



## Research article

# Fluctuations and disparity in broiler and carcass price before during and after covid-19 pandemic in Indonesia

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## ARTICLE INFO

## Keywords:

Fluctuations  
Disparity  
Broiler  
Carcass  
Price

## ABSTRACT

This study aims to analyze fluctuations and disparity in broiler and carcass prices before, during, and after COVID-19 pandemic in five broiler-producing regions in Indonesia, including North Sumatra, West Java, Central Java, East Java, and South Sulawesi. Weekly data series were used to analyze fluctuations and disparity before (2017–February 2020), during (March 2020–2022), and after (January–June 2023) COVID-19 pandemic. Furthermore, Coefficient of variation (CV) and convergence models were also used during the analysis. The results showed that broiler price fluctuations in the five study areas were categorized as “medium” before and during pandemic. After pandemic, the majority of the areas were in the “low” category, except for South Sulawesi province, where CV was 10.02%. Carcass price fluctuations were categorized as “low” and “moderate” before and during COVID-19 pandemic. After the viral outbreak, all the provinces investigated in this study were classified as “low”. This indicated that the variability in carcass price decreased across all provinces after pandemic. The coefficient value of  $\beta_1$  was less than 1 indicating that broiler and carcass price did not show significant disparity between regions at all periods. The primary drivers of fluctuations and disparity were related to production and availability factors, and the government played a role in maintaining stability in producing areas.

## 1. Introduction

Coronavirus disease 2019 (COVID-19) is a highly contagious disease that poses a severe threat to global public health, having been declared pandemic crisis worldwide [1]. COVID-19 has plunged the world into deepest recession with unprecedented levels of poverty, deprivation, and unemployment making them more volatile and has left an indelible mark on countries across the globe, including Indonesia [2,3]. Furthermore, its adverse effects have extended into the poultry industry, creating significant challenges across various segments of the supply chain. From the perspective of producers, the decrease in consumption demand has led to a corresponding decline in poultry production [4].

The poultry industry, especially broiler industry, is an industry with quite large capitalization and is integrated from upstream to downstream, including breeding (Great Grand Parent Stocks/GGPS, Grand Parent Stocks/GPS, Parent Stocks/PS), feed/medicine, cultivation (on-farm), distributors, processing and final consumers has faced formidable obstacles due to this pandemic, despite its

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Received 27 September 2023; Received in revised form 25 March 2024; Accepted 29 March 2024

Available online 6 April 2024

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relatively resilient economic cycle [5]. One of the most significant challenges in the poultry supply chain has been the catastrophic impact of COVID-19 [6]. This pandemic has led to disruptions in production levels, shifts in customer demand and product access, as well as economic challenges for broiler breeders and traders [7–11]. The reduced demand for broiler chickens will certainly disrupt the production process starting from DOC, production and marketing processes, where the broiler industry is a living thing industry that has perishable properties. The impact on poultry demand and production has been continuously observed in Bengkulu Province. Recent data showed that there was a decrease in chicken demand from 2019 to 2020 (509385–498367 chickens), as evidenced by the reduced number of chickens sold in 2020 [12]. This decreased demand is consistent with the broader trends observed during pandemic, where various factors such as lockdowns, reduced consumer spending, and supply chain disruptions have reshaped consumption patterns [10].

The impact of COVID-19 on the global poultry industry has been significant and widespread, extending well beyond the borders of Indonesia and affecting several countries around the world. This sector also grapples with an array of challenges caused by pandemic, including disruptions within supply chains, shifts in consumer demand, and labor shortages. Several global studies examining the association between COVID-19 and the poultry sector have emerged from countries, such as India [7,13], Canada [14,15], China [14], Nigeria [16], Iran [8], Kuwait [17], United Kingdom, Italy, Brazil, Germany, Saudi Arabia, Egypt [18], Myanmar [19], USA [18,20], and Poland [21]. The global chicken meat trade has experienced a 4% decline due to the impact of COVID-19 on the poultry supply chain, aligning with broader trends and challenges faced by the poultry industry, as observed in Canada and the USA [15,22]. Poultry supply chains are severely constrained by restrictions on human movement and logistics [14,17,23]. In Bangladesh, the sector suffered damage due to COVID-19 pandemic, with the implementation of a lockdown and rumors suggesting that poultry and their products can transmit diseases [23]. The combination of production and transportation disruptions, decreased consumer demand and market uncertainties created significant challenges, causing the permanent closure of several farms [23,24]. Furthermore, a significant loss of up to 1.35 billion US\$ was recorded in just two weeks from 20 March to April 4, 2020 [25]. As of August 2020, Brazil reported approximately 50,000 cases among poultry workers, while India experienced \$3 million in losses [7]. This situation raised concerns about the potential occurrence of a food crisis due to the collapse of the livestock sector during pandemic. In the USA, the impact of COVID-19 was also felt by workers in the meat and poultry processing industry [22]. DOC production in the US decreased significantly in April and May 2020 compared to the previous year [4]. Consequently, the global COVID-19 pandemic had a significant impact on broiler farms, especially the commodity price.

