



Market Performance, Price Integration and Substitution: Case study of Gazipur Wholesale Fish Market, India

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ABSTRACT

Marketing of fish and fish products is critical in India's thriving fisheries sector, ensuring efficient distribution and consumer satisfaction. This study focuses on Delhi's biggest wholesale fish market, assessing the market behavior, intermediaries, marketing efficiency, price trends of major fish species, and co-integration between shrimp and fish prices. Freshwater fish represents 60% of the total supply, driven by high demand. Wholesalers incur costs of Rs. 2.60 for Catla fish and Rs. 9.95 for pomfret, while retailers face costs of Rs. 4.40 and Rs. 3.77, respectively. Price spreads in channel I (Rs. 29 for catla and Rs. 60 for pomfret) exceed channel II (Rs. 14 for catla and Rs. 35 for pomfret). Marketing efficiency ranges from 6 to 12.8, favoring marine species over freshwater species. 31% of fish-consuming respondents prioritize fish as their primary non-vegetarian item, with 58% expressing a preference for rohu, catla, and magur species. Over 2010-2018, shrimp prices experienced marginal growth (0.5% CAGR), with shrimp-50 exhibiting significant price fluctuations due to consumer preference. Co-integration analysis reveals price integration among black pomfret, rohu, pangasius, seer fish, and shrimp-20, with seer and black pomfret acting as substitutes. Establishing a cold storage plant and a fish waste management facility is recommended to ensure an uninterrupted cold chain and expand market capacity as a central supply and consumption hub for northern India.

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INTRODUCTION

Fisheries in India is a rapidly growing sector, providing nutrition, food security, income, and employment to millions of people. Inadequate and poor market infrastructure as well as multiple inefficiencies in the fish value chain in the domestic fish markets are considered perennial bottlenecks in the Indian context. Insufficient cold chain facilities and improper handling practices lead to post-harvest losses, compromising product quality and marketability (Upadhyay, 2016). This not only affects the incomes of fishers and farmers limiting their ability to access higher-value markets, but also limits the consumers' choice and demand. Market access and distribution networks are also a concern,

particularly for small-scale fishers and farmers. Limited market linkages, high transaction costs, and lack of market information result in restricted market reach and lower returns. Additionally, price volatility and fluctuations affect the profitability of fishers and make it challenging to plan investments and predict incomes. Market integration and the development of value chains are crucial for creating efficient marketing systems. Strengthening linkages between fish-producing regions and consumer markets, promoting organized marketing platforms, and establishing transparent pricing mechanisms will enhance market access and provide fair returns to fishers and farmers (Gupta, 1984 and Kumar et al, 2008).

Fish holds a significant position in the dietary preferences of the people in Delhi, surpassing the consumption levels of other meat sources such as chicken and mutton (Kumar et al, 2021). The Gazipur Wholesale Fish Market (GWFM) in Delhi is a prominent and largest regulated fish market in India, specializing in freshwater fishes, marine fishes, and shrimps. It receives fish supplies from various regions including Rohtak, Haryana, Andhra Pradesh, and Gujarat, and distributes them to nearby retail markets. With 252 wholesale shops and 70-80 retail stalls, the market handles an average arrival of 100-150 tons of fish per day, amounting to an estimated annual supply of 24,000-36,000 tons. Established in 2001, the GWFM is a national market that operates from 6 am to 12 pm, handling fish. Market holidays are observed on Tuesdays and the second Saturday. Transactions are predominantly carried out through on-the-spot cash, credit, or online methods. This specialized market focuses solely on fish, catering to consumer demands through retailers and direct buyers via wholesalers and commission agents. Fresh, iced, and live fish are the primary forms of commodities sold.

This study provides an overview of GWFM in Delhi, India, with the aim of assisting fish and shrimp farmers and traders in planning an adequate supply to meet daily consumer demand. The study delves into various aspects, including the role of market intermediaries, major marketing channels, and the overall structure of the fish market. It explores both wholesale and retail fish markets, as well as retail fish outlets, to comprehend the complete distribution system and identify potential areas for improvement. Furthermore, the study examines the price spread for selected freshwater and marine fish species, analysing the pricing dynamics within the market. It investigates the marketing efficiencies of different marketing channels, aiming to assess the effectiveness of various distribution methods and identify opportunities for optimising resource allocation. In addition, the study analyses long term price trends and compound growth rates to gain insights into the market's evolving dynamics and predict future market behavior. It also considers the impact of competing commodities on fish marketing, and examines the current policies relevant to the industry.

