Journal of Socioeconomics and Development

https://publishing-widyagama.ac.id/ejournal-v2/index.php/jsed

Price fluctuations and market integration of fresh skipjack tuna in Indonesia

Abd. Rahim[1*], Diah Retno Dwi Hastuti[1], Abdul Malik[1], Wardihan Sabar[2], and Irwandi[1]

[1]Universitas Negeri Makassar, Indonesia
[2]Universitas Islam Negeri Alauddin Makassar, Indonesia

*Correspondence email: abd.rahim@unm.ac.id

ARTICLE INFO

►**Research Article**

Article History
Received 22 October 2023
Accepted 18 December 2023
Published 20 March 2024

Keywords
fresh skipjack tuna; market integration; price fluctuation; symmetric information

JEL Classification
D82; Q11; Q22

ABSTRACT

Price fluctuations significantly impact the market integration of fresh skipjack tuna. This study employed quantitative methods, analysing time-series data sourced from publicly available secondary outlets. Skipjack price fluctuations were estimated through multiple regression analysis, while skipjack market integration was assessed using the Index of Market Connection (IMC). The research findings indicate that skipjack tuna prices in Indonesia, at the retail, wholesale, and producer levels, are positively influenced by past fluctuations in skipjack prices. However, changes in skipjack prices at the wholesale level do not directly affect retail prices. In the short term, there is relatively high market integration between producer and wholesale markets, as well as between wholesale and retail markets. Producers and wholesale markets function as price-makers, while there is relatively low market integration between the producer and retail markets, where producers act as price-takers. For the market to function optimally, it needs to be wholly interconnected. In the long run, there is no integration in the skipjack market. Efficient marketing distribution requires improved access to infrastructure, including roads, land, and sea transportation. Furthermore, the establishment of a digital marketing system is essential for obtaining quick information on the prices of fishery products, spanning from producer markets, such as fish auctions, to wholesale and retail markets.

To cite this article: Rahim, A., Hastuti, D. R. D., Malik, A., Sabar, W., & Irwandi (2024). Price fluctuations and market integration of fresh skipjack tuna in Indonesia. Journal of Socioeconomics and Development, 7(1), 1-13. https://doi.org/10.31328/jsed.v7i1.5085

ISSN 2615-6075 online; ISSN 2615-6946 print

INTRODUCTION

The capture fisheries sector holds significant importance for numerous countries worldwide (Nguyen & See, 2023), spanning across regions such as Asia, Europe, and the Americas. Among these nations, Indonesia, an Asian country, plays a pivotal role in both economic development and food security within the region. Indonesia's contribution to the region includes being a substantial source of income through its gross domestic product and foreign exchange earnings. Furthermore, the impact of Indonesia's capture fisheries sector extends beyond its borders, notably in other Asian countries like China (Huang & He, 2019). Within the diverse range of capture fishery resources in Indonesia, the large pelagic fish group, particularly skipjack, stands out for its immense potential and high economic value (Duggan & Kochen, 2016). Skipjack tuna, being a The capture fisheries sector holds significant importance for numerous countries worldwide (Nguyen & See, 2023), spanning across regions such as Asia, Europe,

and the Americas. Among these nations, Indonesia, an Asian country, plays a pivotal role in both economic development and food security within the region. Indonesia's contribution to the region includes being a substantial source of income through its gross domestic product and foreign exchange earnings. Furthermore, the impact of Indonesia's capture fisheries sector extends beyond its borders, notably in other Asian countries like China (Huang & He, 2019). Within the diverse range of capture fishery resources in Indonesia, the large pelagic fish group, particularly skipjack, stands out for its immense potential and high economic value (Duggan & Kochen, 2016). Skipjack tuna, being a sought-after seafood with global demand, significantly influences the economic and social landscape, not only in Indonesia but also in other Asian countries (Guillotreau et al., 2017; Vayghan & Lee, 2022).

The skipjack tuna industry in Indonesia has played a crucial role in the economic and fishery development. Commercial exploitation of skipjack tuna is widespread in Indonesian marine waters (Tadjuddah, 2019; Widodo et al., 2021) with subsequent exports to various countries including the United States, Japan, Thailand, and Saudi Arabia. The export volume of skipjack tuna has reached a substantial 209,410 tons, valued at USD764.8 million (Firdaus, 2018). Despite these positive trends, the industry faces challenges, particularly in the fluctuation of catch rates. The fishing season witnesses an increase in catch, but prices tend to be lower. Conversely, during the lean season, prices rise while the catch decreases. Price fluctuations are notable during the fishing season, particularly when there is a bright full moon or when traders buy fish at sea and land in other areas. Comparatively, the price of skipjack tuna in Hawaii experiences fluctuations due to factors such as fish quality, encompassing size, fat content, handling methods, and market conditions (McConnell & Strand, 2000). The quality of the fish results in significant spatial disparities in prices (Gobillon & Wolff, 2016). Notably, during the fishing season, there is an excess supply, while production decreases during the lean season (Macusi et al., 2022).

On the demand side, skipjack consumption is rising due to the preferences of Indonesian consumers, despite the higher prices. The demand for fish is shaped by various factors, including consumer preferences, cultural considerations, and pricing. Additional research indicates that income (Can et al., 2015), consumer habits (Erdogan et al., 2011), demographics, and attitudes also contribute to influencing the demand for fish. Consequently, fluctuations in prices create a disequilibrium between the demand for and the supply of fresh marine fish in Indonesia.

This study investigates the impact of price fluctuations on the integration of fresh skipjack tuna into the market. Fluctuations in production, whether they increase or decrease at any given time, contribute to the instability of skipjack prices, influencing market integration in both producer and consumer markets. In Indonesia, the price of skipjack in producer, wholesale, and retail markets exhibited monthly fluctuations from 2014 to 2021 (Figure 1).

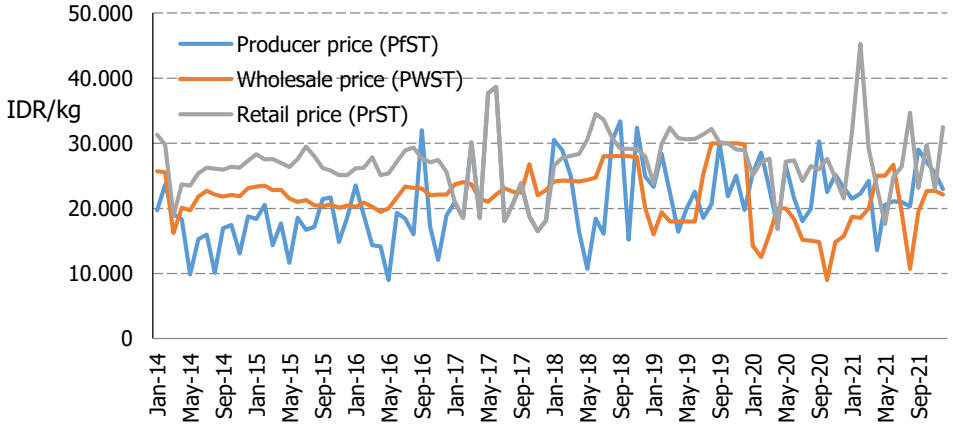

Figure 1. Price fluctuations of skipjack tuna in the producer, wholesale, and retail markets in Indonesia, 2014-2021

