Fishery Technology 57 (2020) : 59 - 68

Analysis of Marine Products Export from India using Markov-Chain Analysis

V. Chandrasekar[1]*, P. Paramasivam[2], C. Jayanthi[1], R. Sathy[2], Nikita Gopal[1] and K. Mani[2]
[1] *ICAR-Central Institute of Fisheries Technology, P. O. Mastyapuri, Cochin - 682 029, India*
[2] *Tamil Nadu Agricultural University, Lawley Road, Coimbatore - 641 003, India*

Abstract

The present study analyses the changing pattern of marine product exports from India to seven regions/ countries such as Japan, USA, European Union (E.U), China, South East Asia (SEA), Middle East (ME) and others, during two decades from 1995 to 2015. The average growth rate of marine seafood export in relation to quantity and value for the two decades was 6.78 and 12.5% respectively. Frozen shrimp export quantity had nearly 40% share in the total export basket. Instability in value was higher than the quantity of export, out of which frozen shrimp price instability was nearly 60%. Using Markov Chain Analysis, it was observed that European Union was having higher probability of retention (0.82) compared to the other regions. In the first decade Japan was the major importer with higher probability of retention which reduced from 0.91 to 0.56 during the second decade with a gain by European Union (0.87) in the same decade.

Keywords: Marine product export, export instability, markov chain analysis

Introduction

IIndia is considered a labour abundant country and as per traditional Hecksher-Ohlin trade theory, the growth of the country can be considered as being based on an outward looking trade policy, i.e, exporting labour intensive goods. The seafood industry can be considered predominantly a labour intensive sector. India is the major producer of fish in the world with a marine fish production of about 3.63 million tonnes in the year 2016 (CMFRI, 2016) a 6.6% increase compared to the previous year. Nearly 31.4% marine fish production is exported i.e 1.14 million tonnes with a value about Rs.37871 crores (USD 5778 million). In recent decades the international trade in seafood has been rising both in volume as well as in value mainly due to rise in consumer demand for processed sea foods in importing countries. The present study analyses the changes in the export of major marine products frozen shrimp, frozen fin fish, frozen cutlet, frozen squid, dried items, live items, chilled items and all others (grouped together) from India to seven major export markets Japan, United States of America, European Union, China, South East Asia, Middle East and Others (other countries grouped together) over the decades 1995-96 to 2015-16 and discusses how the pattern of marine fish product export has changed over the years and also assesses the future direction of marine export trade.

Received 25 August 2018; Revised 28 December 2019; Accepted 28 December 2019

**E-mail: vcsecon@gmail.com*

Materials and Methods

The study is based on secondary data collected from published sources MPEDA (Marine Product Export Development Authority) for the period 1995-96 to 2015-16. The product-wise export quantity and value of marine products in (frozen shrimp, frozen fin fish, frozen cutlet, frozen squid, dried items, live items, chilled items and others) have been used for the analysis the seven different markets both countries and regions are Japan, USA, European Union, China, South East Asia, Middle East and Others.

The exponential growth function was used

$$Y = ab^t e \quad \text{------- (1)}$$

Where,

Y = quantity exported (tonnes) or value realized (Rs.Crores)

a = intercept

© 2020 Society of Fisheries Technologists (India)

b = regression co-efficient

t = time

e = error term

Taking log on both side of the equation (1) to obtain the compound growth rate as follows:

$$\log Y = \log a + t \log b \text{ ------- (2)}$$

The percent compound growth rate (CGR) was computed using the following:

$$CGR = (\text{Antilog of } b - 1) \times 100 \text{ ------- (3)}$$

Where,

b – regression co-efficient

Della Valle instability index (Della Valle, 1979) was used to measure the variability of marine product export both in quantity and value, from India over 20 years. Instability index is derived from the co-efficient of variation which was multiplied by square root of the differences between the coefficient of multiple determinations (R2) and unity to de-trend the times series of export data as given in the equation 4.

$$\text{Instability Index} = CV \times (1 - R^2)^{0.5} \text{ ------- (4)}$$

Where,

CV = Co-efficient of Variation (values in Rs.Crores)

R^2 = ESS/ coefficient of multiple determinations

ESS = Explained sum of square

TSS = Total sum of square

The level of instability was categorized into low (between 0-15), medium (15< instability <30) and high (>30).