Material and Methods

The study relied on both primary and secondary data sources. Information on the GWFM profile, structure, wholesalers, retailers, fish arrivals, and market regulations were collected from the Delhi Fish, Poultry & Egg Marketing Committee (DFPEMC) which has its office in the GWFM premise. Monthly wholesale time series data of fishes and shrimp for the period from January 2010 to February 2019 was obtained from www.agmarknet.gov.in portal. Primary data on the market conduct and performance was collected through semi-structured interviews with selected wholesalers

(5), retailers (15), and consumers (30) in GWFM who were available and willing to engage with authors during September and October, 2018. The sample for primary survey was small as the purpose was only to broadly understand the market as it functions. The study didn't attempt to assess the socio-economics of wholesalers and retailers. In addition, informal interactions and direct observation of market transaction by the authors complemented the quantitative data collected from other sources.

Primary information was also collected on fish prices, marketing costs, and marketing margins to estimate the indicate price spread for the selected fish species using descriptive analysis. Producer's (or fisher / farmer) share in consumer's rupee was obtained from the price spread analysis. Marketing efficiency was calculated as the ratio of consumer's price to total marketing cost and margins (Shepherd, 1972). Higher the ratio, higher the marketing efficiency and vice-versa (Elenchezian and Kombairaju, 2004). Trend analysis and compound annual growth rate (CAGR) analysis was carried out to understand the distribution pattern of fish and shrimp prices over the period. Co-integration analysis was carried out using E Views software (8th Students version).

Market/Commodity (species) Integration (Co-integration analysis)

The success of free trade between regions relies on the effective transmission of price signals among markets within and across countries. This is based on the principle of the law of one price (LOP), which assumes free competition, absence of trade restrictions, and price flexibility. LOP states that identical goods should be priced equally in efficient markets or across different markets. Market integration can be determined by examining the correlation between prices of different products. When the LOP holds true, the market is considered integrated. In the analysis of integration, the relationship between prices of two products is studied using the expression: $\ln(p_1t) = \alpha + \beta \ln(p_2t)$

P_1 and p_2 are the prices of two products in the same market

If $b = 0$, no correlation and products don't compete each other

If $b = 1$, products substitute/compete with each other and changes in the price of one product affect the price of another product

The time series data of fish and shrimp was subjected to the stationarity test using the Augmented Dickey-Fuller (ADF) test. To ensure stationarity, the series was differenced, and an appropriate lag length was determined using the Akaike information criterion (AIC), Final prediction error (FPE), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ). Integration (substitute/compete) among fish and shrimp prices in the market was examined using the

Trace and Maximum eigenvalue tests. The tests also identified the maximum related equations between dependent and independent variables. System analysis was conducted to assess the short and long-run effects of each independent variable on the dependent variable. Lastly, the Granger causality test compared pairwise relationships between the species and identified which species influenced changes in the price of others. The analysis focused on wholesale monthly time-series data of the most demanded and marketed fish and shrimp in the Gazipur market. The selected species included black pomfret, pangasius, rohu (Andhra Pradesh), seer fish, shrimp 20, catla, rohu (Delhi), shrimp 50, and shrimp 70. The data covered the period from 2010 to 2019, comprising a total of 105 data points for analysis.

Results and Discussion

Market Profile

The table 1 provides the basic information and the characteristic features of the Gazipur wholesale fish market located in the eastern part of the sprawling Delhi metropolis. Commission agent cum wholesalers are the primary intermediaries in the Gazipur market. They purchase fish in bulk from various landing sites and sell it to retailers and vendors. Wholesalers undertake value addition activities and handle the risk of selling the fish, earning higher profit margins. Freshwater fish is sourced from Rajasthan, Haryana, and Andhra Pradesh, while marine fish and shrimp come from Gujarat, Maharashtra, West Bengal, Orissa, and Andhra Pradesh. Wholesalers incur costs such as agricultural marketing board commissions and ice. Usually wholesalers are aware of the fish demand in markets outside of Gazipur as well as the daily fish catch and price movements at the landing sites from where they primarily source fish (Bishnoi, 2005).

Retailers in the GWFM sell fish directly to consumers as per the local demand and purchasing power of the consumers. They add value by grading, cutting, cleaning, packing, and displaying fish (Kumar, 2008). Retailers purchase from wholesalers and maintain a marketing margin of minimum 5-6%. Ice and agricultural marketing board commission charges add to retailers' costs. The market attracts 100-200 retailers on weekdays, and more on weekends. INA market and Chittaranjan Park are other major retail markets in New Delhi. Retailers also supply fish to other states. The market serves approximately 400-500 local consumers daily, with consistent buyer-seller numbers in recent years.

