



Estimation of Marketing Efficiency for Key Fish Species Produced in Egypt

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ABSTRACT

This study assessed the marketing efficiency of two crucial fish species in Egypt, the Nile tilapia (Balti) and mullet (Bouri), contributing 73.4% to the nation's total fish production. Utilizing data envelopment analysis (DEA) and the variable returns to scale model, marketing efficiency for the Nile tilapia ranged from approximately 62.4 to 100%, with an average of 87.5%, while mullet fish exhibited a range of 36.2 to 100%, averaging 83.4%. The findings suggest a marketing efficiency deficit of 12.5% for the Nile tilapia and 16.6% for mullet fish, attributable to factors not considered in the model. To enhance efficiency, increasing marketing margins or fish production is recommended. Scale efficiency analysis revealed that some fishers failed to achieve an optimal production efficiency. The Nile tilapia could increase productivity by 24.1%, through optimization at the minimum point on the average total cost curve ($MC = AC$). Similarly, mullet fish could increase productivity by 27.4%, using the same approach. Furthermore, 70% of the Nile tilapia volume demonstrated increasing returns to scale (IRS), while 25% exhibited decreasing returns to scale (DRS). For mullet, 80% demonstrated IRS, and 10% exhibited DRS. Identified marketing challenges included high summer temperatures causing significant losses, financial constraints, insufficient liquidity, high labor costs, lack of marketing information, and elevated taxes. Recommendations include providing comprehensive marketing information, ensuring well-equipped transportation, attempting to enhance liquidity through lending, and supporting energy to reduce costs for fishing-related activities.

INTRODUCTION

The fisheries sector is one of the vital production sectors for the national economy. Fishery production represents a crucial resource contributing to the increase of the gross agricultural domestic product. Moreover, it serves as a fundamental pillar in addressing the food gap, providing an essential animal protein due to its high protein content. Despite the growth in fish production from around 771.8 thousand tons in 2001 to approximately 2.034 million tons in 2020, fish imports still reached about 300 thousand tons in 2020. In contrast, fish exports amounted to only 28 thousand tons in the same year. This indicates a lack of self-sufficiency in this

essential commodity in Egypt, with a self-sufficiency rate estimated at around 85% in 2020.

Marketing is a dynamic aspect of the fisheries sector, and agricultural marketing holds a significant importance for both the national and agricultural economies. The marketing of the fishery production is a critical operation complementary to the production process itself. It involves services and functions that connect production to consumption, aiding consumers in obtaining fish in their preferred time, place, and form. Fish marketing is defined as the process of delivering fish from the primary producer (the fisherman) to the final consumer.

Given the continuous improvement in the marketing performance across various marketing functions, several challenges persist in fish marketing. These challenges include issues related to fish spoilage and the imposition of high additional margins. Therefore, it is essential to assess the marketing efficiency of key fish species to inform pricing and marketing policies for fish products.

Problem statement

The decline in the marketing efficiency of fish is one of the significant obstacles facing both producers and consumers. This decline can be attributed to various marketing problems encountered by fish producers. These challenges manifest in increased marketing margins and a reduction in product prices that do not align with the services provided. Consequently, this leads to a decrease in the fishermen's share and an increase in the share of marketing intermediaries from the consumer's pound. As a result, the overall marketing efficiency of fish is compromised. Therefore, it is imperative to address the marketing efficiency of key fish species in Egypt, such as tilapia and mullet. The focus should be on identifying and rectifying the issues affecting their marketing efficiency, ultimately working toward improving and enhancing the marketing capabilities of these fish species.

Research objectives

The research aimed to estimate the marketing efficiency of the most important types of fish produced in Egypt (tilapia and mullet) during the period 2001- 2020. This was achieved by studying the price development of the most important types of fish in Egypt and estimating the price differences and marketing margins, as well as analyzing the distribution of the consumer pound as a measure of the marketing efficiency. Additionally, the study aimed to identify the most important problems and obstacles in fish marketing in Egypt.

Data sources and research methodology

The research aimed to achieve its objectives through the utilization of both descriptive and quantitative analyses. The data envelopment analysis (DEA) was employed using the DEAP software to estimate marketing efficiency. The research relied on two main sources of data:

Published secondary data: It relied on fishery production statistics from the General Authority for the Development of Fish Wealth.

Data from the Central Agency for Public Mobilization and Statistics were used.

Unpublished secondary data: The research benefited from some scientific studies and relevant research on the topic.