The most significant variation in skipjack selling price over the past 8 years occurred at the fisherman level in 2020, reaching IDR23,452 per kg, while the lowest price was recorded in 2014 at IDR16,520 per kg. At the wholesale level, the highest price was observed in 2018 at IDR25,484 per kg, contrasting with the lowest price in 2020 at IDR15,472 per kg. Similarly, at the retailer level, the highest price occurred in 2019 at Rp 29,981 per kg, and the lowest was in 2017 at Rp 24,918 per kg. The average selling price of skipjack from 2014 to 2021 at the fisherman level remained within the price range of IDR20,892 per kg. At the wholesaler and retailer levels, the average selling price of skipjack stood at IDR21,662 per kg and IDR27,252 per kg, respectively. Notably, the average selling price of skipjack at the fisherman level is lower than at the wholesale and retail levels. It is essential to recognize that significant fluctuations in skipjack prices occur not only at the producer market level (production centres), such as fish auction sites (TPI) and fish landing centres (PPI), but also at the consumer market level, encompassing wholesale and retail markets in Indonesia. These price fluctuations stem from supply-side changes related to fishing season and technology, demand-side changes influenced by consumer preferences and income, and the formation of an oligopoly market structure where retailers act as price setters.

Market conditions experience fluctuations due to seasonal and monthly pricing changes (Yazdani et al., 2013). The variability in fish prices within the market is attributed to changes in the quantity and types of fish available. On the supply side, fluctuations are influenced by the fishing season and technological factors, while consumer income and market prices play a role on the demand side. Climate change further contributes to the oscillations in skipjack prices (Dueri et al., 2016) and alters the distribution of fish, impacting economic returns (Wu et al., 2023). Notably, climate change affects skipjack populations (Lahodey et al., 2013), the abundance and size of various species (Basurko et al., 2022), and the overall global productivity of skipjack (Erauskin-Extramiana et al., 2023). Additionally, it has far-reaching implications on socioeconomic aspects and global food security (Dueri et al., 2016).

Price fluctuations can result in market disintegration and a reduction in the income of fishermen. The issue of market integration is closely linked to the inequality in income distribution between fishermen and traders (Wamukota et al., 2014). When skipjack prices increase at both the wholesale and consumer levels, producers (fishermen) face challenges in promptly passing on the price hike due to asymmetric fluctuations. In contrast, adjustments in prices at the wholesale and consumer levels occur swiftly within marketing institutions, enabling them to make informed decisions and enhance market efficiency. This scenario is identified as market disintegration, where price changes become imbalanced between consumer and producer markets. It is important to note that wholesalers hold the capacity to influence fish prices at the producer level (Setälä et al., 2008). The transmission of prices between marketing institutions, however, remains low, resulting in asymmetric information and contributing to market disintegration.

The volatility in skipjack tuna prices tends to have a more significant impact on fishermen compared to traders, encompassing both wholesale and retail aspects. The substantial price fluctuations provide traders with the opportunity to manipulate information at the fishermen's level, enabling them to strategically time their sales for more advantageous prices. Moreover, fishermen face a disadvantage in price negotiations due to their limited bargaining power, compelled to uphold previous agreements and debts with traders. The interplay of price information and the short shelf life of fish further contributes to the fluctuations in prices. Consequently, fishermen find themselves compelled to accept prevailing prices as mere takers, while marketing institutions emerge as the influential price makers.

While price fluctuations and the market disintegration of skipjack tuna are common occurrences, the capture fisheries sector remains highly promising due to the growing demand in both domestic and international markets. The issues of price fluctuations and market integration concerning skipjack tuna are central challenges faced by capture fisheries globally, with a particular emphasis on Indonesia. Market integration refers to the phenomenon wherein changes in prices in one market influence prices in related markets. The analysis of spatial integration (cointegration) will contribute valuable insights to the existing literature on fish market structure (Yazdani et al., 2013). Market integration plays a pivotal role in ensuring effective

and efficient integrated marketing across all stages of the market, including production, wholesale, and retail.

This research aims to deliver essential information and understanding to address the needs of fishermen, industries, marketing institutions, and the government. The establishment of effective and efficient conditions in the skipjack tuna market is imperative to prevent income inequality among key players in marketing, including fishers, wholesalers, and retailers. Market integration can equip policymakers with valuable insights to enhance price efficiency for the welfare of fishermen. Given the critical role of the fisheries sector in ensuring local economy (Ibarra et al., 2012) and global economy (Mohammed & Uraguchi, 2013). This study focuses on estimating price fluctuations and market integration in the producer, wholesale, and retail markets for fresh skipjack tuna.

RESEARCH METHOD

This study employed a quantitative research methodology, focusing on selected research locations in Indonesia. The choice of these locations was deliberate, given that skipjack is recognized as a superior commodity comparable to other tuna species such as yellowfin tuna, bigeye tuna, and albacore. The analysis delved into the fluctuations in the price of skipjack tuna and its market integration, utilizing time-series data that encompassed both short-term and long-term trends. The time-series data spanned a period of 96 months, covering the years from 2014 to 2021 (KKP, 2022). The estimation analysis of fresh skipjack tuna price fluctuations at the retail, wholesale, and producer levels involved the application of multiple regression analysis.

$$\mathrm{PrST_t} = \beta_0 + \beta_1 \mathrm{PrST_{t-1}} + \beta_2 \mathrm{PWST_t} + \beta_3 \mathrm{PfST_t} + \mathrm{e_{1t}} \quad (1)$$

$$\mathrm{PWST_t} = \beta_4 + \beta_5 \mathrm{PWST_{t-1}} + \beta_6 \mathrm{PfST_t} + \mathrm{e_{2t}} \quad (2)$$

$$\mathrm{PfST_t} = \beta_7 + \beta_8 \mathrm{PfST_{t-1}} + \mathrm{e_{3t}} \quad (3)$$

where, $\mathrm{PrST_t}$ is the fresh skipjack tuna price at retail (IDR). $\mathrm{PrST_{t-1}}$ is the lag of fresh skipjack tuna price at retail (IDR). $\mathrm{PWST_t}$ is the fresh skipjack tuna price at wholesaler (IDR). β_0, β_4, β_7: intercept. β_1, β_2, β_3, β_5, β_6, β_8 : regression coefficient. $\mathrm{PWST_{t-1}}$ is the lag of fresh skipjack tuna price at wholesaler (IDR). $\mathrm{PfST_t}$ is the fresh skipjack price tuna at producer (IDR). $\mathrm{PfST_{t-1}}$ is the skipjack tuna price at producer (IDR). $\mathrm{e_{1t}}, \mathrm{e_{2t}}, \mathrm{e_{3t}}$ is error term

