable rebalancing, indicating that competitive positioning may still be organized around scale relationships with dominant importers rather than a wide portfolio logic. Strategically, the evidence is consistent with a need to transform episodic diversification into persistent market development, because only sustained dispersion would materially reduce vulnerability while preserving overall export capacity.

Table 5. Market Diversification in India's Shrimp and Prawn Exports.

Years	**2020**	**2021**	**2022**	**2023**	**2024**

 doi:10.20944/preprints202601.0924.v1

HHI in Value	2644	2833	2020	2199	2271

Note. Own elaboration.

In Table 6, NRCA values are predominantly in the comparative advantage range for the main destinations, indicating a robust and persistent competitiveness profile rather than a marginal or ambiguous specialization. The advantage is especially strong and stable in Japan and Viet Nam, while China also exhibits a notably elevated advantage that strengthens relative to earlier years and remains high thereafter. The United States shows a steady but less extreme advantage, suggesting a mature position that is resilient but not necessarily accelerating, whereas Belgium displays a shift from weak advantage toward clearer advantage by the end of the period, consistent with improving relative positioning in that market. The breadth of comparative advantage across multiple importers suggests that India's concentration is not driven by competitiveness confined to a single market, but by the gravitational pull of large buyers and established trading relationships. This distinction matters: it implies that diversification is feasible from a capability standpoint, since competitive strength appears portable across destinations rather than narrowly market-specific. However, because comparative advantage remains strongest in a subset of markets, the export system may continue to self-select into those channels unless market development efforts intentionally convert capability into a wider demand base, thereby reducing concentration risk without undermining the underlying specialization.

Table 6. NRCA for India's Shrimp and Prawn Exports.

Importers	2020	2021	2022	2023	2024
United States of America	0.45	0.47	0.38	0.41	0.40
China	0.37	0.42	0.69	0.65	0.67
Japan	0.69	0.63	0.69	0.68	0.66
Viet Nam	0.50	0.50	0.65	0.63	0.63
Belgium	0.25	0.06	0.26	0.32	0.48

Note. Own elaboration.

3.3. Viet Nam

In Table 7, Viet Nam's shrimp and prawn exports display a clear pattern of level-shifting rather than smooth growth: aggregate receipts rise into the early part of the window, then contract sharply before a partial recovery. The composition of destinations indicates a portfolio anchored in a small set of large markets, while the residual "Others" block remains structurally decisive for the total and becomes the main source of short-run volatility. Across the principal importers, leadership rotates rather than consolidates, which signals that year-to-year performance is driven more by demand reallocation across partners than by a uniform expansion of Viet Nam's sales frontier. This configuration implies a trade profile that is simultaneously broad and exposed. Breadth is suggested by the large "Others" segment, which can cushion bilateral shocks and provide adaptive room when specific markets soften. Exposure arises because the same segment also concentrates uncertainty: when "Others" compresses, the overall export level deteriorates even if some key partners hold steady.

Table 7. Exports of Shrimp and Prawns from Viet Nam (in millions of USD).

Importers	2020	2021	2022	2023	2024
China	268	264	310	365	331
United States of America	314	500	302	290	314
Japan	340	329	368	276	275
Republic of Korea	221	239	299	201	188
Australia	76	107	163	144	146
Others	723	823	814	601	675

 doi:10.20944/preprints202601.0924.v1

Total	1942	2261	2256	1878	1929

Note. Data taken from International Trade Center (2025).

In Table 8, the HHI values place Viet Nam's destination structure firmly in the zone of moderate concentration throughout the period, with only a brief move into diversified territory. The diversification signal is therefore not a trend of steady broadening, but a cyclical oscillation around the moderate-concentration threshold, indicating sensitivity of market shares to relatively small reallocations among destinations. The quick reversion after the diversification episode suggests that the underlying distribution of demand remains sticky: Viet Nam can widen its market footprint temporarily, but the export mix tends to snap back toward a more concentrated configuration. This persistence of moderate concentration implies that risk is managed but not eliminated. A moderately concentrated structure typically offers some efficiency advantages—scale and relational depth in core markets—yet it leaves the export profile vulnerable to synchronized downturns or tighter access conditions in those anchors.

Table 8. Market Diversification in Viet Nam's Shrimp and Prawn Exports.

Years	**2020**	**2021**	**2022**	**2023**	**2024**
HHI in Value	1028	1083	970	1085	1010

Note. Own elaboration.

