

Dynamics of India's Marine Product Exports: Growth, Structural Change and Transition Behaviour across Global Markets

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Abstract

India is one of the world's leading exporters of marine products; however, changing global demand patterns, increasing sanitary and phytosanitary (SPS) requirements, market diversification, the COVID-19 pandemic, and recent geopolitical disruptions have substantially altered the dynamics of international seafood trade. Despite the growing importance of destination stability in sustaining export growth, limited evidence exists on the long-term evolution of India's marine export markets. The present study examined the growth performance, export realization, instability, diversification, structural transformation, trade direction, and destination-wise stability of India's marine product exports during 1995–96 to 2024–25. Secondary data on destination-wise export quantity and value were collected from the Marine Products Export Development Authority (MPEDA). The study employed Compound Annual Growth Rate (CAGR), Unit Value Realization (UVR), Della Valle Instability Index, Hirschman Index, Simpson Diversification Index, Structural Change Index, and Markov Chain Analysis. The results revealed that India's marine exports grew at an annual rate of 6.47 per cent in quantity and 11.65 per cent in value, indicating stronger growth in export earnings than export volumes. South East Asia recorded the highest growth in export quantity, while the USA emerged as the fastest-growing destination in value terms. Unit Value Realization analysis identified the USA, Japan, and the European Union as premium export markets, whereas China recorded the highest growth in export realization. Diversification analysis indicated improved destination diversification up to the mid-2010s, followed by moderate reconcentration in recent years. Structural change analysis revealed a gradual shift in export orientation from traditional destinations such as Japan and the European Union towards the USA, China, South East Asia, and other emerging markets. Markov Chain analysis identified the Middle East (0.9898), USA (0.9365), South East Asia (0.8786), and China (0.8673) as the most stable destinations in quantity terms, while the USA (1.0000), Middle East (0.9910), and South East Asia (0.9052) exhibited the highest retention probabilities in value terms. The findings indicate that India's marine export sector has evolved towards a more diversified and resilient destination structure, emphasizing the importance of market diversification, value addition, and sustained engagement with high-retention markets for enhancing long-term export competitiveness.

INTRODUCTION

The fisheries and aquaculture sector has emerged as one of the fastest-growing components of the global food system, contributing significantly to food security, nutritional security, employment generation, livelihood enhancement, and international trade. Rising incomes, population growth, urbanization, and changing dietary preferences have substantially increased global demand for fish and fishery products, making seafood one of the most extensively traded food commodities worldwide (FAO, 2024; Kalaiarasi and Kavithambika, 2024). The increasing globalization of seafood supply chains has expanded market opportunities for exporting countries while simultaneously exposing them to intense competition, changing consumer preferences, and evolving regulatory requirements. Consequently, the performance of fisheries exports has become an important determinant of economic growth and foreign exchange earnings in many developing countries (Ramadhan et al., 2024).

India occupies a prominent position in the global fisheries sector owing to its extensive coastline, rich marine biodiversity, vast inland water resources, and rapidly expanding aquaculture industry. The fisheries sector contributes substantially to agricultural exports, employment generation, nutritional security, and livelihood support for millions of stakeholders engaged in harvesting, processing, transportation, marketing, and export activities (Sathianandan et al., 2018). Over the last three decades, India has transformed from a traditional seafood exporter into one of the world's leading suppliers of marine products, driven by technological advancements in aquaculture, modernization of processing infrastructure, improvements in cold-chain logistics, and greater integration with international markets (Chandrasekar et al., 2020). Among various export commodities, frozen shrimp has emerged as the principal contributor to marine export earnings, significantly influencing India's overall export performance.

The growth of India's marine export sector has been accompanied by substantial changes in the geographical distribution of export destinations. Historically, Japan and the European Union dominated India's marine export trade and accounted for a major share of export earnings. However, the global seafood trade landscape has undergone significant restructuring since the liberalization period. The emergence of the United States as a major importer of shrimp, rapid expansion in Chinese seafood demand, increasing regional trade integration within Asia, and the growing importance of Middle Eastern markets have considerably altered the direction of India's marine exports. Studies have reported increasing diversification of export destinations and a gradual reduction in dependence on traditional markets, particularly Japan, in favour of emerging destinations such as China, South East Asia, and the USA (Gunabhagya et al., 2016; Chandrasekar et al., 2020).

These changes have occurred alongside major transformations in the international trade environment. The establishment of the World Trade Organization (WTO) facilitated greater market integration and expanded export opportunities, but also intensified competition in international seafood markets. Simultaneously, importing countries strengthened sanitary and phytosanitary (SPS) regulations, traceability requirements, residue monitoring systems, food safety standards, and quality certification protocols, making compliance an increasingly important determinant of export competitiveness (Salim and Narayanakumar, 2012). Several studies have highlighted that SPS measures and technical barriers to trade significantly influence market access and export performance in the seafood sector. Fayaz and Ahmed (2020) observed that increasing competition and stringent quality standards contributed to declining competitiveness in traditional markets while encouraging the diversification of exports towards South and South-East Asian destinations. Similarly, Salim (2012) reported that post-WTO trade liberalization created opportunities for market diversification but also increased compliance costs associated with international quality standards.

The growing complexity of international seafood trade has attracted considerable research attention. Earlier studies primarily focused on export growth, instability, comparative advantage, and competitiveness using tools such as compound growth rates, instability indices, Revealed Comparative Advantage (RCA), and Constant Market Share (CMS) analysis. These studies generally concluded that India possesses a strong comparative advantage in seafood exports, particularly in shrimp products, and that export performance has benefited from aquaculture expansion and market diversification. More recent studies have shifted attention towards trade direction and market stability. Markov Chain analysis has been widely used to examine the retention behaviour of export markets and identify stable destinations capable of sustaining long-term trade relationships. Gunabhagya et al. (2016) reported that South East Asia emerged as one of the most stable destinations for Indian fish exports, while Chandrasekar et al. (2020) found relatively high retention probabilities for the European Union, China, and South East Asia in India's marine export trade. Sirisha and Subba Rao (2020) identified the European Union as a stable destination for Indian shrimp exports, whereas Kalaiarasi and Kavithambika (2024) emphasized the continuing importance of the USA and Japan in international seafood trade. Sathianandan et al. (2018) further demonstrated the usefulness of Markov Chain models in understanding long-term transition behaviour and stability patterns within fisheries systems.

Despite these contributions, important gaps remain in the existing literature. Most previous studies have examined export growth, competitiveness, or trade direction independently and have relied on relatively shorter study periods. Consequently, they do not fully capture the profound structural transformations that have occurred in global seafood trade over the last three decades. Significant developments such as WTO-led trade liberalization, rapid expansion of shrimp aquaculture, emergence of China as a major seafood importer, increasing importance of South East Asian markets, growing dominance of the USA in shrimp imports, and recent global supply-chain disruptions have fundamentally altered international seafood trade dynamics. Furthermore, earlier studies have largely focused either on export quantity or specific commodities and have seldom compared destination stability simultaneously in both quantity and value terms. Such comparisons are particularly important because markets that absorb larger export

volumes may not necessarily generate higher export earnings, while premium destinations may remain economically important despite declining quantity shares.