In this study, fresh skipjack tuna market integration is measured using the concept of Index of Market Connection (IMC) using the least squares method (OLS), written as follows:

a. Producer market – Wholesale market

$$\mathrm{PfST_t} = \beta_9 + \beta_{10}(\mathrm{PfST_{t-1}}) + \beta_{11}(\mathrm{PWST_t} - \mathrm{PWST_{t-1}}) + \beta_{12}(\mathrm{PWST_{t-1}}) + \mathrm{e_{4t}} \quad (4)$$

Where, $\mathrm{PfST_t}$ is the price of fresh skipjack tuna in the producer market (IDR). β_9 is intercept. β_{10}, β_{11}, β_{12}: regression coefficient. $\mathrm{PfST_{t-1}}$ is lag of fresh skipjack tuna price in producer market (IDR). $\mathrm{PWST_t} - \mathrm{PWST_{t-1}}$ is the price of fresh skipjack tuna in the producer market (IDR). $\mathrm{PWST_{t-1}}$ is the lag in the skipjack tuna price in the wholesale market (IDR). $\mathrm{e_{4t}}$: error term.

b. Wholesale market – Retail Market

$$\mathrm{PWST_t} = \beta_{13} + \beta_{14}(\mathrm{PWST_{t-1}}) + \beta_{14}(\mathrm{PrST_t} - \mathrm{PrST_{t-1}}) + \beta_{15}(\mathrm{PrST_{t-1}}) + \mathrm{e_{5t}} \quad (5)$$

Where, $\mathrm{PWST_t}$ is the price of fresh skipjack tuna in the wholesale market (IDR). β_{13} is intercept. β_{14}, β_{15}, β_{16} is regression coefficient. $\mathrm{PWST_{t-1}}$: Lag of fresh skipjack tuna price in wholesaler market (IDR). $\mathrm{PrST_t} - \mathrm{PrST_{t-1}}$ is *fresh skipjack tuna price in retail market (IDR). $\mathrm{PrST_{t-1}}$ is the lag in fresh skipjack tuna prices in the retail market (IDR). $\mathrm{e_{5t}}$ is error term.

c. Producer market – Retail market

$$\mathrm{PfST_t} = \beta_{16}(\mathrm{PfST_{t-1}}) + \beta_{17}(\mathrm{PrST_t} - \mathrm{PrST_{t-1}}) + \beta_{18}(\mathrm{PrST_{t-1}}) + \mathrm{e_{6t}} \quad (6)$$

Where, $\mathrm{PfST_t}$ is the fresh skipjack tuna price in producer market (IDR). β_{16} is the intercept. β_{17}, β_{18}, β_{19}: regression coefficient. $\mathrm{PfST_{t-1}}$ is the lag of fresh skipjack tuna price in producer market (IDR). $\mathrm{PrST_t} - \mathrm{PrST_{t-1}}$ is the fresh skipjack tuna price in retail market (IDR). $\mathrm{PrST_{t-1}}$ is the lag of skipjack tuna price in retail market (IDR). $\mathrm{e_{6t}}$ is error term

The degree of integration of the fresh skipjack tuna market was determined by looking at the magnitude of the price effect using the Index of Market Connection (IMC) method (Ravallion, 1986) as follows:

$$\mathrm{IMC} = \frac{\beta_1}{\beta_3} \quad (7)$$

A value of $\mathrm{IMC} < 1$ indicates a significant level of short-term market integration. When $\mathrm{IMC} > 1$, this indicates minimal market integration in the short-term. If the IMC value is infinite, then there is no market integration in the short run. The analysis of long-term

market integration uses a β_2 coefficient calculation. If $\beta_2 = 1$, then long-term market integration occurs. Long-term market integration cannot be achieved if β_2 is lower than zero. In other words, if $\beta_2 < 0$, then there is no long-term market integration.

RESULT AND DISCUSSION

Production Volume

According to the Ministry of Marine Affairs and Fisheries, the production of skipjack tuna from fishermen's catches in Indonesia exhibited fluctuations between 2014 and 2021 (Table 1). The most significant fluctuation took place in 2015, witnessing a decrease of 18.57%, equivalent to 404,433 tonnes. Similarly, in 2020 and 2021, the production declined by 11.7% (468,270 tonnes) and 4.48% (447,266 tonnes), respectively. Notably, the only instances of production volume increase were observed in 2016, reaching 440,812 tonnes with an uptick of 8.99%, and in 2018, registering 510,686 tonnes, reflecting a 9.22% increase. The fluctuations in fish catches are intricately tied to the presence of fish or the prevailing fishing season (Nurani et al., 2021). Catches vary due to annual changes in the fishing season, food scarcity (Rahim et al., 2019) and climate change. The fishing season denotes a period during which fishing activities are more intensive compared to other times of the year. During this time, fish stocks tend to be more abundant than under normal conditions. However, with the onset of climate change, fishing activities become less intensive, and there are instances when fishermen abstain from fishing altogether.

Table 1. Production of Skipjack Tuna in Indonesia

Year	Production	Increase
	tons	%
2014	496,682	-
2015	404,433	-18.57
2016	440,812	8.99
2017	467,550	6.06
2018	510,686	9.22
2019	527,173	3.22
2020	468,270	-11.17
2021	447,266	-4.48

Source: KKP (2022)

Fluctuations in skipjack catches can be attributed to changes in global climate. The three major oceans—the Atlantic, Indian, and Pacific Oceans—are all affected by global climate change conditions (Dueri et al., 2016). In Indonesia, global climate change manifests through extreme weather events, such as tidal waves, tsunamis, heavy rain with high velocity, and an increase in sea surface temperature (Shaffril et al., 2017). The occurrence of extreme weather significantly impacts fishermen's activities and their opportunities to catch fish at sea (Maltby et al., 2021), both in terms of quantity and quality of the catch (Shaffril et al., 2019).

While skipjack catches may vary annually, exports persist to numerous importing countries. The export of Indonesian skipjack products holds significance due to the substantial market share, presently dominated by Thailand and Vietnam, both of which rely on importing raw materials from Indonesia (Hartanto et al., 2021). Skipjack, a prominent pelagic fish group, boasts considerable potential and plays a pivotal role in the global tuna fishery. According to Islamaji et al. (2020), data from the Ministry of Maritime Affairs and Fisheries in 2013 indicated an export growth target of 19%. The strategic positioning of tuna, skipjack, and tongkol (TCT) proves crucial for foreign exchange generation, besides serving as a commodity that contributes significantly to the provision of animal protein for the Indonesian population. Remarkably, the TCT group alone contributes 12% to the overall 40% export of fishery products.