To quantify the market retention and market switching Markov chain approach has been used. Markov chain analysis was used to measure the structural change in any system over a period of time in terms of single outcome variable (Dent, 1967, Jayesh, 2001). The dynamics in the direction of the trade of marine products export from India to the selected seven major importing countries/regions in terms of the measure of gain and losses is examined.

In Markov chain analysis the transitional probability matrix (P) is estimated, where the Pij matrix tells the probability that the exports would switch from the i^{th} country to j^{th} country over a period of time. The diagonal elements Pij indicates the export retention probability of the country over the period. In other words, it measures the loyalty of an importing country to a particular exporting country. In the transition probability matrix, the row and column elements provide the information on the extent of loss and gain in market share on account of competing countries respectively. The off-diagonal or transfer probabilities indicates the probability of whether the export share will shift from one country to another country over time.

The transition probability matrix was worked out for quantity and value (nominal price) separately for both country / region as well as for item. The average export to a particular country was considered to be a random variable which depends only on the export to that country which was denoted algebraically by equation 5.

$$X_{jt} = \Sigma_{i=1}^{n} (X_{it-1}) P_{ij} + e_{jt} \text{ ------- (5)}$$

Where,

X_{jt} = Exports from India to the j^{th} country during the year t

X_{it-1} = Exports to the i^{th} country during the year t – 1

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

E_{jt} = Error-term statistically independent of e_{jt-1}, and

n = Number of importing countries.

The transitional probabilities P_{ij}, can be arranged in a (c × n) matrix, having following properties:

$$\Sigma_{i=1}^{n} P_{ij} = 1 \text{ ------- (6)}$$

Where, $0 \leq P_{ij} \leq 1$

Thus, the expected export share of each country during period 't' is obtained by multiplying the exports to these countries in the previous period (t-1) with the transitional probability matrix. The probability matrix was estimated for the period 1995-96 to 2015-16. The transition probability matrix was calculated using linear programming method referred to as minimization of the mean absolute deviation (MAD) Eq. (7)

$$Min \text{ O } P^* + Ie \text{ ------- (7)}$$

Subject to,

$$DP^* + V = Y$$

$$GP^* = 1$$

Where,

P^* = vector of the probabilities P_{ij}

O = vector of zeros

I = appropriately dimensional vectors of areas

e = vector of absolute errors

Y = proportion of exports to each country.

D = block diagonal matrix of lagged values of Y

V = vector of errors

G is a grouping matrix to add the row elements of P arranged in P* to unity.

Predictions of quantity of marine products export were made by using the Transitional Probability Matrix, which indicated the complete structure of the transitions in the system.

$$Q_t = Q_0 * T$$

$$Q_{t+i} = Q_{t+i-1} * T$$

Where,

Q_0 = Quantity exported in base years

Q_{t+i}= Quantity exported in next year (forecast)

T = Transitional probability matrix

Results and Discussion

The growth in quantity and value of marine products export from India from 1995 to 2015 is shown in Fig. 1. The compound growth rate is 6.78% in terms of quantity and 12.5% in-terms of values (Figures. 2 to 5). During the year 2014-15 both quantity and value of export touched a peak of 10.5 lakhs tonnes and 33 thousand crores (INR) respectively.

The decline in the level of marine product exports during the year 2015-16, compared to its pervious year was around 10% in terms of quantity and 9% in terms of value. This was mainly because of the revival of aquaculture production in Thailand and Vietnam, and a fall in the international prices of shrimp. Further the depreciation of Euro, and devaluation of the Chinese Yen contributed to the decline in export demand (MPEDA 2016).

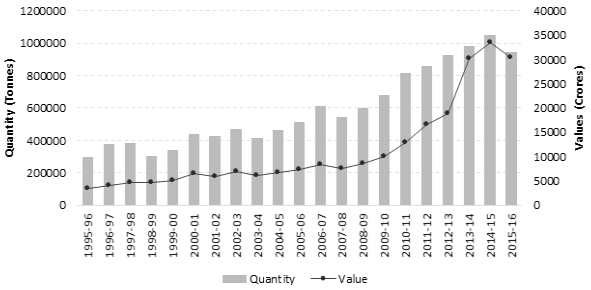

Fig. 1. Growth of Indian marine products export from 1995-96 to 2015-16

Source: www.mpeda.com

Table 1. Compound growth rate for marine products items (in %).