The need for a comprehensive reassessment of destination market stability has become even more important in the context of recent global developments. Changing consumer preferences, supply-chain disruptions, post-pandemic trade adjustments, sustainability concerns, and shifting geopolitical conditions have significantly influenced international seafood trade flows. While export growth statistics provide useful information regarding market expansion, they do not adequately explain whether a destination consistently retains its importance over time or whether export shares are gradually shifting among competing markets. Understanding such retention behaviour is essential for identifying reliable markets, formulating export diversification strategies, and enhancing the resilience of the marine export sector.

Against this backdrop, the present study examines the direction of trade and destination-wise stability of India's marine product exports during the period 1995–96 to 2024–25 using Markov Chain analysis. By estimating transition probability matrices and retention probabilities for both export quantity and export value across three distinct phases of export development, the study provides a comprehensive assessment of long-term structural changes in destination markets. The findings are expected to contribute to the growing literature on fisheries trade while offering valuable insights for policymakers, exporters, and trade promotion agencies seeking to strengthen market diversification, improve export resilience, and sustain India's competitiveness in the evolving global seafood trade environment.

1.1 OBJECTIVES OF THE STUDY

1. To analyse the growth performance of India's marine product exports across major international destinations in quantity and value terms.
2. To examine destination-wise export price realization using Unit Value Realization (UVR).
3. To measure instability in marine product exports across major importing destinations using the Della Valle Instability Index.
4. To analyse export market concentration and diversification patterns using the Hirschman Index and Simpson Diversification Index.
5. To assess structural changes in the direction and composition of marine product exports across different export phases.
6. To analyse destination-wise trade direction and market stability using Markov Chain Analysis.
7. To estimate retention probabilities and identify relatively stable and unstable export destinations for India's marine products.
8. To examine net gain or loss in export shares among major importing destinations over the study period.

Materials and Methods

2.1. Nature and Source of Data

The present study is based entirely on secondary data relating to India's marine product exports. Annual destination-wise export data on quantity (tonnes) and value were collected from the published records of the Marine Products Export Development Authority (MPEDA), Ministry of Commerce and Industry, Government of India, for the period 1995–96 to 2024–25. MPEDA is the apex statutory organization responsible for the promotion, regulation, and monitoring of marine exports from India and provides the most comprehensive and consistent database on marine export performance. Consequently, MPEDA statistics have been widely used in studies examining export growth, competitiveness, trade direction, and market stability of Indian marine products (Vinay et al., 2016; Chandrasekar et al., 2020). The major export destinations considered in the study include Japan, USA, European Union, China, South East

Asia, Middle East, and Others. The analysis was carried out separately for export quantity and export value in order to understand differences between physical export expansion and export earnings across international markets.

Unlike many earlier studies that focused primarily on export quantity or specific commodity groups, the present study analyses both export quantity and export value separately. Such a distinction is important because destinations that absorb larger export volumes may not necessarily generate higher export earnings, while premium markets may continue to contribute substantially to export value despite declining quantity shares. Consequently, separate analysis of quantity and value enables a more comprehensive assessment of destination-wise export performance and market stability.

2.2 Period of Study

The study covers a period of thirty years from 1995–96 to 2024–25. The selection of this period was guided by the need to capture long-term structural transformation in India's marine export sector under changing domestic and international trade environments. The period encompasses several major developments including WTO-led trade liberalization, rapid expansion of shrimp aquaculture, emergence of China and South East Asia as important seafood markets, increasing significance of the USA as a premium shrimp-importing destination, and growing influence of sanitary and phytosanitary (SPS) regulations on seafood trade (Salim, 2012; Madan and Salim, 2012). The latter part of the study period also captures major disruptions arising from the COVID-19 pandemic and subsequent geopolitical conflicts. Studies have shown that the pandemic significantly affected seafood supply chains, logistics networks, processing activities, and international market access, thereby altering traditional trade relationships and destination preferences (Meharoor et al., 2020; Khanal and Deb, 2022). Furthermore, geopolitical tensions and sanctions associated with the Russia–Ukraine conflict generated trade diversion effects and contributed to restructuring of global seafood trade networks (Kim et al., 2023). These developments underscore the need to reassess destination-wise export stability using recent data.

To capture temporal changes in market behaviour and trade direction, the study period was divided into three phases:

- **Phase I (1995–96 to 2004–05): Early Liberalization and Export Expansion Phase**
- **Phase II (2005–06 to 2014–15): Aquaculture Expansion and Market Diversification Phase**
- **Phase III (2015–16 to 2024–25): Market Consolidation, Global Trade Disruptions and Post-Pandemic Adjustment Phase**

The phase-wise classification facilitates identification of structural changes in destination stability and export market dynamics across distinct stages of marine export development.

2.3 Analytical Framework

Marine export performance is multidimensional and cannot be adequately explained using a single analytical indicator. Earlier studies have analysed fisheries exports using growth measures, instability indices, competitiveness indicators, and Markov Chain models (Gunabhagya et al., 2016; Vinay et al., 2016; Chandrasekar et al., 2020; Ramadhan et al., 2024). However, growth measures explain the rate of export expansion, instability measures capture fluctuations, diversification indices evaluate market concentration, and structural change measures identify shifts in destination composition. These approaches do not reveal whether destination markets consistently retain their export shares over time or whether exports are gradually diverted towards competing destinations.

To overcome this limitation, Markov Chain Analysis was employed to estimate destination-wise transition probabilities and retention behaviour. The technique has been widely applied in fisheries and agricultural trade studies because it identifies stable and unstable markets and provides insights into long-term market loyalty, persistence, and trade

direction (Vinay et al., 2016; Chandrasekar et al., 2020; Singh et al., 2023). Sathianandan et al. (2018) further demonstrated the usefulness of Markov models in analysing transition behaviour and stability patterns within fisheries systems.

The present study extends previous investigations by integrating growth, instability, diversification, structural change, and Markov analyses within a unified framework. Furthermore, unlike earlier studies, it simultaneously examines destination stability in both quantity and value dimensions and incorporates the effects of recent developments such as SPS intensification, pandemic-related disruptions, and geopolitical shocks.

Sl. No.	Analytical Tool	Purpose	Formula / Approach	Supporting Citation
1	Compound Annual Growth Rate (CAGR)	Growth analysis	$CAGR = (\text{Antilog } b - 1) \times 100$	Gunabhagya et al. (2016); Chandrasekar et al. (2020)
2	Unit Value Realization (UVR)	Export price realization analysis	$UVR = \text{Export Value} / \text{Export Quantity}$	Chandrasekar et al. (2020)
3	Della Valle Instability Index	Export instability analysis	$CDVI = CV \times \sqrt{(1 - R^2)}$	Cuddy & Della, (1978)
4	Hirschman Index (HI)	Export market concentration analysis	$HI = \sum (Pi^2)$	Hirschman (1964)
5	Simpson Diversification Index (SDI)	Export market diversification analysis	$SDI = 1 - \sum (Pi^2)$	Simpson (1949)
6	Structural Change Index (SCI)	Structural transformation analysis	$SCI = \frac{1}{2} \sum P_{it} - P_{i(t-1)} $	Gunabhagya et al. (2016)
7	Markov Chain Analysis	Trade direction and export stability analysis	$E_{jt} = \sum (E_{it} - 1 \times P_{ij}) + e_{jt}$	Dent (1967); Chandrasekar et al. (2020)
8	Transition Probability Matrix	Market retention and transition analysis	$\sum P_{ij} = 1$	Sirisha & Subba Rao (2020)
9	Retention Probability Analysis	Identification of stable export destinations	Diagonal elements of transition matrix	Ramadhan et al. (2024)

Marine export performance is a multidimensional phenomenon encompassing growth, instability, diversification, structural transformation, and destination stability. Consequently, reliance on a single analytical technique may provide only a partial understanding of export dynamics. To overcome this limitation, the present study employed a combination of complementary analytical tools. Compound Annual Growth Rate (CAGR) was used to assess long-term growth in export quantity and value, while Unit Value Realization (UVR) measured destination-wise export earnings efficiency. Export instability was analysed using the Della Valle Instability Index (DVI), whereas the Hirschman Index (HI) and Simpson Diversification Index (SDI) were employed to evaluate market concentration and diversification, respectively. Structural changes in destination composition were examined using the Structural Change Index (SCI).

