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Leads and Lags in Indian Seafood Exports: An Analysis of Market Concentration and Forecasts

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Abstract

The present study analyzed the changing scenario of volume, value, principal markets and composition of sea food exports of India. Compound growth rates and the market concentration of Indian seafood export srevealed that frozen shrimp remains the flagship product of Indian seafood exports (2004-2018). South East Asia including China recorded the highest compound growth rate for Indian seafood exports among the different principal markets. The Herfindahl-Hirschman index (HHI) revealed a high level of overall market concentration. The Markov's transitional probability matrix revealed that the frozen shrimp will remain the mainstay of Indian seafood exports and both USA and South East Asia including China would remain a stable market. The matrix also revealed a minor shift of market share to European Union. Forecasted values indicated similar results. European Union and South East Asia were expected to improve their contributions to total value of Indian seafood exports substantially by 2020.

Keywords: *Markov's transitional probability matrix, Herfindahl-Hirschman index, Indian seafood exports, Market concentration and forecasts*

JEL Classification: *F140, Q17*

Introduction

The seafood industry is most important and commands maximum turnover of global business among animal protein industry. Globally, 121 out of 195 countries trade in seafood fetching a value of US $ 103.7 billion in export earnings (2016-17). Crustaceans (mainly shrimp) and frozen fish accounted for 26 per cent and 21 per cent of the Indian seafood exports baskets, res. India is a predominant player in global seafood export market with 6.4 per cent share, next only to China (12.8 %) and Norway (10.6 %) (UN Comtrade, 2018). It may be noted that this value has doubled in the last 5 years (Rabo Bank, 2018). India ranks 8th in terms of share of the total value of global seafood exports (DGCI, 2017).Seafood export of India contributed 17.07 per cent of the total agricultural exports of India during the year 2016-17. India's seafood export of 13,77,244 tons earned Rs. 45,107 crores in foreign exchange during 2017-18. The quantity rose by 21.35 per centwhile the value rose by 19 per cent over the previous year. In dollar terms, the exports fetched $ 7.08 billion as against $5.77 billion a year ago with frozen shrimp and fish

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continuing to dominate the export basket. The USA and South East Asia are the major import markets of India's seafood products (MPEDA, 2018)

Changing scenario of share of quantity, value and markets of seafood exports from India

For a long time, USA was the principal buyer for the India frozen shrimp but after 1977, Japan emerged as the principal buyer of the products, followed by the Western European countries. Japan retained its position till 2001-02 as the single largest buyer for Indian marine products accounting for about 31per cent in the total export value. During the year 2002-04, USA emerged as the single largest market for the Indian marine products in terms of value. During the year 2004-05, the European Union had collectively become the single largest importer of Indian marine products and it remained the principal market for Indian seafood exports since 2005-06. During 2011-12 South East Asia became the largest buyer of Indian marine products with a share of 39.90 per cent in volume and 25.09 per cent in value. European Union came second with a share of 22.96 per cent followed by USA 18.17 per cent, Japan 13.01per cent, China 7.51per cent, Middle East 5.33per cent and other countries by 7.95per cent. In 2014 South East Asia again emerged as the largest buyer of Indian marine products with a share of 50 per cent volume and 23 per cent value followed by European Union (18 % and 23 %), Japan(10 % and 13 %) followed by USA(8 % and 18 %). In 2017-18, South East Asia continued to be a top buyer of Indian marine products with a share of 45per cent by volume and 32per cent by value but dynamics for other countries had changed a little. South East Asia was followed by USA with a share of 18 per cent volume, 33 per cent value and European Union (14 % and 16 %) (MPEDA, 2018).

Data Sources and Methodology

The study is based on the secondary data collected from various official publications. The data on seafood exports of India in terms of quantity, value and unit value, composition of exports and major markets were compiled from the various reports of Marine Products Export Development Authority of India (MPEDA) and from UN Com trade data base. Markov's chain analysis was used for deriving transitional probability matrices and forecasting.