The Ministry of Maritime Affairs and Fisheries has set an ambitious goal to export fishery resources in the form of Tuna, Crustaceans, and Mollusks (TCT) valued between US$7.13 and $8.00 billion from 2022 to 2024 (Hartanto et al., 2021). Indonesia currently holds the title of the world's largest producer of TCT, boasting a catch of 1.3 million tonnes, which accounts for 20.06% of the global production. Despite this, Indonesia stands in third place, following Thailand and Vietnam, in TCT exports to the US. During the IST International Tuna Conference in Legian on Wednesday, May 24, 2023, the Minister of Maritime Affairs and Fisheries, Wahyu Sakti Trenggono, emphasized the potential for further enhancing Indonesia's contribution to global capture fisheries. Trenggono highlighted the importance of combating illegal fishing and emphasized the need for better management of fish catch reporting, as a significant portion of it currently goes unreported. By addressing these issues, Indonesia can effectively boost its impact on global capture fisheries.

Table 2. Estimates Fluctuations in the Price of Skipjack Tuna at the Producer, Wholesale, and Retail Levels in Indonesia

Independent Variable	E.S	Skipjack price at retail		Skipjack price at wholesaler		Skipjack price at Producer	
		β_i	t-test	β_i	t-test	β_i	t-test
Lag Skipjack price at retail	-	0.281***	2.903	-	-	-	-
Skipjack price at wholesaler	-	0.035 ^{ns}	0.321	-	-	-	-
Lag Skipjack price at wholesaler	-	0.218***	2.884	0.695***	9.376	-	-
Skipjack price at producer	-	-	-	0.002 ^{ns}	0.036	-	-
Lag Skipjack price at producer	-	-	-	-	-	0.293***	2.953 ^{ns}
Intercept			14123.976		6517.997		14790.530
Adjusted R^2			0.139		0.478		0.076
F-test			6.079		43.971		8.722
n			96		96		96
n – 1			95		95		95

*** is a level error significance of 1%, ^{ns} is not significant, and ES is an expectation sign.

Price Fluctuations

The retail price of fresh skipjack tuna is influenced by previous fluctuations in both retail and wholesale prices, with a 1% error rate or 99% confidence level, as illustrated in Table 2. When the retail price of fresh skipjack tuna increased by 1%, its overall price rose by 0.281%. Furthermore, the increase in price at the wholesale level compared to the retail level showed a rise of 0.218%. This trend indicates that the average price of skipjack over 96 months from 2014 to 2021 stands at IDR20,892.11 per kg at the producer level, IDR21,662.41 per kg at the wholesale level, and IDR27,056.93 per kg at the retail level, respectively. The price of skipjack in Indonesia experiences monthly fluctuations in the producer, wholesale, and retail markets throughout the year. The producer saw its highest fluctuation in June 2017 at IDR39,634 per kg, while the lowest was recorded in May 2016 at IDR8,980 per kg. In the wholesale market, the highest fluctuation occurred in August 2019, with the lowest prices being IDR30,000 and IDR9,000 per kg. Meanwhile, the retail market witnessed its highest price fluctuation at IDR45,263 in February 2021, and the lowest at IDR16,790 per kg in April 2020 (Figure 1).

Fluctuations in the price of fresh skipjack tuna can be attributed to variations in production, resulting in both increases and decreases and causing prices to be unpredictable. In Indonesia, fish prices experience fluctuations due to factors related to the fishing season and lean season. The fishing season in Indonesia spans from January to May and November to December, with the peak occurring in May. Indonesia's skipjack tuna fishing seasons are specific to different regions: March to July in the Southern Makassar Strait Waters, September to March in the Flores Sea, Banda Sea, and Aru Waters, and August to May in the Arapura Sea. In contrast, other countries, such as Bony Iran in the Caspian Sea, observe a fishing season lasting from October to April (Yazdani et al., 2013).

In contrast, the lean season in Indonesia spans from June to October. During this period, fishermen refrain from venturing into the sea, leading to a decrease in catch production and an increase in fish prices. Interestingly, even during the fishing season, prices may surge, especially under the influence of a full moon. The caught fish are typically sold directly in the middle of the sea and then distributed to various areas.

Skipjack tuna, a prevalent species in Eastern Indonesia, can be found in diverse waters, including the Maluku Sea, Banda Sea, Tomoni Bay, the North Pacific waters of Papua, the Flores Sea, the Makassar Strait, and the Gulf of Bone. These tunas generally inhabit deep-sea waters, with some individuals located at depths ranging from 20 m to 200 m below the surface. The migration patterns of skipjack tuna are influenced by environmental factors such as temperature (Tangke et al., 2020), salinity, currents, water area, and water quality.

Changes in the prices of fresh skipjacks in Indonesia can lead to an imbalance between supply and demand. Production tends to exceed demand during the fishing season but decreases during the lean season. This situation is referred to as the "supply side." Several factors, such as the fishing season and technological advancements, affect the availability of skipjack. The primary fishing technology widely employed in Indonesia for catching skipjacks is the

pole and line method (Khan et al., 2018) or the Huhate fishing gear. The Huhate gear, essentially a fishing rod, plays a highly selective and influential role in catching skipjacks without causing damage to the surrounding environment. Notably, this fishing technique requires a substantial quantity of live fish bait. The fishing fleet consists of 10–80 GT pole and line motorboats with crews ranging from 15 to 30 people. In addition to pole and line motorboats, Indonesian fishermen also utilize outboard motor boats with a speed range of 7–15 knots (PK) or a boat power of up to 10 GT to capture fish. This is in addition to the use of motorized boats (Rahim et al., 2020).

In the waters of Indonesia, skipjacks are captured using purse-seine gear. The fishing fleet employed ranges from 30 to 600 gross tonnage (GT) for purse-seine vessels, typically with a crew size of 20 to 35 individuals. In contrast, Spain, a prominent force in skipjack tuna fishing, boasts a purse-seine fleet exceeding 2700 GT (García-del-Hoyo et al., 2021). Purse-seine fishing gear is versatile as it allows for the capture of multiple fish species. This method is specifically designed for targeting large schools of skipjacks, making it highly efficient in their capture. In Spain, marine waters frequently witness the deployment of purse-seine vessels dedicated to Skipjack tuna fishing (Basurko et al., 2022). Additionally, Indonesian fishermen utilize various fishing gears, including longlines, troll lines, traditional seine nets, hand lines, gill nets, and Fish Aggregating Devices (FADs), to capture skipjacks.

On the demand side, increased fish consumption is driven by people's tastes and preferences. The demand for fish is influenced by several factors, including price, income level, demographics, culture, preferences, and market structure. Consumer preference plays a crucial role in boosting global demand for marine fish (Duggan & Kochen, 2016). In Indonesia, fish consumption is significantly influenced by the cultural tradition of consuming a variety of fish, particularly in regions such as South Sulawesi, North Sulawesi, and North Maluku. Notably, Indonesia's most substantial export demand for fresh skipjack tuna comes from Japan, the United States, and the European Union (EU). Specifically, tuna exports to Japan account for 27%, the United States for 17%, and the European Union for 12%. North Maluku is a key supplier of tuna exports from Indonesia to the United States. Indonesia is a major global producer of tuna, skipjack, and tuna, contributing to 15% of the total production worldwide. In the ASEAN region, Indonesia holds the second position as a skipjack tuna producer after Thailand. This distinction can be attributed to differences in exploitation levels, both in terms of quantity and technology used in fishing gear.