Although these measures provide valuable insights into export performance and market structure, they do not reveal whether destination markets consistently retain their export shares over time or whether export shares shift among competing importing regions. Therefore, Markov Chain Analysis was employed to estimate transition probabilities and destination-wise retention behaviour. The resulting transition probability matrices and retention coefficients enabled identification of stable and unstable markets and facilitated examination of trade direction among competing destinations. Similar approaches have been successfully applied in fisheries and agricultural trade studies to analyse export stability and market loyalty (Vinay et al., 2016; Gunabhagya et al., 2016; Chandrasekar et al., 2020; Sirisha and

Subba Rao, 2020; Ramadhan et al., 2024). The integration of these analytical tools provides a comprehensive assessment of India's marine export performance and destination stability under changing global trade conditions.

Results and Discussions

Table 1

Compound Annual Growth Rate (CAGR) of India's Marine Product Exports across Major Destinations in Quantity and Value Terms (1995–96 to 2024–25)

Destination	b Value (Quantity)	CAGR (%) Quantity	Rank	b Value (Value)	CAGR (%) Value	Rank
Japan	0.0183	1.85	7	0.0268	2.71	7
USA	0.0961	10.09	3	0.1493	16.05	1
European Union	0.0453	4.63	5	0.1003	10.55	6
China	0.0227	2.30	6	0.1120	11.83	5
South East Asia	0.1044	11.00	1	0.1482	15.92	3
Middle East	0.0708	7.34	4	0.1324	14.17	4
Others	0.1034	10.88	2	0.1484	15.95	2
Total	0.0627	6.47	—	0.1102	11.65	—

The Compound Annual Growth Rate analysis revealed substantial variation in the growth performance of India's marine product exports across major international destinations during the study period. In quantity terms, South East Asia recorded the highest CAGR of 11.00 per cent, followed by Others (10.88%) and the USA (10.09%), indicating rapid expansion of India's marine exports toward emerging and diversified markets. Japan recorded the lowest growth rate of 1.85 per cent, reflecting the gradual decline in dependence on traditional export destinations. In value terms, the USA registered the highest CAGR of 16.05 per cent, followed by Others (15.95%) and South East Asia (15.92%), highlighting increasing export earnings from diversified and high-value international markets. The comparatively lower growth observed for Japan and the European Union suggests gradual redistribution of export shares away from traditional markets toward emerging destinations. The higher growth rates observed in export value compared to export quantity across all destinations indicate improved export realization, increasing value addition, and strengthening competitiveness of Indian marine products in global seafood trade. The strong growth observed in exports toward South East Asia and the USA is consistent with the findings of Gunabhagya et al. (2016), who reported that South East Asia emerged as one of the fastest-growing and most stable importers of Indian fish products. Similarly, Chandrasekar et al. (2020) observed increasing diversification of India's marine exports toward emerging destinations such as China, South East Asia, and the USA during the post-liberalization period. The overall CAGR of 6.47 per cent in quantity and 11.65 per cent in value terms further indicates that India's marine export sector experienced stronger expansion in export earnings than physical export volumes during the study period, reflecting increasing global demand for value-added seafood products.

Table 2
Unit Value Realization (UVR) Growth and Instability of India's Marine Product
Exports across Major Destinations

Destination	Mean UVR	UVR Growth (%)	Rank	Instability Index
Japan	2.977	10.18	7	0.202
USA	4.219	365.17	2	0.160
European Union	2.552	318.96	3	0.130
China	1.554	704.56	1	0.255
South East Asia	1.502	272.78	5	0.210
Middle East	2.148	300.15	4	0.157
Others	1.655	271.61	6	0.171
Overall	2.274	211.00	—	0.188

The Unit Value Realization analysis revealed substantial variation in export realization across major importing destinations. The USA recorded the highest mean UVR (4.219), followed by Japan (2.977) and the European Union (2.552), indicating stronger demand for premium and value-added marine products in these destinations. In contrast, China and South East Asia recorded relatively lower mean UVR values, suggesting that exports to these destinations were initially dominated by lower-value or processing-oriented seafood products. However, China registered the highest UVR growth of 704.56 per cent during the study period, reflecting a major shift toward higher-value seafood imports and increasing importance of the Chinese market in India's marine export trade. The instability analysis showed comparatively higher fluctuations in China (0.255) and South East Asia (0.210), indicating variability in export realization due to changing demand patterns and market dynamics. On the other hand, the European Union (0.130) and Middle East (0.157) exhibited relatively stable UVR performance over time. The overall increase in UVR across destinations indicates improving export realization, growing value addition, and strengthening competitiveness of Indian marine products in global seafood markets. Similar improvements in export realization and expansion of high-value seafood exports were also reported by Chandrasekar et al. (2020) and Gunabhagya et al. (2016).

Table 3
Phase-wise Composition of India's Marine Product Exports across Major Destinations (Quantity Share in %)

Destination	Liberalization and Export Integration Phase (1995–96 to 2004–05)	Aquaculture Expansion and Market Diversification Phase (2005–06 to 2014–15)	Export Consolidation and Value Realization Phase (2015–16 to 2023–24)	Overall Average
Japan	16.21	9.55	6.54	10.99
USA	10.52	8.35	20.39	12.46
European Union	19.80	22.04	13.95	18.88
China	33.63	18.37	15.80	22.87
South East Asia	11.16	25.44	28.28	21.45
Middle East	3.89	4.89	4.54	4.45
Others	4.78	11.36	10.50	8.89
Total	100.00	100.00	100.00	100.00

The phase-wise export composition analysis revealed substantial structural transformation in the destination pattern of India's marine product exports during the study period. During the Liberalization and Export Integration Phase (1995–96 to 2004–05), China dominated marine exports with a share of 33.63 per cent, followed by the European Union (19.80%) and Japan (16.21%), indicating high dependence on traditional Asian and European markets. However, during the Aquaculture Expansion and Market Diversification Phase (2005–06 to 2014–15), South East Asia emerged as a major destination with its share increasing sharply from 11.16 per cent to 25.44 per cent, while the “Others” category also increased from 4.78 per cent to 11.36 per cent, reflecting improved market diversification. In the Export Consolidation and Value Realization Phase (2015–16 to 2024–25), South East Asia recorded the highest export share (28.28%), while the USA's share increased substantially from 10.52 per cent to 20.39 per cent, indicating growing exports of high-value seafood products. In contrast, Japan's share declined continuously to 6.54 per cent, reflecting reduced dependence on traditional markets. Overall, the results indicate a gradual shift from concentrated traditional export destinations toward diversified and high-growth markets such as South East Asia and the USA. Similar diversification trends and changing export orientation in India's marine trade were also reported by Chandrasekar et al. (2020) and Gunabhagya et al. (2016).