Compound Annual Growth rates

The model can be written as

$$\log Y_t = A + B_t + \epsilon'$$

$$A = log\ Y_0; B = \log(1+r)\ and\ \epsilon' = \log \epsilon$$

Then the unknown parameter constants A and B are estimated by the method of ordinary least squares. Thus, once B is estimated, the CGR 'r' is given by

$$r = \exp(\beta) - 1$$

Markov Chain Analysis

A Markov chain, studied at the discrete time points 0;1;2;:::, is characterized by a set of states, 'S' and the transition probabilities P_{ij} between the states. Here, p_{ij} is the probability that the Markov chain is at the next time point in state 'j', given that it is at the present time point at state i. The matrix P with elements p_{ij} is called the transition probability matrix of the Markov chain. Note that the definition of the p_{ij} implies that the row sums of P are equal to 1. Under the conditions that all states of the Markov chain communicate with each other (i.e., it is possible to go from each state, possibly in more than one step, to every other state), the Markov chain is not periodic (a) periodic Markov chain is a chain in which, e.g., you can only return to a state in an even number of steps), the Markov chain does not drift away

to infinity. The stochastic process is called a Markov Chain. If 'S' represents the state space and is countable, then the Markov Chain is called time-homogeneous. If 'S' represents the state space and is countable, then the Markov Chain is called Time-Homogeneous if $P_{ij}(n) = P_{ij}$ for all i, j S and $n \geq 0$.(Buckwell and Shucksmith, 1979). In this study only time homogenous Markov Chains also called discrete time Markov chains have been used. Defining $P = p_{ij}$. If 'S', have 'm' states.
The matrix is called stochastic if

$$1 \geq p_{ij} \geq 0 \text{ and}$$
$$\sum P_{ij} = 1 \text{ where j takes values from 1 to m.}$$

The transition probability matrix is central to Markov chain analysis (Keane, 1991). In this study the states of the Markov chain are the seafood products being exported from India and the lead markets importing Indian seafood. The transition has been modeled in the Markovianframework. The transition probability matrix was estimated using the Minimization of Absolute Deviation (MAD) estimator, which has been estimated in the linear programming algorithm. (Disney *et al.* 1988)
The formulation of the MAD estimator is as follows:

$$\text{Min } Z = 0P + Ie'$$

Subject to

$$X_{t-1}P + |e| = X_t$$
$$IP = 1$$
$$P \geq 0$$

Where I is an identity matrix, e is a vector of positive and negative deviations, X_{t-1} is a matrix of lagged values of the variables under study, e is a vector a negative and positive values of one and P is the transition probability matrix to be estimated. The transitional probability matrices were derived by using a new version called New Markov in excel and by using LPDE software version 5.5.2.

Herfindahl - Hirschman Index

The calculation of the HHI differs from the standard concentration ratio in that it squares each market share value which places a higher importance on those top countries that have a larger market share. The formula for determining the HHI is as follows:

$$HHI = MS_1^2 + MS_2^2 + MS_3^2 + MS_4^2 \ldots + MS_n^2$$

The HHI can have a theoretical value ranging from close to zero to 10,000. If there exists only a single market participant which has 100per cent of the market share the HHI would be 10,000. If there were a great number of market participants with each company having a market share of almost 0per cent then the HHI could be close to zero. (AmosWeb, 2018)

- When HHI < 100 = High Concentration
- When HHI > 100 but <1000= Low market Concentration
- When HHI >1000 but <1800 = Medium oncentration
- When HHI>1800= High Concentration

Results and Discussion

Changing Scenario of Seafood exports from India overtime

It can be seen from Figure 1 that India exported frozen shrimp which was 31per cent of the total seafood exports in terms of quantity and 66per cent in terms of value during the period 2003-2006. Compared to 2003-06, in 2011-16 the share of frozen shrimp fell to 20per cent of the total seafood exports of the country while in terms of value frozen shrimp brought in 68per cent of the total export value of seafood exports from India. This also implies that there has been a tremendous increase in unit value realization of frozen shrimp despite an 11per cent drop in terms of

quantity of frozen shrimp exported over the period considered. This also implies that there could have been only marginal increase in total export value of seafood items from India during the period 2003-16. It is heartening to note that the share of frozen shrimp would be around 27per cent of the total seafood items exported from the country in quantity terms for the projected year 2020. The projected value from frozen shrimp is expected to remain around 62 per cent in 2020 (Figure 2)

Market wise percentage change in quantity and value of seafood exports during 2003-06 is given in figure 3. During the period 2003-06 South East Asia including China yielded 42per cent of the market share while European Union yielded 23per cent. For the same period of time in terms of value USA yielded 28per cent followed by European Union 24per cent, South East Asia including China 20per cent and Japan 19per cent respectively. For the period 2011-16 in terms of quantity South East

