

Price Variability and Beef Market Integration in Java

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ABSTRACT

The high demand for beef for consumption activities that is not accompanied by the adequacy of domestic production causes instability in the beef market and has an impact on prices that tend to fluctuate. In response to this, the government implements various policies such as import fulfillment, self-sufficiency and the establishment of beef production centers, but this is also an obstacle in meeting the uneven demand for beef in each region. The purpose of this study is to find out the variability and changes in beef prices as well as how the asymmetry of beef prices at each level of the beef market on the island of Java. Data analysis uses the variance of quantitative statistical coefficients and econometric models of the ECM and Houck approaches. The results show that the variation in beef prices on the island of Java, namely in the provinces of Banten, West Java, Central Java and East Java, is at a low level of variation with significant fluctuating price changes. In addition, there is a price asymmetry relationship between the market level of wholesalers and traditional markets and vice versa in West Java, Central Java and East Java as well as from traditional markets to wholesalers in Banten. This identifies that there is no balance between each level of the beef market in Java, which is allegedly caused by various factors, including commodity characteristics, infrastructure, and local market dynamics. Therefore, better policies are needed to stabilize prices and improve the efficiency of beef distribution.

Keywords: Asymmetry, Beef Prices, Coefficient Variance, ECM, Market Price

BACKGROUND

Meeting food needs particularly for animal protein, is a primary concern in public consumption. Beef is a strategic food commodity in Indonesia, playing a crucial role in fulfilling animal protein requirements. Rich in high quality protein, essential amino acids, and other beneficial nutrients, beef is vital for meeting nutritional needs. As a staple food and ingredient in various processed products, beef is an integral part of people's consumption patterns (Saputro T, 2020; Nggadu, 2023). The increase in beef consumption is always accompanied by population growth, income, and changing dynamics of public consumption (Muminah, et.al., 2014; Nggadu, 2023). In an effort to meet food demands, these dynamic puts beef in second place after poultry (Komalawati, 2021). Furthermore, changes in consumer preferences also influence the demand for beef products.

In 2023, Indonesia's beef consumption will reach 816.79 thousand tons or reach 2.93 kg of beef per capita annually. This increase grew by around 19 percent from the previous year (BPS Indonesia, 2024). On the other hand, in the same year, beef production in Indonesia decreased slightly

compared to the previous year, which was around 7.5 percent with a total production of only 139.4 thousand tons. This trend is consistent with the increasing public awareness of nutrition, which is in line with the increasing consumption of animal protein (Santoso, 2022). Consequently, domestic beef consumption is highly dependent on the efficiency of the livestock sector, improving the quality of cattle, and government policies that support beef self-sufficiency as an effort to meet domestic beef needs. The increase in consumption has impacted the high demand for beef in Indonesia, which is driving the development of the livestock, distribution, and supply chain management sectors to ensure availability, quality, and affordability in the market.

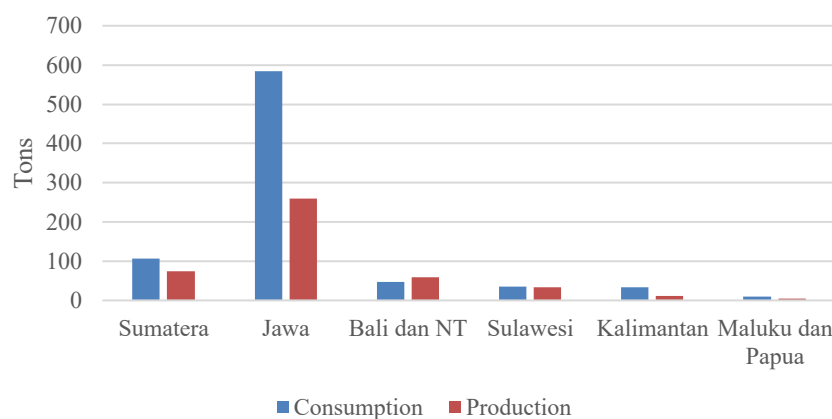


Figure 1. Beef Production and Consumption in Indonesia in 2023
Source: BPS Indonesia (2024)

Beef production and consumption in Indonesia in 2023 by region (Figure 1) shows that almost all islands in Indonesia experience inequality between production and consumption and beef production. The demand of beef and buffalo meat on the six major islands in Indonesia is generally higher than the availability resulting from local production of cattle and buffalo in each region (Figure 1). This is due to the characteristics of the region as a center of beef and buffalo production in Indonesia which is supported by a relatively low level of meat consumption among the local community (Riwukore, et. al., 2021). Relatively high beef consumption compared to beef production has created a deficit in domestic beef demand and imported beef of around 238,433.6 tons (BPS Indonesia, 2023). Indonesia is still one of the countries that has a beef import volume of 21.44 percent, which is relatively higher than the import of other types of meat as a whole (Rouf, *et al.*, 2014).

