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Understanding the dynamics in fish price behaviour across selected coastal states of India

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Abstract
The fish price variations leads to issues related to fish availability, accessibility and affordability. The price variations are affecting all stages of transactions and attributed to the uncertainty in fish production, distribution and consumption. The present study portrays the dynamics of fish price behaviour across the different species and markets and identifies the need for implementing a Fish Market Price Information System (FMPIS). The study was based on the primary data of fish prices were collected from the 25 highly diversified fish markets including landing centres, retail and wholesale markets across the coastal states of Kerala, Andhra Pradesh, Maharashtra and Telangana during the period Jan 2018 – June 2020. The results depicts that the markets of Kerala indicates that Nadakkav, Kavanad and Chambakkara shows the high probability of retention at 0.542, 0.590 and 0.577 respectively. Sabzimandi (0.899) show the highest probability of retention of fish prices in Telangana followed by Kashmirgadda (0.754) and Karimnagar (0.827). The Colaba market (0.858), Desaiganj (0.680) and Umred (0.627) shows the high probability of retention in fish prices in Maharashtra and in Andhra Pradesh the markets Markapuram (0.807), Guntur (0.707) and Baptla (0.535) has the high probability of retention. The results also point outs that sardine, mackerel, tilapia, pearl spot catla, rohu and Asian sea bass are the most consuming fish species there exists a very clear cut demand and supply pattern for these fish species. The price of Tilapia are found to be co integrated in the markets and the demand for Tilapia is steadily increasing over Pearl spot, irrespective of the geographic vicinities.

Keywords: Species diversity, market diversity, markov chain analysis

Introduction
India is the second largest fish producer in the world with a total production of 14.16 million tonnes in 2019-20 (13.7 million tonnes in 2018-19) showing a consistent growth in the total gross value added with more than one per cent Gross Domestic Product (GDP) contribution and providing meaningful employment to about 14 million people across the value chain in harvesting, processing, packaging, and distribution (Shyam *et al.* 2020) [10]. Marine fish production in India was about 3.72 million metric tonnes in the year 2019-20 (Handbook on Fisheries Statistics, 2020) [11]. Though the country is a significant producer and supplier of several marine food products, contribution of the marine sector to the total fish production has declined over the years. Vast coastal lines spanning about 8118 km and diverse inland water ecosystems enable the country to produce enough fish to meet domestic requirements and export to more than 100 countries. About two third of the total marine production is consumed domestically while the remaining one third is exported. (Shyam *et al.* 2020) [10] There is a visible geographic separation between the fish landing centres and consuming centres. Therefore addressing the shortcomings in the existing fish value chain is necessary for enhancing domestic/international fish trade and marketing efficiency. Given its seminal role in ensuring food and nutritional security of the country and employment generation, livelihood security and welfare of the fisher community, the importance of the marine fish supply chain is rising. Moreover, with increasing purchasing power, health consciousness and taste preferences, domestic markets have massive potential for diversification of fish production systems and high-value fish trade. India's average fishers' share in the consumer rupee - an indicator of market efficiency is 65.9 per cent. (Shyam 2015) [3].

However, the efficiency of the marine fish supply chain has notable discrepancies across maritime states, fish species, seasons, landing source and proximity to the markets. In addition, lacunae in existing marine fish marketing channels exacerbate the inefficiencies in cost, post-harvest loss, and access.

The marketing channel for fish in the country isn't organized much in the domestic sector whereas the marketing channel for the export sector is more organized with minimal marketing and constituents and price spread and mostly relying on forward markets and registering the market economies of scale thereby ensuring competitive markets and assured quality (Srinath 2003) [9]. The case is different with the domestic marketing system with grappling issues in the market infrastructure and marketing efficiency levels. The markets are devoid of adequate infrastructure and forward integration facilities (Somy 2006) [8]. There aren't facilities for the cold storage or any improve interventions available for value addition. The consumers are hugely concerned with the unhygienic handling and practices in the market and are reluctant to buy the fishes from the markets as noticed from the fact that the retailers and vendor do sizeable business in the fish marketing channel (Sathianandan *et al.* 2011) [7]. The markets are scattered and with minimal or no value addition thereby leading to distress sale and the consumption (Manjunath *et al.* 2017) [1] The prospect of improved information flow in the fisheries sector is important as the fish production and the consumption is on the high across the rural and urban areas a cheap source of protein when compared to other non-vegetarian protein supplement. However the geographical separation of the fish between the production and consumption centres coupled with quality constraints etc. necessitated the need for developing e- marketing interventions in the fish distribution across the sector (Shyam *et al.* 2020) [10].