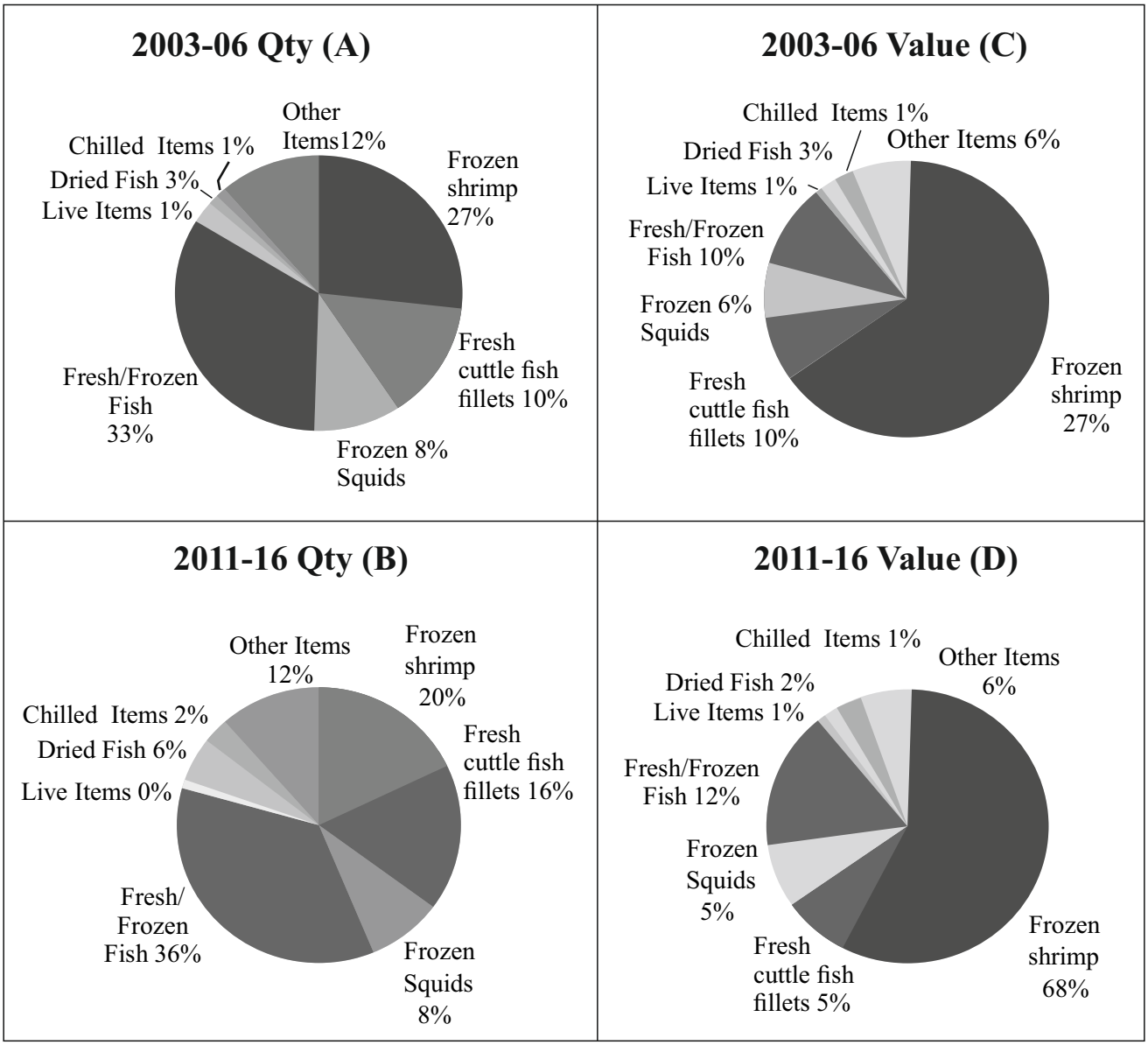

Figure 1. Cross sectional change of composition in Quantity (A,B) and Value (C,D) of Indian seafood exports (2003-16)