There is a policy that has been carried out by the government in covering the shortage of domestic supply of beef, the reality that occurs is that imports continue to increase without being accompanied by an adequate increase in national production capacity. Continued dependence on imports can risk weakening Indonesia's food independence, creating structural dependence on foreign supplies, and threatening long-term economic stability and food sovereignty if not immediately addressed with a planned and sustainable strategy to strengthen domestic production (Danasari, et.al., 2020).

Inequality in beef commodities is also found in significant inequality in various regions of Indonesia. The highest beef consumption occurred on the island of Jawa with a figure of around 583.36 kg tons, far exceeding its production which was only around 260.38 kg tons. This shows that Jawa is

highly dependent on beef supplies from other regions to meet consumption needs. On the other hand, the Bali and Nusa Tenggara regions are one of the centers of beef production because of the higher production compared to consumption. Furthermore, data from BPS shows that the province of East Nusa Tenggara has the highest beef production per capita, with an average of 45.6 kg per capita per year (BPS Indonesia, 2023). In contrast, the province of Jakarta has the lowest beef production per capita, with an average of only 2.3 kg per capita per year (BPS Indonesia, 2023). This highlights the significant regional disparities in beef production and consumption in Indonesia.

In an effort to meet food needs, the amount of production and consumption are closely related. This includes efforts to provide a sufficient amount of output to meet domestic needs and overcome the dynamics of public demand for these products. The factors that affect people's consumption levels are consumer preferences, consumption patterns, income levels, and people's purchasing power, while the speed of production depends on the availability of inputs such as land, labor, technology, and the influence of market conditions, including price fluctuations (Heatubun & Matatula, 2023). The government overcomes this problem by establishing Indonesian beef production center areas in seven provinces with four provinces centered on the island of Java, which in 2021 contributed 53.48 percent of Indonesia's total beef production. The second position is occupied by East Java with a contribution of 21.31 percent and is accompanied by West Sumatra, West Java, Central Java, Banten, and South Sulawesi (PDSIP, 2022).

Table 1. Beef Production Deficit in 2023 (thousand tons)

Area	Production Deficit
West Java	-171,25
Banten	-43,38
Central Java	-26,93
Lampung	-10,78
West Sumatra	-2,67
South Sulawesi	-2,05
East Java	-1,03

Source: BPS Indonesia, 2023

Java Island as the region with the most populous population faces the largest deficit. The production of beef and buffalo meat in Java is only around 260.38 thousand tons, which is far below consumer needs which reaches 583.36 thousand tons. This created a significant deficit of 322.98 thousand tons. This condition also occurs in other Indonesian islands (Sumatra, Kalimantan, Sulawesi, Maluku, and Papua) albeit with a smaller deficit scale. If traced in more detail by province, the highest deficit was experienced by West Java, which reached 171.25 thousand tons (Table 1).

West Java and East Java, as the provinces with the highest population in Indonesia, have considerable challenges in meeting the needs of beef consumption. This imbalance indicates the need for strategies in the management of meat production and distribution, such as the government's program to achieve meat self-sufficiency in 2010 through agricultural revitalization efforts to shift surpluses from regions such as Bali and Nusa Tenggara to high-deficit areas such as Java. This effort will not only help reduce dependence on meat imports, but also support national food security more evenly and reduce imports which are increasing every year (Pakpahan, 2014).