Primary data (Field data): Field data were collected from a random sample of various markets in Egypt. A questionnaire was designed specifically for this purpose to investigate the significant problems and obstacles in fish marketing. By utilizing these sources and methods, the research aimed to provide a comprehensive assessment of the marketing efficiency of key fish species in Egypt. This involved analyzing both published and unpublished data, along with firsthand field data obtained through a tailored questionnaire designed to explore the major marketing challenges and impediments in the fish marketing sector.

Results and discussion

1. Price trends for key fish species in Egypt (2001- 2020)

The prices of different fish species vary based on their production quantities (supply) and consumer preferences. Additionally, they are influenced by production and marketing costs, prices of alternative goods, and consumer purchasing power. The selected species for this study were tilapia and mullet, considering their economic significance in the Egyptian fish production, accounting for approximately 73.4% of the total fish production in 2020. The study aimed to analyze the price trends of these species over the study period of 2001- 2020.

Table 1. Price trends for key fish species in Egypt during the period of 2001- 2020 (In Egyptian pounds per kilogram)

Year	Tilapia (Producer)	Tilapia (Wholesale)	Tilapia (Retail)	Mullet (Producer)	Mullet (Wholesale)	Mullet (Retail)
2001	6.52	6.86	7.38	9.6	10.48	13.9
2002	6.37	6.71	7.47	11	11.89	14.45
2003	6.75	7.11	7.38	11.58	12.18	13.4
2004	7.88	8.29	10.02	12.05	12.87	14.36
2005	7.34	7.73	8.61	12.28	12.92	14.58
2006	8.73	9.19	9.5	13.03	16.14	16.51
2007	9.42	9.91	10.86	13.67	16.58	17.85
2008	8.95	9.42	10.81	14.04	17.25	19.95
2009	9.9	10.42	12.01	14.4	19.67	22.25
2010	9.91	10.52	12.26	21.14	23.58	26.6
2011	11.59	11.59	14.02	18.11	24.82	28.1
2012	12.85	13.00	17.34	20.05	30.76	32.01
2013	14.59	14.89	20.32	19.38	33.6	36.35
2014	16.78	17.28	22.78	20.32	35.25	40.79
2015	17.58	18.08	23.58	20.2	36.75	40.25
2016	17.81	18.31	23.81	21.77	39.25	42.75
2017	25.58	26.08	31.58	33.52	56.6	60.1
2018	22.78	23.27	28.77	45.50	61.16	64.66
2019	23.12	24.10	28.64	46.18	48.15	54.30
2020	23.85	25.00	28.75	47.22	49.10	55.16
Average	13.42	13.89	16.80	21.25	28.45	31.42

Source: Compiled from various issues of the Central Agency for Public Mobilization and Statistics - Quarterly Bulletin for Producer, Wholesale, and Retail Prices for Food Commodities (2001 - 2020).

1.1 Nile tilapia price trends

- **Producer prices**
- The data in Table (1) illustrate the evolution of producer prices for the Nile tilapia during the study period of 2001- 2020, ranging from approximately

6.4EGP/ kg as the minimum in 2002 to about 25.6EGP/ kg as the maximum in 2017, with an average of approximately 13.4EGP/ kg over the study period. The estimated annual growth rate of the Nile tilapia prices indicates a statistically significant increasing trend at a confidence level of 0.01, estimated at about 7.7%, as depicted by the following equation:

$$Y = 2.60 + 1.03x$$

(12.74)**

$$R^2 = 0.90$$

$$F = 162.4$$

- Wholesale prices trends for the Nile tilapia: The data from Table (1) reveal the evolution of wholesale prices for the Nile tilapia during the study period of 2001- 2020, fluctuating from approximately 6.7EGP/kg as the minimum in 2002 to about 26EGP/ kg as the maximum in 2017, with an average of approximately 13.9EGP/ kg. The estimated annual growth rate of the Nile tilapia wholesale prices indicates a statistically significant increasing trend at a confidence level of 0.01, estimated at about 7.6%, as demonstrated by the following equation:

$$Y = 2.85 + 1.05x$$

(12.65)**

$$R^2 = 0.90$$

$$F = 160.1$$

- **Retail prices trends for the Nile tilapia**

The data from Table (1) illustrate the evolution of retail prices for the Nile tilapia during the study period of 2001– 2020, starting from approximately 7.4EGP/ kg in 2001 as the minimum and reaching about 31.6EGP/ kg in 2017 as the maximum, with an average of around 16.8EGP/ kg. The estimated annual growth rate of the Nile tilapia retail prices indicates a statistically significant increasing trend at a confidence level of 0.01, estimated at about 8.1%, as demonstrated by the following equation:

$$Y = 2.51 + 1.36 X$$

(14.17)**

$$R^2 = 0.92$$

$$F = 200.8$$

1.2 Prices trends for the Nile mullet

- **Producer prices trends for the Nile mullet**

- The data in Table (1) demonstrate an evolution of prices for the Nile catfish during the study period of 2001– 2020, ranging from approximately 9.6EGP/ kg as a minimum in 2001 to about 47.2EGP/ kg as a maximum in 2020, with an average of around 21.2EGP/ kg. The estimated annual growth rate of the Nile catfish producer prices indicates a statistically significant increasing trend at a confidence level of 0.01, estimated at about 8.3%, as illustrated by the following equation:

$$Y = 2.65 + 1.77 X$$

(7.40)**

$$R^2 = 0.74$$

$$F = 54.74$$

- **The wholesale prices of mullet fish**

Table (1) data reveal the evolution of wholesale prices of mullet fish during the study period of 2001- 2020. Prices ranged from a minimum of approximately 10.5 pounds per kilogram in 2001 to a maximum of around 61 pounds per kilogram in 2018, with an average of about 28.5 pounds per kilogram. Calculating the annual growth rate of mullet fish in pounds indicates

a statistically significant increasing trend at a level of 0.01, estimated at approximately 8.9%, as shown in the following equation.

$$Y = 1.80 + 2.54 X$$

(12.01)**

$$R^2 = 0.89 \qquad F = 144.2$$

- The development of retail prices for mullet fish during the study period of 2001- 2020. Prices ranged from approximately 13.4 pounds per kilogram in 2003 as a minimum to around 64.6 pounds per kilogram in 2018 as a maximum, with an average of about 31.4 pounds per kilogram. Estimating the annual growth rate of mullet prices in pounds indicates a statistically significant increasing trend at a level of 0.01, estimated at approximately 8.7%, as shown in the following equation:

$$Y = 2.82 + 2.72 X$$

(12.67)**

$$R^2 = 0.9 \qquad F = 160.6$$

2. Marketing margins for fish

Fish prices in various markets are influenced by production costs, marketing services, as well as the purchasing power of consumers and market characteristics, including competition and monopolies. The efficiency of marketing services across different stages and channels is considered one of the most crucial factors affecting the stability and production expansion of fish. Marketing margins, both absolute and relative, and the distribution of the consumer's pound among fish market participants, including producers, wholesalers, and retailers, are essential analytical methods to assess the marketing efficiency of fish.

2.1. Marketing margins for tilapia

- **The marketing margin for tilapia among intermediaries in fish markets**

The marketing margin for various fish species differs among intermediaries in different fish markets due to the variation in fish types and the marketing services provided by each intermediary. The marketing margin between the wholesaler and the producer for tilapia fish is analyzed below.

According to the data in Table (3), the absolute marketing margin between the wholesaler and the producer for tilapia increased from about 34 piasters in 2001 to around 115 piasters in 2020, indicating an approximately 81% increase from the 2001 level. Meanwhile, the relative marketing margin between the wholesaler and the producer decreased from about 5% in 2001 to around 4.6% in 2020, showing a decrease of about 0.4% from the 2001 level.

- **The marketing margin for tilapia between retailers and wholesalers**

The absolute marketing margin between retailers and wholesalers for tilapia increased from about 52 piasters in 2001 to around 375 piasters in 2020, marking an increase of approximately 958% from the 2001 level. The relative marketing margin between retailers and wholesalers increased from about 7% in 2001 to around 13% in 2020, indicating an increase of about 90% from the 2001 level.

- **The marketing margin for tilapia between retailers and producers**

The absolute marketing margin between retailers and producers for tilapia increased from about 86 piasters in 2001 to around 490 piasters in 2020, showing an increase of approximately 500% from the 2001 level. Meanwhile, the relative marketing margin between retailers and producers increased from about 12% in 2001 to around 17% in 2020, representing an increase of about 9% from the 2001 level.

2.2. Distribution of the consumer pound for tilapia fish

- **Producer's share of the consumer pound for tilapia**

The data in Table (2) show the evolution of the producer's share of the consumer pound for tilapia fish during the study period of 2001- 2020. It is evident that the producer's share has decreased from approximately 88% in 2001 to about 82% in 2020, a decrease of around 3%. The producer's share fluctuates between a minimum of about 71% in 2013 and a maximum of about 91% in 2006, with an average of around 82% during the study period of 2001-2020.