In Table 9, the NRCA map is heterogeneous rather than uniformly favorable: sustained comparative advantage is concentrated in a subset of importers, while others remain in comparative disadvantage or hover near the intra-product trade corridor. Japan and Australia consistently sit in the comparative-advantage range, indicating persistent alignment between Viet Nam's export strength and those markets' import structure, while the Republic of Korea stays positive but closer to the boundary, suggesting a more contestable position. China transitions from mild disadvantage toward the intra-product/near-neutral zone, pointing to improving relative competitiveness without yet consolidating a strong advantage; by contrast, the United States remains on the disadvantage side and even crosses into deeper disadvantage at one point, signaling a structurally tougher competitive benchmark. These asymmetries imply that Viet Nam's competitiveness is market-specific, with "safe" destinations where advantage appears entrenched and "pressure" destinations where performance is more dependent on competing margins. Advantage markets provide a platform for stability and upgrading because they are consistent with durable specialization, whereas disadvantage markets imply that growth—if pursued—may require sharper differentiation, cost discipline, or stronger market access positioning to avoid volume-driven fragility. The near-neutral positioning in China is especially meaningful: it suggests strategic optionality, where incremental improvements could shift the relationship into clear advantage, thereby improving the overall robustness of the export portfolio without necessarily increasing concentration if additional gains are spread across secondary markets.

Table 9. NRCA for Viet Nam's Shrimp and Prawn Exports.

Importers	**2020**	**2021**	**2022**	**2023**	**2024**
China	-0.11	-0.18	-0.06	0.06	0.06
United States of America	-0.26	-0.13	-0.38	-0.28	-0.29
Japan	0.44	0.42	0.43	0.38	0.40
Republic of Korea	0.25	0.24	0.34	0.23	0.21
Australia	0.50	0.56	0.66	0.67	0.65

Note. Own elaboration.

3.4. Indonesia

 doi:10.20944/preprints202601.0924.v1

In Table 10, Indonesia's shrimp and prawn exports display a marked shift from expansion to contraction, with the aggregate trajectory peaking early and then falling sharply before settling into a lower plateau. The profile is structurally skewed toward one dominant destination, such that changes in that single market largely determine the overall slope of total exports. The mid-period decline is therefore not merely a generalized weakening across partners, but a re-scaling of the export envelope driven by the largest buyer, while secondary markets remain comparatively small and unable to offset that adjustment. This configuration implies that Indonesia's export performance is best understood as exposure to buyer-specific demand and price-cycle sensitivity rather than as a broadly distributed portfolio outcome. The limited compensatory capacity of alternative destinations constrains resilience: when the leading market retrenches, total export revenues mechanically compress even if other buyers remain stable or improve marginally. From an international business perspective, the pattern is consistent with a commercial strategy anchored in a primary market where Indonesia is deeply embedded, but it also signals that upgrading resilience would require either scaling second-tier destinations or cultivating new markets capable of absorbing volume at meaningful value levels.

Table 10. Exports of Shrimp and Prawns from Indonesia (in millions of USD).

Importers	2020	2021	2022	2023	2024
United States of America	1018	1118	933	677	677
Japan	247	270	285	232	219
China	62	29	97	83	58
Chinese Taipei	11	13	23	22	20
Malaysia	5	6	11	10	14
Others	74	93	103	87	98
Total	1416	1531	1452	1111	1086

Note. Data taken from International Trade Center (2025).

In Table 11, the HHI levels are consistently far above the threshold for high concentration, indicating a persistently concentrated market structure rather than episodic dependence. While the index declines from the earlier years toward the middle of the period, the improvement is partial and does not cross into a lower concentration regime; instead, it resembles a modest easing of dominance within an otherwise concentrated portfolio. The slight rebound at the end of the period suggests that diversification gains are fragile and can be reversed when the distribution of sales across destinations re-tightens. The implication is that Indonesia's export system remains strategically exposed to destination-specific shocks, bargaining power asymmetries, and compliance or logistics disruptions tied to a narrow set of markets. Even when concentration softens, the structure still reflects limited optionality: the country's ability to re-route exports across multiple sizable destinations appears constrained, which can amplify revenue volatility when the lead market adjusts. Consequently, a diversification narrative here would be one of incremental rather than transformational change, where risk reduction depends on building scale in alternative markets rather than relying on marginal dispersion across small buyers.

Table 11. Market Diversification in Indonesia's Shrimp and Prawn Exports.

Years	2020	2021	2022	2023	2024
HHI in Value	5490	5657	4573	4209	4330

Note. Own elaboration.

In Table 12, the NRCA signals a clear segmentation of competitiveness across destinations. The United States exhibits a strong and stable comparative advantage throughout, indicating persistent market-specific strength rather than a temporary spike. Japan also remains in comparative advantage, though at a less extreme level, and its trajectory suggests consolidation of competitiveness

 doi:10.20944/preprints202601.0924.v1

over time. By contrast, China and Malaysia consistently register comparative disadvantage, implying structural limitations in those markets. Chinese Taipei moves from comparative disadvantage toward the intra-product trade band in later years, indicating a partial normalization of competitiveness that remains short of a sustained advantage. These patterns imply that Indonesia's concentration is not only a demand-side outcome but also aligns with where its revealed competitiveness is strongest, reinforcing path dependence toward the leading markets. Strong and stable advantage in the primary destinations supports revenue generation, but it can also lock the export model into a narrow set of market requirements and buyer relationships, raising adjustment costs if conditions shift. Meanwhile, persistent disadvantages in certain Asian markets suggest that diversification cannot be assumed to materialize simply through outreach; it may require changes consistent with market access conditions, product positioning, or value-chain configuration to convert those destinations from structurally weak to competitively viable.