In the context of trade between regions, market integration is a very relevant issue to ensure efficient and equitable distribution of beef. A study conducted by Pramita, D., & Ruslan, J (2023) Price Variability and Beef Market Integration in Java (Andriansyah et al., 2025)

shows that the lack of beef market integration in Indonesia is one of the main causes of significant price disparities between producer regions, such as West Nusa Tenggara, and major consumer regions such as Jakarta. This disparity not only burdens consumers in regions with high demand, but also reduces incentives for farmers in producing regions to increase their production, as the prices received do not reflect the actual demand. Therefore, in this discussion to answer the question of the research formulation that is relevant to the objectives of (1) knowing the variability and changes in beef prices on the island of Java, which is the most populous island in Indonesia and has the highest beef consumption, and (2) how the price asymmetry at each level of the beef market on the island of Java, as a representative region that reflects the complexity of Indonesia's beef market.

RESEARCH METHODS

This study uses data on daily beef prices at the level of producers, wholesalers, and traditional markets in several provinces on the island of Java, namely Banten, West Java, Central Java, and East Java. This province is selected because these regions have relatively significant price changes in several periods. The price data collected comes from daily data ranging from January 1, 2020 to November 19, 2024 (1276 observations) sourced from PHIPS (National Food Price Information Center), and other relevant sources. The selected time period captures recent trends in daily beef prices, including potential fluctuations caused by significant economic and policy events. This period encompasses the impact of the COVID-19 pandemic, recovery phases, and recent market dynamics that could influence price movements. Additionally, the availability and reliability of data for this range ensured a comprehensive analysis while maintaining consistency in data sources. As for answering the objectives in this study, several method approaches are carried out, including the following:

Coefficient Variance (CV)

Coefficient of Variation (CV) is a statistical method used to measure the level of dispersion or variation of a data relative to its mean. In this study, the calculation of the value of the Coefficient of Variation (CV) was used to analyze the stability of food prices, especially beef prices in several provinces on the island of Java (Jati, 2014). The CV value is calculated by comparing the standard deviation against the average food price. Standard deviation reflects how far the data spreads out from the mean value, while CV allows for comparison of variation between different data groups with varying units.

Using this approach, analysis can provide a clearer picture of the level of stability or price fluctuations in various regions. The higher the CV value, the greater the fluctuation or instability of beef prices, which indicates a significant price variation among provinces on the island of Java. In contrast, a low CV value indicates better price stability because prices tend to move in a narrower range.

Econometrics model

In conducting data processing, there are several stages carried out in testing price asymmetry, namely (1) structural break, (2) the cointegration problem must be examined and the number of t lags that will be included in each asymmetric equation, (3) the causal relationship between beef prices at the producer level and meat prices at wholesalers and traditional markets. After that, the price of Price Variability and Beef Market Integration in Java (Andriansyah et al., 2025)

asymmetry in the supply chain of quality one and quality two beef uses the Houck and ECM-EG approaches.

1. Structural Break

Structural Break is used to detect significant changes in beef prices due to certain circumstances or conditions. In determining the structural break, an additive outlier model is carried out with the following formula:

$$y_t = \mu + \beta \cdot t + \gamma DT_t^* + \tilde{y}_t \dots\dots\dots(1)$$

Information:

t : the sum of the time series ($t=1,2,\dots t$ in this case is 1276)

DT_t^* : a dummy variable whose value is equal to one if $t > Tb$ (Tb is the break date)

$\tilde{y}_t$: Beef prices have decreased

2. Cointegration

Cointegration is the first stage before data processing. The cointegration test is a test to find out how the balance relationship or long-term relationship of variables is used (Insukindro, 1999). In this study, the variables that were verified for their cointegration were producer price variables with consumer price series for beef. The object used in the study is the price of beef at the level of producers, wholesalers, and traditional markets in several provinces on the island of Java (West Java, Central Java, East Java, and Banten). Referring to Johansen & Jeselius (1990), the formula used to conduct the cointegration test is as follows:

$$P_t = \mu + j = 1kP_{t-1} + e_t \dots\dots\dots (2a)$$

Information:

P_t : price vectors of producers (PP), large producers (PB), and traditional markets (PT)

k : determines how many previous periods (lags) of the variable are included in the model

e_t : residual Gaussian.

After conducting the cointegration test, the next step is to conduct an *Augmented Dickey Fuller* (ADF) test to ensure that the data processed is stationary at the level and difference level. Reparameterization of equation (2a) into the form of VECM (equation 1b) is required to determine the power of to obtain a conclusion regarding the sum of the cointegration equations.

$$P_t = c + P_{t-1} + j = 1kB_j P_{t-j} + e_t \dots\dots\dots (2b)$$

Information:

P_t : long-term matrix and adjustment parameters;

B_j : matrix of short-term parameters;

e_t : vector i.d; and j is the amount of lag.