COVID-19 pandemic has caused significant challenges, including rising production costs and selling price, exerting immense pressure on poultry meat consumers [15]. The shortage in broiler supply can lead to an increase in price of broiler chickens, both live and carcass. This condition can be attributed to the fundamental economic principle of supply and demand, as well as the concept that price serves as an indicator of the relationship between both factors [26,27]. Price is a dynamic and multifaceted element within the marketing mix and it extends beyond being a simple number on a label. Furthermore, it is responsive to changes in supply and demand, competitive forces, economic conditions, and consumer preferences. Businesses often adjust their price to remain competitive, capture market share, or respond to shifts in the market environment. According to previous studies, it can take on several forms and serves develop their marketing strategy around three key dimensions: (1) standardization-adaptation, (2) configuration-coordination, and (3) strategic integration [28]. This element also plays a crucial role in shaping the perceived value of a product or service. Therefore, price can be narrowly defined as the amount of a customer pays for a product or the sum of the values that consumers exchange for the benefits of using a product [29].

The scarcity of supply of broiler chickens serves as an indicator of potential increases in chicken carcass price in the market. Chicken carcass are derived from broiler after various processing steps, including the removal of feathers, viscera, organs, heads, and feet [30,31]. Disruptions in the goods distribution system due to health protocols often lead to a lack of supply of these commodities. As COVID-19 cases decrease and restrictions are lifted, various industries, including broiler and chicken carcass industries, have the opportunity to fully resume their operations. Several studies have shown that when supply is ample and meets or exceeds the demand from consumers and other buyers, it can lead to a decrease in price. This is because suppliers find themselves with more products available than buyers are willing to purchase at the current price levels. Consequently, suppliers can reduce the value of their products to stimulate demand and encourage more purchases. A decline in chicken carcass price has a positive impact on the inflation rate, and it is generally considered beneficial for the government and the overall economy. Designating chicken meat as a strategic food commodity subject to monitoring for price fluctuations and disparity is a common practice by governments to ensure food security, stabilize price, and protect consumers. This designation reflects the importance of chicken meat as a staple protein source and recognizes its significant role in the overall food supply chain.

Strategic food commodities play a crucial role in shaping inflation figures, particularly within categories of goods, such as food-stuffs or volatile items [32,33]. A stable and sufficient supply of these commodities helps to prevent sudden spikes and fluctuations, thereby promoting price stability in the market. Maintaining a steady supply helps to avoid supply-demand imbalances that can contribute to inflation. The government contributes to controlling inflation rates by managing the availability of essential food items such as broiler [34].

According to previous studies, the government actively plays a role in maintaining stable price for broiler chickens to control fluctuations and disparity. Stability is important to ensure that consumers have access to affordable food, and producers continue to operate profitably without facing extreme fluctuations. Price variations in commodity markets, including broiler chickens, are often caused by the interplay between supply and demand dynamics [35]. Fluctuations in the value of food commodities are a common challenge in several countries, including Indonesia. This condition can be attributed to various factors, such as changes in supply and demand, weather conditions, market speculation, and the economy. The list of commodities, such as rice, corn, chicken meat, broiler eggs, shallots, sugar, garlic, cayenne pepper, meat, red chili, and cooking oil represents a range of essential food items, each with its

unique set of influencing factors [36]. Weather events, diseases, supply disruptions, and other factors have been reported to have cascading effects on crop yields and availability, leading to shortages and price increases. This is especially critical for essential items, including chicken meat, which is a staple protein source for many people. Governments often prioritize the stability of strategic food commodities to ensure that the population has access to affordable and reliable sources of nutrition. Results have shown that studies on the impact of COVID-19 on broiler industry have primarily focused on the aspects of production and supply chain. These include studies conducted by Ref. [4] in Mississippi [19], in Myanmar [37], in the European region, and [38] in Indonesia. Research results in Indonesia show that there is negative price transmission at the farmer and consumer levels as a result of market power by the poultry industry [39].

Price disparity refers to significant differences in price of goods or commodities based on a range of factors, such as time, location, consumer segment, demographic factors, infrastructure support, and supply-demand variations [40]. Disparity is measured by the difference between the highest price and the average national price [41]. Furthermore, it can be interpreted as a positive or negative difference between domestic market and international price [42]. It also refers to the variation or difference in price of a commodity compared to a standard or reference price, which can be at different geographical levels, including local, regional, national, or international. This variation often occurs due to a range of factors, including production cost, public policy, scarcity of goods, local market conditions, supply and demand dynamics, infrastructure support, length of supply chains, geographical barriers, transportation costs, taxes, tariffs, and other economic and regulatory factors [43].