Particulars	Quantity		Value	
	1995-2005	2006-2016	1995-2005	2006-2016
Fr. Shrimp	4.24	12.03	6.75	21.57
Fr. Fin Fish	2.43	16.52	2.92	3.56
Fr. Cuttle fish	5.32	15.02	1.07	10.18
Fr. Squid	2.54	4.13	6.25	11.72
Dried items	1.93	6.99	0.69	6.94
Live items	4.85	14.57	0.61	9.71
Chilled items	4.07	14.59	15.61	20.11
Others	10.96	15.09	2.23	8.85
Total	8.39	19.89	4.03	14.90

CAGR: Compound Annual Growth Rate (%)

From 2007-08 to 2012-13 both quantity and value have shown an increasing trend. In 2013-14 there is an increase in value by 60% whereas the increase in quantity is around 5%. This is due to the increase in value of frozen shrimp export in the year 2013-14. The main driver of the total export earnings is frozen shrimp. Even though the quantity of frozen shrimp export increased by only around 6% only, the value wise realization is almost two times.

Compound growth rates for marine products item-wise export quantity and values were calculated for a period of twenty years in two periods i.e from 1995-96 to 2015-16 (Table 1). The results show that export in both quantity and value terms showed a positive growth rate, which found that more growth was seen in the case of chilled items and frozen cuttlefish, though it is not significant to the overall export as the contribution of chilled and frozen cuttlefish to the overall export basket is insignificant. The major quantity exported is frozen shrimp with nearly 40% share in the total seafood export basket. Frozen shrimp export showed higher growth rates in the second decade with 5.84% and 9.24% growth in quantity and value respectively.

The overall instability in value terms is more than the quantity export instability, which shows that there was low price stability for all the items particularly in case of frozen shrimp export price of nearly 60%. The Fig. 2 & 3 shows the comparison of growth rate and instability of marine products export for past two decades. Based on the level of instability of the items they were grouped into three categories i.e low, medium and high. High instability was seen in frozen shrimp, chilled items and dried items. The medium level instability was observed for frozen squid, fin-fish and live items and frozen cuttlefish and others items were under low instability for both quantity and value. There was both positive as well as negative relationship in between the growth rate and instability of marine product exports. MacBean, (1966) observed positive relationship between the economic growth and instability and postulated that if risk-averse behavior is assumed uncertainty about export earnings can lead to a reduction in consumption and in turn an increase in saving and investment, and thus lead to economic growth. Knudsen & Parnes (1975) using the cross section data of 28 developing countries worked out a transitory index to measure instability and found Marginal Propensity to Consume (MPC) is negatively related to export instability. But many studies such as Glezakos (1973), Voivodas (1974) and Ozler & Harrigan (1988) found negative correlation with the economic growth and export instability.

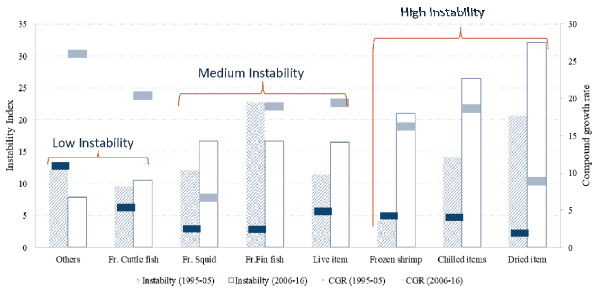

Fig. 2. Quantity-wise growth and instability of marine products export for two decades (1995-2005 & 2006-2016)

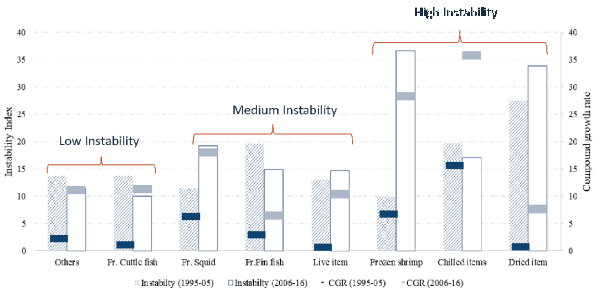

Fig. 3. Value-wise growth and instability of marine products export for two decades (1995-2005 & 2006-2016)

Fig. 2 depicts the comparison of growth and instability of the quantity of marine products export from India for both decades. It indicates an average of 7.83% higher growth rate in export compared to its previous decade for all the marine products items. Similarly while comparing the export instability between two decades a general increase in the second decade for all marine products except frozen fin fish and others. In both the decades overall instability in quantity of all marine products export was (13.18%). Fig. 3 shows value-wise comparison of export instability and growth of marine products export from India, showed a general decline in the instability level in the second decade except for frozen shrimp, dried items and frozen squid. Positive growth rate was seen in all the marine products exported between the two decades, but without stability in the export price. This implies that no fish processing industry will venture into the trade due to uncertainty in making profits.