DFPEMC plays a significant role in fish marketing. While Gupta (1984) found that the cooperative sector had limited success and incurred losses due to poor management and lack of marketing strategies, an exception was observed in the Kerala State Cooperative Federation for Fisheries Development Ltd.

(Matsyafed). Matsyafed regulates auctions at fish landing centres through primary fishers' cooperative societies, ensuring better prices and immediate payment to fishermen. Similarly, DFPEMC is considered successful in regulating market sales and is responsible for regulating the fish market. It has complete control over registration, licensing, entry of retailers and consumers, vehicle entry and parking, power and water supply, security, sanitation, and infrastructure maintenance. The marketing committee charges a license fee and commission from wholesalers, generating annual revenue of Rs. 8-9 crores. It is also installing chiller plants at the fish market and manages other specialized markets in Gazipur village. The committee provides market information, including daily price details and quantity supplied and source of supply records. Daily price information for fish is collected and made available online through the Agriculture Marketing Information Network (AGMARKNET). The committee's staff collect daily price data for various fish species, with the most demanded and supplied 22 species updated on a weekly basis. GWFM is managed by DFPEMC as per Delhi Agricultural Produce Marketing (Regulation) Act (1998), Rules and Byelaws (2001). It's an 11 member elected body of market users consisting of Chairman, Vice-Chairman, and Members, assisted by secretarial and support staff.

Fish and Shrimp: Species and Market Arrivals

The predominant freshwater fish species available at GWFM are catla, rohu, mrigal, murrel, and catfish. Marine fish species like pomfret, mackerel, seer fish, tiger shrimp (*P. monodon*), and white-leg shrimp (*P. vannamei*) are also in high demand (Table 2).

The Gazipur market handles about 100-150 tons of fish daily, with higher sales on weekends. Catla is the largest supplied commodity, followed by rohu, mrigal and catfish. Freshwater fish accounts for 60% of market arrivals, with relatively higher demand during the winter months. Marine fish is mainly sourced from Gujarat. Fish is transported to the market by trucks, tempos, and rickshaws. November to March is the peak season while lean season is from April to June.

Marketing Channels, Costs, Efficiency and Price Spread

Fish prices are determined by the daily demand and supply in the market. Price differences among wholesalers for the same species can vary by Rs. 20-25/kg (13-14%), primarily influenced by transportation and storage costs. Reduced price variation indicates a move towards perfect competition in the market. Wholesalers and retailers rely on their experience to determine prices, access market information, and manage the source of supply. The quality of fish is found to be moderate in the supply chain at GWFM. Market resources are not efficiently utilised to ensure hygiene and waste management.

Table 1: General profile of Gazipur wholesale fish market (GWFM), Delhi

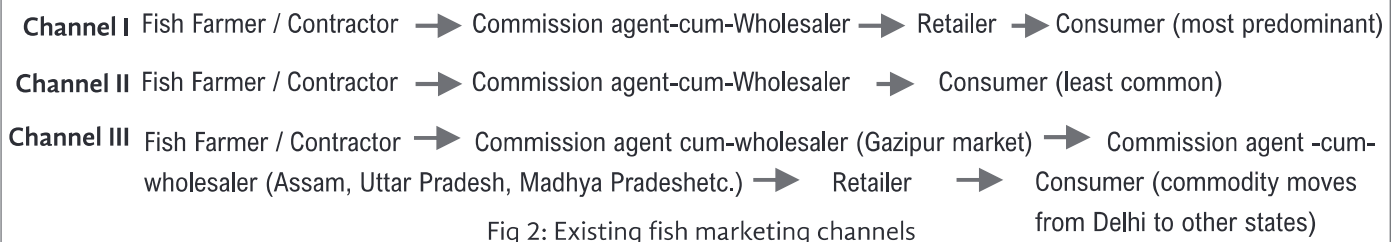
Particulars	Details
Name of the market	: Shaheed Ashfaq Ullah Kahn Fish Market
Year of establishment	: 2001 (21 years old)
Location	: Gazipur village, East Delhi
Area / Coverage	: Regional market (Delhi, Uttar Pradesh, Haryana, Rajasthan, Punjab)
Time	: Short period market (6 am-12 pm)
Market holidays	: Tuesday & Second Saturday
Type of transaction	: Wholesale (mainly)
Mode of transaction	: Cash (mainly); credit / online transaction as well
Degree of product differentiation	: Homogeneous (fish and shrimp)
Nature commodities	: Specialized market (All marine and freshwater fishes)
Stage of marketing	: Consuming market
Type of consumption	: Fresh fish, Iced fish, Live fish
No. of fish sellers	: 252 wholesalers; 150 retailers
The extent of public intervention	: Regulated market
Condition for entry into the market	: License from Agricultural Marketing Board
Mechanism of market information	: Price discovery based on demand
Weighing process	: Physical balance and electronic balance (both wholesalers and retailers)
Cold storage facilities	: None
Ice plant facility	: 4 numbers
Maintenance of sanitation	: Average
Quality checking	: None
Facilities for women	: None
Managing Authority	: Delhi Fish, Poultry and Egg Management Committee (DFPEMC)