Table 2. Marketing margins for tilapia fish production in Egypt during the period of 2001- 2020

Year	Marketing margins					
	Wholesale - Producer		Retail - Wholesale		Retail - Producer	
	Absolute	Percentage	Absolute	Percentage	Absolute	Percentage
2001	34	4.96	52	7.05	86	11.65
2002	34	5.07	76	10.17	110	14.73
2003	36	5.06	27	3.66	63	8.54
2004	41	4.95	173	17.27	214	21.36
2005	39	5.01	88	10.22	127	14.75
2006	45	4.9	32	3.37	77	8.11
2007	49	4.94	95	8.75	144	13.26
2008	47	4.99	139	12.86	186	17.21
2009	52	4.99	159	13.24	211	17.57
2010	61	5.8	174	14.19	235	19.17
2011	21	1.81	243	17.33	264	18.83
2012	15	1.15	434	25.03	449	25.89
2013	30	2.01	543	26.72	573	18.20
2014	50	2.89	550	24.14	600	26.43
2015	50	2.77	550	23.32	600	25.45
2016	50	2.73	550	23.10	600	25.20
2017	50	3.11	550	17.42	600	19.00
2018	49	2.11	550	19.12	599	20.82
٢٠١٩	٩٨	٤.٠٦	٤٥٤	١٥.٨٥	٥٥٢	١٩.٢٧
٢٠٢٠	١١٥	٤.٦	٣٧٥	١٣.٠٤	٤٩٠	١٧.٠٤
Average	48.3	3.90	291	15.30	339	18.12

1. Retail - Producer (Absolute) = Retail Price - Producer Price
2. Retail - Producer (Percentage) = (Retail Price - Producer Price) / Retail Price × 100
3. Wholesale - Retail (Absolute) = Wholesale Price - Retail Price
4. Wholesale - Retail (Percentage) = (Wholesale Price - Retail Price) / Wholesale Price × 100
5. Wholesale - Producer (Absolute) = Wholesale Price - Producer Price
6. Wholesale - Producer (Percentage) = (Wholesale Price - Producer Price) / Wholesale Price × 100

Source: Compiled and calculated from: Central Agency for Public Mobilization and Statistics (CAPMAS) reports – Quarterly bulletin of prices for producer, wholesale, and retail of food products, various issues for the period of 2001- 2020.

- **Wholesaler's share of the consumer pound for tilapia fish**

The data in Table (2) illustrate the evolution of the wholesaler's share of the consumer pound for tilapia fish during the study period of 2001- 2020. A decrease was detected in the wholesaler's share from approximately 4.6% in 2001 to about 4% in 2020, with a percentage decrease of around 1% from the 2001 level. The wholesaler's share ranges from a minimum of about 87.0% in 2012 to a maximum of about 5% in 2010, with an average of about 3% during the study period.

- **Retailer's share of the consumer pound for tilapia**

The data in Table (2) show the evolution of the retailer's share of the consumer pound for tilapia fish during the study period of 2001- 2020. The retailer's share increases from approximately 7% in 2001 to about 13% in 2020, with an increase of around 6% from the 2001 level. The retailer's share fluctuates between a minimum of about 3% in 2006 and a maximum of approximately 26% in 2013, with an average of about 15% during the study period.

Table 3. Distribution of the consumer pound for tilapia fish in Egypt during the period of 2001- 2020

Year	The prices are in piasters per kilogram			The distribution of the consumer pound %			
	Producer	Wholesaler	Retailer	Producer's share	Wholesaler's share	Retailer's share	Brokers' share
2001	652	686	738	88.35	4.61	7.05	11.65
2002	637	671	747	85.27	4.55	10.17	14.73
2003	675	711	738	91.46	4.88	3.66	8.54
2004	788	829	1002	78.64	4.09	17.27	21.36
2005	734	773	861	85.25	4.53	10.22	14.75
2006	873	918	95	91.89	4.84	3.36	8.11
2007	942	991	1086	86.74	4.51	8.75	13.26
2008	895	942	1081	82.79	4.35	12.86	17.31
2009	99	1042	1201	82.43	4.33	13.24	17.57
2010	991	1052	1226	80.83	4.98	14.19	19.17
2011	1138	1159	1402	81.17	1.50	17.33	18.83
2012	1285	1300	1734	74.11	0.87	25.03	25.90
2013	1459	1489	2032	71.80	1.48	26.72	28.20
2014	1678	1728	2278	73.66	2.19	24.14	26.33
2015	1758	1808	2358	74.55	2.12	23.32	25.44
2016	1781	1831	2381	74.80	2.10	23.10	25.20
2017	2558	2608	3158	81.00	1.58	17.42	19.00
2018	2278	2327	2877	79.18	1.70	19.12	20.82
٢٠١٩	٢٣١٢	٢٤١٠	٢٨٦٤	٨٠.٧٢	٣.٤٢	١٥.٨٥	١٩.٢٧
٢٠٢٠	٢٣٨٥	٢٥٠٠	٢٨٧٥	٨٢.٩٦	٤.٠٠	١٣.٠٤	١٧.٠٤
Average	١٣٤٢	١٣٨٩	١٦٧٩	٨١.٨٣	٣.٣٣	١٥.٢٩	١٨.٦٢