With the increased fish consumption on account of being healthier and cheaper among the animal protein substitutes the consumption behaviour have been found skewed towards protein. Even at a higher price there is existence of high demand for high value fish (Somy *et al.* 2006) [8]. The consumption studies indicates that the poor supply of fish to the domestic fish markets will lead to a situation where the domestic consumers will be devoid of fish in markets at affordable prices. Other than any other commodity it is important to ensure the availability and affordability of high value fishes whose consumption could be augmented by creating awareness among the consumers. The price of fish is determined by the interaction between the production and distribution centres. The uncertainty in production, landings and perishability are the main reasons for the variations in fish prices. (Shyam *et al*., 2015) [3].

The fish travels from long distances from landing centres to the domestic markets referred as the marketing channels through which fish passes from the producer to the consumers. The fish marketing in India is not fully developed as it faces enumerous number of functional hazards. With the advent of new technologies in transport, processing and storage facilities there is progressive transformation for the current level of marketing. There are a large number of stakeholders involved in the marketing of fish which includes fishermen, wholesalers, retailers, commission agents, middle men etc. Fish are also been disposed by auctioning at the production centres which provides the buyers and sellers for quick disposal of fish. Because of the practical difficulties the fish at landing centres are not sold in weight. Usually auctioning is done by the middle men on commission basis and they take 5-10 percent of fish auctioned by them as commission. The middle men also provide advance loans to the fishermen and take a portion of shares towards the loan (Firdaniza *et al.* 2018) [6]. Like this there involved numerous activities in the production and distribution of fish. With this background the present study potrays the dynamics of fish price behaviour across the different species and markets and also for developing a Fish Market Price Information System (FMPIS).

Objectives

The overall objective of the proposed study is to analyse the dynamics in fish price behaviour across the selected coastal states of India. However the specific objectives are to identify the price transitions of the different markets and species on the marine fish prices of selected coastal states of India to provide an insight into the trends in price behaviour and identifying the different transits in fish trade.

Data and Methodology

The study was based on the primary data of fish prices were collected from the 25 highly diversified fish markets including landing centres, retail and wholesale markets across the coastal states of Kerala, Andhra Pradesh, Maharashtra and Telengana during the period Jan 2018 – June 2020. The price data (frequency) period were collected through regular and systematic primary surveys conducted by the SEETTD Division Central Marine Fisheries Research Institute (CMFRI), Cochin as a part of the NFDB – FMPIS project. The extent of diversification was identified using species/market diversity index for both species and markets. Accordingly market diversity indicates that the number of species available/ traded in a particular market and it ranges from 0 to 1. Similarly the species diversity indicates the spatial distribution of a particular species across markets and it ranges from 0 to 1. More market diversity index indicates more species traded within a market and similarly more species diversity index indicates the spatial spread of a particular species across markets. Based on this the fish prices of the 28 highly diversified species (attached as annexure) with 7 species in each state were sort out to identify the transits in the fish trade. Further an attempt was made to forecast the future direction of Indian fish trade using Markov Chain Analysis. The Markov-chain analysis was employed and the transition probabilities and steady state probabilities pertaining to the fish prices of different markets vs species of fish trade were computed.

Markov analysis identifies the current movement of fish prices in different markets as well as for the different species and predicts the foreseeable future price movements. The row in transition probability matrix identifies the current fish price to different markets and the columns could identify the alternative to which market pattern could move. Here the row probabilities are associated with fish price market retention and shift to other markets while the column probabilities are associated with fish price market retention and shift towards the market further adding to the share. The diagonal elements represent probability of retaining the same level of fish price with a specific market. In order to estimate the transition probabilities minimum absolute deviations (MAD) estimation procedure was employed.