During 2015-16 it is observed that major export of marine products from India was to South East Asian countries (34.6%), European Union (19.9%) and USA (10.8%). Export in terms of value USA was higher than South East Asia. The transitional probability matrix worked out by using the annual quantity exported in tonnes of marine products from 1995-2005 and 2006-2016 has been presented in Table 2 and Table 3 respectively. This represents a change in the direction of marine products export from India to seven major regions importing marine products. It is observed from the analysis of two separate decades that European Union, China and South East Asia have become more stable importers of Indian marine products in the second decade compared to the first decade as revealed by high probability of retention at 0.82732, 0.75403 and 0.58574 respectively. On the contrary, Japan and other countries having a probability of retention around 50% in the first decade, decreased near to zero level in the second decade, indicating that they are unstable with respect to the quantity of marine

Table 2: Transition Probability Matrix for quantity of Marine products export Region-wise from 1995-2005

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.54291**	0.05764	0	0.39946	0	0	0
USA	0	**0.22192**	0	0.41247	0.36561	0	0
EU	0	0	**0.59088**	0.03182	0.26427	0	0.11302
China	0.20652	0.09956	0.22987	**0.29231**	0.06729	0.08915	0.01528
SEA	0	0	0	0.91721	**0**	0.08279	0
ME	0	0.94521	0	0	0	**0.05478**	0
Others	0	0	0.42246	0	0	0	**0.57754**

Table 3. Transition Probability Matrix for quantity of Marine products export Region-wise from 2006-2016

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.08391**	0	0.01766	0	0	0	0.89843
USA	0	**0**	0.09692	0	0.75781	0.14527	0
EU	0.00155	0	**0.82732**	0.08630	0	0.02231	0.06250
China	0.24596	0	0	**0.75403**	0	0	0
SEA	0.11649	0.25924	0	0	**0.58574**	0	0.03852
ME	0.09236	0.46482	0.29649	0	0	**0.14632**	0
Others	0	0.25900	0	0	0.43234	0.19995	**0.10870**

Table 4. Transition Probability Matrix for value of Marine products export Region-wise from 1995-2005

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.85876**	0.05131	0	0.08993	0	0	0
USA	0	**0.68016**	0.10914	0	0.09506	0.00281	0.11282
EU	0	0	**0.62769**	0.19601	0.09425	0.08033	0.00172
China	0.14872	0	0.21387	**0.09948**	0.38125	0.13577	0.02092
SEA	0	0.60984	0	0.39016	**0**	0	0
ME	0	0	1	0	0	**0**	0
Others	0	0	0.50455	0	0	0	**0.49545**

products imported from India. In the second decades South East Asia region countries has shown increased stability from zero in the first decade in the import of Indian marine products by gaining its share from USA and other countries 0.75781 & 0.43234 i.e., the probability gained in the quantity of Indian marine products export share is at the cost of that of other countries.

Similarly the transitional probability matrix was worked out for the value of marine products export during the period from 1995 to 2005 (first decade) and 2006-2016 (second decade) in the Table 4 & Table 5 respectively. This shows that in first decade Japan is the major source of foreign exchange which shows higher probability of retention (0.8506) in terms of its export value compare to USA, though the annual average unit price realization from Japan was higher compared to USA until 2000-01. On comparing the Table 4 & 5, in the second decade both Japan and USA retention levels declined and EU (0.8075), China (0.7071) and South East Asia

Table 5. Transition Probability Matrix for value of Marine products export Region-wise from 2006-2016

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.40375**	0	0.14219	0.06616	0	0.05071	0.33719
USA	0.05819	**0.42712**	0.09901	0	0.25732	0.09486	0.06351
EU	0.12983	0	**0.80747**	0.06269	0	0	0
China	0.19021	0	0	**0.70713**	0.04920	0.05346	0
SEA	0	0.44924	0	0	**0.53587**	0.014839	0
ME	0	0.70811	0	0	0.29189	**0**	0
Others	0	0	0	0	0.37824	0.27253	**0.34923**

