

Growth, instability and direction of trade of Indian marine products

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Abstract

This study examines the export trends of marine products from India, analysing growth rates, trade instability and market direction over the period 2003-04 to 2022-23. Findings indicate that dried marine products experienced the highest growth in both export quantity (12.74%) and export value (14.54%), while frozen cuttle fish had the lowest growth in quantity (1.86) and value (8.9%). Export instability measured using Cuddy-Della Valle Index, was highest for dried marine products in quantity (39.11%) and in value (35.84%) and lowest for frozen cuttlefish in quantity (13.85%) and in value (15.68%). The major markets for India's marine product exports were USA, South East Asia, Europe, China, Middle East and Japan. All markets except China showed positive growth in export quantity. The USA led with the highest growth rate in both export quantity (14.22%) and export value (20.39%) and moderate instability in quantity (29.75%) and value (33.49%). Despite a notable increase in export value (13.98%), China was the most volatile market, with instability levels reaching 63.38 percent in quantity and 58.19 percent in value. Markov chain analysis of export trends showed frozen shrimp as the dominant product, maintaining a 92.60 percent market share. Frozen squid and live items exhibited least share of export basket. South East Asia emerged as the most consistent market, retaining 89.23 percent of its trade share, followed by the USA (87.61%) and China (85.19%). In contrast, Japan had the lowest retention rate (28.25%) indicating weaker market loyalty.

Keywords: Marine products, growth, trend, instability, cuddy-della valle index, Markov chain

Introduction

Since the late 1930s, marine product exports have been a significant source of foreign exchange for India, with the seafood industry playing a key role in boosting income and employment. Growing domestic and international demand for fresh and processed fish, a nutrient-rich commodity high in omega-3 fatty acids and protein, has driven rapid economic growth in this sector (Aswathy *et al.*, 2012) ^[1]. Landmark changes, such as the liberalization of India's economy in the 1990s and the inclusion of fisheries in the Non-Agricultural Market Access (NAMA) agreement in 2001, further fuelled growth by encouraging the establishment of processing industries and cold storage facilities to improve profitability. Key exports include frozen shrimp, cuttlefish, squid, dried, live, and chilled products, with major markets in Japan, the USA, the EU, South East Asia (SEA), China and Middle East. While lifting quantitative restrictions initially boosted exports, quality standards imposed post-WTO agreements introduced new challenges (Sarada *et al.*, 2006) ^[10]. Therefore this paper aims to study the growth, instability and direction of trade of Indian marine products export from India both in

terms of product category and destination countries.

Export of marine products from India

India's marine product exports in 2022-23 reached an all-time high, demonstrating the country's growing prominence in the global seafood market. The export value surged to USD 8.09 billion, marking a 4.31 percent increase compared to the previous year. In terms of quantity, India exported 17.35 lakh metric tons (LMT) of marine products, with shrimp accounting for the lion's share, contributing over 53 percent of the total earnings. The United States remained the largest importer, followed by China and the European Union. Frozen shrimp, frozen fish, and frozen squid were among the top exported products, emphasizing India's strength in the seafood sector (Marine Products Export Development Authority, MPEDA) ^[5].

India's marine product exports grew from 467.29 million tonnes in 2002-03 to 1735.28 million tonnes in 2022-23, marking an increase of over four times. Export data from 2002-03 to 2022-23 (figure 1) show an overall upward trend in both quantity and value, despite some fluctuations, with an average growth rate of 6.91 percent in quantity and 14.10

percent in value. In 2007-08, exports declined in both quantity and value, likely due to the U.S. subprime mortgage crisis and its economic impact. A similar decline in quantity and in value was observed in 2015-16, mainly due to increased aquaculture production in Thailand and Vietnam, along with the weakened Euro and devaluation of the Chinese Yuan, which reduced demand (Chandrashekar *et al.*, 2020) [2]. Exports saw consecutive declines from

2019-20 to 2020-21, largely due to the COVID-19 pandemic. However, a significant recovery followed in 2021-22. Linear trend lines on the chart show steady positive growth for both export quantity and value, with value surging particularly between 2020-21 and 2022-23, indicating robust growth in this sector, especially in monetary terms.