Table 12. NRCA for Indonesia's Shrimp and Prawn Exports.

Importers	2020	2021	2022	2023	2024
United States of America	0.73	0.74	0.74	0.74	0.72
Japan	0.35	0.39	0.40	0.44	0.44
China	-0.63	-0.85	-0.55	-0.54	-0.63
Chinese Taipei	-0.54	-0.55	-0.31	-0.13	-0.15
Malaysia	-0.87	-0.85	-0.76	-0.68	-0.57

Note. Own elaboration.

3.5. Comparative Overview

In Table 13, the cross-country profile reveals four distinct export-growth–diversification–competitiveness configurations. Ecuador combines a strong upward export trajectory with persistent high concentration, where the modest easing of HHI does not overturn the central diagnosis: growth has been achieved through a narrowly distributed destination structure that tightened around the peak period and only partially relaxed afterward. India exhibits more moderate net expansion but with a pronounced cycle—an early surge followed by retrenchment—alongside high concentration that intermittently loosens and then re-tightens, suggesting that dispersion gains have not yet become structurally entrenched. Viet Nam stands out for near-stagnant export levels paired with moderate concentration that oscillates around a stable band, including a brief diversification episode that does not persist, consistent with reallocation across markets rather than sustained scale-up. Indonesia presents the most fragile configuration: a clear contraction in exports coexisting with extremely high concentration that, despite some improvement, remains exceptional in magnitude, indicating that the export base is not only shrinking but also highly dependent on a narrow set of destinations. The competitiveness signals clarify why these trajectories differ in resilience and strategic room to maneuver. India's pattern is the most structurally favorable: comparative advantage is broad and stable across multiple key markets, implying that its constraint is less about market-specific competitiveness and more about converting that advantage into a more evenly distributed destination portfolio and steadier expansion. Ecuador's advantages are sustained but more market-selective, and the movement of the U.S. position toward neutrality implies incremental upgrading of competitiveness in a large market; however, the continuing high concentration means that positive shocks translate quickly into growth while negative shocks can propagate just as rapidly. Viet Nam's advantages are concentrated in a small set of partners, while the U.S. remains a comparative disadvantage; the combination of moderate concentration and flat exports is consistent with a profile that can reassign volumes across destinations but struggles to generate net growth without deeper competitiveness gains in large-demand markets. Indonesia's competitiveness is sharply asymmetric—very strong advantage in the U.S. alongside persistent disadvantages in other major partners—so the observed export contraction is consistent with a model that is highly exposed to a

 doi:10.20944/preprints202601.0924.v1

single anchor market and limited in its capacity to offset losses through alternative destinations, making diversification not simply desirable but foundational for reducing systemic vulnerability.

Table 13. Comparison table.

Country	Export Trend (2020–2024)	Key Growth Markets	HHI Trend	Competitiveness
Ecuador	Increases from 3627 in 2020 to 6875 in 2024 (+89.6%). Peak in 2022 (7769); 2024 is 11.5% below the peak.	China +1381; United States +809; Others +690.	High concentration throughout. HHI declines from 3037 (2020) to 2747 (2024), with higher concentration in 2022–2023 (3426–3402).	Sustained advantage in China (≈0.50–0.53), France (≈0.45–0.58), and Spain (≈0.28–0.43). Italy strengthens (from 0.21 to 0.37). The U.S. improves to a near-neutral position (from −0.14 to 0.02).
India	Rises from 3793 in 2020 to 4381 in 2024 (+15.5%). Peak in 2021 (5149); 2024 is 14.9% below the peak.	Others +220; China +180; Belgium +81. (The U.S. remains the largest destination, but its net change is +72).	High concentration persists. HHI falls from 2644 (2020) to 2271 (2024), with a peak in 2021 (2833), a low in 2022 (2020), and re-tightening in 2023–2024.	Broad and stable advantage in Japan (≈0.63–0.69), Viet Nam (≈0.50 to 0.63), China (≈0.37 to 0.67), and the U.S. (≈0.38–0.47). Belgium improves sharply (from 0.06 to 0.48).
Viet Nam	Essentially flat: 1942 in 2020 and 1929 in 2024 (−0.7%). Peak in 2021 (2261); 2024 is 14.7% below the peak.	Australia +70 and China +63 increase, while Japan −65 and Others −48 decrease; the outcome is reallocation.	Moderate concentration. HHI moves from 1028 (2020) to 1010 (2024), with a diversification episode in 2022 (970) and a subsequent return.	Advantage in Australia (≈0.50–0.67) and Japan (≈0.38–0.44); Korea shows moderate advantage (≈0.21–0.34). China improves to near-neutral/incipient advantage (from −0.18 to 0.06). The U.S. remains in disadvantage (≈−0.13 to −0.38).
Indonesia	Declines from 1416 in 2020 to 1086 in 2024 (−23.3%). Peak in 2021 (1531); 2024 is 29.1% below the peak.	Marginal increases: Others +24, Malaysia +9, Chinese Taipei +9. The contraction is dominated by the U.S. −341.	Very high concentration. HHI drops from 5490 (2020) to 4330 (2024), with partial easing in 2022–2023 (4573 to 4209) and slight re-tightening in 2024.	Very strong advantage in the U.S. (≈0.72–0.74) and advantage in Japan (from 0.35 to 0.44). Structural disadvantage in China (≈−0.54 to −0.85) and Malaysia (≈−0.57 to −0.87). Chinese Taipei improves but remains negative (from −0.54 to −0.15).