Table 4
Phase-wise Average Structural Change Index (SCI) of India's Marine Product Export Destinations

Destination	Phase I (1995–96 to 2004–05)	Phase II (2005–06 to 2014–15)	Phase III (2015–16 to 2024–25)	Overall Mean SCI
Japan	4.01	1.18	0.59	1.85
USA	2.86	2.97	3.10	2.98
European Union	4.40	2.25	1.36	2.61
China	2.74	2.25	3.08	2.69
South East Asia	0.69	2.65	3.75	2.42
Middle East	0.55	0.42	0.35	0.44
Others	0.65	0.74	0.72	0.70

The Structural Change Index analysis revealed considerable shifts in the destination composition of India's marine product exports across different phases. During Phase I, the European Union (4.40) and Japan (4.01) recorded the highest SCI values, indicating major fluctuations in export shares during the early globalization period. In Phase II, structural changes became more prominent in the USA (2.97) and South East Asia (2.65), reflecting diversification toward emerging seafood markets. During Phase III, South East Asia recorded the highest SCI value (3.75), followed by China (3.08) and the USA (3.10), indicating substantial reorientation of exports toward Asian and high-growth international markets. In contrast, the Middle East consistently exhibited lower SCI values across all phases, suggesting relatively stable export shares over time. Overall, the results indicate gradual transition from traditional destinations such as Japan and the European Union toward diversified and rapidly expanding markets including South East Asia, China, and the USA, consistent with findings reported by Chandrasekar et al. (2020) and Gunabhagya Kumar et al. (2016).

Table 5
Five-Year Average Hirschman and Simpson Diversification Indices of Marine Product Exports from India

Period	Quantity HI	Quantity SDI	Rank	Value HI	Value SDI	Rank
1995–96 to 1999–00	0.29	0.71	4	0.50	0.50	5
2000–01 to 2004–05	0.27	0.73	3	0.48	0.52	4
2005–06 to 2009–10	0.25	0.75	2	0.31	0.69	1
2010–11 to 2014–15	0.23	0.77	1	0.36	0.64	2
2015–16 to 2019–20	0.27	0.73	3	0.49	0.51	4
2020–21 to 2024–25	0.29	0.71	4	0.51	0.49	6
Overall Mean	0.27	0.73	—	0.44	0.56	—

The diversification analysis revealed noticeable changes in the concentration and diversification pattern of India's marine product exports over time. In quantity terms, the Hirschman Index declined from 0.29 during 1995–96 to 1999–00 to 0.23 during 2010–11 to 2014–15, while the Simpson Diversification Index increased from 0.71 to 0.77 during the same period, indicating improved diversification in export composition. In value terms, diversification improved substantially during 2005–06 to 2009–10 with the lowest HI value (0.31) and highest SDI value (0.69), suggesting reduced dependence on a few export destinations and increasing participation of diversified markets in export earnings. However, during 2020–21 to 2024–25, concentration increased again as reflected by the higher HI value (0.51) and lower SDI value (0.49), indicating renewed dependence on dominant export destinations. Overall, the results suggest that India's marine exports experienced gradual diversification during the export expansion phase, followed by moderate reconcentration in recent years. Similar diversification trends in marine exports were also reported by Chandrasekar et al. (2020) and Kalaiaarasi and Kavithambika (2024).

Table 6
Instability Analysis of India's Marine Product Exports across Major Destinations in Quantity and Value Terms

Destination	Mean	SD	CV	R.S.Q.	CDVI	Mean	SD	CV	R.S.Q.	CDVI
JAPAN	73539.68	15328.27	0.21	0.65	0.12	2233.38	785.65	0.35	0.48	0.25
USA	129920.27	118258.86	0.91	0.79	0.42	7269.33	8132.80	1.12	0.80	0.50
EUROPEAN UNION	141274.34	51070.58	0.36	0.84	0.15	4115.62	2953.57	0.72	0.92	0.20
CHINA	167101.90	108395.74	0.65	0.27	0.56	3001.11	3769.39	1.26	0.61	0.78
SOUTH EAST ASIA	209823.98	173600.79	0.83	0.65	0.49	4023.01	4166.51	1.04	0.65	0.61
MIDDLE EAST	38144.21	21505.08	0.56	0.90	0.18	1025.15	885.41	0.86	0.90	0.27
OTHERS	85931.45	64020.49	0.75	0.89	0.25	1760.41	1751.11	0.99	0.85	0.39
Total	845735.81	460397.71	0.54	0.92	0.16	23428.01	20879.49	0.89	0.87	0.33

The instability analysis revealed considerable variation in the stability of India's marine product exports across major destinations, both in terms of quantity and value. In quantity terms, China recorded the highest instability index (0.56), followed by Southeast Asia (0.49) and the USA (0.42), indicating substantial fluctuations in export quantities due to inconsistent demand, changing trade regulations, and market uncertainties. Despite South East Asia recording the highest mean import quantity (209823.98 tonnes), the high instability suggests fluctuating regional demand and re-

export activities. In contrast, Japan recorded the lowest instability index (0.12), followed by the European Union (0.15), indicating comparatively stable and consistent import behaviour. In value terms, instability was higher than quantity instability for most destinations, indicating that export earnings were more vulnerable to international price fluctuations than export volumes. China again recorded the highest instability index (0.78), followed by South East Asia (0.61) and the USA (0.50), reflecting unstable price realization and volatile market demand. Relatively lower instability was observed for the European Union (0.20), Japan (0.25), and the Middle East (0.27), indicating more stable export earnings in these destinations. Overall, the total instability index was lower in quantity terms (0.16) compared to value terms (0.33), suggesting that fluctuations in export earnings were more severe than fluctuations in export volumes. Similar findings were reported by Gunabhagya et al. (2016), who identified Japan as a stable seafood export market, while Chandrasekar et al. (2020) observed higher market stability for the European Union and greater volatility in export earnings due to international price fluctuations. Sirisha and Subba Rao (2020) also reported comparatively higher instability in Asian seafood markets because of changing trade dynamics and demand conditions.

Markov-Chain Analysis

Markov Chain Analysis is important in the present study as it facilitates the examination of dynamic changes, stability, and structural transformation in marine export commodities over time. The technique provides insights into retention behaviour, transition movements, and shifts in the composition of the marine export basket across different phases (Dent, 1967; Chandrasekar et al., 2020). In the transition probability matrix, the diagonal elements represent retention probabilities, which indicate the likelihood of a commodity retaining its export share in successive periods. Higher diagonal values reflect greater stability and stronger market retention of a commodity within the export structure (Sirisha & Subba Rao, 2020). Conversely, the off-diagonal elements represent the probability of shifts in export share from one commodity to another over time. These transition probabilities indicate gains and losses among competing commodities and help in understanding diversification patterns and structural changes in marine exports (Kalaierasi & Kavithambika, 2024; Ramadhan et al., 2024).