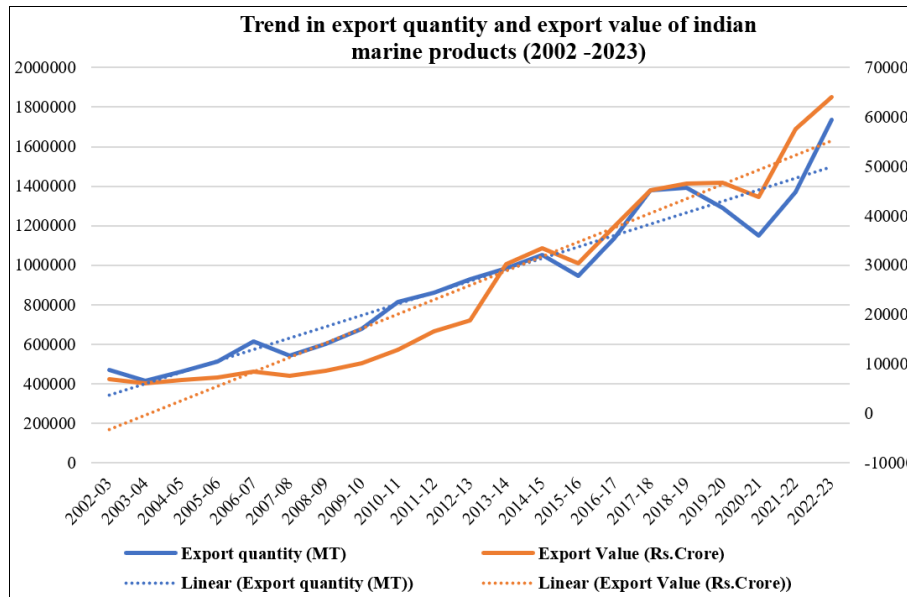
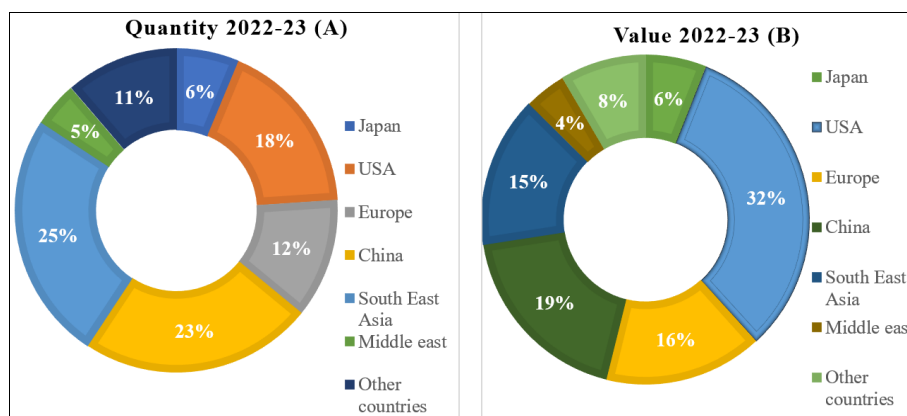


Fig 1: Trend in export quantity and export value in Indian marine products

Country wise share of Indian marine products exports

Figure 2 illustrate the country-wise share of India’s total marine product exports in terms of both quantity (MT) and value (Rs. Crores) for the year 2022-23. India’s marine exports reached a broad range of global markets, with Southeast Asia emerging as the largest destination by quantity, accounting for 25 percent of total exports. This highlights the region's crucial role in absorbing Indian seafood products. China followed closely with 23 percent of the exports, reflecting its strong demand. The United States accounted for 18 percent of the export volume, while Europe represented 12 percent. Other notable regions included Japan with 6 percent, the Middle East with 4 percent, and 11 percent distributed across various other global markets.

However, in terms of export value, the United States led with a significant 32 percent share, making it the most profitable market for India’s seafood industry. China accounted for 19 percent of the value, while Southeast Asia, despite leading in quantity, contributed 15 percent of the total value, reflecting its importance both in volume and monetary terms. Europe accounted for 16 percent, Japan 6 percent, and the Middle East 4 percent. The remaining 8 percent of the value came from other global regions. This distribution shows the diversity of India’s marine export markets and shows how different regions contribute differently in terms of both quantity and value, with the United States standing out as a particularly lucrative market for Indian seafood.



Source: Marine Products Export Development Authority, MPEDA

Fig 2: Country wise share of Total Marine Products Export Quantity (A) and Value, (B) for the year 2022-23

Materials and Methods

The study was based on time series data on export of marine products both product wise and market wise in terms of quantity (M.T) and value (Crores) for the period from 2003-04 to 2022-23. The data was collected from Marine Product Export Development authority (MPEDA) [7]. To know the growth, instability and structural changes in exports, compound growth rate, instability analysis using Coefficient of Variation and Cuddy Della and Vella instability index and Markov chain analysis were used respectively.