Price stability was observed solely in the wholesale market, where the average price remained constant at IDR20,412.25 per kg over eight months (August 2015 to March 2016). Moreover, there was a six-month period (January 2018 to June 2016) with an average price of IDR24,311.83 per kg, and another four-month period (March 2019 to June 2019) with an average price of IDR18,000 (see Figure 1). This stability in prices is attributed to the abundance of skipjack tuna stocks, preventing significant fluctuations. The consistent availability of skipjack tuna stocks has prevented both price increases and decreases. A crucial factor contributing to this stability is the seamless flow of price information, which serves as a vital indicator for ensuring efficient marketing channels. It is important to note, however, that this price stability was only sustained for a limited duration during the period of 2014-2021. The majority of the time, skipjack tuna prices experienced fluctuations dominated by factors beyond stability.

Changes in skipjack prices at the wholesale level did not have a corresponding impact on price variations at the retail level, as depicted in Table 2. The reaction to alterations in skipjack prices appears to be rigid and unresponsive to fluctuations in the skipjack price within each market. This observation aligns with the conclusions drawn by Squires et al. (2023) in Ecuador, where the price responsiveness of tuna demonstrated inflexibility across all imports, except for other tuna varieties such as yellowfin. At the wholesale level, the pricing dynamics of skipjack tuna are significantly influenced by previous fluctuations in skipjack prices at the same level, with a 99% confidence level. Similarly, the prices of skipjack at the producer level, which encompasses fishermen, are also influenced by historical fluctuations in skipjack prices within the same tier.

Price fluctuations occur at the producer, wholesale, and retail levels due to shifts in demand and supply. Changes in demand are influenced by factors such as evolving consumer tastes and preferences, while alterations in supply are a result of variations in fishing and famine seasons. These price fluctuations inevitably affect skipjack tuna market integration across producer, wholesale, and retail sectors.

Table 3. Integration of the Skipjack Tuna Market at Producer, Wholesale and Retail levels in Indonesia

Independent Variable	Producer –Wholesale		Wholesale – Retail		Producer – Retail	
	β_i	t-test	β_i	t-test	β_i	t-test
Lag Skipjack price at producer (PfST_{t-1})	0.294***	2.926	-	-	0.294***	2.926
*Skipjack price at wholesaler $(\mathrm{PWST}_t - \mathrm{PWST}_{t-1})$	0.039 ns	0.211	-	-	-	-
Lag Skipjack price at wholesaler (PWST_{t-1})	- 0.048 ns	-0.338	0.696***	9.348	-	-
*Skipjack price at retail $(\mathrm{PrST}_t - \mathrm{PrST}_{t-1})$			- 0.023 ns	-0.312	0.017 ns	0.124
Lag Skipjack price at retail (PrST_{t-1})			- 0.037 ns	-0.624	0.013 ns	0.116
Intercept		14778.543		6552.016		14771.325
Adjusted R^2		0.057		0.474		0.056
F-test		2.902		29.266		2.853
Index of Market Connection $\mathrm{IMC} = \frac{\beta_1}{\beta_3}$		- 6.125		-18.810		22.615
n		96		96		96
n – 1		95		95		95

*** is a level error significance of 1%, ns is not significant

Market Integration

To comprehend the short-term market integration between the producer and wholesale markets in Indonesia, an analysis of the IMC value is essential (Table 3). The obtained value is -6.125 $(\mathrm{IMC} < 1)$, signifying a relatively high degree of short-term integration between the producer and wholesale markets. Notably, fluctuations in the price of skipjack tuna in the wholesale market have a direct impact on prices in the producer market. Interestingly, when the price of skipjack tuna increases in the producer market, a corresponding increase is observed in both wholesale and retail markets. This consistent pattern extends to the relationship between wholesale and retail markets, with a value of -18.810 indicating high short-term integration. Essentially, an increase in skipjack prices in the wholesale market leads to a parallel increase in the same market. Based on this observation, a robust correlation emerges between the current price of skipjack tuna at the producer level and its price in the preceding month, reaching a 99% confidence level. A parallel relationship is evident at the wholesale level, with the price of skipjack tuna determined by analysing past pricing trends, whether at the producer or wholesale level.

When the prices of skipjack tuna are seamlessly integrated across producer, wholesale, and retail markets, it facilitates the efficient transmission of price changes to fishermen, who stand to benefit from increases. This system ensures that producers are promptly informed of any changes, enabling them to capitalize on price hikes. Similarly, the retail-level price can be accurately transmitted to the wholesale level, allowing wholesalers to also reap the rewards of price increases. By integrating these two markets, producers can directly provide prices, relieving wholesalers of the burden of setting prices themselves. This discovery highlights the role of fishermen and wholesalers as price-makers. According to Deb et al. (2022), when market information flows from retail to wholesale, the retail market becomes more organized, leading wholesalers to align their prices with those of retailers. Fishers leverage auction sites, known as TPIs, to enhance their bargaining power and secure higher prices for their catch. Auction activities provide fishermen with valuable insights into price formation, addressing the historical control over price information held by traditional marketing institutions (wholesale and retail).

A seamless flow of information serves as a crucial indicator of efficient and integrated marketing. Flawless market integration stands as a fundamental aspect of effective marketing system management, exerting a substantial influence on maximizing profits for producers, consumers, and traders within the marketing chain. Effective marketing activities ensure an equitable return for all involved parties, encompassing fishers as producers and intermediary traders functioning as wholesalers and retailers. The market operates at its optimum efficiency when it adeptly utilizes all available information. Notably, the market demonstrates efficiency if it effectively employs past prices to determine current prices, thereby establishing the effectiveness of the marketing system in place. A market is deemed efficient when it exhibits strong price integration, demonstrating proficient utilization of past price data.

The establishment of good information linkages between markets is pivotal for facilitating market integration. This linkage is essential for fostering sound price transmission among various actors in the market. Such a condition arises from close relationships and effective communication patterns among the market participants. The existence of robust communication signifies cooperation and satisfaction among actors, and vice versa. In summary, a well-integrated and efficient market is characterized by seamless information flow, effective use of past prices, and strong communication linkages between market participants.

In another case involving the producer and retail markets, an Integrated Marketing Communication (IMC) value of 22.615 was obtained. This value indicates a relatively low degree of short-term integration, suggesting a tendency for the market to be imperfectly integrated or imperfectly competitive. When the market lacks proper integration, it becomes non-competitive, leading to marketing price distortions (Jiménez-Toribio et al., 2010). The observed lack of integration between retailer-level prices and producer-level prices implies that information regarding price changes is not effectively transmitted to the producer level. Consequently, producers do not benefit from price increases. In simpler terms, this situation places a burden on fishers who are unable to determine prices and can only act as price-takers. This, in turn, creates price uncertainty and renders marketing inefficient as control rests with retailers. In contrast to European countries, where changes in skipjack tuna prices are swiftly communicated throughout the marketing chain, other regions exhibit a more beneficial scenario. This efficient communication benefits various stakeholders, including market participants, fishermen, and marketing institutions (Jiménez-Toribio et al., 2010).