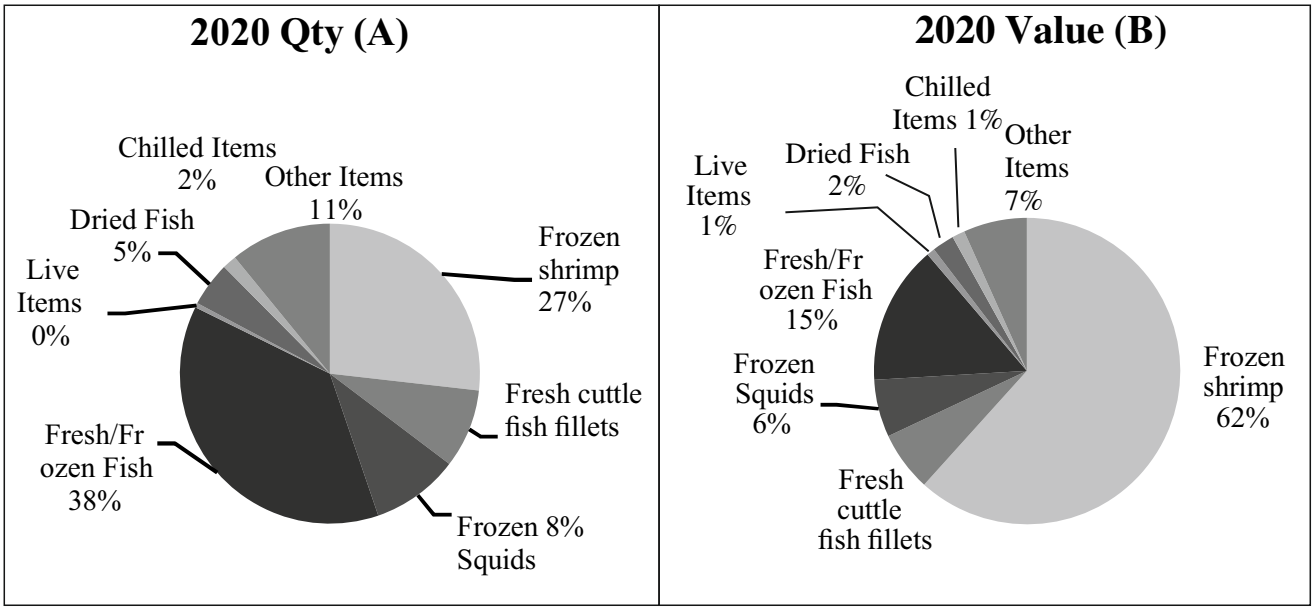

Figure 2. Category wise forecasted percentage change in quantity (A) and value (B) of Indian seafood exports in 2020