4. Discussion

The evidence indicates that, over 2020–2024, shrimp and prawn export performance cannot be interpreted solely from total export value, but must be read through changes in destination structure—where growth and vulnerability may coexist depending on the degree of anchoring in major markets. Using International Trade Center data [60], Ecuador exhibits expansion with a peak in 2022 followed by a correction; India shows a surge and adjustment with subsequent stabilization; Viet Nam displays relative stagnation with oscillations; and Indonesia records a net contraction. This heterogeneity confirms that performance assessment depends on whether variation is driven by the dominant destination or by shifts across secondary markets, which is directly linked to external exposure under concentration [15].

HHI results reinforce that destination concentration is persistent and that diversification, when present, tends to be partial and potentially reversible. Ecuador, India, and Indonesia remain mostly within high concentration regimes, whereas Viet Nam stays largely in moderate concentration with occasional episodes of greater dispersion. This pattern is consistent with non-monotonic trajectories of diversification and re-specialization (Imbs and Wacziarg [20]) and with the notion that trade openness does not automatically produce deconcentration when productive and institutional constraints are binding (Osakwe et al. [22]). Persistent concentration implies continued vulnerability,

 doi:10.20944/preprints202601.0924.v1

as diversification is associated with lower exposure (Mano and Combary [24]); moreover, even moderate concentration retains residual risk when shocks are synchronized across anchor markets (Haddad et al. [23]). For Indonesia, the observed contraction is also compatible with logistical and infrastructure constraints typical of perishable seafood trade, which limit the feasibility and speed of rerouting toward new trade corridors (Asche et al. [35]).

NRCA results show that competitiveness is neither homogeneous nor necessarily transferable across destinations. NRCA is appropriate in this setting because its comparability reduces scale bias [3], helping avoid conflating export size with advantage. Ecuador and Viet Nam display market-differentiated advantages, underscoring the value of normalized indicators relative to the limitations of traditional RCA (Hinloopen and van Marrewijk [26]). At the same time, the limited translation of competitiveness into lower concentration may reflect standards-based access and market governance constraints [8]. In India, a broader advantage profile suggests that concentration is shaped less by competitiveness limitations and more by the gravitational pull of large buyers and entrenched relationships, consistent with arguments on learning and export performance (Markakkaran et al. [21]) and with the role of regulatory compatibility and market development for sustaining diversification [19]. In Viet Nam, the persistence of disadvantage in a large-scale market points to structural positioning barriers (Khan et al. [40]). In Indonesia, NRCA asymmetry—strong advantage in the dominant destination combined with disadvantages in alternatives—implies a dual dependence on demand and competitiveness and calls for cautious interpretation in light of value-chain linkages and gross-trade measurement issues (Seung [37]).

The integrated HHI–NRCA reading confirms that a positive NRCA does not automatically imply low HHI, and that vulnerability increases when concentration coincides with the location of advantage. When the dominant market concentrates both export value and competitiveness, the capacity to reorient under shocks is constrained—consistent with interpreting diversification as a proxy for resilience (Barbieri et al. [25]) and with the association between export resilience and lower concentration [58]. However, HHI shifts should be interpreted cautiously because apparent diversification at the national level may coexist with firm-level concentration (Straume et al. [36]). Overall, the results suggest that performance sustainability depends less on "exporting more" and more on expanding destinations at scale where competitiveness is favorable or improvable, so that diversification is effective in value terms rather than merely nominal, and aligns with upgrading and learning processes [59].

5. Conclusions

Using a quantitative descriptive–comparative design, the study shows that combining destination diversification (HHI) and revealed competitiveness (NRCA) provides a more comprehensive characterization of shrimp and prawn export performance in Ecuador, India, Viet Nam, and Indonesia during 2020–2024. First, destination-level disaggregation reveals differentiated trajectories of expansion and adjustment, confirming that performance is shaped not only by totals but also by shifts in destination architecture and varying degrees of anchoring in major markets, with direct implications for external exposure.

Second, HHI classifies concentration regimes that appear partially reversible: diversification gains may reflect short-lived shifts in relative shares rather than sustained portfolio transformation. Accordingly, diversification operates as an applied metric for interpreting commercial resilience as a function of geographic dependence, consistent with its theoretical foundation as risk mitigation.

Third, exporter–destination–year NRCA indicates that observed competitiveness is segmented in several cases: diversification capacity depends not only on increasing sales but also on sustaining comparative advantages in new destinations or converting near-neutral positions into persistent advantages, as suggested by the approach of Yu et al.