Table 6. Transition Probability Matrix for quantity of Marine products export Item-wise from 1995-2005

	Fr. Shrimp	Fr. Fin Fish	Fr. Cuttle fish	Fr. Squid	Dried items	Live items	Chilled items
Fr. Shrimp	**0.25658**	0.34350	0.12039	0.20719	0.03735	0.01297	0.02205
Fr.Fin Fish	0.33386	**0.56682**	0.01855	0.05381	0.02171	0.00489	0.00477
Fr.Cuttle fish	1	0	**0**	0	0	0	0
Fr. Squid	0	0.66707	0.33293	**0**	0	0	0
Dried items	0	0	0.70258	0.27461	**0**	0.02281	0
Live items	1	0	0	0	0	**0**	0
Chilled items	0	0	0	1	0	0	**0**

Table 7. Transition Probability Matrix for quantity of Marine products export Item-wise from 2006-2016

	Fr. Shrimp	Fr. Fin Fish	Fr. Cuttle fish	Fr. Squid	Dried items	Live items	Chilled items
Fr. Shrimp	**0.94667**	0	0.00980	0	0	0.00418	0.03935
Fr.Fin Fish	0	**0.83296**	0.07819	0.06413	0.02472	0	0
Fr.Cuttle fish	0	0.31629	**0.54996**	0.10146	0	0.32292	0
Fr. Squid	0	0.28195	0	**0**	0.51322	0.00146	0.20337
Dried items	0.47722	0	0	0.31461	**0.20244**	0.00573	0
Live items	0	0	0	0.84459	0	**0.15541**	0
Chilled items	0	0	0	0.98079	0	0.01921	**0**

(0.5359) gained prominently and was observed that EU was a more loyal market for marine products export from India.

In general, on comparing both decades it is observed that there is doubling in the overall total annual quantity of marine products export to the different regions. The increase in South East Asia is 5.3 and 8.3 times in terms of decadal quantity and value. It is found out that maximum quantity exported to China is about 34% and followed by EU countries of about 20% and same percentage were continued in the second decade also. The maximum quantity exported during the second decade to South East Asian countries was around 29%. The highest value of revenue generated through export of marine product to Japan during the first decade is around 32% and next decade it reduced to 11% whereas the export value to EU countries is higher of about 24%.

It is evidenced from Tables 6 & 7 that, though in the first decade frozen fin fish retention was dominating in the export basket in the second decade frozen shrimp shows higher probability of retention (0.9467) i.e., the probability with which frozen shrimp had retained its export quantity share is 94 per cent over the second decade. Thus, the quantity of frozen shrimp export from India had the most stable export market in the world.

Similarly from the table 9 & 10, it can be concluded that the export value of frozen shrimp was most dominating and had stable market price in both the decades of about 90 and 92% i.e. on an average of 90% retention in the export value compared to other items in the export basket is noteworthy. Though quantity of frozen products export was seen higher than frozen shrimp export, the value of frozen shrimp was 5.3 and 3.7 times higher than the frozen fish in both decades. Frozen shrimp alone accounted for 70 and 62% of the total value of seafood export from India for the first and second decade respectively.

In the overall Indian export basket, shrimp dominates both in terms of quantity as well as value and this is largely because of increase in shrimp aquaculture and this production feeding the processing industries. Based on the India's overall shrimp exports during the two decades, China in the first decade had the import share of 72%, whereas

Table 8. Transition Probability Matrix for Value of Marine products export Item-wise from 1995-2005

	Fr. Shrimp	Fr. Fin Fish	Fr. Cuttle fish	Fr. Squid	Dried items	Live items	Chilled items
Fr. Shrimp	**0.89985**	0.01695	0.02397	0.03676	0.00646	0.00068	0.01533
Fr.Fin Fish	0.49501	**0.45386**	0.00168	0	0	0.04944	0
Fr.Cuttle fish	0	0	**0.68711**	0.28001	0	0.03014	0.00274
Fr. Squid	0	0.94327	0.05673	**0**	0	0	0
Dried items	0	0	0	0.71566	**0.28434**	0	0
Live items	0	0	0.40155	0.59845	0	**0**	0
Chilled items	0	0	0	0.56152	0.43499	0.00348	**0**