Table 2: Major fish species handled in the Gazipur market

Major species handled in the market		Species with high demand	Primary reasons to buy
Freshwater	Marine		
Catla, <i>Catla Catla</i> Rohu, <i>Labeo rohita</i> Mrigal, <i>Cirrhinus mrigala</i> Murrel, <i>Channa punctatus</i> Pacu, <i>Piaractus brachypomus</i> Pangas, <i>Pangasius pangasius</i> Tilapia, <i>Oreochromis niloticus</i> African catfish, <i>Clarias gariepinus</i> Big head carp, <i>Hypophthalmichthys nobilis</i> Singhi, <i>Heteropneustes fossilis</i> Giant River catfish, <i>Sperata seenghla</i> Freshwater prawn, <i>Macrobrachium rosenbergii</i>	Black and white Pomfret (<i>Parastromateus niger</i> , <i>Pampus argenteus</i>) Sardine, Mackerel Seer Dolphin fish Croaker Anchovy Hilsha Bombay duck Monodon Vannamei Crabs & Lobsters	<i>Catla</i> , <i>Rohu</i> , <i>Mrigal</i> , Pangasius	Taste, health benefits, and less costly than other meats.

Table 3: Quantity of major fish species sold and bought in the Gazipur market (2019)

Species	Weekdays		Weekend	
	Qty. sold (Tons/day)	Price (Rs/Kg)	Qty. sold (Tons/day)	Price (Rs/Kg)
Catla (Small & Big)	20-25	100-170	20-30	120-180
Rohu	9-10	120	10-12	130
Mrigal	5-6	80-90	7-8	100
Catfish	6-7	80-85	8-10	95
Murrel (live)	1-2	300	2-3	400



The commission agent-cum-wholesaler procures fish from commission agents/fish farmers and sells it to retailers and sometimes directly to consumers. However, consumers typically prefer buying fish from retailers to meet their minimum preferred quantity. The fish marketing in the Gazipur market operates through three main channels:

The marketing cost and price spread were calculated for the most popular freshwater catla and the marine pomfret in the market to understand the market performance. We found that the retail marketing cost of catla was higher for retailers (Rs. 4.40/kg) compared to wholesalers (Rs. 2.60/kg) due to higher expenses on ice by retailers (Table 4). Wholesalers sell fish immediately, reducing the need for ice. On the other hand, the marketing cost of pomfret is higher for wholesalers (Rs. 9.95/kg) than retailers (Rs. 3.77/kg) because fewer retailers handle marine fish, making wholesalers responsible for the entire process. The price spread analysis of catla and pomfret in the Gazipur wholesale market (Table 5) revealed that channel I had higher price spread (Rs. 29 and Rs. 60) compared to channel II (Rs. 14 and Rs. 35). Channel I involved more intermediaries, resulting in higher marketing costs and margins, which contributed to the higher prices at each stage. The higher price spread implies a lower share for the producer in the consumer's rupee. For catla and pomfret, the producer's share in the consumer rupee was highest in channel II, at 91.5% and 92.3% respectively.

The marketing efficiency of the marketing Channel II had a marginally higher efficiency for both catla and pomfret (Table 6). A marketing efficiency value greater than one indicates that the supply channel is efficient. Channel II had higher efficiency values (11.78 and 12.83) compared to Channel I (6.2 and 8) for both catla and pomfret, respectively. However, the study doesn't capture the entire supply chain from the point of first sale at the source of catch (or production). It essentially captures from the point (or source) from where (and whom) the commission agent-cum-wholesaler at the GWFM source their fish from different places. For instance, the catla coming from Andhra Pradesh is first sold by the farmer to a commission agent or a small trader at his farm gate who in turn sells it to large trader or the primary wholesaler from whom the wholesaler at GWFM (secondary wholesaler) buys either directly or through a commission agent. A comparable scenario exist in case of pomfret (and other marine fishes) coming from Gujarat where the primary point of sale is the fisher at the landing centre.