Fourth, the integrated comparison confirms that concentration can coexist with high competitiveness, yet it can also restrict adjustment capacity under shocks when comparative advantage is aligned with a small set of anchor markets. Competitiveness and commercial resilience

 doi:10.20944/preprints202601.0924.v1

are therefore not equivalent and may evolve in a decoupled manner. With respect to the general objective, the evidence supports that export performance is interpreted more robustly when competitive strength and destination structure are assessed jointly as complementary metrics to understand both the sustainability of export leadership and exposure to external disturbances.

In terms of implications, the study recommends institutionalizing a trade-risk management system that integrates concentration signals by destination and competitive performance by market within a single dashboard; strengthening market intelligence and destination-based early warning mechanisms (including monitoring the dominant destination and the "Others" block); setting operational deconcentration targets with staged penetration plans for secondary destinations; and adopting market-differentiated strategies—consolidating advantages where NRCA is robust, transforming neutral positions into sustained advantages, and redesigning entry into disadvantaged markets through improvements in quality, presentation, traceability, and logistics efficiency. The study also suggests promoting learning and benchmarking schemes among leading exporters to accelerate the translation of competitiveness into effective diversification.

Finally, given the limitations of the descriptive–comparative design, the use of annual FOB values, and the 2020–2024 window, further work should complement HHI and NRCA with quantities, unit prices, cost structures, logistics conditions, and market-specific regulatory changes, avoiding causal interpretations. As a future agenda, explanatory approaches and greater granularity are proposed (gravity models, firm- or producing-region analysis, value-added measures, and indicators of non-tariff barriers, certifications, and sanitary events) to identify determinants and mechanisms underlying changes in concentration and NRCA and to prioritize interventions with greater rigor.

Author Contributions: Conceptualization, L.A.O.G., A.M.S.Y. and F.L.P.L.; methodology, F.E.R.N. and F.L.P.L.; software, J.C.M.N., L.I.G.A. and C.E.M.O.; validation, P.R.M.O., C.E.M.O and L.I.G.A.; formal analysis, J.C.M.N., P.R.M.O. and Y.P.S.R.; investigation, L.A.O.G. and L.I.G.A.; resources, C.E.M.O. and M.M.F.C.; data curation, J.C.M.N. and M.M.F.C.; writing—original draft preparation, F.E.R.N. and M.M.F.C.; writing—review and editing, F.E.R.N. and F.L.P.L.; visualization, L.A.O.G. and A.M.S.Y.; supervision, P.R.M.O. and Y.P.S.R.; project administration, A.M.S.Y and Y.P.S.R.. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Balassa, B. Trade Liberalisation and "Revealed" Comparative Advantage. *The Manchester School* 1965, *33*, 99–123. https://doi.org/10.1111/j.1467-9957.1965.tb00050.x.
2. Laursen, K. Revealed Comparative Advantage and the Alternatives as Measures of International Specialization. *Eurasian Business Review* 2015, *5*, 99–115. https://doi.org/10.1007/s40821-015-0017-1.
3. Yu, R.; Cai, J.; Leung, P. The Normalized Revealed Comparative Advantage Index. *Ann Reg Sci* 2009, *43*, 267–282. https://doi.org/10.1007/s00168-008-0213-3.
4. Mano, H.; Combary, O. Effects of Export Diversification on Economic Vulnerability: The Case of WAEMU Countries. *J Int Trade Econ Dev* 2025, *34*, 1872–1892. https://doi.org/10.1080/09638199.2025.2482542.
5. Trinh, P.; Thuy, H. Export Diversification and Economic Growth: A Threshold Regression Approach for Emerging Markets and Developing Countries. *Economic Journal of Emerging Markets* 2021, *13*, 188–199. https://doi.org/10.20885/ejem.vol13.iss2.art8.