1. Producer's share = (Producer price / Retailer price) × 100
2. Wholesaler's share = (Wholesaler price - Producer price / Retailer price) × 100
3. Retailer's share = (Retailer price - Wholesaler price / Retailer price) × 100

4. Broker's share = Wholesaler's share + Retailer's share

Source: Compiled and calculated from the Central Agency for Public Mobilization and Statistics (CAPMAS) quarterly bulletin on the prices of wholesale and retail products for food items, various issues for the period of 2001- 2020.

- **Broker's share of the consumer pound for tilapia fish**

The data in Table (2) indicate that the broker's share of the consumer pound for tilapia fish increases from around 11% in 2001 to about 17% in 2020, with an increase of about 6% from the 2001 level. The broker's share ranges between a minimum of about 8% in 2006 and a maximum of about 28% in 2013, with an average of 18% during the study period.

3. Marketing margins for mullet fish

3.1. Marketing margin between intermediaries in fish markets

- **Marketing margin between wholesaler and producer for mullet fish**

The absolute marketing margin between the wholesaler and the producer for mullet fish during the study period of 2001- 2020 is evident from the data in Table (ξ). It increases from about 88 piasters in 2001 to approximately 188 piasters in 2020, representing an increase of about 81% from the 2001 level. Meanwhile, the relative marketing margin between the wholesaler and the producer for mullet fish decreases from around 8% in 2001 to about 4% in 2020, with a decrease of about 100% from the 2001 level.

- **Marketing margin between retailer and wholesaler for mullet fish**

Table (ξ) shows that the absolute marketing margin between the retailer and wholesaler for mullet fish during the study period 2001- 2020 increases from about 52 piasters in 2001 to approximately 375 piasters in 2020, indicating an increase of about 958% from the 2001 level. The relative marketing margin between the retailer and wholesaler for mullet fish increases from about 7% in 2001 to about 13% in 2020, with an increase of about 90% from the 2001 level.

- **Marketing margin between retailer and producer for mullet fish**

The absolute marketing margin between the retailer and producer for mullet fish during the study period of 2001- 2020 is evident from Table (4). It increases from about 342 piasters in 2001 to approximately 974 piasters in 2020, representing an increase of about 200% from the 2001 level. Meanwhile, the relative marketing margin between the retailer and producer for mullet fish increases from about 24% in 2001 to about 14% in 2020, with a decrease of about 40% from the 2001 level.

3.2. Distribution of consumer pound for mullet fish

- **Producer's share of consumer pound for mullet fish**

The data from Table (5) reveal the evolution of the producer's share of the consumer pound for mullet fish during the period of 2001- 2020. It increased from around 69% in 2001 to approximately 85% in 2020, marking a 6% increase from 2001. The producer's share fluctuates between a minimum of about 49% in 2014 and a maximum of around 85% in 2020, with an annual average of approximately 85.6%.

- **Wholesaler's share of consumer pound for mullet fish**

The analysis of Table (5) data illustrates the development of the wholesaler's share of the consumer pound for mullet fish from about 6% in 2001 to around 3%

in 2020, indicating a decrease of approximately 3% from 2001. The wholesaler's share ranges between a minimum of about 2% in 2003 and a maximum of around 41% in 2015, with an annual average of approximately 3.4% during the study period.

- **Retailer's share of consumer pound for mullet fish**

The examination of Table (5) data showcases the evolution of the retailer's share of the consumer pound for mullet fish from approximately 24% in 2001 to around 11% in 2020. This reflects a decrease of about 13% from 2001. The retailer's share varies between a minimum of about 2% in 2006 and a maximum of around 24% in 2001, with an annual average of approximately 11%.

- **Middlemen's share of consumer pound for mullet fish**

The data from Table (5) elucidates the evolution of the middlemen's share of the consumer pound for mullet fish from around 30% in 2001 to about 14% in 2020. This indicates a decrease of approximately 16% from 2001. The middlemen's share fluctuates between a minimum of about 11% in 2002 and a maximum of around 50% in 2014, with an annual average of approximately 14% during the study period.