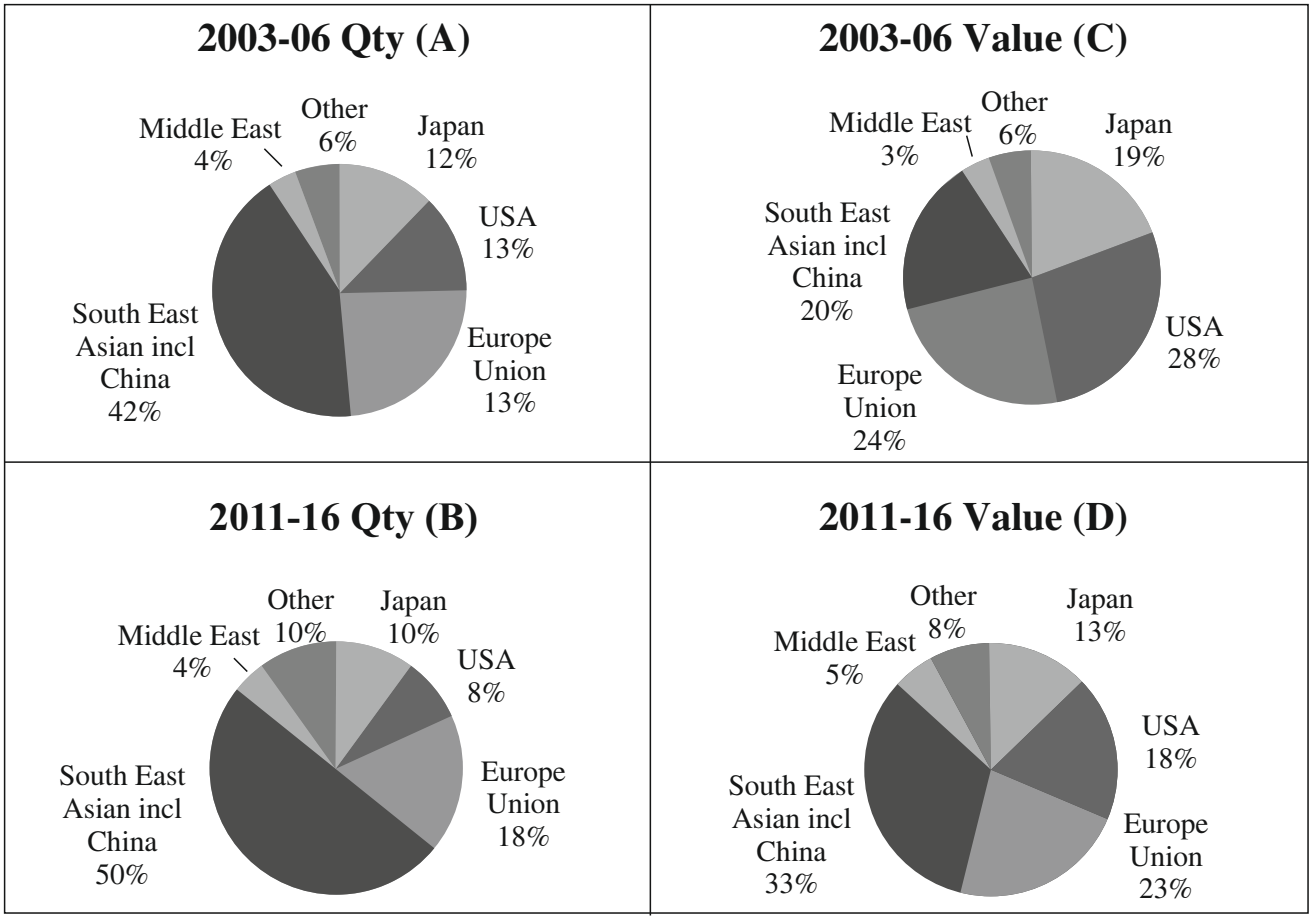

Figure 3. Market wise percentage change in the Quantity (A,B) and value (C,D) of seafood exports.

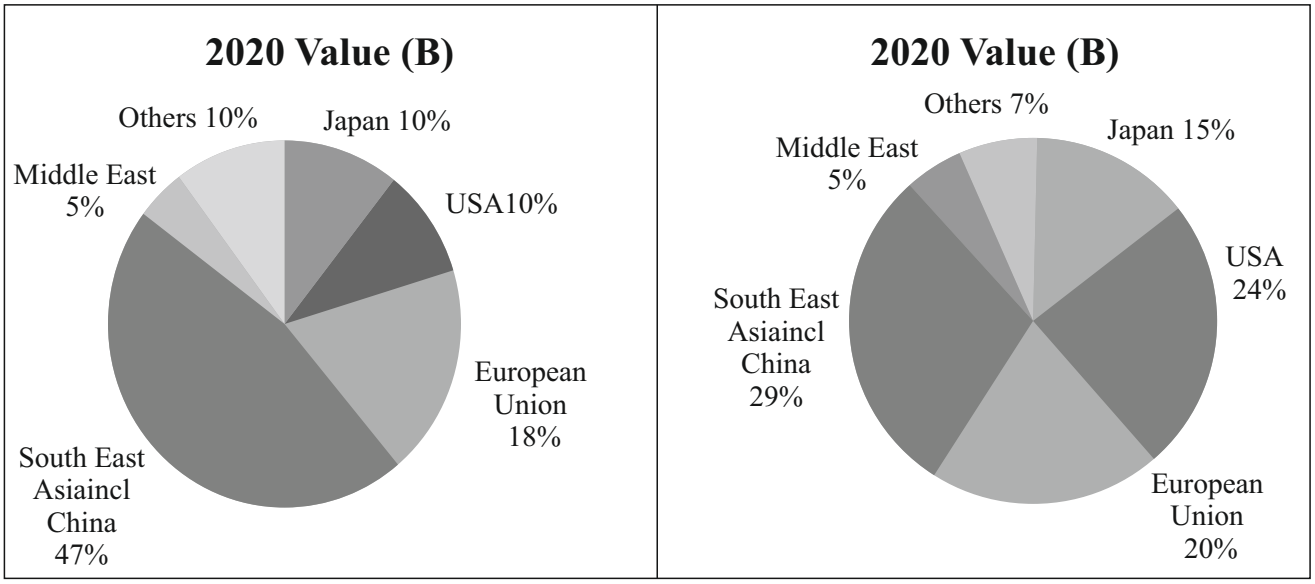

Figure 4. Market wise forecasted percentage change in Quantity (A) and Value (B) of Seafood Exports from India in 2020

Asia including China accounted for 50 per cent of the total market share of Indian seafood exports followed by European Union 18per cent. In terms of value South East Asia including China yielded 33per cent followed by European Union 23per cent, USA 18per cent and Japan 13per cent. It can be seen during the period 2003-16, though the market of South East Asia including China increased from 42per cent to 50per cent in terms of value, the share of this block of countries increased by 13per cent. Figure 4 reveals the market wise forecasted percentage of quantity and value for seafood exports and it shows that in 2020 the share of South East Asia will decrease both in terms of quantity and value. Presently 50per cent of market is dominated by South East Asia in terms of quantity and 33per cent in terms of value and by 2020 it will be reduced to 47 per cent in terms of quantity and 20 per cent in terms of value. Though the projected fall in quantity terms is by a marginal 3 per cent, the projected fall in value terms is alarming. The fall in prices may be attributed to supply surges in the market for frozen shrimp as the technology for farming of the Pacific White shrimp is getting standardized.