 doi:10.20944/preprints202601.0924.v1

6. Villarreal, H. Shrimp Farming Advances, Challenges, and Opportunities. *J World Aquac Soc* 2023, *54*, 1092–1095. https://doi.org/10.1111/jwas.13027.
7. Boyd, C.; Davis, R.; Wilson, A.; Marcillo, F.; Brian, S.; McNevin, A. Resource Use in Whiteleg Shrimp Litopenaeus Vannamei Farming in Ecuador. *J World Aquac Soc* 2021, *52*, 772–788. https://doi.org/10.1111/jwas.12818.
8. Kruk, S.; Toonen, H.; Bush, S. Digital Sustainability Assurance Governing Global Value Chains: The Case of Aquaculture. *Regul Gov* 2024, *18*, 1153–1170. https://doi.org/10.1111/rego.12571.
9. Watanabe, H.; Ubukata, F. Does International Environmental Certification Change Local Production and Trade Practices? A Case Study of Shrimp Farming in Southern Vietnam. *Hum Ecol* 2023, *51*, 781–794. https://doi.org/10.1007/s10745-023-00424-x.
10. Chang, C.; McAleer, M.; Nguyen, D. US Antidumping Petitions and Revealed Comparative Advantage of Shrimp-exporting Countries. *Rev Aquac* 2019, *11*, 782–792. https://doi.org/10.1111/raq.12257.
11. Ministerio de Producción, C.E.I. y P. de E. ANÁLISIS TRIMESTRAL COMERCIO EXTERIOR. 2024.
12. Chandrasekar, V.; Geethalakshmi, V.; A. Suresh; Nikita Gopal Indian Marine Products Exports: Growth, Instability and Geographical Diversification. *Indian Journal of Fisheries* 2024, *71*. https://doi.org/10.21077/ijf.2024.71.3.135286-18.
13. Islam, S. Product and Geographical Concentrations of Exports: Some Evidence for Selected Asian Countries. *South Asian Research Journal of Business and Management* 2025, *7*, 218–220. https://doi.org/10.36346/sarjbm.2025.v07i03.005.
14. Aranda, T.; Yuddy, C. Hit by US Tariffs, Indonesia Plans to Sell Shrimp to China Instead Available online: https://www.reuters.com/world/china/hit-by-us-tariffs-indonesia-plans-sell-shrimp-china-instead-2025-08-06/ (accessed on 1 January 2026).
15. Villarreal, H. Shrimp Farming Advances, Challenges, and Opportunities. *J World Aquac Soc* 2023, *54*, 1092–1095. https://doi.org/10.1111/jwas.13027.
16. Ministerio de Producción, C.E.I. y P. *ANÁLISIS TRIMESTRAL - Comercio Exterior*; 2024;
17. Santhosha, K.; Naik, A.D.; Patil, G.I.; Yadava, C.G.; Srinivasulu G. B.; Raghavendra Export Performance and Trade Competitiveness of India's Frozen Shrimps: A Temporal Analysis. *Archives of Current Research International* 2024, *24*, 427–436. https://doi.org/10.9734/acri/2024/v24i5720.
18. Vietnam Association of Seafood Exporters and Producers After 11 Months, Shrimp Exports Reach Nearly 3.6 Billion USD Available online: https://seafood.vasep.com.vn/key-seafood-sectors/shrimp/news/after-11-months-shrimp-exports-reach-nearly-3-6-billion-usd-32420.html (accessed on 9 January 2026).
19. Baylis, K.; Nogueira, L.; Fan, L.; Pace, K. Something Fishy in Seafood Trade? The Relation between Tariff and Non-tariff Barriers. *Am J Agric Econ* 2022, *104*, 1656–1678. https://doi.org/10.1111/ajae.12303.
20. Imbs, J.; Wacziarg, R. Stages of Diversification. *American Economic Review* 2003, *93*, 63–86. https://doi.org/10.1257/000282803321455160.
21. Markakkaran, S.; Sridharan, P. Impact of Export Diversification on Economic Growth: A System GMM Approach. *International Journal of Development Issues* 2022, *21*, 309–320. https://doi.org/10.1108/IJDI-10-2021-0210.
22. Osakwe, P.; Santos-Paulino, A.; Dogan, B. Trade Dependence, Liberalization, and Exports Diversification in Developing Countries☆. *Journal of African Trade* 2018, *5*, 19. https://doi.org/10.1016/j.joat.2018.09.001.
23. Haddad, M.; Lim, J.J.; Pancaro, C.; Saborowski, C. Trade Openness Reduces Growth Volatility When Countries Are Well Diversified. *Canadian Journal of Economics/Revue canadienne d'économique* 2013, *46*, 765–790. https://doi.org/10.1111/caje.12031.
24. Mano, H.; Combary, O.S. Effects of Export Diversification on Economic Vulnerability: The Case of WAEMU Countries. *J Int Trade Econ Dev* 2025, *34*, 1872–1892. https://doi.org/10.1080/09638199.2025.2482542.
25. Barbieri, E.; Capoani, L.; Cattaruzzo, S.; Corò, G. Export Diversification Dimensions and Performance: Analysis and Industrial Policy Insights from Italian Territories over Covid-19 Shocks. *Socioecon Plann Sci* 2024, *94*, 101923. https://doi.org/10.1016/j.seps.2024.101923.
26. Hinloopen, J.; Marrewijk, C. On the Empirical Distribution of the Balassa Index. *Weltwirtsch Arch* 2001, *137*, 1–35. https://doi.org/10.1007/BF02707598.