Fish Consumption Pattern

A short consumer survey was carried out in the Gazipur fish market to understand the consumers visiting the market and their fish consumption patterns and preferences. The findings revealed that one-third prioritised fish as their first choice in their non-vegetarian platter, followed by chicken (39%) and mutton (30%). Similar research conducted on a national level by Barik (2016) indicated that 24.8% of individuals consume fish, with a higher preference observed among rural (26.5%) compared to urban (21.0%) populations. In the context of NCR and Delhi, Kumar et al. (2021) found that despite the vegetarian population being predominant, per capita fish consumption (4.04 kg/year) surpassed that of chicken (2.27 kg/year) and mutton (0.31 kg/year). The average age of the visitors surveyed was 42 years, with an average family size of 6 members. Their average monthly income was Rs. 69,850. Fifty one percent of the respondents were graduates, followed by higher secondary (29%) and primary education (19%).

The study indicated that educated and employed consumers are more likely to directly visit the market and purchase high-quality fish. Additionally, the majority surveyed (61%) lived in joint families, which may contribute to their preference for purchasing fish due to its lower cost compared to other meat. Among the various fish species available in the market, including rohu, catla, magur, pangasius, hilsa, singhara, pomfret, croaker, black pomfret, and seer fish, 58% of the respondents stated rohu, catla, and magur as their preferred species. Consumers in and around the Delhi Gazipur market have varying preferences for fish, with rohu and catla being popular among freshwater species, which confirms with the earlier study by Kumar et al, 2005, and pomfret being popular among marine species. The preference for fish is influenced by factors such as price, perceived taste, and availability.

Shrimp Price Trend Analysis

Shrimp, especially the farmed white-leg *P. vannamei*, is gaining prominence in the domestic fish markets with India having emerged the largest producer in the world. Delhi Gazipur market is no exception. Besides, *Vannamei* shrimp is also being farmed in Delhi's adjoining states of Haryana, Punjab and Rajasthan since the successful introduction of shrimp aquaculture in inland salt-affected areas by ICAR-CIFE in 2014. Shrimp producers from Haryana, Punjab, and Andhra Pradesh can tap into the demand for shrimps in the Gazipur Wholesale market in Delhi, which hitherto primarily catered to freshwater fish consumers. We performed a price trend analysis (2010 to 2018) for shrimp which is

Table 4: Marketing costs of the intermediaries in the supply chain (Rs/kg of fish)

Activity/Function	Market Intermediaries			
	Catla		Pomfret	
	Wholesaler	Retailer	Wholesaler	Retailer
Labour	0.40 (15.38)	-	1.61 (16.13)	0.75 (20.27)
Ice	0.55 (21.15)	2.75 (62.50)	2.63 (26.35)	3.00 (79.47)
Telephone	0.002 (0.08)	0.002 (0.04)	0.008 (0.08)	0.025 (0.66)
Agricultural marketing board commission charge	1.65 (63.46)	1.65 (37.50)	5.7 (57.57)	- -
Total marketing cost	2.60 (100)	4.40 (100)	9.95 (100)	3.77 (100)
Marketing margin	11.40	10.60	20.05	26.23

Note: Figures within the parentheses are percentages of the total

Table 5: Price spread for major fish species at Ghazipur market (Rs/kg)

Activity/Function	Market Intermediaries			
	Catla		Pomfret	
	Channel 1	Channel 2	Channel 1	Channel 2
Wholesaler's purchase cost (producer's price)	151	151	420	420
Cost incurred by Wholesalers (in percent)	2.6 (1.44)	2.60 (1.57)	9.95 (2.07)	9.95 (2.07)
Margin (in percent)	11.40 (6.33)	11.40 (6.90)	20.05 (4.17)	25.50 (5.31)
The price paid by Retailers	165	-	450	-
The cost incurred by Retailers (in percent)	4.40 (2.44)	-	3.77 (0.78)	-
Margin (in percent)	10.60 (5.89)	-	26.23 (5.46)	-
The price paid by the consumer	180 (100)	165 (100)	480 (100)	455 (100)
Price Spread	29	14	60	35
Producer's share in consumer rupee (in %)	83.8	91.51	87.50	92.3

Note: Figures within the parentheses are percentages of the total

Table 6: Marketing costs of the intermediaries in the supply chain (Rs/kg of fish)