Compound Growth Rate (CGR)

Country wise and commodity wise growth of marine products exports from India in terms of quantity and value were estimated using compound annual growth rate. Which is expressed as follows.

$$Y_t = ab^t u_t$$

Where,

Y_t = Export of marine products in terms of quantity and value

t = Time period

b = Regression coefficient

a = intercept

Compound Growth Rate (CGR %) = $(\text{Antilog } b - 1) \times 100$

Instability analysis

The variation and level of instability in both quantity and value of exports was estimated by using coefficient of variation and cuddy Della and Vella index.

Coefficient of Variation (CV)

$$CV = [S.D/X] \times 100$$

Where,

S.D = Standard deviation

X = Mean of export quantity or Value

Cuddy Della and Vella instability index

The coefficient of variation is generally used as a measure of instability. But time series data often contain a trend component. In order to take care of this trend component and for meaningful measurement of instability. CV is modified as proposed by Cuddy and Della called as the Cuddy Della and Vella instability index and given by formula.

$$CDVI_{\square} = CV\sqrt{1 - R^2}$$

Where,

CDVI = Cuddy Della and Vella instability index

CV = Coefficient of variation

R^2 = Coefficient of determination

Markov chain analysis

The structural change in the exports of selected marine products from India in terms of market retention and market switching was examined by using the Markov chain approach. The estimation of the Transitional Probability Matrix (TPM, (P)) was central to this analysis. The element P_{ij} of the matrix indicated the probability that the exports would switch from the i^{th} country to j^{th} country over a period of time. The diagonal elements P_{ij} indicated the probability that the export share of a country would be retained in the successive time periods, which in other words, measured the loyalty of an importing country to a particular exporting country.

$$E_{jt} = \sum_{i=1}^n [E_{i,t-1}]P_{ij} + e_{jt}$$

Where,

E_{jt} = Exports from India to the j^{th} country in the year t

$E_{i,t-1}$ = Exports of i^{th} country during the year t-1

P_{ij} = Probability that exports will shift from i^{th} country to j^{th} country

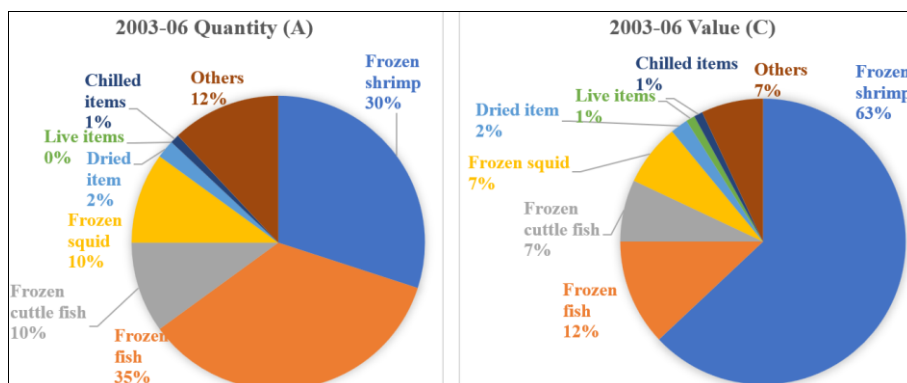
e_{jt} = Error term which is statistically independent of $e_{i,t-1}$

n = number of countries of India's marine exports

Results and Discussion

Product wise percentage change in quantity and value in marine exports from India

Frozen shrimp played a very important role in the exports of marine products from India over time (Fig 3). During 2003-06, frozen shrimp occupies 30 percent of the total volume of marine exports, and this share was increased to 48 percent between 2020-23, reflecting an 18 percent increase in the quantity of frozen shrimp exports. In terms of export value, frozen shrimp accounted for 63 percent of the total value of marine exports during 2003-06, and this share rose to 72 percent during 2020-23, reflecting a 9 percent increase in the value. Despite the substantial 18 percent rise in export quantity, there was a relatively lesser growth in export value, this can be attributed to the marginal increase in the unit value realisation of frozen shrimp.