Investigating price fluctuations and disparity in this context is crucial in identifying price gaps between regions to maintain stability. This is important for the government as a staple food value stabilizer in maintaining a balance between supply and demand for broiler chickens and their carcass. Based on previous reports, price fluctuations and disparity are terms used to describe pricing phenomena in real market conditions, especially the value of broiler and carcass chickens. These phenomena are influenced by a complex interplay of various factors, and understanding the dynamics is essential for businesses, policymakers, and consumers. Therefore, this study aims to analyze fluctuations and disparity in broiler price at the farmer level and broiler carcass at the consumer level before, during, and after COVID-19 pandemic in Indonesia. The results are expected to provide valuable insights into the impact of pandemic on the poultry industry and the broader economy.

## 2. Material and methods

### 2.1. Study locations and data collection

Location determination was based on the consideration of the largest population of broiler chickens in Indonesia, namely the provinces of West Java, Central Java, East Java, South Sulawesi, and North Sumatra (Fig. 1). Furthermore, these provinces were also the regions with the highest number of consumers in the country.

This study collected both primary and secondary data, where the primary data referred to information that was directly collected from original sources. Meanwhile, the secondary data consisted of information that had been collected and published by an individual or institution. In this study, primary data were gathered through interviews with informants, specifically broiler farmers and traders. The interview results with these informants served as a crucial component in supporting the data analysis and overall results. Secondary data was a time series dataset collected from the Directorate General of Livestock and Animal Health, Ministry of Agriculture, and Central Bureau of Statistics to provide historical trends and patterns in poultry farming and trading. The data collected were the average price of broiler and carcass series per week before (2017–February 2020), during (March 2020–2022), and after COVID-19 pandemic (January–June 2023).

### 2.2. Analysis method

Analysis of coefficient of variation (CV), and convergence models was used to detect price fluctuations and disparity. CV calculated as the ratio of the standard deviation (SD) to the mean price ( $\bar{X}$ ), provided a quantitative measure of relative variability by following the formula:

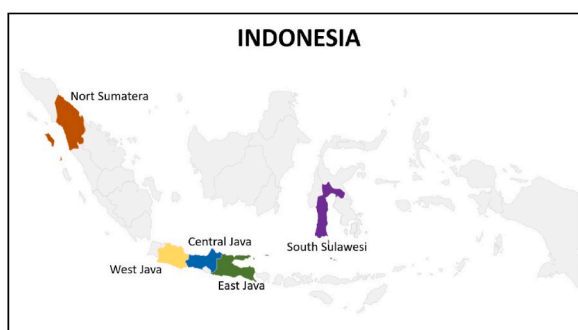


Fig. 1. Location study (using various colors).

$$CV = \frac{SD}{\bar{X}} \tag{1}$$

The smaller CV, the lower the level of price fluctuations and vice versa [44]. CV value of >25 percent indicated that there was fluctuations, while CV < 25 percent showed smaller variation. According to Ref. [45], price variations were grouped based on CV, namely: CV = 0: not critical fluctuations; CV < 10 percent: low; 10 percent ≤ CV < 20 percent: moderate; 20 percent ≤ CV < 30 percent: high; and over 30 percent: very high. This CV value was used to detect price fluctuations at the study locations before, during, and after COVID-19.

Disparity in live bird price at the farmer level and broiler carcass price at the consumer level was determined using the convergence model with the following formula [41]:

$$P_{it} = \beta_1 P_{it-1} + \beta_2 PX_{it} + \epsilon_{it} \tag{2}$$

where:  $P_{it}$  is price of broiler or carcass at the regional level (rupiah);  $P_{it-1}$  is price at the regional level in the previous period (rupiah);  $PX_{it}$  is price of broiler (live bird) or carcass at the national level;  $\beta_1$  is the convergence coefficient;  $\beta_2$  is the coefficient of the national broiler or carcass price variable. When the coefficient  $\beta_1 < 1$ , there was no convergence or price disparity. This formula was a multiple regression used to measure price disparity in each region where  $P_{it-1}$  reflected commodity value in the area and  $PX_{it}$  was commodity price at the national level. Therefore, price conditions in the regions reflected disparity compared to national commodity price, as seen from the coefficient value  $\beta_1$ .

### 3. Results and discussion

#### 3.1. Broiler chicken population in Indonesia

The development of broiler population in Indonesia could be seen as a response to the rapid demand for broiler chickens. Furthermore, these animals served as a primary source of meat for consumption in several countries, including Indonesia. As the population grew and consumer preferences shifted, there was a need to increase poultry production to meet the rising demand for protein-rich meat. The growth of broiler industry in Indonesia, as well as in other countries, could be facilitated by an integrated farming industry and investments, including those from foreign investors [38,46,47]. An integrated method comprised various stages of broiler production, from breeding and hatching to raising and processing, being managed by a single entity or under a coordinated system. This could lead to improved efficiency, quality control, and supply chain management, contributing to the rapid development of the sector.