Table 4. Marketing margins for produced Barramundi fish in Egypt during the period of 2001- 2020)

Year	Marketing margins					
	Wholesale - Producer		Retail - Wholesale		Retail - Producer	
	Absolute	Percentage	Absolute	Percentage	Absolute	Percentage
2001	88	8.4	342	24.6	430	30.94
2002	89	7.49	256	17.72	345	23.88
2003	33	2.71	122	9.1	155	11.57
2004	82	6.37	149	10.38	231	16.09
2005	64	4.95	166	11.39	230	15.78
2006	284	17.6	37	2.24	321	19.44
2007	291	17.55	127	7.11	418	23.42
2008	321	18.61	270	13.53	591	29.62
2009	527	26.79	258	11.6	785	35.28
2010	244	10.35	302	11.35	546	20.53
2011	671	27.03	328	11.67	999	35.55
2012	1071	34.82	125	3.91	1196	37.36
2013	1422	42.32	275	7.57	1697	46.69
2014	1493	42.35	572	13.96	2065	50.4
2015	1655	45.03	350	8.7	2005	49.81
2016	1748	44.54	350	8.19	2098	49.08
2017	2308	40.78	350	5.82	2658	44.23
2018	1566	25.6	350	5.41	1916	29.63
٢٠١٩	١٩٧	٤.٠٩	٦١٥	١١.٣٣	٨١٢	١٤.٩٥
٢٠٢٠	١٨٨	٣.٨٣	٧٩٤	١٤.٤٠	٧٩٤	١٤.٤٠
Average	717	21.56	307	10.50	1015	29.93

Source: Compiled and calculated from the Central Agency for Public Mobilization and Statistics (CAPMAS) quarterly bulletin on prices of wholesale and retail products for food items, various issues covering the period of 2001- 2020.

4. Estimating the marketing efficiency for the main fish species in Egypt

The marketing efficiency for the main fish species in Egypt is estimated using two methods: the traditional method using the ratio of marketing costs to retail prices, and the Farrell approach utilizing data envelopment analysis (DEA). Due to the lack of information on production costs, two economic variables are used to estimate efficiency: the marketing margin (marketing costs), which is the difference between the retail price and the producer price, and the retail price. The retail price is derived from wholesale and producer prices and subsequently influences the magnitude of the marketing margin.

Table 5. Distribution of consumer pound for produced mullet fish in Egypt during the period of 2001- 2020

The prices are in piasters per kilogram				The distribution of the consumer pound %			
Year	Producer	Wholesale	Retailer	Producer's share	Wholesaler's share	Retailer's share	Brokers' share
2001	960	1048	1390	69.06	6.33	24.6	30.94
2002	1100	1189	1445	76.12	6.16	17.72	23.88
2003	1185	1218	1340	88.43	2.46	9.1	11.57
2004	1205	1287	1436	83.91	5.71	10.38	16.09
2005	1228	1292	1458	84.22	4.39	11.39	15.78
2006	1330	1614	1651	80.56	17.2	2.24	19.44
2007	1367	1658	1785	76.58	16.3	7.11	23.42
2008	1404	1725	1995	70.38	16.09	13.53	29.62
2009	1440	1967	2225	64.72	23.69	11.6	35.28
2010	2114	2358	2660	79.47	9.17	11.35	20.53
2011	1811	2482	2810	64.45	23.88	11.67	35.55
2012	2005	3076	3201	62.64	33.46	3.91	37.37
2013	1938	3360	3635	53.31	39.12	7.57	46.69
2014	2032	3525	4097	49.6	36.44	13.96	50.4
2015	2020	3675	4025	50.19	41.12	8.7	49.82
2016	2177	3925	4275	50.92	40.89	8.19	49.08
2017	3352	5660	6010	55.77	38.4	5.82	44.22
2018	4550	6116	6466	70.37	24.22	5.413	29.63
٢٠١٩	٤٦١٨	٤٨١٥	٥٤٣٠	٨٥.٠٤	٣.٦٣	١١.٣٣	١٤.٩٦
٢٠٢٠	٤٧٢٢	٤٩١٠	٥٥١٦	٨٥.٦٠	٣.٤٠	١١.٠٠	١٤.٤٠
Average	2127.9	2845	3142.5	٨٥.٦	٣.٤	١١	١٤.٤

Source: Compiled and calculated from the Central Agency for Public Mobilization and Statistics (CAPMAS) quarterly bulletin on prices of wholesale and retail products for food items, various issues covering the period of 2001- 2020.

4.1. Estimating efficiency using the ratio of marketing costs to retail prices for the main fish species in Egypt during the period of 2001- 2020

Marketing costs include both marketing and production costs, and lower marketing costs lead to higher marketing efficiency. Marketing efficiency is calculated by dividing marketing costs by the sum of marketing and production costs.