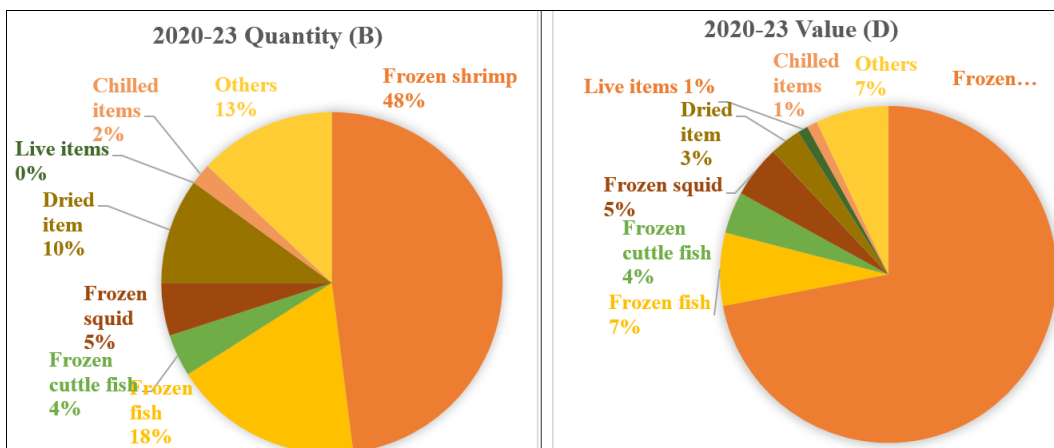


Fig 3: Product wise percentage change in quantity (A&B) and Value (C&D) in marine exports from India

Even though frozen fish occupies 35 percent of the quantity of marine exports between 2003-06, its share dropped to 18 percent during 2020-23. In terms of export value, its contribution was only 12 percent in total exports between

2003-06, and further it was reduced to 7 percent from 2020 to 2023. This highlighted that the unit value realisation from frozen fish was very less compared to frozen shrimp.