In the long run, there has been no integration observed in the skipjack market in Indonesia. This conclusion is supported by the β2 values, such as 0.039 for the producer market with a wholesale market, -0.023 for a wholesale market with a retail market, and 0.017 for a producer market with a retail market. These coefficient values indicate an insignificant relationship (Table 3). The lack of market integration over time can be attributed to the rapidly changing demand and supply conditions. Unintegrated prices from the producer level to the wholesale and retail levels pose challenges, particularly when fishermen require assistance in determining prices and maximizing profits. Moreover, the considerable distance between these markets exacerbates the difficulty in obtaining timely market information on price changes. Despite the presence of the Internet, accessing market information remains challenging. The markets in question encompass various districts, cities, and regions in Indonesia. In cases where these markets eventually integrate to form a single market in the long run, prices are expected to move in tandem (Jiménez-Toribio et al., 2010).

The short-term integration results reveal two distinct but interrelated segments. Specifically, skipjack tuna prices exhibit robust integration within the producer market–wholesale and retail markets. One of these segments must exhibit superior integration, particularly between the producer market and the consumer market. In the long run, it is imperative to achieve enhanced integration across all three segments. This discovery stands in contrast to the skipjack tuna market in Ecuador, where two distinct yet price-linked market segments exist, featuring mutually substitutable skipjack imports (Squires et al., 2023). Short-term market integration implies that changes in skipjack tuna prices within one market during specific periods (months) promptly impact prices in another market during the subsequent period. This condition underscores the sensitivity of skipjack tuna price distribution among markets. Over an extended period, market integration signifies that fluctuations in skipjack tuna prices in the reference market (wholesale and retail) can immediately influence the price conditions of skipjack tuna in the producer market (fishermen), even with a minor price adjustment. Integrating the producer market with marketing institutions can mitigate income distribution inequality and benefit all stakeholders, especially fishermen. In developing countries like Kenya, income distribution inequality in the fisheries sector is more pronounced among fishers than traders (Wamukota et al., 2014).

Research Implication

The capture fisheries sector plays a critical role in ensuring food security in both local (Ibarra et al., 2012) and global economies (Mohammed & Uraguchi, 2013). Moreover, it significantly influences economic development on a global scale, particularly in developing countries such as Indonesia (Nguyen & See, 2023). Within Indonesia's diverse range of

capture fisheries resources, the large pelagic fish group, particularly skipjack (Duggan & Kochen, 2016), holds immense potential and substantial economic value. Skipjack stands out as one of the most sought-after seafood items, commanding high demand and extensive global trade (Vayghan & Lee, 2022).

Skipjack, a valuable commodity in Indonesia, has played a significant role in the country's economic development and fisheries. It has been extensively exploited in the marine waters of Indonesia (Widodo et al., 2021) and is regularly exported to various foreign countries, including the United States, Japan, Thailand, and Saudi Arabia. However, the fluctuations in catch levels have posed a challenge, leading to an oversupply during the fishing season and a subsequent decrease in production during the lean season (Macusi et al., 2022). Despite its relatively high price, the demand for skipjack has been on the rise, driven by the preferences and tastes of people.

Fluctuations in catch production can significantly impact price dynamics, carrying substantial implications for both fishers and traders, encompassing wholesalers and retailers. Price volatility may manifest when fish prices decline, presenting unfavourable conditions for fishers and traders. The weakened bargaining position of fishers is attributed to the marketing system established at the production site (Yamin et al., 2021). Conversely, fluctuations in prices, marked by an upward trajectory, also pose challenges for the purchasing power of consumers. The persistence of market mechanism failures could lead to distortions or disruptions in the supply and demand chain, contributing to both annual and monthly price fluctuations. Prolonged and irregular variations in prices create hurdles for producers, such as fishermen, and intermediaries, hindering their ability to generate profits. If these market inefficiencies persist, they can further exacerbate difficulties for both producers and middlemen in maintaining profitability.

Fluctuations in skipjack prices can be effectively managed by both fishermen and traders. Fishermen and traders alike have the opportunity to enhance the value of their products through various processing methods, such as creating Abon skipjack. The skipjack commodity is influenced by seasonal factors, including fishing and feeding patterns, as well as the broader impact of climate change, particularly in the context of extreme weather conditions. Climate change, as studied by (Dueri et al., 2016), directly impacts the abundance, catch, and profitability of skipjack. For traders, gauging skipjack abundance based on fishermen's catches enables them to make informed decisions about when to procure stocks.

In the presence of symmetric skipjack price information, market integration can be achieved, leading to increased socio-economic benefits, especially for fishermen's income. Socio-economic conditions play a crucial role in influencing changes in household income and promoting the welfare of coastal fishermen (Rahim et al., 2022). The integration of markets helps to balance the supply and demand of fish, preventing any disparities between the income of fishermen and that of middlemen (Wamukota et al., 2014).

In relation to the reliance of fishermen (producer market) on intermediaries, fishermen find themselves in a precarious bargaining position. This situation results in inefficient marketing practices and can pose challenges for fishermen seeking to enhance their income. The influence of wholesalers and the fishing industry in determining the price of skipjack highlights an imperfectly competitive market structure. Given that skipjack is a perishable product, it necessitates swift handling facilitated by a robust marketing system.

Efforts to rectify the issues within the skipjack marketing system in Indonesia have been undertaken through the application of market structure, market conduct, and market performance approaches (Pohan et al., 2023; Yamin et al., 2021). Market structure elucidates the nature of the market that fishermen encounter in their roles as producers and market participants. The interplay between market structure and market behaviour manifests in market performance, as evidenced by the efficiency levels and profitability of marketing institutions.

Ultimately, these fluctuations in price may adversely affect the seamless integration of fresh skipjack into the market. Price volatility and market integration challenges are inherent in the fresh skipjack industry. Nevertheless, the sector holds promise due to escalating domestic and international export demands for the product. Conducting an integration analysis will contribute significantly to the knowledge base concerning the structure of the fish market (Yazdani et al., 2013) in both short and long-term perspectives. A robust market integration is vital, allowing for a cohesive marketing approach across all market segments, encompassing producers,

wholesalers, and retailers. It is imperative to consider market integration in both the short and long term to prevent distortions in marketing prices stemming from inadequate integration, as highlighted by research (Jiménez-Toribio et al., 2010). Efficient marketing activities can yield balanced benefits for all stakeholders involved, including fishers, wholesalers, and retailers.

The findings hold the potential to offer valuable insights and solutions for fishermen, industry stakeholders, marketing institutions, and the government. Implementing this control policy or program will establish effective and efficient conditions within the skipjack market, thereby preventing income inequality among key marketing actors, including fishermen, middlemen, and retailers. Access to price information and enhanced market integration can furnish policymakers with pertinent data, significantly boosting price efficiency and improving the socio-economic conditions of fishermen.