In this test, Trace statistics are used to determine the cointegration between producers and wholesalers and traditional markets for each province on the island of Java.

3. Causality Relationship

After conducting a stationary test, a Granger causality test was carried out to analyze the causal relationship between producers and consumer prices of beef at the producer level, at wholesalers, and in traditional markets. Two equations are used in this step (equations 2a and 2b). Equation 2 is the regression equation and the price of beef producers is influenced by prices at the traditional market level.

$$PP_t = \mu_1 + j=2n_{1pp}PP_{t-1} + i=1n_{2pb}PB_{t-1} + i=0n_{3ptd}PT_{t-1} + e_{t1} \dots\dots\dots (2a)$$

$$PB_t = \mu_2 + i=1n_{1pp}PP_{t-1} + i=2n_{2pb}PB_{t-1} + i=0n_{2pt}PT_{t-1} + e_{t2} \dots\dots\dots (2b)$$

$$PT_t = \mu_3 + i=0n_{1pp}PP_{t-1} + i=1n_{2pb}PB_{t-1} + i=2n_{2pt}PT_{t-1} + e_{t3} \dots\dots\dots (2c)$$

Information:

PP_t ; PB_t ; PT_t : Value at time t where price vectors of producers (PP), large producers (PB), and traditional markets (PT)

n : Coefficient model

e_{t1} ; e_{t2} ; e_{t3} : Error term.

p_p ; p_b ; t : The lag selected based on the information criteria (AIC, BIC, or HQC).

The conclusions to be obtained are as follows:

- If the p_p value; p_b ; $p_t \neq 0$, then there is no long-term reciprocal relationship between variables.
- If $p_p=0$ and $p_b \neq 0$, then in the long run, PB_t causes a change in PP_t
- If $p_b=0$ and $p_t \neq 0$, then in the long run, PT_t causes a change in PB_t
- If $p_p=0$ and $p_t \neq 0$, then in the long run, PT_t causes a change in PP_t
- If $p_p \neq 0$ and $p_b = 0$, then in the long run PP_t causes a change in PB_t
- If $p_b \neq 0$ and $p_t = 0$, then in the long run PB_t causes a change in PT_t
- If $p_p \neq 0$ and $p_t = 0$, then in the long run PP_t causes a change in PT_t

4. Price Asymmetry

Based on the results obtained from the causality test that changes in PP_t that result in changes in PB_t , changes in PB_t that result in changes in PT_t , and changes in PT_t that result in changes in PP_t , Houck's approach can be written as follows:

$$PB_t = 0 + {}_1PP_t^+ + {}_2PP_t^- + t \dots\dots\dots (3)$$

$$PT_t = 0 + {}_1PB_t^+ + {}_2PB_t^- + t \dots\dots\dots (4)$$

$$PP_t = 0 + {}_1PT_t^+ + {}_2PT_t^- + t \dots\dots\dots (5)$$

Information:

$PP_t^+ = PP_t - PP_{t-1}$ when $PP_t > PP_{t-1}$ and 0 or vice versa

$PP_t^- = PP_t - PP_{t-1}$ when $PP_t < PP_{t-1}$ and 0 or vice versa.

According to Capps & Sherwell (2007), it takes time to adjust prices between producers, wholesalers, and traditional markets with the following formula:

$$PB_t = a_0 + i=0m_{1i}PP_{t-1}^+ + i=0m_{2i}PP_{t-2}^- + t \dots\dots\dots (6)$$

$$PT_t = b_0 + i=0m_{1i}PB_{t-1}^+ + i=0m_{2i}PB_{t-2}^- + t \dots\dots\dots (7)$$

$$PP_t = c_0 + i=0m_{1i}PT_{t-1}^+ + i=0m_{2i}PT_{t-2}^- + t \dots\dots\dots (8)$$