Table 7
– Overall Quantity Destination Matrix

Destination Market	Japan	USA	European Union	China	South East Asia	Middle East	Others
Japan	0.7392	0.0000	0.0546	0.1099	0.0000	0.0000	0.0000
USA	0.0000	0.9365	0.0000	0.0228	0.0000	0.0000	0.0759
European Union	0.0000	0.0000	0.7353	0.0000	0.0583	0.0000	0.0000
China	0.0717	0.0000	0.1661	0.8673	0.0255	0.0102	0.0145
South East Asia	0.0000	0.0635	0.0193	0.0000	0.8786	0.0000	0.0000
Middle East	0.1891	0.0000	0.0000	0.0000	0.0000	0.9898	0.0996
Others	0.0000	0.0000	0.0247	0.0000	0.0376	0.0000	0.8100

The transition probability matrix indicates that the Middle East (0.9898), USA (0.9365), South East Asia (0.8786), and China (0.8673) were the most stable destinations for India's marine product exports during the study period. In contrast, Japan (0.7392) and the European Union (0.7353) exhibited relatively lower retention probabilities, indicating a gradual decline in their relative importance. Significant transitions from Japan and the European Union towards China and South East Asia suggest a structural shift in export orientation from traditional developed markets to emerging Asian destinations. The increasing stability of the USA, China, South East Asia, and Middle East reflects growing demand, expanding trade linkages, and diversification of India's export markets. Similar trends of declining dependence on traditional markets and increasing importance of emerging destinations have been reported by Chandrasekar et al.

(2020), Khanal and Deb (2022), and Suresh et al. (2023). Overall, the results indicate a significant geographical reorientation of India's marine exports, highlighting the need to strengthen market presence in high-retention destinations while maintaining competitiveness in traditional premium markets.

Table 8
– Phase I Quantity Destination Matrix

Destination Market	Japan	USA	European Union	China	South East Asia	Middle East	Others
Japan	0.7386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
USA	0.0000	0.4527	0.4453	0.0000	0.2157	0.0000	0.1167
European Union	0.0000	0.0000	0.2980	0.3767	0.2322	0.0000	0.0082
China	0.0509	0.1154	0.2567	0.6233	0.0690	0.0102	0.0088
South East Asia	0.1478	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Middle East	0.0628	0.4319	0.0000	0.0000	0.0000	0.9898	0.8294
Others	0.0000	0.0000	0.0000	0.0000	0.4830	0.0000	0.0369

The Phase I transition probability matrix indicates that Japan (0.7386) and China (0.6233) were the most stable destination markets during the initial phase of the study period, reflecting their dominant role in India's marine export trade. The USA exhibited moderate retention (0.4527), while the European Union retained only 29.80 per cent of its export share, suggesting relatively unstable market relationships. Notably, a substantial proportion of exports from the USA shifted towards the European Union (44.53%), while exports from the European Union moved towards China (37.67%) and South East Asia (23.22%), indicating intense competition among destination markets. The absence of retention in South East Asia and the low retention in the others category further suggest that these markets had not yet emerged as stable export destinations during this period. The strong retention observed for Japan corroborates earlier studies identifying it as the principal market for Indian marine products during the pre-aquaculture expansion era, while the growing stability of China reflects the beginning of a structural shift towards emerging Asian markets. Overall, the results indicate that Phase I was characterized by dependence on traditional destinations, with early signs of market diversification and the gradual emergence of China as an important export destination.

Table 9
– Phase II Quantity Destination Matrix

Destination Market	Japan	USA	European Union	China	South East Asia	Middle East	Others
Japan	0.2896	0.0000	0.0000	0.1214	0.0000	0.0000	0.8022
USA	0.1719	0.6214	0.0127	0.0000	0.0000	0.0111	0.0000
European Union	0.0000	0.0000	0.8764	0.0000	0.0551	0.0000	0.0000
China	0.1522	0.0000	0.0000	0.8106	0.0000	0.0000	0.0000
South East Asia	0.0000	0.0946	0.0054	0.0000	0.9449	0.0000	0.1246
Middle East	0.3863	0.2840	0.0000	0.0680	0.0000	0.9554	0.0000
Others	0.0000	0.0000	0.1054	0.0000	0.0000	0.0335	0.0732

The Phase II transition probability matrix reveals a significant restructuring of India's marine export destinations. South East Asia (0.9449), Middle East (0.9554), European Union (0.8764), and China (0.8106) exhibited high retention probabilities, indicating the emergence of stable and sustained trade relationships with these markets. In contrast, Japan retained only 28.96 per cent of its export share, reflecting a substantial decline in its relative importance during

this period. The large transition of exports from Japan towards the Others category (80.22%) suggests increasing diversification away from traditional destinations. The strong retention observed in China and South East Asia coincides with the rapid expansion of Asian seafood markets, increasing regional trade integration, and growing demand for seafood products. Similarly, the exceptionally high stability of the Middle East reflects the increasing importance of non-traditional destinations in India's export portfolio.

The observed shift away from Japan and the increasing prominence of emerging destinations are consistent with the findings of Salim (2012), who reported that post-WTO trade liberalization facilitated diversification of India's seafood export markets and reduced dependence on a limited number of traditional destinations. The growing role of China and other Asian markets also corroborates the observations of Suresh et al. (2023), who highlighted the changing geographical composition of Indian marine exports and the increasing contribution of emerging markets to export growth. Furthermore, the relatively lower retention of Japan may be partly attributed to increasingly stringent sanitary and phytosanitary requirements, quality certification protocols, and food safety regulations imposed by developed importing countries, as documented by Gopal and Salim (2012) and Madan and Salim (2012). These studies noted that compliance with SPS measures became an important determinant of market access and competitiveness in international seafood trade. The results are also in agreement with Chandrasekar et al. (2020), who reported a gradual reorientation of Indian marine exports towards emerging destinations characterized by higher growth potential and stronger market retention. Overall, Phase II represents a decisive period of market diversification in which emerging Asian and Middle Eastern destinations consolidated their position in India's marine export basket, while the dominance of traditional markets, particularly Japan, weakened considerably.

Table 10
– Phase III Quantity Destination Matrix

Destination Market	Japan	USA	European Union	China	South East Asia	Middle East	Others
Japan	0.0000	0.0000	0.0151	0.0000	0.0000	0.0000	0.0000
USA	0.0916	0.6338	0.0200	0.1155	0.2933	0.0000	0.0000
European Union	0.0000	0.0000	0.6537	0.0000	0.1133	0.0000	0.0000
China	0.0010	0.2114	0.0767	0.6046	0.0320	0.0000	0.1915
South East Asia	0.0010	0.1548	0.0000	0.2650	0.5614	0.0000	0.0733
Middle East	0.8523	0.0000	0.0000	0.0149	0.0000	1.0000	0.3506
Others	0.0541	0.0000	0.2345	0.0000	0.0000	0.0000	0.3846

The Phase III transition probability matrix indicates a further consolidation of India's marine export markets, with the Middle East (1.0000), European Union (0.6537), USA (0.6338), China (0.6046), and South East Asia (0.5614) exhibiting relatively high retention probabilities. The complete retention observed for the Middle East suggests that the region emerged as the most stable destination during the recent period, reflecting sustained demand and strengthening trade linkages. The USA, China, and South East Asia also maintained substantial retention, highlighting their growing strategic importance in India's marine export portfolio. In contrast, Japan recorded negligible retention, indicating a significant decline in its role as a stable destination market. The matrix further reveals notable shifts of exports from the Middle East towards Japan (85.23%) and from South East Asia towards China (26.50%) and the USA (15.48%), reflecting increasing interdependence among Asian markets and changing trade dynamics.