CONCLUSION AND SUGGESTION

The price fluctuations of skipjack tuna in Indonesia, whether at the retail, wholesale, or producer level (fishers), tend to increase when there are fluctuations in skipjack prices in the previous month. The fluctuations in price among fishermen are influenced by previous price changes in skipjacks at the production level. However, changes in skipjack prices at the wholesale level do not affect price fluctuations at the retail level. In the short term, there is a relatively high integration of the skipjack tuna market between the producer and wholesale markets and the wholesale and retail markets. This finding implies that fishermen and wholesale markets can act as price-makers. Market integration is relatively low between the producer and retail markets. Consequently, fishermen cannot set prices and only act as price-takers in the skipjack marketing system in Indonesia. This suggests that the market can be more perfectly integrated. In the long run, there is no integration of the skipjack market. This finding implies that it is challenging to reach or access market information. However, it's worth noting that the Internet is available in Indonesia's district/city and regional markets.

Price fluctuations significantly impact fishermen and traders, including wholesalers and retailers, affecting the profitability of each party involved. The implementation of a digital marketing system can play a crucial role in swiftly providing price information for fishery products, starting from producer markets, such as fish auctions, and extending to wholesale and retail markets. This involves incorporating marketing strategies based on market structure, market behaviour, and market performance. Implementing such marketing systems contributes to reducing risk within institutions and markets, ultimately enhancing marketing efficiency. The availability of symmetric price information across all markets and parties involved helps mitigate price uncertainty, facilitating the achievement of market integration. Furthermore, it is essential to enhance access to infrastructure, including roads, land, and sea transport, to support the smooth flow of marketing distribution. By decentralizing the market and preventing a small group of traders from controlling it, market integration fosters a balance between supply and demand. This, in turn, eliminates the income disparity between fishermen and middlemen, thereby improving the overall social economy, particularly for fishermen.

REFERENCES

Basurko, O. C., Gabiña, G., Lopez, J., Granado, I., Murua, H., Fernandes, J. A., Krug, I., Ruiz, J., & Uriondo, Z. (2022). Fuel consumption of free-swimming school versus fad strategies in tropical tuna purse seine fishing. Fisheries Research, 245. https://doi.org/10.1016/j.fishres.2021.106139

Can, M. F., Günlü, A., & Can, H. Y. (2015). Fish consumption preferences and factors influencing it. Food Science and Technology (Campinas), 35(2), 339–346. https://doi.org/10.1590/1678-457X.6624

Deb, P., Dey, M. M., & Surathkal, P. (2022). Price Transmission and market integration of Bangladesh fish markets. Aquaculture, 560. https://doi.org/10.1016/j.aquaculture.2022.738592

Dueri, S., Guillotreau, P., Jiménez-Toribio, R., Oliveros-Ramos, R., Bopp, L., & Maury, O. (2016a). Food security or economic profitability? projecting the effects of climate and socioeconomic changes on global skipjack tuna fisheries under three management strategies. Global Environmental Change, 41, 1–12. https://doi.org/10.1016/j.gloenvcha.2016.08.003

Duggan, D. E., & Kochen, M. (2016). Small in scale but big in potential: opportunities and challenges for fisheries certification of Indonesian small-scale

tuna fisheries. Marine Policy, 67, 30–39. https://doi.org/10.1016/j.marpol.2016.01.008

Erauskin-Extramiana, M., Chust, G., Arrizabalaga, H., Cheung, W. W. L., Santiago, J., Merino, G., & Fernandes-Salvador, J. (2023). Implications for the global tuna fishing industry of climate change-driven alterations in productivity and body sizes. Global and Planetary Change, 222, 104055. https://doi.org/10.1016/j.gloplacha.2023.104055

Erdogan, B. E., Mol, S., & Coşansu. (2011). Factors influencing the consumption of seafood in Istanbul, Turkey. Turkish Journal of Fisheries and Aquatic Sciences, 11, 631–639. https://doi.org/10.4194/1303-2712-v11_4_18

Firdaus, M. (2018). Profil perikanan tuna dan cakalang di Indonesia. Buletin Ilmiah MARINA Sosial Ekonomi Kelautan Dan Perikanan, 4(1), 23–32. https://doi.org/10.15578/marina.v4i1.7328

García-del-Hoyo, J. J., Jiménez-Toribio, R., & García-Ordaz, F. (2021). Granger causality between the Canning sector and the Spanish tuna fleet: Evidence from the Toda-Yamamoto approach. Marine Policy, 132. https://doi.org/10.1016/j.marpol.2021.104701

Gobillon, L., & Wolff, F. (2016). Evaluating the law of one price using micro panel data: The case of the French fish market. American Journal of Agricultural Economics, 9(1), 134–153. https://doi.org/10.1093/ajae/aav008

Guillotreau, P., Squires, D., Sun, J., & Compean, G. A. (2017). Local, regional and global markets: what drives the tuna fisheries? Reviews in Fish Biology and Fisheries, 27, 909–929. https://doi.org/10.1007/s11160-016-9456-8

Hartanto, T. R., Suharno, & Burhanuddin. (2021). Daya saing ekspor ikan tuna-cakalang-tongkol Indonesia di pasar Amerika Serikat. Jurnal Pengolahan Hasil Perikanan Indonesia, 24(2), 227–235. https://doi.org/10.17844/jphpi.v24i2.36075

Huang, S., & He, Y. (2019). Management of China's capture fisheries: Review and prospect. Aquaculture and Fisheries, 4, 173–182. https://doi.org/10.1016/j.aaf.2019.05.004

Ibarra, A. A., Vargas, A. S., & Lopez, B. M. (2012). Economic impacts of climate change on two Mexican coastal fisheries: implications for food security. Journal of Economic Literature Classification, 36, 1–36. http://www.economics-ejournal.org/economics/discussionpapers/2012-64/

Islamaji, B., Patanda, M., & Nurdin, E. (2020). Kajian status ikan cakalang (Katsuwonis pelamis) di Palabuhanratu, Sukabumi, Jawa Barat. Jurnal Ilmiah Satya Minabahari, 6(1), 11–18. https://doi.org/10.53676/jism.v6i1.94

Jiménez-Toribio, R., Guillotreau, P., & Mongruel, R. (2010). Global integration of European tuna markets. Progress in Oceanography, 86(1–2), 166–175. https://doi.org/10.1016/j.pocean.2010.04.022

Khan, A. M. A., Gray, T. S., Mill, A. C., & Polunin, N. V. C. (2018). Impact of a fishing moratorium on a tuna pole-and-line fishery in Eastern Indonesia. Marine Policy, 94, 143–149. https://doi.org/10.1016/j.marpol.2018.05.014

KKP. (2022). Statistik Kelautan dan Perikanan. https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2