Particulars	Catla		Pomfret	
	Channel 1	Channel 2	Channel 1	Channel 2
Consumer price (CP)	180	165	480	455
Total marketing cost (MC)	7.00	2.60	13.72	9.95
Total marketing margin (MM)	22.00	11.40	46.28	25.50
Marketing Efficiency ME= (CP/MC+MM)	6.20	11.78	8.00	12.83

available in GWFM in different size categories with significant price variation. We considered three shrimp size categories (shrimp20, shrimp50, and shrimp70) which indicate respective number of shrimp count per kg. Significant increase in prices was observed between 2010 and 2018 for all the three size categories of shrimp in GWFM. The average price range for shrimp20 was Rs. 438 to Rs. 701, for shrimp50 it was Rs. 230 to Rs. 400, and for shrimp70 it was Rs. 160 to Rs. 298 (Fig 3). The price range varied based on the size of the shrimp, with larger sizes commanding higher prices.

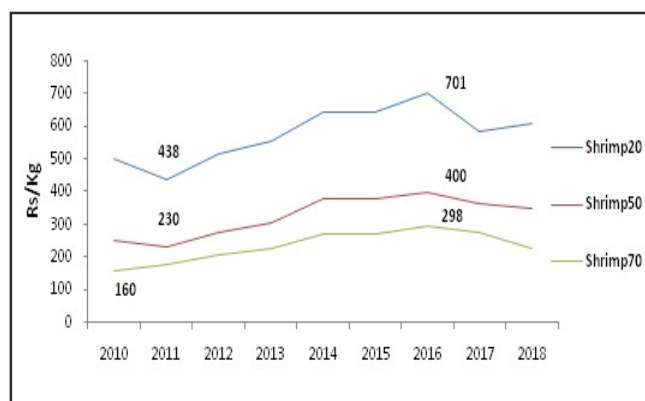


Fig3: Yearly wholesale price of shrimps

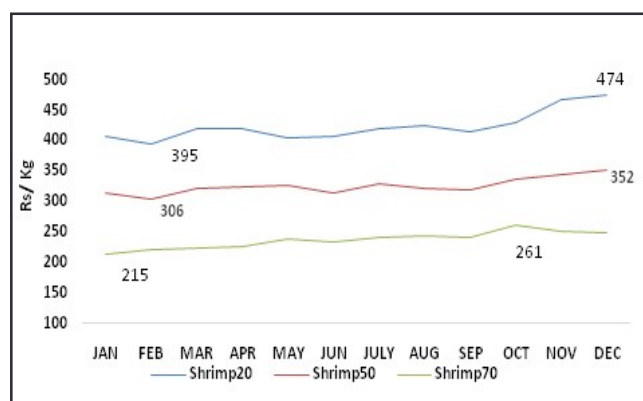


Fig4: Monthly wholesale price of shrimps

We could also observe significant price fluctuations within the year for all size categories. The prices for shrimp20 category ranged between Rs. 395 and Rs. 474 per kg, and for the Shrimp50 category, it ranged between Rs. 306 and Rs. 352 per kg, and for shrimp70 category it ranged from Rs. 215 to Rs. 261 per kg. A seasonality in prices could be observed with price peaks were observed during the winter months, while price dips occurred during Hindu festival seasons, such as in June-July due to the Shravan month and in September during Navrathri pooja when overall meat consumption among Hindus decline drastically. Shrimp50 showed higher price fluctuations, potentially due to greater consumer preference for this size category (Fig 4). Over the past eight years, both supply-side and demand-side factors have contributed to low compound growth rate (CGR) in the shrimp market. Supply-side

factors include increased production in coastal and inland states, as well as disease outbreaks and lower prices. In 2017 and 2018, an abundance of shrimps from Haryana and Punjab led to a decline in prices at GWFM, resulting in negative growth. Prior to 2016, the shrimp in GWFM was sourced primarily from Andhra Pradesh. On the demand side, the limited consumer market for shrimps has constrained the overall demand. The analysis also shows that the prices of all three shrimp size categories have experienced marginal growth with a CGR of 0.5% between 2010 and 2018. The fluctuation in prices can be attributed to the increase in the supply of vannamei shrimp, coupled with limited demand. However, the growing demand for shrimp among consumers may create opportunities for shrimp farmers, particularly in the shrimp50 category, in the Gazipur market.