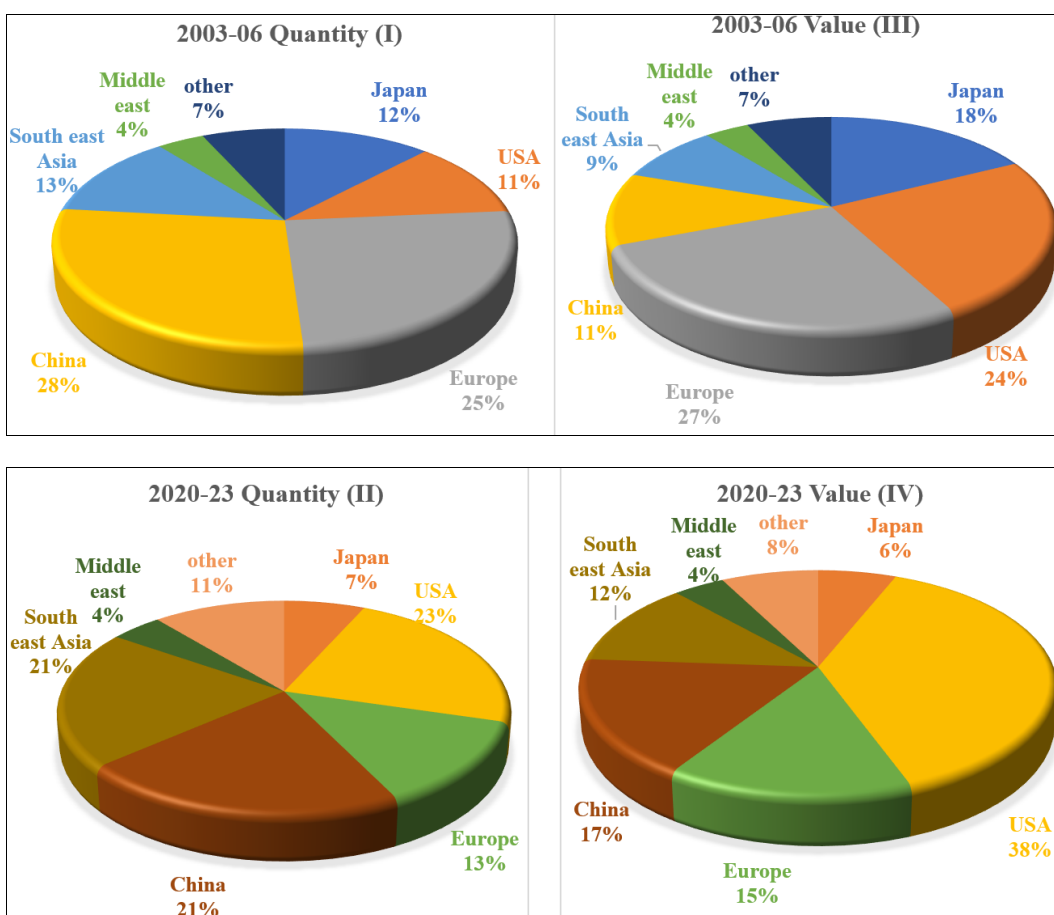


Fig 4: Market wise percentage changes in Quantity (I&II) and Value (III&IV) in marine exports from India

Market wise percentage changes in quantity and value in marine exports from India

The analysis of market wise exports of marine products from India revealed that USA was established as a major destination (Fig 4). During 2003-06, 11 percent of the total volume of marine exports were sent to the USA, this share rose to 23 percent between 2020 to 2023, revealing a substantial 12 percent growth in export volume. In terms of

value of exports, USA’s contribution was 24 percent during 2003-06, and it increased to 38 percent from 2020 to 2023 indicating a significant increase in value of exports in this market. A notable rise in exports to South East Asia had observed in both volume (8%) and value (3%) of exports during the concerned period. There was no change in the share of marine exports to Middle East. Europe experienced a substantial decrease in the share of volume and value of

marine exports. Although, there was a reduction (7%) in the volume of exports to China, the share in total export value was raised (6%) because of the growth in unit value of exports.

Commodity wise Growth Rates and Instability indices of Marine Products Export

A positive growth in export of marine products from India was observed during the period from 2003 to 2023 (Table 1). Dried items (12.74%) and frozen shrimp (11.69%) witnessed the highest significant growth in volume of exports for the above said period. In export value, frozen shrimp experienced a major growth of 16.71 percent

followed by dried items, which saw an increase of 14.54 percent. An interesting finding was dried items had shown highest instability in export quantity (39.11%) and export value (35.84%) and frozen shrimp demonstrated a moderate level of instability with export quantity (19.06%) and export value (23.72%) based on the Cuddy Della and Vella instability index (Table 2). The marine product export sector offers growth opportunities but also faces market instability. Dried and Chilled Items have strong expansion potential, while Frozen Shrimp requires stabilization through market diversification. Policymakers must balance growth strategies with risk mitigation to ensure long-term sustainability and competitiveness.

Table 1: Product wise growth in marine exports from India during 2003 to 2023

S. No.	Product	Export quantity (MT)	Export value (Rs. Crore)
		CGR (%)	CGR (%)
1	Frozen shrimp	11.69***	16.71***
2	Frozen fish	2.27**	9.98***
3	Frozen cuttle fish	1.86***	8.98***
4	Frozen squid	4.07***	12.29***
5	Dried item	12.74***	14.54***
6	Live items	6.90***	12.58***
7	Chilled items	8.67***	14.04***
8	Others	7.25***	12.92***

Note: **** indicates significant at 1% level, ** indicates significant at 5% level

Table 2: Product wise Instability in marine exports from India during 2003 to 2023

S. No.	Product	Export quantity (MT)		Export value (Rs. Crore)	
		CV (%)	CDV (%)	CV (%)	CDV (%)
1	Frozen shrimp	65.45	19.06	79.86	23.72
2	Frozen fish	26.22	23.85	49.49	24.83
3	Frozen cuttlefish	17.18	13.85	45.66	15.68
4	Frozen squid	28.86	20.06	63.19	19.05
5	Dried item	80.93	39.11	77.27	35.84
6	Live items	42.67	21.51	59.91	22.01
7	Chilled items	49.06	36.28	60.33	27.85
8	Others	41.42	10.61	68.54	12.10
9	Total	65.45	19.06	79.86	23.72

Market wise Growth Rates and Instability indices of Marine Products Export

In growth rate analysis of market wise exports (Table.3), USA experienced highest significant growth in both volume and value with 14.22 and 20.39 percent respectively. Further, USA has shown moderate level of instability (Table 4) both in export volume (29.75%) and export value (33.49%) during the same period. South East Asia also recorded 11.75 and 18.99 percent growth in export quantity and value, but a slight higher level of instability with 40.09 percent in export quantity and 42.57 percent in export value. All the markets exhibited positive growth in both export quantity and export value of marine products. China demonstrated a significant growth (13.98%) in export value, but it had a high instability both in export quantity (63.38%) and export value (58.19%).