The linear programming formulation is Min OP^{*} + Ie subject to.

$XP^{*}+V=Y$

$GP^{*}=1$, $P^{*}>0$

Where,
0 is the vector of zeros.
P* is the vector of probability Pij.
I is an appropriately dimensioned identify matrix.
E is the vector of absolute errors.
Y is the vector of price of each market.
X is the block diagonal matrix of lagged values of Y.
V is the vector of error.
G is the grouping matrix to add row elements of P arranged in P* to unity.

Result and Discussions

The concept of a good market describes the characteristics of the market that influence from actions and outcomes to function efficiently. Essentially, an efficient marketing system is one that has perfect market integration and perfect price communication, with adjusting instantly to the changes incurred in the marketing system. Such a system allows producers, intermediaries and consumers in the marketing chain to obtain maximum profit. It also helps eliminate unprofitable arbitrage and spatially differentiated market isolation, ensuring efficient allocation of resources across space and time. Market efficiency is highly dependent on price volatility and market consolidation. The price of fish is determined by the interaction of supply and demand in both producing areas and consumer markets. Fish price action is characterized by large fluctuations at all transaction levels in the supply chain. In order to analyse the price behaviour and direction of fish trade the markov chain analysis was computed and the transition probability matrix worked out using the prices collected over the period has been represented in table 1-4.

Table 1: Transition Probability Matrix for highly diversified markets of Kerala

Markets	Nadakkav	Vadakara	Kavanad	Thoppumpady	Balaramapuram	Payippadu	Chambakkara
Nadakkav	0.542	0.057	0.000	0.00	0.000	0.000	0.000
Vadakara	0.000	0.221	0.000	0.00	0.365	0.000	0.000
Kavanad	0.000	0.000	0.598	0.032	0.267	0.000	0.112
Thoppumpady	0.200	0.096	0.227	0.291	0.067	0.085	0.018
Balarampuram	0.000	0.000	0.000	0.911	0.000	0.089	0.000
Payippadu	0.000	0.000	0.000	0.102	0.203	0.000	0.000
Chambakkara	0.000	0.012	0.103	0.000	0.000	0.000	0.000

The estimated transitional probability matrix of the highly diversified markets of Kerala is furnished in table 1.The table revealed that Nadakkav, Vadakara, Kavanad and Thoppumpady were the stable markets with probability of retention 0.542, 0.221, 0.598 and 0.291 respectively. The unstable markets were Balarampuram, Payippadu and Chambakkara even with high probability of transfer from Thoppumpady (0.911) and Payippadu (0.089) with respect to Balarampuram, Thoppumpady (0.102) and Balarampuram (0.203) with respect to Payippadu and Vadakara (0.12) and Kavanad (0.103) with respect to Chambakkara. Nadakkav market gained from Thoppumpady (0.200) with minimal losses to Vadakara (0.057).Kavanad gained from Thoppumpady (0.227) and Chambakkara (0.103) with losses to Balarampuram (0.267), Thoppumpady (0.032) and Chambakkara (0.112).Vadakara gained from Thoppumpady (0.096) and Chambakkara (0.012) with minimal losses to Balarampuram (0.365).

Table 2: Transition Probability Matrix for highly diversified markets of Telengana

.	Begumbazar	Toopran	Karimnagar	Kashmirgadda	Banswada	Musheerabad	Sabzimandi
Begumbazar	0.084	0.000	0.018	0.000	0.000	0.321	0.898
Toopran	0.000	0.000	0.097	0.000	0.758	0.145	0.000
Karimnagar	0.002	0.000	0.827	0.086	0.000	0.022	0.063
Kashmirgadda	0.000	0.024	0.000	0.754	0.000	0.000	0.000
Banswada	0.116	0.259	0.000	0.000	0.586	0.000	0.039
Musheerabad	0.092	0.465	0.296	0.000	0.000	0.146	0.000
Sabzimandi	0.000	0.259	0.000	0.000	0.432	0.200	0.109