Fig. 2 showed the history of the poultry population in Indonesia, including local, layer, as well as broiler chickens, which were dominant. This is to illustrate the poultry industry map in Indonesia. Broiler chickens had been specifically bred and developed to efficiently and economically produce high-quality meat protein for human consumption. This industrial method was driven by the need to provide a cost-effective and accessible source of animal protein to meet the nutritional demands of a growing global population. The development of local chickens in several regions, including Indonesia, tended to be relatively stable compared to the growth seen in commercial laying hens and broiler populations. However, local species often had a smaller population size compared to these commercial breeds. Based on Fig. 2 Layer chickens continued to grow despite COVID-19 pandemic, compared to broiler, which experienced a decline. The decline could be attributed, at least in part, to the impacts of pandemic on the poultry industry.

#### 3.2. Broiler and carcass chickens price before, during, and after COVID-19 in study locations

The development of broiler price in five locations in the period before (2017 to February 2020), during (March 2020–December 2022), and after COVID-19 pandemic (January–June 2023) is presented in Fig. 3. Fig. 3 shows the variation of broiler prices across five provinces as source areas for broiler production in Indonesia. Price of broiler chickens increased along with staple food items, and this could have implications for inflation in Indonesia. When price of a critical food item increased substantially, it could contribute to overall inflation, affecting the cost of living for consumers. Therefore, the Indonesian government was expected to make various efforts

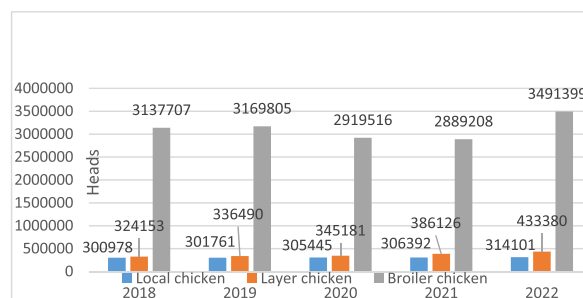


Fig. 2. Local chicken. Layer chicken. and broiler chicken population in Indonesia (Central Bureau of Statistics of Indonesia. 2023).



Fig. 3. The lowest and highest price of broiler chickens in study locations before. During. And after COVID-19 pandemic.

when price of broiler chickens continued to increase, such as regulating imports and exports, implementing price ceilings, providing subsidies, and conducting market operations.

Fig. 3 showed that the lowest price for broiler chickens before COVID-19 pandemic was IDR 9216/kg in Central Java Province. Furthermore, the province consistently had lower price compared to other provinces during and after pandemic. The highest value before, during, and after the viral infection was obtained in South Sulawesi. Competitive production input factor value could cause price in Central Java to be cheaper compared to other regions. The factors that caused inflation in South Sulawesi during these 3 periods included the cost of input production and transportation. Higher input costs could directly impact the overall cost of production, while increased transportation expenses increased the final price of broiler chickens.

The history of broiler and carcass price before COVID-19 pandemic in five location study is presented in Fig. 4. The five study locations are source areas for broiler production, so price fluctuations in these five areas can provide an overview of price fluctuations in other areas. Price during this period fluctuated greatly throughout 2017–February 2020 in all provinces. The seasonal increase in broiler (chicken) value, particularly during the Eid Al-Fitr celebrations, occurred in June from 2017 to 2019. Eid Al-Fitr was a significant religious holiday for Muslims that marked the end of Ramadan, a month of fasting and prayer. A consistent pattern of increases starting around two months before the Eid Al-Fitr holidays in both 2017 and 2018 was observed. This pattern suggested that the anticipation of increased demand during the holiday season caused increased price leading up to Eid Al-Fitr. In 2018, there was a notable and significant increase, particularly in the South Sulawesi Province. This upward trend actually began in October 2017 and culminated in a peak in July 2018. This phenomenon could be attributed to several factors, including high demand and supply constraints.

The historical data for carcass price, as depicted in Fig. 4, showed anomalies in the months of May and June 2019 across the provinces of West Java, Central Java, and East Java. During this period, although broiler price decreased, the value of carcass continuously increased. The participation of broiler collectors and brokers in managing the supply of these animals to carcass cutters and traders could contribute to the observed pricing dynamics. The relationship between broiler and carcass price, as influenced by the actions of these intermediaries, underscored the complexities of poultry market dynamics. These results suggested that when the

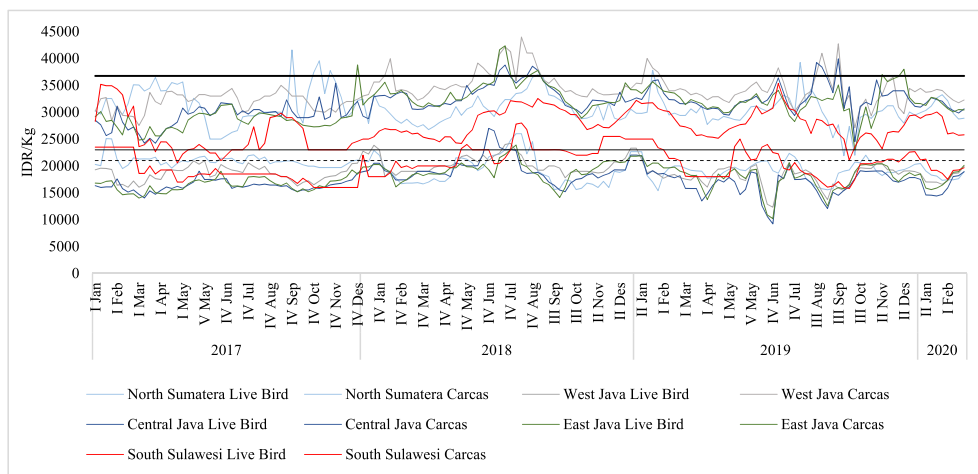


Fig. 4. Broiler and carcass price trends before COVID-19 pandemic at study locations.