Total marketing and production costs are replaced by the retail price as an alternative variable, as it includes both the producer price and the marketing margin.

- **The Nile tilapia**

The results from Table (6) indicate that the average ratio of marketing costs to retail prices for the Nile tilapia was approximately 11.65% in 2001, and then increased to about 17.04% in 2020, with an increase of around 46.3%. The average ratio over the period of 2001- 2020 is approximately 18.54%.

- **Mullet fish**

The results from Table (6) indicate that the average ratio of marketing costs to retail prices for mullet fish was approximately 30.94% in 2001, then decreased to about 14.39% in 2020, with a decrease of about 115%. The average ratio over the period of 2001- 2020 is approximately 30.1%.

Table 6. Evolution of marketing efficiency using the ratio of marketing costs to retail prices for major fish species in Egypt during the period of 2001- 2020

Year	The Nile tilapia		Mullet fish	
	Marketing costs	Efficiency	Marketing costs	Efficiency
2001	0.86	11.65	4.3	30.94
2002	1.1	14.73	3.45	23.88
2003	0.63	8.54	1.82	13.58
2004	2.14	21.36	2.31	16.09
2005	1.27	14.75	2.3	15.78
2006	0.77	8.11	3.48	21.08
2007	1.44	13.26	4.18	23.42
2008	1.86	17.21	5.91	29.62
2009	2.11	17.57	7.85	35.28
2010	2.35	19.17	5.46	20.53
2011	2.43	17.33	9.99	35.55
2012	4.49	25.89	11.96	37.36
2013	5.73	28.20	16.97	46.69
2014	6	26.34	20.47	50.18
2015	6	25.45	20.05	49.81
2016	6	25.20	20.98	49.08
2017	6	18.20	26.58	44.23
2018	5.99	20.82	19.16	29.63
2019	5.52	19.27	8.12	14.95
2020	4.9	17.04	7.94	14.39
Average	3.40	18.54	10.16	30.10

Source: Compiled and calculated from data in Table (1).

4.2. Estimating marketing efficiency using data envelopment analysis for major fish species in Egypt during the period of 2001- 2020

Farrell's manual method (1957) was used to estimate technical efficiency by determining the piecewise linear convex isoquant curve. Subsequently, **Charnes, Cooper and Rhodes (1978)** established the data envelopment analysis (DEA) method using linear programming to estimate input surplus. This method evolved to include an output in the analysis. Previous analyses were conducted based on the assumption of constant returns to scale (CRS), meaning that facilities operate at the optimal scale. However, due to the lack of full competition and the technical and economic constraints faced by facilities, they often operate under conditions that do not align with the optimal scale for production. Therefore, the linear programming method was developed by **Banker et al., (1984)** to express the variable returns to scale (VRS)

assumption. This allowed for the estimation and separation of scale efficiency from technical efficiency.

- **Estimating marketing efficiency for the Nile tilapia using data envelopment analysis during the period of 2001- 2020**

Estimating the marketing efficiency according to the variable returns to scale (VRS) model reveals that the marketing efficiency for the Nile tilapia ranges between a maximum of approximately 100% and a minimum of about 62.4%, with an average of about 87.5%. This indicates that the Nile tilapia producers can increase their production by approximately 12.5%, without any increase in the quantity of resources used for fish production. Thus, the Nile tilapia producers lose some economic resources used in production, resulting in a decrease in marketing efficiency of about 12.5%. This is attributed to other factors not included in the model. Therefore, increasing marketing efficiency for the Nile tilapia can be achieved by achieving marketing margins or increasing fish production. Scale efficiency ranges between a maximum of approximately 100% and a minimum of about 30.3%, with an average of about 75.9%. This means that some of the Nile tilapia fishers did not reach the optimal scale efficiency, and they can reach it by working to increase the Nile tilapia production by about 24.1%.

Table 7. Price and technical efficiency for marketing the Nile tilapia in Egypt during the period of 2001- 2020 using data envelopment analysis

Year	CRS	VRS	Scale	irs
2001	0.413	1.000	0.413	irs
2002	0.522	1.000	0.522	irs
2003	0.303	1.000	0.303	irs
2004	0.757	1.000	0.757	irs
2005	0.523	0.916	0.571	irs
2006	0.287	0.777	0.370	irs
2007	0.470	0.765	0.615	irs
2008	0.610	0.863	0.707	irs
2009	0.623	0.828	0.752	irs
2010	0.680	0.866	0.785	irs
2011	0.615	0.774	0.794	irs
2012	0.918	0.967	0.950	irs
2013	1.000	1.000	1.000	-
2014	0.934	1.000	0.934	drs
2015	0.902	0.966	0.934	drs
2016	0.894	0.957	0.934	drs
2017	0.674	0.721	0.934	drs
2018	0.738	0.789	0.936	drs
2019	0.683	0.688	0.993	irs
2020	0.604	0.624	0.969	irs
Average	0.658	0.875	0.759	-

Note: "irs" stands for increasing return to scale, and "drs" stands for decreasing return to scale.