Information:

i_1 : P price increase against PB price

B_{1i} : increase in the price of PB against the price of PT

C_{1i} : increase in PT prices against PP prices

z_1 : P price decrease against PB price

B_{2i} : the decrease in the price of PB against the price of PT

C_{2i} : decrease in PT prices against PP prices

The hypothesis in this asymmetry can be known based on the following formula:

$$H_0 = i=0m_{11i} = i=0m_{21=2i} \dots\dots\dots (9)$$

$$H_0 = i=0m_{1b1i} = i=0m_{2b1=2i} \dots\dots\dots (10)$$

$$H_0 = i=0m_{1c1i} = i=0m_{2c1=2i} \dots\dots\dots (11)$$

Where if H_0 is rejected, it indicates that there is an asymmetric price asymmetry of the price from the PB price to the PP price; PT to PB; and PP to PT. The ECM-EG model has the following formula:

$$PP_t = \mu_1 + i=0n_2^-PB^-_{t-i} + i=1n_1^-PP^-_{t-i} + i=0n_3+PB^+_{t-i} + i=0n_4+PP^+_{t-i} + t \dots (12)$$

$$PB_t = \mu_1 + i=0n_2^-PT^-_{t-i} + i=1n_1^-PB^-_{t-i} + i=0n_3+PT^+_{t-i} + i=0n_4+PPB^+_{t-i} + t \dots (13)$$

$$PT_t = \mu_1 + i=0n_2^-PP^-_{t-i} + i=1n_1^-PT^-_{t-i} + i=0n_3+PP^+_{t-i} + i=0n_4+PTPT^+_{t-i} + t \dots (14)$$

The surplus (positive) value in the coefficient indicates a positive change in the variable and the negative value indicates a negative change in the variable (Rao & Rao, 2005). Furthermore, the steps taken were taken to test the asymmetric price transmission hypothesis in equations 9, 10, and 11 and the F test in equations 12, 13, and 14.

RESULT AND DISCUSSION

In this section, the discussion is focused on discussing the results of data analysis to answer the research objectives. The first analysis is to find out how the **variability of beef prices** in the provinces includes Banten, West Java, Central Java and East Java Provinces. The results of the analysis are seen based on the Coefficient Variance (CV) value for the value of the comparison between the standard deviation and the average value of the data. The equation used in this analysis uses the original price value equation. The results of the analysis are as follows:

Table 2. Description of Beef Prices Statistics in Java for Period 1/01/2020 – 19/11/2024

Area/ Pass	Obs	Original Price				
		Average	Std. Dev	Min	Max	CV
Banten						
Manufacturer (PP)	1276	122959	9232,33	107500	140000	7,5
Wholesaler (PB)		130008	11731,97	115000	150500	9
Traditional Market (PT)		135119	8126,69	121250	165850	6
West Java						
Manufacturer (PP)	1276	118132	8908,18	102100	133650	7,5
Wholesaler (PB)		128705	7238,25	116800	146550	5,6
Traditional Market (PT)		139743	7613,43	124800	160000	5,5
Central Java						
Manufacturer (PP)	1276	116417	5252,94	106700	123500	4,5
Wholesaler (PB)		121928	7644,45	110550	141650	6,3
Traditional Market (PT)		126719	6778,99	113150	143150	5,4
East Java						
Manufacturer (PP)	1276	110036	3250,68	103900	116250	3
Wholesaler (PB)		112046	2974,28	105650	124700	2,7
Traditional Market (PT)		121048	3455,55	114350	131300	2,9

Source: Data processing results using Stata MP17 Software

Beef prices in the period from January 1, 2020 to November 20, 2024 in Java (Table 2) show that there are price variations at various market levels. The lowest average price of beef at the producer level is in West Java at IDR102,100, which is suspected to be due to the fact that this region has good access to livestock centers and efficient logistics infrastructure, thus reducing production and distribution costs. The lowest price at the wholesale level in East Java is IDR105,650, which is suspected to be caused by this region being the main production center with abundant supply and short distribution distances. because this area is the main distribution channel on the island of Java with efficient logistics flows and high market competition. On the other hand, the highest average price at the producer level is in Banten at IDR107,500 because this area is not a production center, so it depends on external supply with high transportation costs. At the wholesale level, Banten also recorded the highest price of IDR116,800 due to limited local supply and high distribution costs from other provinces. The highest price at the traditional market level was recorded in West Java at IDR124,800 due to high demand in urban areas such as Bandung, as well as distribution costs from rural areas which added to the price burden at the end consumer level.