Table 9. Transition Probability Matrix for value of Marine products export Item-wise from 2006-2016

	Fr. Shrimp	Fr. Fin Fish	Fr. Cuttle fish	Fr. Squid	Dried items	Live items	Chilled items
Fr. Shrimp	**0.91992**	0.00284	0.00969	0.03897	0	0.00807	0.02051
Fr.Fin Fish	0	**0.51828**	0.19808	0.10695	0.12997	0.01231	0.03439
Fr.Cuttle fish	0	0.57021	**0.40865**	0	0.02114	0	0
Fr. Squid	0.48474	0.32653	0	**0.11708**	0	0	0.07165
Dried items	0.01408	0.18607	0	0.33586	**0.46397**	0	0
Live items	0	0.38469	0.24861	0	0	**0.36671**	0
Chilled items	1	0	0	0	0	0	**0**

it decline declined to 33% in the second decade. The shifting in the export of frozen shrimp to South East Asia was observed up to 6.5 times and 16.7 times in value higher than the pervious decade.

major importer of shrimp in the world.

In Table 10 & 11 were worked out separate transitional probability matrices were worked out for frozen shrimp export quantity for different regions in two decades. It was observed that Japan (91.3%) was dominating, followed by other countries (85.2%) & USA (60.5%) and had more probability of market share retention in terms of total shrimp trade volume in the first decade. In the second decade especially after the year 2010 there was drastic increase of 44% in the quantity of frozen shrimp export to the South East Asia.

The quantity of shrimp export to Japan started fluctuating after the year 2000. The quantity of export is dependent on unit price realisation. Other reasons were sudden increase in quantity exported to China which continued up to the year 2010, as well as fluctuation in the domestic shrimp production.

Similarly in terms of value in frozen shrimp export, higher retention was seen in Japan (0.89) in first decade which shifted to USA (0.83) in second decade this was probably was due to more comparative advantage for India exports to USA in terms of foreign exchange earnings. There was sudden increase in quantity and value of shrimp export to EU, USA and South East Asian countries after the year 2009-10. This was due to the introduction of white leg shrimp (Litopenaeus vannamei) as an alternative species due to their disease resistance and tolerance to high stocking densities, low salinity and temperature, as well as their high growth rate with the existing scampi (Macrobrachium rosenbergii) culture which faced severe disease outbreaks that affected the India shrimp production significantly. General fall in the shrimp export were seen from South East Asian countries because of fall in production, but also growing domestic shrimp consumption there (Bith-Hong Ling et al., 1996). There was also reduction in countervailing duties on shrimp import in addition with higher unit price value by USA which is a major importer of shrimp in the world. Though shrimp export to China and

Table 10. Transition Probability Matrix for quantity of shrimp export Region-wise from 1995-2005

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.91340**	0	0	0.06850	0.01465	0.00346	0
USA	0	**0.60451**	0.20032	0.02889	0.07259	0.04130	0.05239
EU	0	0.31667	**0.43592**	0.02101	0.11507	0.10442	0.00690
China	0	0.70768	0	**0**	0.17921	0.11311	0
SEA	0	0	1	0	**0**	0	0
ME	0	0	1	0	0	**0**	0
Others	0	0	0.14778	0	0	0	**0.85220**

Table 11. Transition Probability Matrix for quantity of shrimp products export Region-wise from 2006-2016

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.56356**	0	0.02938	0	0	0.10022	0.30684
USA	0	**0.76424**	0	0.02824	0.08777	0.05510	0.06376
EU	0.13339	0	**0.86661**	0	0	0	0
China	0	0	0.36333	**0**	0	0	0.63667
SEA	0	0.23195	0	0.00855	**0.75951**	0	0
ME	0	1	0	0	0	**0**	0
Others	0.12726	0.12362	0.12165	0.09541	0	0.24585	**0.28621**

South East Asia is higher than any other country and region, both showed zero probability of retention mainly due to loss in its trade share from competing country like USA (46%) and (100%).

Whereas in the second decade in Table 13, transitional probability matrix for the shrimp export value showed that retention probability was high in countries like USA (83%), E.U (79.6%) and SEA (77.6%). USA held their high retention probability and was likely to gain in market share with competing country of SEA of 17%. Similarly E.U could have the possibility of gaining market share from other countries of about 37%. Export retention probability to China is zero and it also one of the largest shrimp exporting country in the world, so the import of shrimp from India will in the long run be less and value wise the situation was unstable.