supply of live broiler chickens became excessive, it led to decreased value, while that of carcass remained relatively stable or even increased in response to the growing demand before Eid Al-Fitr.

Price conditions before and during COVID-19 pandemic were significantly different due to the various measures taken to control the spread of the virus. The development of weekly price during pandemic is presented in Fig. 5. Fig. 5 illustrates the condition of broiler prices in the five production source regions. The increase in the value of these animals in the months leading up to Eid Al-Fitr in April 2020, 2021, and 2022 was likely a reflection of the seasonal demand surge associated with the holiday celebrations. Based on annual price fluctuations, the government of Indonesia managed fluctuations for broiler and carcass price by setting ceiling and floor values through the regulation. The issuance of Regulation Number 5 of 2022 by the National Food Agency of the Republic of Indonesia indicated a proactive effort to stabilize and control variations in the poultry market. The regulation was set in October 2022, where the floor and ceiling price were IDR 21000/kg and IDR 23000/kg, respectively. Meanwhile, the chicken carcass price was set at IDR 36750/kg. In Fig. 5, the observed broiler financial value had generally remained below the government's highest average price threshold of IDR 23000 per kilogram. The average price had also typically fallen within the range of the lowest price set by the government, which was IDR 21000 per kilogram.

At the end of 2022, the Government of Indonesia lifted activity restrictions because pandemic case was considered to be under control and continued to decline. This led to the revival of economic activity, including the poultry industry. Monitoring of broiler price movements after COVID-19 pandemic, which began in January–June 2023, seemed to be under control, as shown in Fig. 6. The figure provides an overview of broiler prices after the government announced Indonesia was free from the Covid-19 Pandemic. Therefore, Figs. 4–6 can explain the position of broiler prices before, during, and after the Covid-19 pandemic. Price control measures were set by the government for the poultry industry and the observation showed that the values generally stayed within the reference range. The figure also showed that price of broiler chicken carcass often followed the trends of live broiler chickens. The success of controlling the financial value of live broiler chickens and carcass, namely by regulating DOC broiler production in breeding companies can be carried out by maintaining a balance between availability and demand. This can be achieved through the early rejection mechanism of parent stock (PS) chickens above 52 weeks and cutting fertile eggs/hatching eggs (HE). The Indonesian government had taken a proactive method to maintain control over DOC (day-old chick) broiler production to achieve more lasting effects and benefits. By focusing on the early rejection mechanism for PS that was above 52 weeks old, the government aimed to further stabilize the poultry market.

### 3.3. Fluctuations in broiler and chicken carcass price before, during, and after COVID-19 pandemic

Fluctuations in commodity price referred to the variations in price of goods over time due to the influence of market mechanisms, supply and demand dynamics, and various external factors. Price of goods, including live broiler chickens and their carcass, were primarily influenced by the fundamental economic principles of supply and demand. These principles were the cornerstone of market economics and played a crucial role in determining the equilibrium price, where supply matched demand.

The results of the data series analysis fluctuation in broiler price for the three periods are presented in Tables 1 and 2. Table 1 provides an overview of the variation in broiler price fluctuations in the five study areas, while Table 2 provides an overview of the level of broiler price fluctuations in the five study areas. Before pandemic, the average price of broiler chicken at the producer level in Central Java and East Java was comparatively lower compared to other provinces. This price difference could be influenced by a variety of factors related to regional supply and demand dynamics, production costs, transportation, and market preferences. The range of CV values between provinces for the average price of broiler chicken ranged between 10.23% and 13.69%. This indicated that price fluctuations were categorized as moderate [45]. Central Java Province had a higher CV value compared to the other four