The strengthening of the USA, China, South East Asia, and Middle East markets during this period is consistent with the findings of Suresh et al. (2023) and Khanal and Deb (2022), who reported increasing diversification of Indian seafood exports towards emerging and high-growth destinations. The declining stability of Japan and the comparatively lower

retention of some traditional destinations may be associated with stringent sanitary and phytosanitary requirements, evolving consumer preferences, and increasing competition from alternative suppliers, as highlighted by Gopal and Salim (2012) and Madan and Salim (2012). The growing importance of Asian destinations also reflects broader shifts in global seafood trade identified by FAO (2024) and recent fisheries trade studies, which emphasize the expanding role of regional markets in shaping international seafood flows. Overall, the results suggest that India's marine export sector has successfully adapted to changing global market conditions by strengthening its presence in emerging destinations, thereby reducing dependence on traditional markets and enhancing the resilience of its export portfolio.

Table 11
– Overall Value Matrix

Destination	Japan	USA	European Union	China	South East Asia	Middle East	Others
Japan	0.8839	0.0000	0.0926	0.0704	0.0000	0.0001	0.0000
USA	0.0000	1.0000	0.0604	0.0000	0.0000	0.0000	0.0070
European Union	0.0000	0.0000	0.8410	0.0000	0.0438	0.0089	0.0281
China	0.0285	0.0000	0.0000	0.8276	0.0000	0.0000	0.0158
South East Asia	0.0000	0.0000	0.0000	0.0000	0.9052	0.0000	0.0000
Middle East	0.0877	0.0000	0.0000	0.0571	0.0000	0.9910	0.1169
Others	0.0000	0.0000	0.0060	0.0449	0.0510	0.0000	0.8323

The overall value-based transition probability matrix reveals a high degree of stability in India's marine export earnings across major destination markets. Among all destinations, the USA exhibited complete retention (1.0000), followed by the Middle East (0.9910), South East Asia (0.9052), Japan (0.8839), the European Union (0.8410), Others (0.8323), and China (0.8276). The exceptionally high retention of the USA indicates its dominant role in sustaining India's marine export earnings, reflecting strong demand for high-value seafood products, particularly frozen shrimp, which constitutes the largest share of India's seafood export value. Similarly, the high retention observed in the Middle East and South East Asia suggests the growing importance of these destinations in generating stable export revenues.

Unlike the quantity-based matrix, Japan exhibited relatively high retention in value terms despite its declining significance in export volumes, indicating that the market continues to contribute substantially to export earnings through premium-priced seafood products. The strong stability of the European Union further suggests that although regulatory requirements remain stringent, the market continues to provide significant value realization for Indian exporters. These findings are consistent with Salim (2012) and Suresh et al. (2023), who reported that India's seafood export earnings increasingly depend on high-value products and diversified destination markets. The dominance of the USA in value retention also supports the observations of Khanal and Deb (2022), who highlighted the growing competitiveness of Indian seafood exports in premium international markets. Furthermore, the sustained importance of developed markets despite stringent SPS and quality standards corroborates the findings of Gopal and Salim (2012) and Madan and Salim (2012), who emphasized that compliance with international standards has become a critical determinant of export performance. Overall, the results indicate that India's marine export earnings are concentrated in a group of highly stable destination markets, with the USA, Middle East, and South East Asia emerging as the principal drivers of long-term export value growth.

Table 12
– Phase I Value Matrix

Destination	Japan	USA	EU	China	SEA	Middle East	Others
Japan	0.8674	0.0682	0.1120	0.0992	0.0321	0.0000	0.0000
USA	0.0000	0.8675	0.4936	0.0000	0.0908	0.0000	0.0551
European Union	0.0000	0.0000	0.3351	0.1663	0.1000	0.0000	0.0000
China	0.1326	0.0000	0.0000	0.0000	0.0000	0.0090	0.0000
South East Asia	0.0000	0.0000	0.0000	0.5269	0.1421	0.0000	0.0000
Middle East	0.0000	0.0345	0.0594	0.2076	0.4112	0.8695	0.0000
Others	0.0000	0.0297	0.0000	0.0000	0.2237	0.1215	0.9449

The Phase I value transition probability matrix indicates that Japan (0.8674), USA (0.8675), Middle East (0.8695), and Others (0.9449) were the most stable destinations in terms of export earnings during the initial period. The high retention observed for Japan and the USA reflects their dominant role in generating export revenues from premium seafood products, while the strong stability of the Middle East suggests the emergence of a reliable market even during the early stages of export diversification. In contrast, the European Union retained only 33.51 per cent of its export value share, while China and South East Asia exhibited very low retention, indicating that these destinations had not yet developed into stable value markets. Significant transitions from the European Union towards the USA (49.36%), China (16.63%), and South East Asia (10.00%) suggest intense competition among destination markets for export earnings. Similarly, South East Asia transferred a substantial proportion of its value share to China (52.69%), highlighting the growing importance of Asian markets during this period.

The dominance of Japan and the USA in value retention is consistent with earlier studies that identified these destinations as major markets for high-value Indian seafood exports, particularly shrimp and other premium marine products. The relatively weak retention of China and South East Asia reflects the fact that these markets were still in the early stages of integration into India's export network, a trend also observed by Chandrasekar et al. (2020) and subsequent fisheries trade studies. The gradual movement of export value towards Asian destinations supports the argument advanced by Salim (2012) that post-liberalization trade dynamics encouraged diversification beyond traditional markets. Furthermore, the increasing interactions among Asian destinations foreshadow the structural transformation that became more evident in later phases of the study period. Overall, the results indicate that Phase I was characterized by strong dependence on traditional high-value markets, particularly Japan and the USA, while simultaneously witnessing the early emergence of China and South East Asia as potential future growth centres for India's marine export earnings.

Table 13
– Phase II Value Matrix

Destination	Japan	USA	EU	China	SEA	Middle East	Others
Japan	0.6075	0.0000	0.0594	0.2138	0.0000	0.0000	0.1615
USA	0.0954	0.4646	0.0963	0.0000	0.0000	0.0057	0.0891
European Union	0.0000	0.0596	0.8443	0.0000	0.0925	0.0000	0.0000
China	0.2155	0.0000	0.0000	0.6704	0.0128	0.0000	0.0000
South East Asia	0.0000	0.4758	0.0000	0.0000	0.8946	0.0223	0.0000
Middle East	0.0816	0.0000	0.0000	0.1158	0.0000	0.9720	0.3997
Others	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3497

The Phase II value transition probability matrix indicates a substantial strengthening of emerging destination markets in India's marine export earnings. The Middle East (0.9720), South East Asia (0.8946), European Union (0.8443), and China (0.6704) exhibited high retention probabilities, suggesting the establishment of stable and profitable trade relationships during this period. Japan retained 60.75 per cent of its export value share, while the USA recorded a relatively lower retention probability of 46.46 per cent, indicating greater redistribution of export earnings across competing destinations. Significant transitions from Japan to China (21.38%) and Others (16.15%), together with strong value retention in China and South East Asia, highlight the growing importance of Asian markets in India's export earnings structure. The exceptionally high retention observed for the Middle East further confirms its emergence as a stable and increasingly valuable destination for Indian marine products.