Price Integration, Competition and Substitution

Co-integration analysis was carried out to understand the level of price integration and possibility of substitution among major fish species sold in GWFM. The test assumes that the selected time series data should be non-stationary at the level and become stationary at the first difference. The ADF test revealed that black pomfret, pangasius, rohu (Andhra Pradesh), seer fish, and shrimp20 were non-stationary at the level but became stationary at the first difference. On the other hand, catla, rohu (Delhi), shrimp50, and shrimp70 were already stationary at the level. As a result, the commodities that were already stationary at the level were excluded from further analysis.

The lag length criterion was used to determine the optimal number of lags in a model for better predictability. In this analysis, the lag order was selected based on the lowest Akaike information criterion (AIC) value, which indicated the best fit. Although the lowest AIC was observed at lag order 2, other criteria such as Final prediction error (FPE), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ) had lower values at lag order 1. Therefore, a lag length of 1 has been chosen for the co-integration test (Table 7). The Trace and Maximum Eigen tests were conducted to assess the integration among fish and shrimp prices in the market and identify the maximum number of related equations between the dependent and independent variables. The null hypothesis (H0) assumes no correlation and no competition among the products, while the alternative hypothesis (H1) suggests that the products substitute or compete with each other, leading to changes in the price of one product affecting the prices of others. The results of the Trace and Maximum Eigen tests indicated the presence of one co-integrating equations, respectively, at the 0.05 significance level. This leads to the rejection of the null hypothesis at the 0.05 level, indicating that the prices of the selected commodities were co-integrated and competed with each other in the market. Furthermore, the tests indicated that up to 4 equations can be derived from the selected price series (Table 8 & 9).

Table 7: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4776.63	NA	9.10e+34	94.68	94.81	94.73
1	-4545.01	435.72	1.52e+33*	90.59	91.37*	90.90*
2	-4520.00	44.57*	1.53e+33	90.59*	92.01	91.17
3	-4505.09	25.08	1.88e+33	90.79	92.86	91.63
4	-4484.64	32.40	2.10e+33	90.88	93.60	91.98

Table 8: Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob.**
None *	0.30	86.01	69.81	0.001
At most 1 *	0.23	48.58	47.85	0.042
At most 2	0.10	21.05	29.79	0.354
At most 3	0.05	9.95	15.49	0.284
At most 4 *	0.04	4.46	3.84	0.034

* denotes rejection of the hypothesis at the 0.05 level

Table 9: Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value	Prob.**
None *	0.30	37.43	33.8	0.018
At most 1	0.23	27.52	27.5	0.050
At most 2	0.10	11.09	21.1	0.637
At most 3	0.05	5.49	14.2	0.678
At most 4 *	0.04	4.465	3.8	0.034

**denotes rejection of the hypothesis at the 0.05 level

The analysis revealed five separate equations for each species, indicating that the prices of all five species have an impact on each other. A price change in one species affected the prices of the others. Coefficients C (1), C (8), C (15), C (22), and C (29) showed a long-run relationship with their respective dependent variables, indicating a sustained effect. On the other hand, the remaining variables had a short-run effect on their dependent variables. This suggests that there is both a long-term and short-term relationship among the prices of the different species.

The Granger causality test was conducted to compare the pairwise relationships between the ten species (Table 10). The pairs that were compared include pangasius vs black pomfret, rohu vs black pomfret, seer fish vs black pomfret, shrimp20 vs black pomfret, rohu vs pangasius, seer fish vs pangasius, shrimp20 vs pangasius, seer fish vs rohuAP, shrimp20 vs rohuAP, and shrimp 20 vs seer fish. The test revealed which species caused a change in the price of the other species in each pair. Among the ten pairs of species compared, two-way relationship between seer fish and black pomfret was observed, indicating that their prices affected each other. Four pairs had a one-way relationship, where in black pomfret Granger caused shrimp20, pangasius Granger caused rohuAP, pangasius Granger caused shrimp20, and seer fish Granger caused shrimp20 suggesting that the changes in the prices of the first species influenced the

price of the second species in the pair. For instance, seer fish and black pomfret can be considered substitutes for each other, as an increase in the price of seer led to a preference for black pomfret as a substitute. Similarly, an increase in the price of black pomfret and seer fish drove consumers to shift towards purchasing shrimp, as its prices fell indicating a possible market for shrimps. On the other hand, pangasius caused changes in the price of rohu, but interestingly the price of pangasius was not affected by changes in the price of rohu, indicating a relatively consistent and stable demand for rohu regardless of its price changes.