Price Behaviour

The perusal of Table 1 reveals the price behavior of various markets and their growth rates. It can be seen for 2017-18, exports to USA fetched the highest unit price of Rs. 5960/ton followed by European Union (Rs. 3739/ton). Lowest price realization was from South East Asia including China (Rs. 2355/ton). Examining the growth in prices it can be concluded that growth was highest for South East Asia including China which was 11.49 per cent followed by European Union and Middle East with a growth rate of 7.77 per cent and 7.68 per cent respectively. However the growth in prices of European Union and USA which at present are highest is growing at the lowest rate of 6.9 per cent per annum. This goes to show that prices are getting equalized (Fathima *et al.,* 2006)

Table 2 gives the growth rates of de-trended prices of Indian seafood exports in lead markets during the period 2003-04 to 2017-18. The growth trends do indicate an increasing demand for Indian seafood exports in countries of South East Asia including China.

Table 1. Price Behaviour and Growth Rates (per cent) of Different Markets

(Rs./tonne)

Year	Japan	USA	European Union	South East Asia	Middle East	Others
2003-04	2326.44	3164.56	1527.76	700.78	1369.85	1499.33
2004-05	2079.29	3109.40	1545.15	700.70	1470.16	1651.65
2005-06	1933.59	2936.74	1559.60	727.78	1381.67	1423.92
2006-07	2006.88	3079.91	1843.00	654.09	1573.28	1330.37
2007-08	1822.08	2777.53	1783.52	777.74	1529.82	1245.71
2008-09	2154.68	2770.15	1847.06	918.24	1750.45	968.68
2009-10	2057.07	3027.50	1828.47	1113.74	1585.90	1021.96
2010-11	2380.56	3972.97	2023.47	1041.00	1524.23	1194.23
2011-12	2494.95	4356.04	2470.76	1272.53	2344.07	1518.97
2012-13	2608.79	4355.44	2637.34	1353.36	2687.99	1330.76
2013-14	3446.68	6984.73	3508.97	2152.77	2755.63	2182.55
2014-15	3859.56	6809.84	3571.52	2123.73	3127.87	2373.28
2015-16	3462.84	5617.22	3386.89	2356.93	3327.46	2192.58
2016-17	3796.94	6087.55	3630.66	2414.61	3455.68	2150.01
2017-18	3323.13	5960.86	3739.06	2355.65	2971.87	2264.25
Growth Rates (Per cent)	5.17	6.99	7.77	11.49	7.68	4.25

Source: *MPEDA, 2018*

Table 2. Growth trends in prices of Indian seafood exports in lead markets (per cent)

Year	Japan	USA	European Union	South East Asia	Middle East	Others
2003-04 to 2007-08	-5.10	-2.66	4.97	1.40	2.92	-5.70
2003-04 to 2008-09	-2.09	-2.69	4.51	4.55	4.30	-8.47
2003-04 to 2009-10	-1.26	-1.48	3.74	7.39	3.23	-8.05
2003-04 to 2010-11	0.40	1.41	3.98	7.35	2.17	-6.01
2003-04 to 2011-12	1.47	3.33	5.21	8.26	4.49	-3.11
2003-04 to 2012-13	2.19	4.13	5.93	8.62	6.23	-2.14
2003-04 to 2013-14	3.79	6.65	7.43	10.72	7.02	0.72
2003-04 to 2014-15	5.04	7.76	8.08	11.46	7.72	2.72
2003-04 to 2015-16	5.25	7.48	8.01	11.89	8.10	3.58
2003-04 to 2016-17	5.50	7.33	7.94	11.88	8.22	3.97
2003-04 to 2017-18	5.17	6.99	7.77	11.49	7.68	4.25