These findings reflect the rapid expansion of aquaculture-based exports, particularly shrimp, and the increasing diversification of India's export markets during the post-liberalization period. The growing stability of China, South East Asia, and the Middle East is consistent with the observations of Salim (2012) and Suresh et al. (2023), who reported a gradual shift in seafood trade towards emerging markets with rising demand and expanding purchasing power. The strong retention of the European Union despite stringent SPS and quality standards suggests that Indian exporters were increasingly able to meet international compliance requirements, a trend highlighted by Gopal and Salim (2012). The declining dominance of Japan and the relatively lower retention of the USA indicate increasing competition among destination markets and a broader redistribution of export earnings. Similar patterns of market diversification and declining dependence on traditional destinations were reported by Chandrasekar et al. (2020) and Khanal and Deb (2022). Overall, the results suggest that Phase II marked a critical period of structural transformation in which export earnings became increasingly diversified across emerging Asian and Middle Eastern destinations while reducing dependence on a limited number of traditional markets.

Table 14
– Phase III Value Matrix

Destination	Japan	USA	EU	China	SEA	Middle East	Others
Japan	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
USA	0.0487	1.0000	0.1137	0.1718	0.0000	0.0000	0.0184
European Union	0.0000	0.0000	0.5768	0.0000	0.4870	0.0000	0.0044
China	0.0150	0.0000	0.0000	0.2850	0.0000	0.0000	0.0158
South East Asia	0.0100	0.0000	0.0000	0.0881	0.4686	0.0000	0.0052
Middle East	0.9263	0.0000	0.0000	0.0000	0.0444	0.9947	0.2243
Others	0.0000	0.0000	0.3095	0.4551	0.0000	0.0053	0.7319

The Phase III value transition probability matrix highlights a further consolidation of India's marine export earnings in a few highly stable destination markets. The USA (1.0000) and Middle East (0.9947) exhibited near-complete retention of export value shares, indicating exceptionally strong and persistent trade relationships during the most recent period. The Others category (0.7319) and the European Union (0.5768) also demonstrated moderate stability, while South East Asia (0.4686) and China (0.2850) recorded comparatively lower retention. Notably, Japan recorded zero retention, indicating a complete loss of its previous value share and confirming its declining importance in India's contemporary export earnings structure. The matrix further reveals substantial transitions from the European Union towards South East Asia (48.70%) and from the Others category towards China (45.51%), suggesting a continued reorientation of export value towards emerging Asian markets.

The dominance of the USA and Middle East in value retention reflects the growing concentration of India's export earnings in markets characterized by strong demand for high-value seafood products, particularly frozen shrimp. This finding is consistent with Suresh et al. (2023) and Khanal and Deb (2022), who reported the increasing importance of the USA as a major destination for Indian seafood exports. The declining significance of Japan and the redistribution of export value towards Asian destinations support the observations of Salim (2012) that India's marine export sector has progressively diversified beyond traditional markets in response to changing global trade conditions. Furthermore, the relatively lower retention observed in some traditional destinations may reflect the influence of stringent quality standards, SPS regulations, and changing consumption patterns documented by Gopal and Salim (2012) and Madan and Salim (2012). The strong movement of export value towards China and South East Asia also aligns with recent evidence highlighting the growing role of Asian markets in global seafood trade. Overall, the results indicate that the recent phase of India's marine export development has been characterized by increasing concentration of export earnings in highly stable markets such as the USA and Middle East, alongside continued diversification towards emerging Asian destinations, thereby enhancing the resilience and adaptability of the export sector under changing global market conditions.

Table 15

Overall Retention Probability and Stability Ranking of Marine Product Export Destinations based on Markov Transition Analysis (1995–96 to 2024–25)

Destination	Retention Probability (Quantity)	Quantity Rank	Retention Probability (Value)	Value Rank
USA	0.9365	2	1.0000	1
Middle East	0.9898	1	0.9910	2
South East Asia	0.8786	3	0.9052	3
Japan	0.7392	6	0.8839	4
European Union	0.7353	7	0.8410	5
Others	0.8100	5	0.8323	6
China	0.8673	4	0.8276	7

The comparative retention probabilities indicate that the USA and Middle East were the most stable destinations for Indian marine exports in both quantity and value terms. While the Middle East recorded the highest retention probability in quantity terms (0.9898), the USA emerged as the most stable destination in value terms with complete retention (1.0000), reflecting its dominant contribution to India's marine export earnings. South East Asia also exhibited high stability in both quantity and value dimensions, highlighting its growing importance as a reliable export destination. Interestingly, Japan ranked sixth in quantity retention but fourth in value retention, suggesting that despite declining export volumes, the market continues to generate substantial export earnings through premium-priced seafood products. Similarly, the European Union displayed greater stability in value than quantity terms, indicating its continued significance as a high-value market despite relatively lower volume retention. In contrast, China ranked higher in quantity retention than value retention, implying that its role is more pronounced in absorbing export volumes than generating export earnings. These findings suggest that destination markets perform distinct functions within India's marine export portfolio, with the USA, Japan, and European Union contributing disproportionately to export value, while China and South East Asia serve as important volume-oriented markets. Similar patterns of increasing dependence on high-value markets alongside diversification towards emerging destinations have been reported by Chandrasekar et al. (2020), Khanal and Deb (2022), and Suresh et al. (2023). Overall, the results highlight the importance of simultaneously strengthening value realization in premium markets and maintaining market access in high-volume destinations to ensure sustainable growth of India's marine exports.

Table 16
Net Change in Export Share of Marine Product Export Destinations in Quantity and Value Terms (%)

Destination Market	Initial Share (%) Quantity	Final Share (%) Quantity	Change (pp) Quantity	Initial Share (%) Value	Final Share (%) Value	Change (pp) Value
Japan	17.48	6.06	-11.42	45.03	5.53	-39.50
USA	8.78	20.42	11.64	10.46	36.41	25.95
European Union	29.03	12.67	-16.36	25.71	15.11	-10.60
China	23.40	23.35	-0.05	6.63	17.09	10.46
South East Asia	14.16	20.47	6.31	7.56	13.09	5.53
Middle East	2.97	3.88	0.91	2.22	3.73	1.51
Others	4.16	13.15	8.99	2.39	9.03	6.64

The analysis of net change in export share revealed substantial structural transformation in India's marine product export destinations in both quantity and value terms over the study period. In quantity terms, South East Asia recorded the highest positive gain in export share (+ 10%), followed by the USA (+ 9) and Others (+ 6), indicating increasing diversification and growing importance of emerging regional markets. In contrast, Japan registered the highest decline (-11%), followed by the European Union (-6) and China (-5), reflecting the gradual decline of traditional export destinations in quantity trade.

In value terms, China recorded the highest gain in export share (+ 15%), followed by South East Asia (+ 12), Others (+ 7), and the USA (+ 6), indicating increasing dominance of Asian and American markets in India's marine export earnings. Japan exhibited the highest decline in value share (-40%), while the European Union showed a moderate decline (-3), suggesting reduced dependence on traditional premium seafood markets over time. The Middle East recorded only marginal improvement (+ 1), indicating relatively stagnant growth in export earnings.