Conclusion

The domestic fish markets and marketing in India is generally unorganized and unregulated. Gazipur fish market stands out as an exception with its regulated and organized approach through DFPEMC with the proper buildings, electricity and water supply, market information system (MIS), and an increasing footfall. The market intermediaries, including commission agents, wholesalers, retailers, and vendors, play a significant role in the fish marketing process. The co-integration analysis revealed interdependence and competition among fish and shrimp prices in the market. The study confirms GWFM as a major hub for freshwater fishes and indicates its gradual development of a market for seafood especially shrimps. It will be a boon for budding shrimp

Table 10: Pairwise Granger Causality tests among fish species groups for shifts in consumer preference

SN	Null Hypothesis	F-Statistic	Prob.	Result
a	Pangasius does not Granger cause Black Pomfret	1.36	0.24	No relation
	Black Pomfret does not Granger cause Pangasius	0.42	0.51	No relation
b	Rohu_AP does not Granger cause Black Pomfret	0.31	0.57	No relation
	Black Pomfret does not Granger cause Rohu_AP	1.11	0.29	No relation
c	Seer does not Granger cause Black Pomfret	4.52	0.03	Perfect substitutes
	Black Pomfret does not Granger cause Seer	6.92	0.00	No relation
d	Shrimp 20 does not Granger cause Black Pomfret	0.01	0.90	No relation
	Black Pomfret does not Granger cause Shrimp20	4.35	0.03	Price rise in Black Pomfret leads to purchase of Shrimp20
e	Rohu _AP does not Granger cause Pangasius	0.41	0.52	No relations
	Pangasius does not Granger cause Rohu _AP	13.82	0.00	Price rise in Pangasius leads to purchase of Rohu_AP
f	Seer does not Granger cause Pangasius	1.81	0.18	No relation
	Pangasius does not Granger cause Seer	1.84	0.17	No relation
g	Shrimp 20 does not Granger cause Pangasius	0.10	0.74	No relation
	Pangasius does not Granger cause Shrimp 20	15.08	0.00	Price rise in Pangasius leads to purchase of Shrimp_20
h	Seer does not Granger cause Rohu _AP	1.54	0.21	No relation
	Rohu AP does not Granger cause Seer	0.36	0.54	No relation
I	Shrimp 20 does not Granger cause Rohu _AP	0.89	0.35	No relation
	Rohu _AP does not Granger cause Shrimp 20	0.69	0.41	No relation
J	Shrimp 20 does not Granger cause Seer	1.93	0.17	No relation
	Seer does not Granger cause Shrimp 20	6.84	0.01	Price rise in Seer shifts to buy Shrimp_20

Note: If $p < 0.05$, reject H_0 .

farmers in Haryana, Punjab and Rajasthan if the supply chain is strengthened. However, the GWFM faces challenges in terms of hygiene, sanitation, and quality control necessitating the need to establish and strengthen cold storage, sanitary and waste management, drainage, and parking facilities is crucial for attracting consumers and ensuring the safety of fish products.

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Conflict of Interest

The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported here.

References

- Bishnoi, K.T. (2005)** Marketing of Marine Fisheries, Sonali Publication, New Delhi, pp. 74-76.
- Elenchezian, T. and Kombairaju, S. (2004)** Marketing efficiency of major vegetable in central vegetable market of Madurai. *Madras Agriculture Journal*, 91(1-3): 27-31.
- Kumar B.G. (2008)** Domestic Fish Marketing in India - Changing Structure, Conduct, Performance and Policies. *Agricultural Economics Research Review*, 21:345-354
- Gupta, V.K. (1984)** Marine Fish Marketing in India (Vol I). IIM Ahmedabad & Concept Publishing Company, New Delhi.
- Kumar R S., Krishnan, M., Kumar P., Narayan, B G., Prakash S, and Kumar D K. (2021).** Estimation of Demand for Fish in Delhi and NCR, India. *Socio-Economic Challenges*. 5(4):46-54.
- Barik N. (2016)** Potential in Improving Nutritional Security through Aquaculture Development in India: A Regional Level Analysis. *Agricultural Economics Research Review*, 29:99-109.
- Kumar P, Dey MM and Paraguas FJ (2005).** Demand for Fish by Species in India: Three-stage Budgeting Framework. *Agricultural Economics Research Review*, 18:167-186.
- Upadhyay, A.D., Jagpal and Piyashi Deb Roy. (2016)** Structural performance of the fish market and socio-economic status of market functionaries of Naveen Machhali Mandi Mahanva of Gorakhpur, Uttar Pradesh. *Economic Affairs*, 61(3):511.