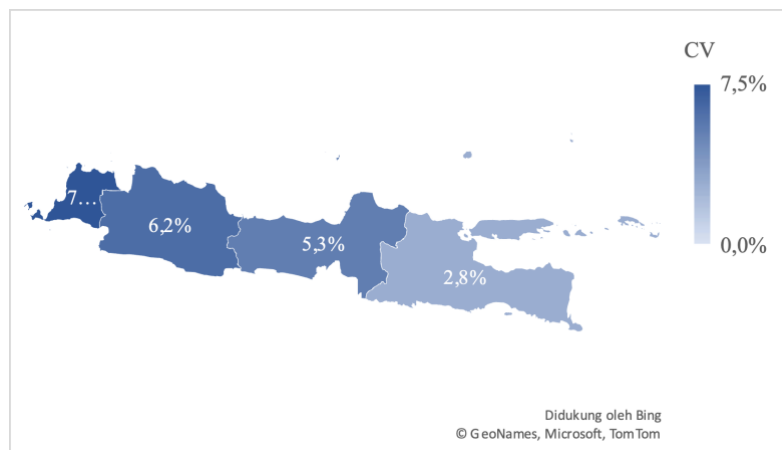


Figure 2. Coefficient Variance of Beef Prices in Java for the Period 1/01/2020 – 20/22/2024

In the context of beef prices in Java (Figure 2), CV shows how much price fluctuations occur in each region compared to the regional average price. Based on the visualization map, the CV value in Banten and West Java Provinces was recorded higher, namely around 6.2% to 7.5%. The high CV in this region can be attributed to the magnitude of demand due to urbanization, rapid market dynamics, and the complexity of longer distribution chains (Harahap. R, & Fitri, 2014; Sandiarti, A & Septiani, 2022). This condition illustrates that price fluctuations in the area are more significant compared to other regions, while the Central Java and East Java regions tend to have lower CV values which are suspected to be caused by these areas as beef production centers.

Central Java has a CV value at the middle level, which is 5.3%. This shows that the price variation in this region is more moderate. This stability can be attributed to Central Java's position as a major distribution area that balances the roles of producers and consumers. Meanwhile, East Java has the lowest CV value, which is around 2.8%. The low price variation in the eastern region of Java Island can be attributed to the role of a significant beef production center in the area (Ilham, 2016). With a more stable supply and shorter access to distribution, prices in the eastern region tend to be

more controlled. The level of price variation is thought to be influenced by geographical, economic, and distribution factors, where urban areas such as Jakarta and West Java tend to have higher price fluctuations than producer areas such as East Java. For example, urban areas in Jakarta and West Java tend to experience higher price fluctuations due to large demand, high distribution costs, and dependence on supply from other regions. In addition, rapid urbanization and dynamic economic activity in the region have also contributed to price instability. In contrast, producer regions such as East Java have lower price variations due to abundant supply and shorter distribution distances, which allows for better price stability.

When viewed from the CV value (Table 1), the Coefficient of Variation (CV) value shows that there is a significant difference in the variation in beef prices between provinces on the island of Java in the 2020-2024 period. East Java has the most stable price variation, with the lowest CV in all market categories (Producer 2.95 percent, Wholesale 2.65 percent, Traditional Market 2.85 percent). This indicates higher price stability at production and distribution levels in the province compared to West Java, Central Java, and Banten. On the other hand, Banten showed the highest price variation, especially in Wholesalers (PB) who had a CV of 9.02 percent. The stability of beef prices in West Java, Banten, and Central Java is allegedly influenced by various factors that interact with each other, such as being positively influenced by international beef prices. In addition, research by Zainuddin et al. (2015) shows that there is an integration between beef prices in the domestic and international markets, which means that price changes in the global market can have a direct impact on prices in the domestic market.

The fluctuation of beef prices at the market level in each region is influenced by various factors such as dependence on external supply, higher distribution costs, and high demand in the region. This is in line with the research of Raihan & Harmini (2023) which said that beef prices in West Java are positively and significantly affected by international beef prices in the long term while the slaughter cattle population has a significant negative effect in the short term. In addition, the opinion of Hasibuan *et al.* (2022) states that the difference in the location of production and consumption centers, as well as high transportation costs, causes disparities in beef prices between provinces in Indonesia.