Lahodey, P., Senina, I., Calmettes, B., Hampton, J., & Nicol, S. (2013). Modelling the impact of climate change on Pacific skipjack tuna population and fisheries. Change Climate, 119, 95–109. https://link.springer.com/article/10.1007/s10584-012-0595-1

Macusi, E. D., Morales, L. D. G., Macusi, E. S., Pancho, A., & Digal, L. N. (2022). Impact of closed fishing season on supply, catch, price and the fisheries market chain. Marine Policy, 138. https://doi.org/10.1016/j.marpol.2022.105008

Maltby, K. M., Simpson, S. D., & Turner, R. . (2021). Scepticism and perceived self-efficacy influence fishers' low risk perceptions of climate change. Climate Risk Management, 31(100267). https://doi.org/10.1016/j.crm.2020.100267

McConnell, K. E., & Strand, I. E. (2000). Hedonic prices for fish: Tuna prices in Hawaii. American Journal of Agricultural Economics, 82(1), 133–144. https://doi.org/10.1111/0002-9092.00011

Mohammed, E. Y., & Uraguchi, Z. B. (2013). Impacts of climate change on fisheries: implications for food security in Sub-Saharan Africa. In M. A. Hanjra (Ed.), International Global Food Security (pp. 113–145). Nova Science Publishers, Inc. https://pubs.iied.org/sites/default/files/pdfs/migrate/G03625.pdf

Nguyen, Q. V., & See, K. F. (2023). Application of the frontier approach in capture fisheries efficiency and productivity studies: A bibliometric analysis. Fisheries Research, 263. https://doi.org/10.1016/j.fishres.2023.106676

Nurani, T. W., Wahyuningrum, P. I., Iqbal, M., Khoerunnisa, N., Pratama, G. B., Widianti, E. A., &

Kurniawan, M. K. (2021). Dinamika musim penangkapan ikan cakalang dan tongkol di perairan Pelabuhan Ratu. Marine Fisheries, 12(2), 149–160. https://doi.org/10.29244/jmf.v12i2.37112

Pohan, F., Safrida, S., & Deli, A. (2023). Structure-conduct-performance analysis of skipjack fish industry in Banda Aceh City. Journal of Social Research, 2(5), 1708–1722. https://doi.org/10.55324/josr.v2i5.876

Rahim, A., Hastuti, D. R. D., Firmansyah, Sabar, W., & Syam, A. (2019). The applied of Cobb-Douglas production function with determinants estimation of small-scale fishermen's catches productions. International Journal of Oceans and Oceanography, 13(1), 81–85.

Rahim, A., Hastuti, D. R. D., & Syam, U. (2020). Estimation comparison of small-scale fisherman decision on choice fishing gear and outboard engine power. ARPN Journal of Engineering and Applied Sciences, 15(2), 574–580. https://doi.org/10.36478/jeasci.2020.574.580

Rahim, A., Hastuti., D. R. D., Bado, B., & Astuty, S. (2022). Are social conditions important to increase household income? The case of coastal fishers in Makassar City, Indonesia. Journal of Socioeconomics and Development, 5(2), 179–189. https://doi.org/10.31328/jsed.v5i2.3832

Ravallion, M. (1986). Testing market integration. American Journal of Agriculture Economics, 68(1), 102–109. https://doi.org/10.2307/1241654

Setälä, J., Laitinen, J., Virtanen, J., Saarni, K., Nielsen, M., & Honkanen, A. (2008). Spatial integration of freshwater fish markets in the Northern Baltic Sea Area. Fisheries Research, 92(2–3), 196–206. https://doi.org/10.1016/j.fishres.2008.01.020

Shaffril, H. A. M., Samah, A. A., & D'Silva, J. L. (2017). Adapting towards climate change impacts: strategies for small-scale fishermen in Malaysia. Marine Policy, 81, 196–201. https://doi.org/10.1016/j.marpol.2017.03.032

Shaffril, H. A. M., Samah, A. A., Samsuddin, S. F., & Ali, Z. (2019). Mirror-mirror on the wall, what climate change adaptation strategies are practiced by the Asian's fishermen of all ? Journal of Cleaner Production, 232, 104–117. https://doi.org/10.1016/j.jclepro.2019.05.262

Squires, D., Jiménez-Toribio, R., Guillotreau, P., & Anastacio-Solis, J. (2023). The ex-vessel market for tropical tuna in Manta, Ecuador. A new key player on the global tuna market. Fisheries Research, 262. https://doi.org/10.1016/j.fishres.2023.106646

Tadjuddah, M. (2019). Tracking skipjack tuna fishing ground in west banda sea relations with sea surface temperature parameters from Aqua MODIS Satellite. Turkish Journal of Fisheries and Aquatic Sciences, 9, 191–197. https://doi.org/10.4194/1303-2712-v19_03_02

Tangke, U., Silooy, F. D., Rochmady, & Saing, Z. (2020). Sea surface temperature and chlorophyll-a condition of skipjack tuna (Katsuwonus pelamis) catching area in Ternate Island marine waters. Journal of Physics: Conference Series, 1517(1). https://doi.org/10.1088/1742-6596/1517/1/012039

Vayghan, A. H., & Lee, M. A. (2022). Hotspot habitat modeling of skipjack tuna (Katsuwonus pelamis) in the Indian Ocean by using multisatellite remote sensing. Turkish Journal of Fisheries and Aquatic Sciences, 22(9). https://doi.org/10.4194/TRJFAS19107

Wamukota, A., Brewer, T. D., & Crona, B. (2014). Market integration and its relation to income distribution and inequality among fishers and traders: The case of two small-scale Kenyan Reef fisheries. Marine Policy, 48, 93–101. https://doi.org/10.1016/j.marpol.2014.03.013

Widodo, A. A., Sadiyah, L., & Satria, F. (2021). Characterizing of skipjack (Katsuwonus pelamis) supply chain on pole and line fishery In Indonesia FMA 714 and adjacent: A case study in Sikka Regency, West Nusa Tenggara-Indonesia. Indonesian Fisheries Research Journal, 27(2), 69–78. https://doi.org/10.15578/ifrj.27.2.2021.69-78

Wu, X. H., Chang, Y., Liao, T. Y., Ding, M. M., & Ke, C. C. (2023). Real-time multi-month forecasting of skipjack tuna (Katsuwonus pelamis) habitat in the western and central Pacific Ocean for improved fishing efficiency and fisheries management. ICES Journal of Marine Science, 1–14. https://doi.org/10.1093/icesjms/fsad159

Yamin, F., Fariyanti, A., & Jahroh, S. (2021). Struktur, perilaku dan kinerja pemasaran ikan cakalang di Kabupaten Halmahera Selatan. Jurnal Agribisnis Indonesia, 9(2), 105–121. https://doi.org/10.29244/jai.2021.9.2.105-121

Yazdani, S., Rafiee, H., Hosseini, S. S., Chizari, A., & Salehi, H. (2013). Spatial integration of the Caspian Sea bony fish market: An application of the seasonal co-integration approach to monthly data. Ocean & Coastal Management, 84, 174–179.