The level of instability in marine products export is very important for sustainable export (Das *et al.*, 2016) [3]. USA with high growth rate and low instability comes under desirable destination. South East Asia is the most desirable destination having high growth and low level of instability. Europe, Japan and Middle East comes under less desirable destinations with low growth and low instability. China is the least desirable destination belonging to the low growth and high instability category. Similar results found in Jana, 2023 [6]. To enhance marine product exports, efforts should prioritize expanding exports to the most desirable destinations within key categories. At the same time, it is crucial to address the instability in exports to less desirable or least desirable markets. By focusing on stable markets, India can boost exports and significantly increase foreign exchange earnings.

Table 3: Market wise growth in marine exports from India during 2003 to 2023

S. No.	Market	Export quantity (MT)	Export value (Rs. Crore)
		CGR (%)	CGR (%)
1	Japan	2.80***	6.96***
2	USA	14.22***	20.39***
3	Europe	2.40***	9.22***
4	China	2.21	13.98***
5	South East Asia	11.75***	18.99***
6	Middle East	7.72***	14.64***
7	Other	8.55***	13.64***

Note: **** indicates significant at 1% level, ** indicates significant at 5% level

Table 4: Market wise instability in marine exports from India during 2003 to 2023

S. No.	Market	Export quantity (MT)		Export value (Rs. Crore)	
		CV (%)	CDV (%)	CV (%)	CDV (%)
1	Japan	18.72	9.27	38.97	11.94
2	USA	78.38	29.75	92.99	33.49
3	Europe	16.55	10.80	48.93	15.15
4	China	63.01	63.38	110.53	58.19
5	South East Asia	64.30	40.09	83.83	42.57
6	Middle East	40.85	17.19	63.91	19.18
7	Other	42.95	20.08	68.34	16.13

Direction of Trade

Transition Probability Matrix (Table 5) indicates the shifts in India’s sea food exports over time, focusing on how various products retained, gained or lost their market share. Over a 20 year period, frozen shrimp remained to be a stable product by retaining 92.60 percent of its share and losing only 7.39 percent to other items. This stability in the export market for frozen shrimp was also indicated by Qureshi and Krishnan (2018) [9]. On the other hand, Frozen fish has retained 71.14 percent of its share in export and lost a notable portion (15.59%) to frozen squid, followed by frozen cuttle fish (8.32%), other items (3.22%), chilled (0.89%), live (0.48%) and dried items (0.33%). The products which had registered lowest retention rates were other items (56.39%), Frozen cuttle fish (42.99%), chilled items (30.92%) and dried items (22.48%). Other items had lost their share to dried items (20.02%), Frozen squid

(17.41%), frozen cuttle fish (2.32%), live items (2.27%) and chilled items (1.57%). Frozen cuttle fish had lost a significant portion of its share to frozen fish (54.82%). Chilled items experienced a major loss in its share i.e., 60.28 percent to dried items. An interesting finding observed where dried items gained 100 percent of the share from live items, 60.28 percent from chilled items and 20.02 percent from other items. Despite of these gains dried items lost 67.96 percent of its share to frozen shrimp. Furthermore, live items lost all their share to dried items. In summary the data revealed that while frozen shrimp maintained a stable and strong presence in the export market, frozen fish faced increasing competition from other products, especially frozen squid and cuttlefish. The trends reflected the shifting dynamics in the global seafood export market. Similar results found in Chandrasekar *et.al* 2020 [2].

Table 5: Transitional Probability Matrix of marine products export - product wise from India (2003-04 to 2022-23)

	Frozen shrimp	Frozen fish	Frozen cuttle fish	Frozen squid	Dried item	Live items	Chilled items	Other items
Frozen shrimp	0.9260	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0739
Frozen fish	0.0000	0.7114	0.0832	0.1559	0.0033	0.0048	0.0089	0.0322
Frozen cuttle fish	0.0000	0.5482	0.4299	0.0000	0.0000	0.0000	0.0000	0.0218
Frozen squid	0.0000	0.5483	0.0827	0.1226	0.0446	0.0031	0.0101	0.1883
Dried item	0.6796	0.0000	0.0000	0.0000	0.2248	0.0000	0.0954	0.0000
Live items	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
Chilled items	0.0000	0.0000	0.0000	0.0000	0.6028	0.0365	0.3092	0.0513
Other items	0.0000	0.0000	0.0232	0.1741	0.2002	0.0227	0.0157	0.5639