Source: Compiled and calculated from the results of the data envelopment analysis (DEA) and from the data in Table (1) in the study.

- **Estimating the marketing efficiency for mullet fish using data envelopment analysis during the period of 2001- 2020**

Through estimating the marketing efficiency according to the variable returns to scale model, it is evident that the marketing efficiency for mullet fish ranges between a maximum of about 100% and a minimum of about 36.2%, with an average of about 83.4%. This means that mullet fish producers can increase their production by

approximately 16.6% without any increase in the quantity of resources used for fish production. Consequently, mullet fish producers lose some of the economic resources used in production, resulting in an efficiency loss of about 16.6%. This is attributed to other factors not included in the model. Therefore, the marketing efficiency of mullet fish can be increased by achieving marketing margins or increasing fish production. The scale efficiency ranges between a maximum of about 100% and a minimum of about 27.1%, with an average of about 72.6%. This indicates that some mullet fishers have not reached their optimal price efficiency, and they can achieve it by increasing the production of mullet fish by approximately 27.4%. This can be achieved by working on production at the optimal volume at the lowest point on the average total cost curve ($MC = ATC$). Table (7) also shows that about 80% of the volume of mullet fish is in the stage of increasing returns to scale (IRS), and about 10% of the volume is in the stage of decreasing returns to scale (DRS).

Table 8. Price and technical efficiency for marketing mullet fish in Egypt during the period of 2000- 2020 using data envelopment analysis

Year	CRS	VRS	Scale	irs
2001	0.616	1.000	0.616	irs
2002	0.501	0.950	0.476	irs
2003	0.271	1.000	0.271	irs
2004	0.341	0.940	0.321	irs
2005	0.340	0.926	0.314	irs
2006	0.505	0.832	0.420	irs
2007	0.600	0.777	0.467	irs
2008	0.710	0.831	0.590	irs
2009	0.790	0.890	0.703	irs
2010	0.687	0.595	0.409	irs
2011	0.852	0.831	0.708	irs
2012	0.895	0.832	0.745	irs
2013	0.967	0.962	0.930	irs
2014	1.000	1.000	1.000	-
2015	0.997	0.996	0.993	irs
2016	0.986	0.992	0.978	drs
2017	0.881	1.000	0.881	drs
2018	0.989	0.597	0.590	irs
2019	0.799	0.373	0.298	irs
2020	0.793	0.362	0.287	irs
Average	0.700	0.834	0.726	-

Source: Compiled and calculated from the results of the data envelopment analysis (DEA) and from the data in Table (1) in the study.

5. Marketing challenges facing major fish species in Egypt

Field questionnaire was conducted on a random sample of 70 individuals, gathered from both wholesale and retail fish traders in various markets across Egypt, to identify the key marketing problems and obstacles facing the marketing of major fish species, specifically Barramundi and Mullet. The findings are as follows:

- Lack of marketing information and news: Problem percentage: Approximately 91.4% of the sample.
- Absence of equipped transportation means: Problem percentage: approximately 51.4% of the sample.
- Shortcomings in financial processes and insufficient cash flow: Problem percentage: Approximately 95.7% of the sample.

- High prices of fresh fish compared to imported ones: Problem percentage: Approximately 75.7% of the sample.
- Rising labor costs: Problem percentage: Approximately 95.7% of the sample.
- High cost of transporting fish products: Problem percentage: Approximately 90% of the sample.
- High cost of commercial registration and tax card: Problem percentage: Approximately 50% of the sample.
- High temperature in summer causing increased losses: Problem percentage: Approximately 97% of the sample.

RECOMMENDATIONS

Based on the identified problems and challenges, the following recommendations can be made:

1. Improve the availability of marketing information for all stakeholders.
2. Provide equipped means of transport to enhance product quality.
3. Support cash flow through lending to enhance marketing operations.
4. Financial support to reduce energy costs for fishermen and related activities.

These recommendations highlight the proposed efforts to improve the fish marketing environment in Egypt, aiming to enhance efficiency and conditions for those involved in this sector.

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