Price variability often occurs due to price changes influenced by various factors, such as demand, supply, production costs, and distribution. When the price of a commodity fluctuates, it reflects unstable market dynamics, where price changes can be triggered by an imbalance between supply and demand (Sukmawati, 2016; Ariestiyanti, Dwi & Adrison, 2020; Marina, 2024). For example, when supply from production centers decreases due to bad weather or logistical disruptions, prices tend to increase due to demand remaining high. On the other hand, when supply is abundant, prices can decrease due to surpluses. This variation is further exacerbated by external factors, such as changes in government policies, exchange rate fluctuations, and global market trends, which make prices non-uniform and create variability in different regions or markets.

Changes in beef prices that are quite high and fluctuating in the four provinces that occur cause variations in beef prices that are quite varied. The changes that occurred describe the factors that affect beef prices throughout the period. Therefore, to further understand where price changes occur, a more in-depth analysis is needed that includes mapping the areas of fluctuations, identifying the main causes in each province in the next discussion.

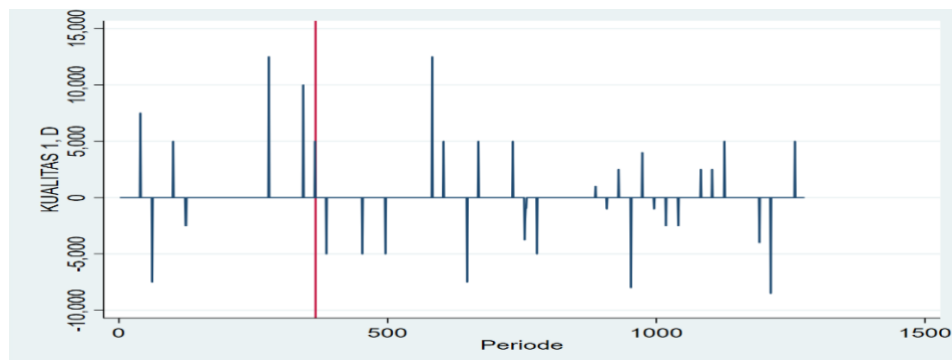


Figure 3. Structural Break of Beef Prices in Banten Province Period 1/02/2020 – 19/11/2024

The change in beef prices in Banten Province occurred in the period of May 26, 2021, as a result of the increase in the average price of beef in Banten before the Breakpoint of around IDR 111,897 per kg, an increase of IDR 127,382 per kg after the Breakpoint. Hasibuan (2022) stated that the average price in Banten Province increased during the Covid-19 pandemic by 6.71%. The existence of mobility restriction policies (PSPB and PPKM) during the Covid-19 pandemic has also resulted in disruption of inter-island trade so that the supply of beef to the region becomes limited so that beef prices increase. Based on data from the Basic Needs Market Monitoring System (SP2KP) of the Ministry of Trade, although Banten Province experienced an increase in beef prices during the pandemic, the average price of meat is still lower than the consumer reference price of IDR120,000 per kg. The price of beef in Banten has no more impact than Eid al-Fitr because the Banten Provincial Government has taken steps to anticipate price increases and maintain the availability of staples during Ramadan and ahead of Eid al-Fitr.

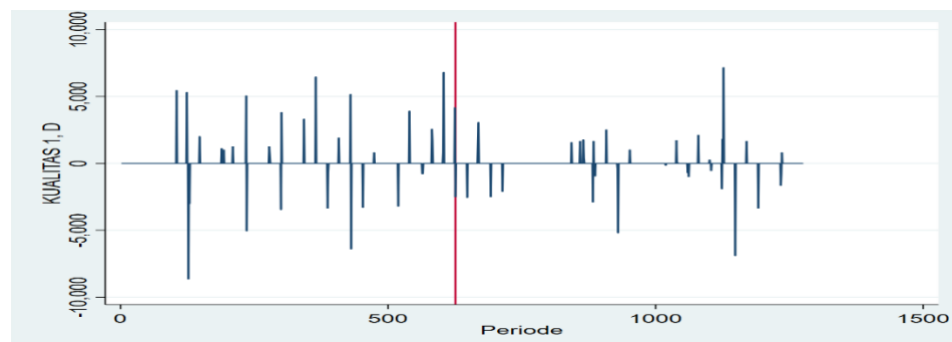


Figure 4. Structural Break of Beef Prices in West Java Province Period 1/02/2020 – 19/11/2024

The change in beef prices in West Java Province occurred in the period of May 25, 2022 with a significant rate of change with a real level of 5 percent. The reason for this is because West Java is ranked sixth out of seven provinces that have beef consumption above the national average beef consumption. The average beef consumption in West Java Province is 0.58 kg/capita/year while the average national beef consumption is 0.45 kg/capita/year (DJPKH, 2021). In the same time period, relatively high beef prices contributed to increasing inflation by 0.37 percent, which became the largest contributor to inflation after intercity transportation (BI, 2021).