 doi:10.20944/preprints202601.0924.v1

27. Foster, J. Putting Social Preferences to Work: Can Revealed Preferences Predict Real Effort Provision? *J Econ Psychol* 2014, *45*, 128–140. https://doi.org/10.1016/j.joep.2014.08.004.
28. Stellian, R.; Danna-Buitrago, J.P. Revealed Comparative Advantage and Contribution-to-the-Trade-Balance Indexes. *International Economics* 2022, *170*, 129–155. https://doi.org/10.1016/j.inteco.2022.02.007.
29. García Juárez, H.D.; Montes Ninaquispe, J.C.; Marquez Yauri, H.Y.; Rodríguez Abraham, A.R.; Corrales Otazú, C.D.; Apaza Miranda, S.J.; Suysuy Chambergo, E.J.; León Luyo, S.L.; Flores Castillo, M.M. Market Diversification and International Competitiveness of South American Coffee: A Comparative Analysis for Export Sustainability. *Sustainability (Switzerland)* 2025, *17*. https://doi.org/10.3390/SU17115091.
30. Montes, J.; Vasquez, K.; Ludeña, D.; Pantaleón, A.; Farías, J.; Suárez, F.; Escalona, E.; Arbulú-Ballesteros, M. Market Diversification and Competitiveness of Fresh Grape Exports in Peru. *Sustainability* 2024, *16*, 2528. https://doi.org/10.3390/su16062528.
31. Montes Ninaquispe, J.C.; Ludeña Jugo, D.A.; Blas Sanchez, J.E.; Cruz Salinas, L.E.; Flores Lezama, M.T.; Martel Acosta, R.; Pacheco Gonzales, I.B.; Guzmán Valle, M. de los Á. An Analysis of Market Diversification Strategy and Commercial Competitiveness in the Cocoa Bean Exporting Companies. *Corporate and Business Strategy Review* 2025, *6*, 178–186. https://doi.org/10.22495/cbsrv6i1art17.
32. Montes Ninaquispe, J.C.; Castillo-Coronado, Y.D.M.; Chavesta Paico, S.J.; Carbonel Mendoza, J.L.; Vasquez Huatay, K.C.; Portilla Sampen, J.E.; Zegarra Escudero, H.T. Diversification and Revealed Comparative Advantage of Global Strawberry Exports, 2019–2023. In Proceedings of the Proceedings of the 23rd LACCEI International Multi-Conference for Engineering, Education and Technology (LACCEI): "Engineering, Artificial Intelligence, and Sustainable Technologies in service of society"; Latin American and Caribbean Consortium of Engineering Institutions, 2025.
33. Corrales Otazú, C.D.; Apaza Miranda, S.J.; Montes Ninaquispe, J.C.; Arbulú Ballesteros, M.A.; Palma Vallejo, J.G.; Rodriguez Novoa, F.E.; Sandoval Reyes, C.J.; Sanchez García, I.E.; Reyes Aroca, M.A.; Medina Rodriguez, J.E. Diversification and Competitiveness of Banana Exports in the Andean Community Countries. *Sustainability* 2025, *17*, 10685. https://doi.org/10.3390/su172310685.
34. García, H.; Montes, J.; León, S.; Marquez, H.; Mendoza, C.; De La Cruz Ruiz, N.V.; Apaza Miranda, S.J.; Corrales Otazú, C.D.; Rodríguez Abraham, A.R.; Villanueva Butrón, G.V. Competitiveness and Diversification in Grape Exports: Keys to Their Sustainability in Global Markets. *Agriculture* 2025, *15*, 1894. https://doi.org/10.3390/agriculture15171894.
35. Asche, F.; Straume, H.; Vårdal, E. Perish or Prosper: Trade Patterns for Highly Perishable Seafood Products. *Agribusiness* 2021, *37*, 876–890. https://doi.org/10.1002/agr.21704.
36. Straume, H.-M.; Asche, F.; Oglend, A.; Gaasland, I.; Pettersen, I.K.; Sogn-Grundvåg, G. The Structure of Norwegian Seafood Trade. *Mar Policy* 2024, *159*, 105921. https://doi.org/10.1016/j.marpol.2023.105921.
37. Seung, C. Decomposing Global Value Chain (GVC) Income for World Fisheries. *Mar Policy* 2022, *137*, 104950. https://doi.org/10.1016/j.marpol.2021.104950.
38. Ling, B.H.; Leung, P.S.; Shang, Y.C. Export Performance of Major Cultured Shrimp Producers in the Japanese and US Markets. *Aquac Res* 1996, *27*, 775–786. https://doi.org/10.1046/j.1365-2109.1996.t01-1-00794.x.
39. Yu, R.; Cai, J.; Leung, P. AN EXPLORATORY PERFORMANCE ASSESSMENT OF SHRIMP EXPORTERS FOR THE U.S. MARKET. *Aquaculture Economics & Management* 2008, *12*, 225–251. https://doi.org/10.1080/13657300802494115.
40. Khan, Md.A.; Hossain, Md.E.; Islam, Md.S.; Rahman, Md.T.; Dey, M.M. Shrimp Export Competitiveness and Its Determinants: A Novel Dynamic ARDL Simulations Approach. *Aquaculture Economics & Management* 2023, *27*, 221–248. https://doi.org/10.1080/13657305.2022.2089772.
41. Montes, J.; Arbulú-Ballesteros, M.; Morales, A.; Salinas, L.; Farfán-Chilicaus, G.; Juárez, H.; Valle, M.; Sanchez, J. Diversification of Export Markets: A Literature Review. *Journal of Educational and Social Research* 2024, *14*, 260–275. https://doi.org/10.36941/jesr-2024-0137.
42. Saviotti, P.-P.; Pyka¤, A.; Jun, B. Diversification, Structural Change, and Economic Development. *J Evol Econ* 2020, *30*, 1301–1335. https://doi.org/10.1007/s00191-020-00672-w.