It does appear from the growth rates that the South East Asian countries including China could be re-processing Indian seafood and exporting the same. This may be attributed to the fact that these countries are themselves seafood producing countries and also basically low income countries (Ayyapan and Krishnan, 2007). The growth rates also indicate that European Union followed by Middle East, USA and Japan are countries of importance as far as Indian seafood exports are concerned. It is also interesting to note that the growth rate of Indian seafood exports to European Union has always been positive. Since the compound growth rates were calculated on an inclusive basis keeping the base year as 2003-04, it may be seen that the perk in the growth rate of seafood exports to all the countries considered has improved substantially in the last year i.e. 2017-18. This may be attributed to the positive impact of *Penaeusvannamei*aqua culture in India during the second decade of 21st century. It may be surmised that area expansion under *P.Vannamei* farming has contributed substantially to shrimp production improving the ability of the country to meet the market demand in the context of crop failures in competing countries (Latha and Krishnan, 2010)

Table 3 depicts the Herfindahl-Hirschman indices for lead markets of Indian seafood exports. Since the HHI values are all, over 1800 for all the years (2003-2018) the Indian

Table 3. Herfindahl- Hirschman Index for overall and lead markets of Indian seafood exports

Year	Herfindahl Hirschman Index
2003-04	2157
2004-05	2091
2005-06	2107
2006-07	2162
2007-08	2211
2008-09	2181
2009-10	2337
2010-11	2221
2011-12	2187
2012-13	2126
2013-14	2285
2014-15	2182
2015-16	2256
2016-17	2500
2017-18	2628

	Japan	USA	European Union	South East Asia	Middle East	Others
2003-2018	2341	4177	8591	7959	252	820

seafood exports enjoy relatively high concentration of market share in seafood exports of the markets considered. Nevertheless, it may be seen that the estimated HHI index for the lead markets give a different picture.

The HHI value is 8591 for European Union for the period 2003-2018 indicates high concentration of Indian seafood exports in its market. The same holds good for South East Asia. The HHI value for USA is again encouraging since the concentration of India seafood exports in its market remains high and similarly for Japan to a lesser extent. The HHI value for Middle East is a matter of concern. The low HHI value indicates poor concentration of Indian seafood exports in that market. Therefore, the country-wise estimates of HHI for the period 2003-2018gives a clearer picture when the estimates were examined for the lead markets. The overall market concentration appears to be high despite the contribution of Middle East being low. Therefore, there is a need to concentrate in the development of Middle East market so that the overall market concentration gains improved stability and performance (Sarada *et al*, 2006).

Markov Chain Analysis

To study the dynamics of change in markets and items of exports, Markov chain analysis was used. Table 4 gives the item-wise probabilities of seafoodto retain their market share in export basket and what are the chances of losing share to other products.

For different seafood items that constitute the export, the Markov's Transitional Probability Matrix (Table 4) revealed that over a decade the contribution of frozen shrimp to export basket of India in terms of value has remained stable. There is 0.93 probability that frozen shrimps will retain its share in export market and 0.007 chance that it will lose its share to fresh cuttle fish/fillets and 0.047 probability of loss to frozen squids. On similar lines there is 0.55 chance that fresh cuttle fish/fillets will retain the market share and 0.28 probability that it will lose its market share to frozen squids. Also there is 0.227 probability that frozen shrimps will take over the market share of fresh/frozen fish. As indicated in the matrix, dried fish has a probability of 0.7 to gain the market share of chilled items. This does imply that frozen shrimp exports will be

Table 4. Markov's Transitional Probability Matrix for Item wise seafood export from India

	Frozen shrimp	Fresh cuttle fish fillets	Frozen Squids	Fresh/ Frozen Fish	Live Items	Dried Fish	Chilled Items	Other Items
Frozen shrimp	0.930	0.007	0.047	0	0.001	0	0	0.013
Fresh cuttle fish fillets	0	0.554	0.289	0.109	0.046	0	0	0
Frozen Squids	0	0.121	0.128	0.749	0	0	0	0
Fresh/Frozen Fish	0.277	0	0	0.592	0.024	0	0.044	0.061
Live Items	0	0.512	0	0.407	0.079	0	0	0
Dried Fish	0	0	0.247	0.196	0	0.555	0	0
Chilled Items	0	0	0	0	0	0.702	0.297	0
Other items	0	0.186	0	0	0	0.014	0.043	0.755

the mainstay of the Indian seafood exports. Table 5 reveals the transitional probabilities of different potential markets which import the Indian seafood in terms of value. It can be interpreted that USA and South East Asia including China yield a stable market share as compared to others and hence the probability of losing the share to others is also less for them as indicated by the values for USA and South East Asia including China. The share of Japan over the last decade has been shifting to European Union with a probability of 0.62. This "shift" should be seen as a net loss for India as Japan is the world's number 1 country in the consumption of seafood.