Overall, the results indicate a gradual shift in India's marine export direction from traditional markets such as Japan and the European Union towards rapidly expanding destinations including China, South East Asia, and the USA. The increasing share of Asian markets reflects growing regional seafood demand, trade integration, and diversification of export destinations. Similar findings were reported by Chandrasekar et al. (2020), who observed structural shifts and changing market orientation in Indian marine exports, while Kalaiaarasi and Kavithambika (2024) highlighted the increasing importance of Asian markets in India's seafood export trade.

Summary

The present study analysed the growth performance, export realization, instability, diversification, structural transformation, trade direction, and destination-wise stability of India's marine product exports during the period 1995–96 to 2024–25. Secondary data on destination-wise export quantity and value were obtained from the Marine Products Export Development Authority (MPEDA) and analysed using Compound Annual Growth Rate (CAGR), Unit Value Realization (UVR), Della Valle Instability Index, Hirschman Index, Simpson Diversification Index, Structural Change Index, and Markov Chain Analysis. The study period was divided into three phases to capture structural changes in export destinations and market behaviour.

The growth analysis revealed that India's marine exports grew at an overall CAGR of 6.47 per cent in quantity and 11.65 per cent in value terms. South East Asia recorded the highest growth in export quantity (11.00%), followed by Others

(10.88%) and the USA (10.09%). In value terms, the USA registered the highest CAGR (16.05%), followed by Others (15.95%) and South East Asia (15.92%), indicating stronger growth in export earnings than export volumes.

The Unit Value Realization analysis showed that the USA recorded the highest mean UVR (4.219), followed by Japan (2.977) and the European Union (2.552). China exhibited the highest UVR growth (704.56%), indicating a substantial increase in export realization during the study period. Relatively lower instability in UVR was observed for the European Union (0.130) and Middle East (0.157), while China recorded the highest instability (0.255).

The phase-wise composition analysis indicated significant changes in destination shares. During Phase I, China accounted for 33.63 per cent of export quantity, followed by the European Union (19.80%) and Japan (16.21%). In Phase III, South East Asia emerged as the leading destination with a share of 28.28 per cent, while the USA's share increased to 20.39 per cent. Japan's share declined continuously from 16.21 per cent to 6.54 per cent over the study period.

Structural Change Index values indicated substantial changes in destination composition. During Phase I, the European Union (4.40) and Japan (4.01) recorded the highest structural changes, whereas South East Asia (3.75), USA (3.10), and China (3.08) recorded the highest values during Phase III, reflecting increasing importance of emerging destinations.

The Hirschman and Simpson indices showed that export diversification improved until 2010–15, when the Hirschman Index declined to 0.23 and the Simpson Diversification Index increased to 0.77 in quantity terms. However, diversification weakened during 2020–25, with the Hirschman Index increasing to 0.29 and the Simpson Index declining to 0.71. Similar trends were observed in value terms.

Instability analysis revealed considerable variation across destinations. In quantity terms, China recorded the highest instability index (0.56), followed by South East Asia (0.49) and the USA (0.42), while Japan (0.12) and the European Union (0.15) were relatively stable. In value terms, China (0.78), South East Asia (0.61), and the USA (0.50) exhibited higher instability, whereas the European Union (0.20) and Japan (0.25) showed greater stability.

The overall quantity-based Markov transition matrix indicated that the Middle East (0.9898), USA (0.9365), South East Asia (0.8786), and China (0.8673) were the most stable destinations in terms of export quantity. In contrast, Japan (0.7392) and the European Union (0.7353) exhibited lower retention probabilities. Phase-wise analysis showed that Japan and China dominated retention during Phase I, while South East Asia, Middle East, European Union, and China emerged as highly stable destinations during Phase II. During Phase III, the Middle East exhibited complete retention (1.0000), followed by the European Union (0.6537), USA (0.6338), China (0.6046), and South East Asia (0.5614).

The value-based Markov analysis revealed even stronger market stability. The USA recorded complete retention (1.0000), followed by the Middle East (0.9910), South East Asia (0.9052), Japan (0.8839), and the European Union (0.8410). Phase-wise results indicated strong value retention for Japan and the USA during Phase I, increasing stability of China, South East Asia, and the Middle East during Phase II, and near-complete retention for the USA (1.0000) and Middle East (0.9947) during Phase III.

The comparative retention ranking showed that the Middle East ranked first in quantity retention (0.9898), while the USA ranked first in value retention (1.0000). South East Asia consistently ranked among the most stable destinations in both quantity and value dimensions. Japan and the European Union exhibited relatively lower quantity retention but maintained stronger value retention, indicating their continued importance as premium seafood markets.

Analysis of net changes in export shares revealed substantial structural transformation in destination markets. In quantity terms, the USA (+ 11.64 percentage points), South East Asia (+ 6.31 percentage points), and Others (+ 8.99 percentage points) recorded gains, while Japan (-11.42 percentage points) and the European Union (-16.36 percentage points) experienced major declines. In value terms, the USA (+ 25.95 percentage points), China (+ 10.46 percentage

points), South East Asia (+ 5.53 percentage points), and Others (+ 6.64 percentage points) gained export share, whereas Japan (-39.50 percentage points) and the European Union (-10.60 percentage points) recorded substantial losses.

Conclusions and Policy implications

The study reveals that India's marine export sector has undergone a significant transformation over the past three decades, characterized by a gradual shift from traditional destinations such as Japan and the European Union towards emerging markets including the USA, China, South East Asia, and the Middle East. This transition reflects changing global demand patterns, increasing market diversification, and the growing integration of India into evolving international seafood trade networks.

The findings demonstrate that export performance cannot be assessed solely through growth indicators, as destination markets differ considerably in terms of stability and retention behaviour. The strong retention observed in the USA, Middle East, South East Asia, and China indicate the emergence of resilient and dependable trade relationships, while the declining shares of some traditional markets highlight changing competitive dynamics in global seafood trade.

A key insight from the study is the distinction between quantity-oriented and value-oriented markets. While emerging Asian destinations have become increasingly important for absorbing export volumes, traditional developed-country markets continue to play a crucial role in generating export earnings through superior price realization. This underscores the need for a balanced export strategy that simultaneously promotes market diversification and value enhancement.

The phase-wise analysis further suggests that destination stability is influenced by broader developments in the global trade environment, including trade liberalization, SPS requirements, changing consumer preferences, COVID-19 disruptions, and geopolitical uncertainties. The emergence of new stable destinations during recent years highlights the importance of adaptability and diversification in strengthening export resilience.

From a policy perspective, sustained growth in marine exports will require strengthening market access in high-retention destinations, maintaining compliance with international quality and traceability standards, promoting value-added products, and expanding presence in emerging markets. Overall, the study concludes that long-term competitiveness of India's marine export sector will depend not only on increasing export volumes but also on building resilient trade relationships, enhancing value realization, and strategically balancing traditional premium markets with rapidly growing emerging destinations.

Declarations

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Authors Contribution

Manoj Kumar Dara conceptualized the study, collected and analysed the data, performed statistical analysis, interpreted the results, and prepared the original manuscript draft. Praveen Kumar Verma supervised the research work, contributed to the analytical framework, interpretation of findings, and critically revised the manuscript for intellectual content.

M.J.S.L. Naga Durga assisted in data compilation, literature review, tabulation, and manuscript editing. All authors read and approved the final manuscript.

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Data availability

The study is based entirely on secondary data collected from published sources, primarily from the Marine Products Export Development Authority (MPEDA), Ministry of Commerce and Industry, Government of India, and other official publications. The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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