The direction of trade over a period of 20 years can be seen in Table 6. South East Asia was the most loyal country for marine product exports as it retained 89.23 percent of its market share. It lost only 8.02 percent of its share to the USA, 2.37 percent to Japan and 0.36 percent to Middle East. The USA has also demonstrated high loyalty by keeping 87.61 percent of its market share and lost 8.63 percent to other countries and 3.74 percent to China. China retained 85.19 percent of its share. With losses of 6.5 percent to Japan, 5.99 percent to other countries and 2.3 percent to

Europe. Europe, Middle East and other countries had shown lower retention rates i.e., 68.72, 63.39 and 61.45 percent respectively. Among the importing countries Japan was the least loyal importer of Indian marine products as it retained only 28.25 percent of its shares. Major part of Japan’s market share was shifted to Europe (63.55%). The most loyal or stable markets for the Indian marine products were South East Asia, USA, and China (Qureshi and Krishnan, 2018) [9]. The USA has emerged as a stable importer of Indian marine products, maintaining its previous

year's share. The relaxation of anti-dumping duties after 2010 fueled rapid growth in exports to the US (Nisar *et al.*, 2020) [8]. This trend reflects a rising demand for Indian marine products in the US and an adaptability in export structure to global market shifts (Fayaz & Ahmed, 2020) [4]. China remains a key market for Indian marine exports, especially for frozen shrimp, due to its high demand despite

market instability and modest growth rates. Japan's decline in marine product imports was primarily due to a sharp reduction in shrimp exports to Japan, driven by factors such as a slump in domestic shrimp production and a gradual decrease in preference among Japanese consumers (Shinoj *et al.*, 2009) [11].

Table 6: Transitional probability matrix of marine product exports – Destination wise from India (2003-04 to 2022-23)

	Japan	USA	Europe	China	South East Asia	Middle East	Other Countries
Japan	0.2825	0.0000	0.6355	0.0818	0.0000	0.0000	0.0000
USA	0.0000	0.8761	0.0000	0.0374	0.0000	0.0000	0.0863
Europe	0.2159	0.0000	0.6872	0.0000	0.0391	0.0324	0.0252
China	0.065	0.0000	0.023	0.8519	0.0000	0.0000	0.0599
South East Asia	0.0237	0.0802	0.0000	0.0000	0.8923	0.0036	0.0000
Middle East	0.0000	0.0000	0.0000	0.0000	0.0812	0.6339	0.2848
Other countries	0.0000	0.0000	0.0000	0.0000	0.2915	0.0938	0.6145

The study highlights significant growth, variability and direction of trade in India's marine product exports over the period from 2003-04 to 2022-23. Dried marine items showed the highest growth in export quantity and frozen shrimp in value, while frozen cuttlefish exhibited the lowest growth, in both export quantity and value indicating demand disparities for different marine products. Instability in exports was pronounced in dried items and frozen fish reflecting fluctuations in demand and price volatility in these categories. Major importing markets like the USA, South East Asia, and China displayed notable differences in growth and stability, China, despite being a key market, showed high instability, likely due to policy shifts and fluctuating demand, while South East Asia emerged as a robust growth market. Additionally, Markov chain analysis highlighted that frozen shrimp dominates India's export basket, indicating its strong market positioning. The Transitional Probability Matrix suggests that South East Asia and the USA are the most loyal markets for Indian marine products, while Japan shows the least loyalty, likely due to diverse seafood sourcing and consumption preferences. These findings emphasize the need for India to focus on product diversification and market stabilization strategies to reduce volatility and enhance export resilience. These findings underscore the importance of targeting stable, high-growth markets for maximizing export potential, while addressing the challenges posed by more volatile destinations like China.

Conclusion

The study highlights significant growth and instability in India's marine product exports from 2003-04 to 2022-23. Frozen shrimp dominated in value, while dried items saw the highest growth in quantity. The USA and South East Asia emerged as stable markets, whereas China showed high volatility. Markov chain analysis confirmed frozen shrimp's market dominance, with South East Asia and the USA being the most loyal importers. Japan had the lowest retention rate. To enhance resilience, India must focus on market diversification, stabilizing volatile segments, and strengthening trade with high-growth, stable markets. Addressing export instability and shifting consumer trends will be crucial for sustaining India's global seafood market position.

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