The estimated transitional probability matrix of the highly diversified markets of Telangana is furnished in table 2.The table revealed that Begumbazar, Karimnagar, Kashmirgadda, Banswada, Musheerabad and Sabzimandi were the stable markets with high probability of retention of 0.084, 0.827, 0.754, 0.586, 0.146 and 0.109 respectively. Toopran was the only unstable market of the selected markets of Telangana with high probability of transfer from Musheerabad (0.465), Banswada (0.29) and Sabzimandi (0.259) respectively. Begumbazar market gained from Kashmirgadda (0.246) with minimal losses to Sabzimandi (0.898). Karimnagar gained from Musheerabad (0.269) with losses to Kashmirgadda (0.086) and Sabzimandi (0.063). Kashmirgadda gained from Karimnagar (0.754) with losses to Toopran (0.024).However Banswada gained from Toopran (0.758) and Sabzimandi (0.432) with losses to Toopran (0.259) and Begumbazar (0.116) respectively. Musheerabad and Sabzimandi have gained from Begumbazar of about 0.321 and 0.898 respectively.

Table 3: Transition Probability Matrix for highly diversified markets of Maharashtra

Markets	Colaba	Desaiganj	Umred	APMC	Agashi	Parseoni	Sassoon dock
Colaba	0.859	0.051	0.000	0.000	0.090	0.000	0.000
Desaiganj	0.000	0.680	0.109	0.000	0.095	0.003	0.113
Umred	0.000	0.000	0.628	0.196	0.094	0.080	0.002
APMC	0.149	0.000	0.214	0.099	0.381	0.136	0.021
Agashi	0.000	0.610	0.000	0.390	0.000	0.000	0.000
Parseoni	0.000	0.000	1.000	0.000	0.000	0.000	0.000
Sassoon dock	0.000	0.000	0.505	0.000	0.000	0.000	0.495

The estimated transitional probability matrix of the highly diversified markets of Maharashtra is furnished in table 3.The table revealed that Cobla, Desaiganj, Umred, APMC and Sasson Dock were the stable markets with high probability of retention of 0.859, 0.680, 0.628,0.099 and 0.495 respectively. Agashi and Parseoni were the unstable markets of Maharashtra with high probability of transfer from APMC (0.381) and (0.136) with respect to Agashi and Parseoni respectively. Colaba gained from APMC (0.149) with minimal loss to Agashi (0.090).Desaiganj and APMC gained from Agashi of 0.610 and 1.00 respectively. They constitute a minimal loss of Umred (0.109) with respect to Desaiganj and (0.196) with respect to APMC. Moreover Sassoon dock gained from Desaiganj with a loss of 0.505 to Umred

Table 4: Transition Probability Matrix for highly diversified markets of Andhra Pradesh

Markets	Vodarevu	Dycus	Markapuram	Guntur	Baptla	Machilipattanam	Chilakaluripeta
Vodarevu	0.404	0.000	0.142	0.066	0.000	0.051	0.337
Dycus	0.058	0.427	0.099	0.000	0.257	0.095	0.064
Markapuram	0.130	0.000	0.807	0.063	0.000	0.000	0.000
Guntur	0.190	0.000	0.000	0.707	0.049	0.053	0.000
Baptla	0.000	0.449	0.000	0.000	0.536	0.015	0.000
Machilipattanam	0.000	0.708	0.000	0.000	0.292	0.000	0.000
Chilakaluripeta	0.000	0.000	0.000	0.000	0.378	0.273	0.349

The estimated transitional probability matrix of the highly diversified markets of Andhra Pradesh is furnished in table 4.The table revealed that Vodarevu, Dycus, Markapuram, Guntur, Baptla and Chilakaluripeta were the stable markets with high probability of retention of 0.404, 0.427, 0.807, 0.707, 0.536 and 0.349 respectively. Machilipattanam was the unstable market of the selected highly diversified markets of Andhra Pradesh. Vodarevu gained from Guntur (0.190), Dycus gained from Machilipatanam (0.708), Markapuram gained from Vodarevu (0.142),Guntur gained from Markapuram (0.063), Baptla gained from Chilakaluripeta (0.378) and Chilakaluripeta gained from Vodarevu (0.337) respectively. Machilipattanam has a high probability of transfer from Chilakaluripeta (0.273), Dycus (0.095) and Vodarevu (0.051) respectively.