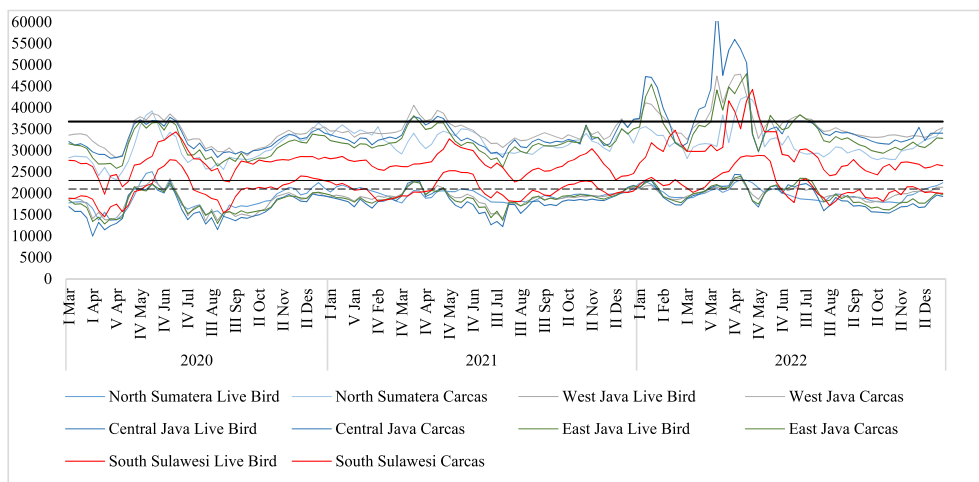


Fig. 5. Broiler price trends during COVID-19 pandemic in study locations.

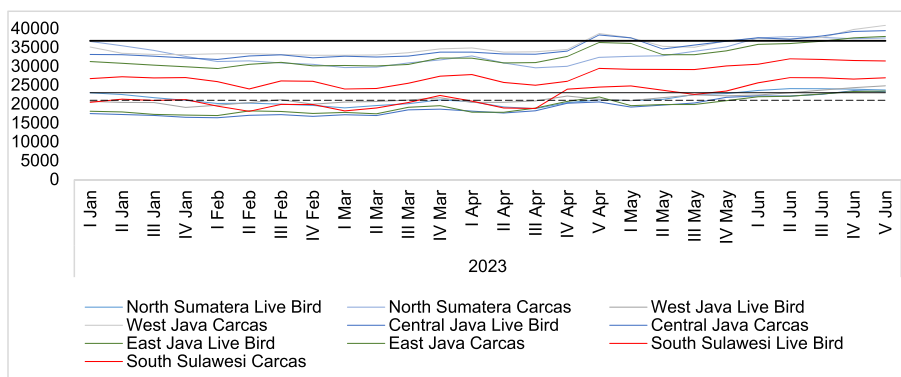


Fig. 6. Broiler price trends after COVID-19 in study locations.

Table 1

Average value, SD, and CV in broiler price variation in the period before, during, and after COVID-19 pandemic at study locations.

Provinces	Before COVID-19			During COVID-19			After COVID-19		
	Mean	stand dev	coeff of var	mean	stand dev	coeff of var	Mean	stand dev	coeff of var
North Sumatera	19696	2139	10.86	19392	2017	10.40	20543	1115	5.43
West Java	18989	1943	10.23	19100	2179	11.41	20714	715	3.45
Central Java	17463	2415	13.83	18080	2827	15.64	17922	1251	6.98
East Java	17873	2203	12.32	18775	2347	12.50	18507	1321	7.14
South Sulawesi	20371	2789	13.69	21268	2812	13.22	20867	2091	10.02

Table 2

Comparison of fluctuations rate of broiler chicken price before, during, and after COVID-19 pandemic at study locations.

Provinces	Before COVID-19		During COVID-19		After COVID-19	
	coeff of var	categorizing price fluctuations	coeff of var	categorizing price fluctuations	coeff of var	categorizing price fluctuations
North Sumatera	10.86	moderate	10.40	Moderate	5.43	Low
West Java	10.23	moderate	11.41	Moderate	3.45	Low
Central Java	13.83	moderate	15.64	Moderate	6.98	Low
East Java	12.32	moderate	12.50	Moderate	7.14	Low
South Sulawesi	13.69	Moderate	13.22	Moderate	10.02	moderate

provinces before COVID-19 pandemic. This showed that the average price of broiler chicken in Central Java exhibited greater variability relative to its mean price compared to the other provinces.

Price fluctuations for broiler chickens before and during pandemic, along with the specific CV values showed that CV range was 10.23%–15.64%, as shown in Table 2. This indicated that during these periods, price fluctuations were categorized as moderate. Central Java Province had the highest CV value in both periods. After pandemic, most provinces experienced low fluctuations, except for South Sulawesi Province. Based on these results, price variability was generally mild and stable in most provinces.

Analyzing price data at the consumer level, specifically for broiler chicken carcass, offered valuable insights into how these price fluctuations impact the end consumers. This level of analysis helped to better understand the real-world implications of price variability and how it affected purchasing decisions and consumer behavior.

Tables 3 and 4 showed CV and categorization of price fluctuations in broiler carcass price in the five study provinces. Table 3

Table 3

Average value, SD, and CV of broiler chicken carcass price in the period before, during, and after COVID-19 pandemic at study locations.