The exported products includes frozen, dried, live, chilled and other items. Quantity of marine products from India is influenced by both domestic and international factors such as trade agreement policies, export promotion subsidies, technological upgradation in fishing and fish processing, foreign exchange rate, domestic fuel price etc. Transition Probability Matrix Analysis of overall marine products export revealed that European Union, China and South East Asia have emerged as more stable importers of Indian marine products in 2006-2016 compared to the previous decade, which was reflected higher retention probability of 82, 75 and 58% respectively.

Further, it is found that frozen products contribute maximum to the export basket especially shrimp and finfish. Further frozen shrimp was most dominating and had higher retention value in both the decades. Until year 2013-14 quantity of frozen fish exported was higher than shrimp, the value of shrimp has always been higher than that of frozen fish at about 5.6 and 3.5 times in the decades studied respectively. Japan was the major importer with higher probability of retention (91%) in the first decade and reduced to its retention (56%) in the second decade and European Union retention (87%) gained during the second decade has also been found to be a loyal market.

Table 12. Transition Probability Matrix for value of shrimp export Region-wise from 1995-2005

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.89621**	0.00344	0.01740	0.06099	0.02197	0	0
USA	0	**0.65285**	0.14744	0	0.09928	0.01743	0.08300
EU	0.01352	0.15382	**0.66300**	0	0.06135	0.10831	0
China	0	0.46270	0.04181	**0**	0.29103	0.02446	0
SEA	0	1	0	0	**0**	0	0
ME	0	0	1	0	0	**0**	0
Others	0	0	0.25165	0	0	0.08597	**0.66238**

Table 13. Transition Probability Matrix for value of shrimp products export Region-wise from 2006-2016

	Japan	USA	EU	China	SEA	ME	Others
Japan	**0.56776**	0	0.03766	0	0	0.14861	0.24598
USA	0	**0.83058**	0	0.00910	0.05272	0.03823	0.06937
EU	0.20427	0	**0.79573**	0	0	0	0
China	0	0	0	**0**	0	1	0
SEA	0	0.17028	0	0.05329	**0.77643**	0	0
ME	0	1	0	0	0	**0**	0
Others	0.08802	0.09556	0.37681	0.09050	0	0.48150	**0.30096**

The frozen shrimp export in terms of value saw higher retention in Japan (0.89) in first decade which shifted to USA (83%) in the second decade due to more comparative advantage in terms of foreign exchange earnings. Therefore to persist in the trade more emphasis has to be give on exporting of highly differentiated product by increasing the quality, productivity and efficiency of the production and export of high quality fish products at higher price.

References

MacBean, (1966) Export Instability and Economic Development (Cambridge, Mass: Harvard University Press, 1966)

Bith-Hong Ling, Ping Sun Leung and Yung C. Shang (1996) Export performance of major cultured shrimp producers in the Japanese and US markets. Aquacult. Res. 27: 775-785

CMFRI (2016) Marine Fish Landings in India 2016, Fisheries Resources Assessment Division, CMFRI, Booklet No: 6/2017. 1p

Glezakos (1973) Export Instability and Economic Growth: A Statistical Verification. Economic Development and Cultural Change. 21: 670-78

Voivodas (1974) The Effect of Foreign Exchange Instability on Economic Growth. Rev. Econ. Stat. 56: 410-12

Della Valle, P. A. (1979) On the Instability Index of Time Series Data: A Generalisation. Oxf. Bull. Econ. Stat. 41(3): 247-248

Dent, W. T. (1967) Application of Markov Analysis to International Wool Flows. Rev. Econ. Stat. 49(2): 613-616

Jayesh, T., (2001) Production and Export Performance of Pepper and Cardamom in South India. – An Economic Analysis, M.Sc. (Agri) thesis, Uni. Agric. Sci. Dharwad

MPEDA (2016) https://economictimes.indiatimes.com/news/economy/foreign-trade/indian-seafood-exports-decline-9-per-cent-to-rs-30421-crore-in-2015-16/articleshow/53448019.cms (accessed 28th May 2018)

Knudsen and Parnes, A. (1975) Trade Instability and Economic Development, London: D. C. Heath

Ozler and Harrigan (1988) Export Instability and Growth. Department of Economics Working Paper No. 486 (University of California, Los Angeles, 1988)