The study identified that the prices of the high probability of retentions are stable and the demand supply paradigm shifts have merely affected with the price fluctuations and thereby market integrations. This also validates the high market diversity which enhances the trading opportunities of these markets. Amidst the impacts of the different external forces such as climatic conditions, regulated fishing seasons, consumption, demand and supply there was low volatility in fish prices across these markets. However the results of high probabilities of retention of the markets shows the extent of price transmission from one market to other and the direction of fish trade with high degree of integration and marketing efficiency.

Table 5: Transition Probability Matrix for highly diversified species of Kerala

Species	Sardine	Mackerel	Anchovies	Threadfin Breams	Clams	Pearl spot	Tilapia
Sardine	0.257	0.344	0.120	0.207	0.037	0.013	0.022
Mackerel	0.334	0.567	0.019	0.054	0.022	0.005	0.005
Anchovies	1.000	0.000	0.000	0.000	0.000	0.000	0.000
Threadfin Breams	0.000	0.667	0.333	0.000	0.000	0.000	0.000
Clams	0.000	0.000	0.703	0.275	0.000	0.023	0.000
Pearl spot	1.000	0.000	0.000	0.000	0.000	0.000	0.000
Tilapia	0.000	0.000	0.000	1.000	0.000	0.000	0.896

Table 6: Transition Probability Matrix for highly diversified species of Telengana

Species	Catla	*Pangasius*	Rohu	Tilapia	Common carp	Silver Carp	Mrigal
Catla	0.900	0.017	0.024	0.037	0.006	0.001	0.015
Pangasius	0.495	0.454	0.002	0.000	0.000	0.049	0.000
Rohu	0.000	0.000	0.687	0.280	0.000	0.030	0.003
Tilapia	0.000	0.943	0.057	0.000	0.000	0.000	0.000
Common carp	0.000	0.000	0.000	0.716	0.284	0.000	0.000
Silver Carp	0.000	0.000	0.402	0.598	0.000	0.000	0.000
Mrigal	0.000	0.000	0.000	0.562	0.435	0.003	0.000

Table 7: Transition Probability Matrix for highly diversified species of Maharashtra

Species	Anchovies	Asian Seabass	Catla	Common Carp	Grass Carp	Indian Mackerel	Tilapia
Anchovies	0.920	0.003	0.010	0.039	0.000	0.008	0.021
Asian Seabass	0.000	0.518	0.198	0.107	0.130	0.012	0.034
Catla	0.000	0.570	0.409	0.000	0.021	0.000	0.000
Common Carp	0.485	0.327	0.000	0.117	0.000	0.000	0.072
Grass Carp	0.014	0.186	0.000	0.336	0.464	0.000	0.000
Indian Mackerel	0.000	0.385	0.249	0.000	0.000	0.367	0.000
Tilapia	1.000	0.000	0.000	0.000	0.000	0.000	0.000
Mrigal	0.000	0.000	0.000	0.562	0.435	0.003	0.000

Table 8: Transition probability matrix for highly diversified species of Andhra Pradesh

Species	Catla	Rohu	Silver Pomfret	Anchovies	Oil Sardine	Indian Mackerel	King Seer
Catla	0.947	0.000	0.010	0.000	0.000	0.004	0.039
Rohu	0.000	0.833	0.078	0.064	0.025	0.000	0.000
Silver Pomfret	0.000	0.316	0.550	0.101	0.000	0.323	0.000
Anchovies	0.000	0.282	0.000	0.000	0.513	0.001	0.203
Oil Sardine	0.477	0.000	0.000	0.315	0.202	0.006	0.000
Indian Mackerel	0.000	0.000	0.000	0.845	0.000	0.155	0.000
King Seer	0.000	0.000	0.000	0.981	0.000	0.019	0.000