Provinces	Before COVID-19			During COVID-19			After COVID-19		
	Mean	stand dev	coeff of var	mean	stand dev	coeff of var	Mean	stand dev	coeff of var
North Sumatera	30757	3055	9.93	31516	3413	10.83	31988	1920	6.00
West Java	33874	2860	8.44	34791	3377	9.71	34370	1680	4.89
Central Java	31697	2909	9.18	34364	5332	15.52	33645	1717	5.10
East Java	31451	3189	10.14	32725	4044	12.36	31586	1907	6.04
South Sulawesi	27186	3354	12.34	28070	3687	13.13	26592	1673	6.29

provides an overview of the variation in broiler carcass price fluctuations in the five study areas, while Table 4 provides an overview of the level of broiler carcass price fluctuations in the five study areas. The average broiler carcass price was lower in South Sulawesi compared to other provinces despite production not meeting demand. This indicated a complex interplay of factors influencing the poultry market. Furthermore, traders were capitalizing on the demand gap for broiler chicken meat in the area by supplying chicken carcass to the region. The use of the subsidized sea toll route from East Java to South Sulawesi was a significant factor that contributed to the lower price in the province. This arrangement leveraged the geographical advantage of South Sulawesi as a sea transportation hub for Eastern Indonesia, allowing efficient and cost-effective distribution of poultry products. The results showed that the area had a cheaper average weekly price for chicken carcass compared to other regions despite having CV values of 12.21% before COVID-19 pandemic and 13.13% during pandemic. Although the average price was lower, CV values indicated a certain level of variability around the average level. West Java had a consistently high average chicken carcass value compared to other provinces before, during, and after COVID-19 pandemic. Furthermore, this suggested a unique market dynamic for poultry products in the region. The situation could be influenced by a combination of factors that contributed to higher price.

### 3.4. Disparity in broiler chicken and broiler carcass price before, during, and after the recovery of COVID-19 pandemic

Price disparity referred to the difference between price of commodities in different regions compared to the national average price [40,41]. Price disparity of broiler chickens was analyzed using the Barro model with a multiple regression method. The model was statistically tested by using the F and R-sq test. The results of statistical tests on broiler and carcass price model showed that it had good fitness, with significance at  $\alpha < 0.01$  and R-sq  $> 71\%$ .

Disparity in broiler price before, during, and after COVID-19 pandemic is presented in Table 5. The table showed the R-sq values in the range between 71.50% and 95.20%. These values were considered statistically significant at a significance level ( $\alpha$ ) of less than 0.01. Furthermore, they reflected the relationship between strong and very strong broiler price in a specific region compared to the national level [48]. The coefficient value ( $\beta_1$ ) was below one ( $\beta_1 < 1$ ) for the time periods before, during, and after COVID-19 pandemic. This showed that there was no significant disparity in the value at the regional level. Therefore, the government's implementation of various policies had effectively controlled price of broiler chickens by ensuring a balance between supply and demand in the study area. This was a positive outcome, as price stability could benefit both consumers and producers, leading to a more predictable and sustainable market environment.

Table 5 showed that there were two provinces with different price disparity values before and after COVID-19, namely North Sumatra and South Sulawesi. According to a previous report, South Sumatra and South Sulawesi had disparity close to one before the viral outbreak. A value of one or more indicated the occurrence of price disparity. The provinces of North Sumatra and South Sulawesi were both producers of broiler chickens, but their production levels were lower compared to other areas, such as Java (West Java, Central Java, and East Java). The post-COVID-19 price disparity values showed the occurrence of changes, with 0.74 for North Sumatra and 0.18 for South Sulawesi. The lower disparity could be attributed to the supply of chicken carcass from outside the province of South Sulawesi. This external supply seemed to have a controlling effect.

Disparity in broiler carcass price in the study areas before, during, and after COVID-19 pandemic is presented in Table 6. The R-squared (R-sq) values in the table were within the range of 73.40%–91.70%. These values were considered statistically significant at a significance level ( $\alpha$ ) of less than 0.01. Price factor included in the model could determine whether there was disparity. Based on Table 6, there was no significant disparity in broiler carcass price across several provinces before, during, and after COVID-19 pandemic, as indicated by the coefficient value  $\beta_1$  being less than 1. West Java exhibited a lower disparity value compared to other provinces. This lower value was characterized by  $\beta_1$  being close to zero. This indicated that the region had been successful in controlling disparity. The incidence disparity in the provinces of North Sumatra and South Sulawesi were similar to those of live broiler. Furthermore, broiler carcass supply from East Java was the key to controlling the variations in South Sulawesi.

The results of this study were in line with [49], that the income of broiler meat sellers after pandemic at Mesir market was still under control. The profitability of selling broiler chicken meat indicated that the business was currently in a profitable position. These results were inconsistent with [12] in Bengkulu and [50] in Bangladesh, that price of chicken meat during COVID-19 pandemic was more volatile compared to the pre-pandemic period. Studies on fluctuations and price disparity for broiler chickens and meat in Indonesia were still rarely carried out. Furthermore, the existing papers were limited to certain regions or provinces and were based on assumptions, rather than real price data in the field.