Forecasting

Based on Markov's Transitional Probability Matrix the values and quantity of different items were forecasted for a period of five years till 2020. It is indicated that by 2020 the quantity of frozen shrimps which constitute more than 36per cent share by quantity and 68per cent by value of export market in India presently, will be 0.37 million

Table 5. Markov's Transitional Probability Matrix for Market wise seafood export from India

	Japan	USA	European union	South East Asia incl china	Middle East	Others
Japan	0.373	0	0.626	0	0	0
USA	0.279	0.674	0	0	0	0.046
European Union	0.124	0	0.619	0.058	0	0.197
South East Asia incl China	0.012	0.238	0	0.674	0.074	0
Middle East	0	0	0	0.901	0.098	0
Others	0	0	0.081	0.335	0.320	0.262

Table 6. Item Wise forecasted Quantity (tons) and value (INR million) of Seafood exports in India

Years	Items	Frozen shrimp	Fresh cuttle fish fillets	Frozen Squids	Fresh/ Frozen Fish	Live Items	Dried Fish	Chilled Items	Other items
2018-19	Q	352718.26	112011	124616	494076	6453	63001	20213	143444
	V	28811.78	28780	28160	68090	3740	11000	6180	30780
2019-20	Q	373881.36	118732	132093	523720	6840	66781	21426	152051
	V	31267.01	31950	30760	74450	4120	11880	6810	34050

tons with a value of INR 31000 Crores. Forecasted percentage gain is only 2per cent in quantity and decrease of 6per cent in value of frozen shrimps (Table 6). Fall in value can be attributed to exchange rate fluctuations as well as supply side effects owing to stabilization of culture technologies of *P. vannamei* (Ali Jubair, 2006).

Quantity and value of seafood exports were forecasted till 2020 for various markets as shown in Table 7 and it can be seen that by 2020 the quantity exported by India to European Union will increase from 3.4 lakh metric tons to 85 lakh metric tons and value from INR 5000 Crore to INR 27000 Crores. It is more interesting to note that by volume sea food exports to South East Asia will increase from 0.87 million metric tons to 21.5 million metric tons in 2020 and by value from INR 9000 Crores to INR 39000 Crores.

Conclusions and Policy Implications

The Indian seafood export market is exhibiting a healthy trend. It is growing at the rate of 9.6per cent (2004-2018). Among the principal export markets, the South East Asian market including China emerged as the top importer of Indian seafood products, but, it is necessary to consolidate the existing markets with a focus on Middle East market so that the overall market concentration gains improved stability and performance. Frozen shrimp continues to be the flagship product of Indian seafood exports and the transitional probabilities indicate that USA and South East Asia including China will remain a stable market for Indian seafood exports but the loss of the share of Japanese market to the European Union needs to be corrected since Japan is a primary market for world global seafood exports. Strong corrective measures to ensure Indian shrimp consignments are never again rejected must be taken swiftly. It is also necessary to stem any deterioration in value arising from supply side effects. Trends in forecasted values also show a positive shift towards European Union and South East Asia in terms of quantity and value by 2020. It is necessary to exploit the potential of these markets without compromising on the market share of India seafood exports to other principal markets. The share of high volume/lower value frozen fish in total seafood exports must not gain larger share in the composition of Indian seafood exports at the expense of low volume/high value shrimp. Shares of low volume/high value items must increase at an increasing rate. Policy and institutional support needs to ensure a

Table 7. Market Wise forecasted Quantity (metric tons) and value (INR million) of Seafood exports in India

Years		Japan	USA	European Union	South East Asia Incl China	Middle East	Others
2018-19	Q	2533875	2414385	4488648	11356121	1099020	2466723
	V	145930	242730	202440	293040	52110	67250
2019-20	Q	4814363	4587331	8528431	21576630	2088138	4686773
	V	197010	327690	273300	395610	70350	90790

balanced composition of items in favour of high value items.

Seafood exports is expected to lead in terms of value generation of agricultural exports from India (Rani *et al*, 2013). Owing to higher adoption levels of improved farming technology of *P.vannamei,* as well as growing realization among the farming community in respect ofadhering to Coastal Aquaculture Authority (CAA) guidelines is expected to stabilize shrimp farm output in India. India is also making rapid progress in terms of production of value added products which conforms to HACCP guidelines as well as MSC certification process. Further progress is expected from diversification of cultivable species which are expected to yield long term returns to the seafood export sector.

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