Other than price, demand is the real driving factor for fish trade and the marketing activities. The fish trade is not restricted to place where it is being abundantly supplied but where in demand. The demand of the species determines the price of fish among the different markets and thereby fish trade. The markov chain analysis of species indicates that there exists high retention of probability in fish prices enhancing the geographical spread of the species in terms of its availability, accessibility across the markets and consumers. The diversity analysis of Kerala shows Sardine has the highest diversity of 0.98 and Tilapia is the second most with diversity index 0.95 followed by Pearl spot (0.93) and Mackerel (0.92) which indicated that among the 60 markets selected sardine was traded in 98 per cent of the markets, tilapia 95 percent, pearl spot 93 percent and Mackerel 92 (Shyam *et al.* 2020) [10]. The results of markov chain analysis validates this as Sardine, tilapia and Mackerel have the high retention of probabilities in fish prices making these four as the most available and accessible fish across the markets. Catla (0.946 in Andhra Pradesh and 0.899 in Telangana) and Rohu (0.832 in Andhra Pradesh and 0.688 in Telengana) registered the high retention of fish prices in Andhra Pradesh and Telengana respectively. However in Maharashtra Anchovies (0.919), Asian Sea bass (0.518) recorded the high probability in fish prices.

The retention results point outs that sardine, mackerel, tilapia, pearl spot catla, rohu, Asian sea bass are the most consuming fish species there exists a very clear cut demand and supply pattern for these fish species. The results also shows that prices of Tilapia are found to be co integrated in the selected market location and the demand for Tilapia is steadily increasing over Pearl spot, irrespective of the geographic vicinities. The increasing growth, the ability to grow in extremely diverse conditions and low cost of production are marked as the major reasons for the diversified culture of tilapia. Even though the most of the markets for tilapia are all domestic, farmers harvest tilapia mostly in their own ponds, pack fish in ice and transport fish to other neighbouring markets in open trucks. The analysis also elucidates that as the demand – supply gap is ironed up by the imports from the neighbouring markets, it will be better to employ a quality assurance check for the imports along with developing appropriate regulatory measures for exports.

Conclusion

Fish marketing system in India is changing with the modern technological innovations in the fish processing, transporting, storage facilities and consequent market penetrations. The study identified that amidst the impacts of the different external forces such as weather conditions, regulated fishing seasons, consumption, demand and supply there was high retention of probabilities of fish prices among the different markets and species. The results of high probabilities of retention of the markets shows the extent of price transmission from one market to other and the direction of fish trade with high degree of integration and marketing efficiency.

The domestic fish marketing is coping with multiple impediments in the production and distribution centres leading to fluctuations in the consumption curves. There exist markets with high price retentions, however the technological innovations identified so far has not enabled much improvements in the in the fish marketing systems. The inelastic supply, seasonality in landings, bycatchs /discards, geospatial differences in production centres, and lack of institutional support are pointed out as the major reasons for the bottlenecks in these price retentions. The unhygienic fish handling practises made the consumer perspectives becoming reluctant to buy fishes leading to high prices in the domestic fish markets.

The study portrays the need for identifying and analysing the market structure in terms of conduct and performance of the different levels of markets at the production, distribution and consumption centres and also the profiling of the market functionaries. The development of a fish market and price information system which provide an inventory of the different fish markets in India on a GIS platform by providing collection of fish prices across selected markets for identified fish species across the state will act as a decision support system ensuring fish market and price information dissemination about availability, accessibility and affordability of fish which also enables different stakeholders in taking rational decision in fish trade mainly fishers in identifying target prices / markets; consumers with rational choices about fish availability and traders with inputs for better marketing efficiency.

Moreover the study suggests the need for an E-auction platform for actively engaging the market functionaries so that the intervention of intermediaries can be eliminated. The market functionaries will thus be directly engaged in auctioning and trading benefiting them in terms of unfiltered information of daily price, demand and supply data. They will also act as information sources. The e-auction platform will act as a bridge connecting the geographically separated buyers and sellers. It will act a single window platform where trading, auctioning and marketing can be done surpassing all the existing physical barriers. Aforementioned improvisations and recommendations by this E- auction platform with combined production and marketing systems, consumption levels are a welcoming factor by marine-dependent coastal communities, which indeed will be effectively perceived and adapted for their better sustenance and development in the future.

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