43. Houngbedji, H.S. Diversification Des Exportations et Vulnérabilité Des Économies Des Pays de l'Afrique Subsaharienne : Rôle de La Dépendance En Ressources Naturelles. *La Revue Internationale des Économistes de Langue Française* 2022, *7*, 111–134. https://doi.org/10.18559/rielf.2022.1.7.
44. Gnangnon, S.K. Export Product Concentration and Poverty Volatility in Developing Countries. *The International Trade Journal* 2024, *38*, 221–244. https://doi.org/10.1080/08853908.2023.2192016.
45. Ortiz, C.; Jiménez, D.; Jaramillo, M. Diversificación Productiva y Cambio Estructural En Economías Cerradas y Abiertas. *Lecturas de Economía* 2019, 11–39. https://doi.org/10.17533/udea.le.n91a01.
46. Satnarine-Singh, N.; Hosein, R.; Saridakis, G. Structural Change and Export Diversification: A Comparison of CARICOM's Position. *J Int Trade Econ Dev* 2024, *33*, 1163–1189. https://doi.org/10.1080/09638199.2023.2240910.
47. Prada Villamizar, E.; García Cediel, G. Concentración o Diversificación Exportadora Por Destinos: Un Análisis a Través Del Índice Herfindahl Hirschmann En Santander, Colombia. *Saber Ciencia y Libertad* 2016, *11*, 111. https://doi.org/10.22525/sabcliber.2016v11n2.111120.
48. Islam, S. Product and Geographical Concentrations of Exports: Some Evidence for Selected Asian Countries. *South Asian Research Journal of Business and Management* 2025, *7*, 218–220. https://doi.org/10.36346/sarjbm.2025.v07i03.005.
49. Cadot, O.; Carrère, C.; Strauss-Kahn, V. Export Diversification: What's behind the Hump? *Review of Economics and Statistics* 2021, *93*, 590–605. https://doi.org/10.1162/REST_a_00078.
50. Canh, N.; Thanh, S. The Dynamics of Export Diversification, Economic Complexity and Economic Growth Cycles: Global Evidence. *Foreign Trade Review* 2022, *57*, 234–260. https://doi.org/10.1177/0015732520970441.
51. Mora, J.; Olabisi, M. Economic Development and Export Diversification: The Role of Trade Costs. *International Economics* 2023, *173*, 102–118. https://doi.org/10.1016/j.inteco.2022.11.002.
52. Montes, J. Diversification and Corporate Strategy of Agricultural Products Exports from a Developing Country. *Corporate and Business Strategy Review* 2025, *6*, 138–148. https://doi.org/10.22495/cbsrv6i3art13.
53. Irsahd, M.S.; Xin, Q. Determinants of Exports Competitiveness: An Empirical Analysis through Revealed Comparative Advantage of External Sector of Pakistan. *Asian Economic and Financial Review* 2017, *7*, 623–633. https://doi.org/10.18488/journal.aefr.2017.76.623.633.
54. Maqbool, M.S.; Rehman, H. ur; Bashir, F. Comparative Advantage in International Trade: A Study Based on Meat Exports in Pakistan. *Review of Applied Management and Social Sciences* 2022, *5*, 43–51. https://doi.org/10.47067/ramss.v5i1.207.
55. Patelli, A.; Napolitano, L.; Cimini, G.; Pugliese, E.; Gabrielli, A. Capability Accumulation Patterns across Economic, Innovation, and Knowledge-Production Activities. *Sci Rep* 2023, *13*, 12988. https://doi.org/10.1038/s41598-023-29979-x.
56. Martínez Hernández, A.; Caamal Cauich, I. Revealed Comparative Advantage and Competitiveness of Mexican Mango Exports. *Agro Productividad* 2024. https://doi.org/10.32854/agrop.v17i9.2737.
57. Mabeta, J.; Smutka, L. Trade and Competitiveness of African Sugar Exports. *Front Sustain Food Syst* 2023, *7*. https://doi.org/10.3389/fsufs.2023.1304383.
58. BURLUTSKI, S.; BURLUTSKA, S.; BEREZIANKO, T. THE EXPORT DETERMINANT OF SOCIO-ECONOMIC RESILIENCE IN FOREIGN ECONOMIC ACTIVITY. *JOURNAL OF LIFE ECONOMICS* 2019, *6*, 413–420. https://doi.org/10.15637/jlecon.6.025.
59. Gehl Sampath, P.; Vallejo, B. Trade, Global Value Chains and Upgrading: What, When and How? *Eur J Dev Res* 2018, *30*, 481–504. https://doi.org/10.1057/s41287-018-0148-1.
60. Trademap Exportaciones Mundiales. *https://www.trademap.org/* 2022.