## 4. Conclusion and implications

In conclusion, fluctuations in broiler price before and during COVID-19 pandemic in the provinces of North Sumatra, West Java, Central Java, East Java, and South Sulawesi were categorized as moderate. Meanwhile, fluctuations were generally low across most provinces during the post-pandemic period, except for South Sulawesi, with CV of 10.02%. The patterns of variation in broiler carcass price in different provinces before, during, and after COVID-19 pandemic were categorized between the low and medium categories. After COVID-19 pandemic, all provinces were in the low fluctuations category.

Disparity in broiler price before, during, and after the viral outbreak between the regions was characterized by a coefficient value of  $\beta_1 < 1$ , indicating the absence of significance. The coefficient value  $\beta_1$ , which related to the impact of a variable on broiler price and price disparity, was close to one in the province of South Sulawesi. Meanwhile, North Sumatra had a coefficient value  $\beta_1$  close to one after the incidence. Similar results were obtained for broiler carcass price, where there was no disparity for this commodity in North Sumatra and South Sulawesi.



**Table 4**

Comparison of fluctuations rate of broiler carcass price before, during, and after COVID-19 pandemic.

Provinces	Before COVID-19		During COVID-19		After COVID-19	
	coeff of var	categorizing price fluctuations	coeff of var	coeff of var	categorizing price fluctuations	coeff of var
North Sumatera	9.93	low	10.83	Moderate	6.00	low
West Java	8.44	low	9.71	Low	4.89	low
Central Java	9.18	Low	15.52	Moderate	5.10	Low
East Java	10.14	Low	12.36	Moderate	6.04	Low
South Sulawesi	12.34	Low	13.13	Moderate	6.29	Low

**Table 5**

Disparity in broiler chicken price before, during, and after the recovery from COVID-19 pandemic.

Provinces	Before COVID-19			During COVID-19			After COVID-19		
	$\beta_1$ LB	Sig	Rsqu	$\beta_1$ LB	Sig	Rsqu	$\beta_1$ LB	Sig	Rsqu
North Sumatera	0.66750	0.000	78.00%	0.53872	0.000	86.30%	0.7308	0.000	84.50%
West Java	0.35234	0.000	80.50%	0.21399	0.000	89.30%	0.0362	0.000	71.50%
Central Java	0.29074	0.000	80.00%	0.08076	0.000	90.40%	0.2320	0.000	86.90%
East Java	0.43233	0.000	79.90%	0.21541	0.000	90.00%	0.0086	0.000	82.40%
South Sulawesi	0.74436	0.000	82.40%	0.68830	0.000	84.90%	0.1788	0.000	95.20%

Note: LB = Live bird.

**Table 6**

Disparity in broiler chicken carcass price before, during, and after COVID-19 pandemic.

Provinces	Before COVID-19			During COVID-19			After COVID-19		
	$\beta_1$ LB	Sig	Rsqu	$\beta_1$ LB	Sig	Rsqu	$\beta_1$ LB	Sig	Rsqu
North Sumatera	0.55542	0.000	74.00%	0.60265	0.000	76.70%	0.6980	0.000	89.20%
West Java	0.25347	0.000	73.80%	0.06471	0.000	91.70%	0.0055	0.000	91.30%
Central Java	0.35958	0.000	73.40%	0.13373	0.000	84.50%	0.0694	0.000	82.60%
East Java	0.45585	0.000	77.80%	0.05922	0.000	90.60%	0.0844	0.000	83.50%
South Sulawesi	0.72954	0.000	81.20%	0.65234	0.000	82.70%	0.1455	0.000	85.40%

This research makes a significant contribution to the existing literature; This has provided an illustration that Covid 19 does not have a significant influence on fluctuations and disparities in chicken and broiler carcass prices in Indonesia. Further studies are advised to analyze supply chain management complexity models and the contestation of actors that influence price mechanism of broiler chickens and carcass in Indonesia.

### Ethics approval and consent to participate

The authors declared that ethics approval and consent to participate are Not applicable.

### Consent for publication

Consent for publication are not applicable.

### Availability of data and materials

The dataset supporting the conclusions of this article are available in [https://drive.google.com/drive/folders/1cOa6cwW9X6w\\_piR1q5xAcxqkMtDaXfro?usp=drive\\_link](https://drive.google.com/drive/folders/1cOa6cwW9X6w_piR1q5xAcxqkMtDaXfro?usp=drive_link) or [https://s.id/data\\_materials](https://s.id/data_materials).

### CRedit authorship contribution statement

**Agung Suganda:** Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Imam Mujahidin Fahmid:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Syahdar Baba:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Darmawan Salman:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization.

## Declaration of competing interest

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

## Acknowledgements

The authors are grateful acknowledge to the Ministry of Agriculture and Hasanuddin University, which provided data related to this study.

## Abbreviation

CV	coefficient of variation
DOC	Day old chick
HE	Hatching eggs
IDR	Indonesian Rupiah
LB	live bird
PS	parent stock
Rsq	R squared
SD	Standard deviation

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