The relatively high inflation rate has a negative impact on economic actors, coupled with annual moments such as Ramadan and Eid al-Fitr fasting in May 2022, causing beef prices to tend to

rise. Based on data from the National Strategic Food Price Information Center or PHIPS (2024), the average price of beef in West Java before the Breakpoint was around IDR 110,203 per kg and after the Breakpoint the price increased to IDR 125,743 per kg. The price of West Java beef after the Breakpoint is higher when compared to the reference price. The Center for Indonesian Policy Studies (2024) said that the increase in domestic beef prices is related to beef prices in Australia and New Zealand as well as the increase in distribution costs.

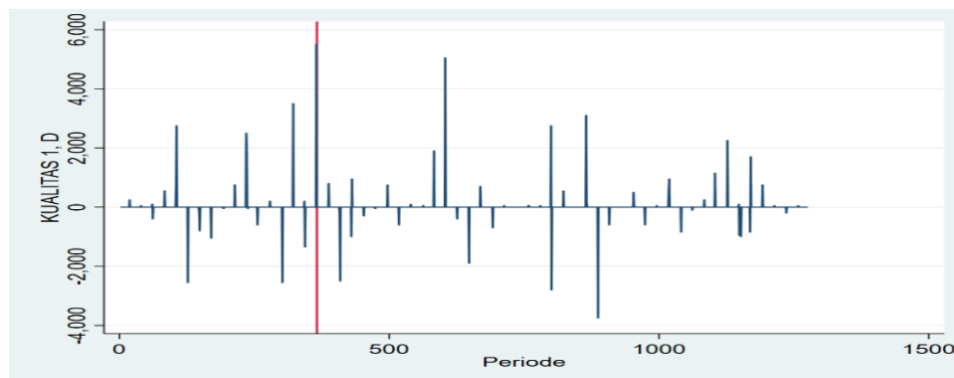


Figure 5. Structural Break of Beef Prices in Central Java Province Period 1/02/2020 – 19/11/2024

The change in beef prices in Central Java Province occurred on May 26, 2021. This is likely to happen because during the pandemic, where the average price of beef in Central Java before the Breakpoint was around IDR 109,132 per kg and after the Breakpoint the average price increased to IDR 119,338 per kg. This price increase, especially in Central Java, is most likely influenced by the increased demand for beef after the Eid al-Fitr celebration, which generally triggers a surge in consumption and food prices (Firmansyah, et.al, 2021; Sandiarti, A., & Septiani, 2022).

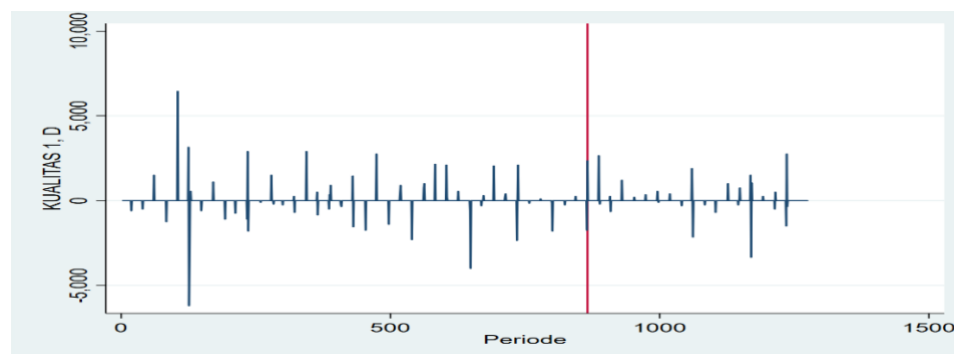


Figure 6. Structural Break of Beef Prices in East Java Province Period 1/02/2020 – 19/11/2024

The change in beef prices in East Java Province occurred in the period of April 26, 2023, which is estimated because East Java Province is one of the centers of beef production so that it plays a role in the volatility of beef prices in East Java. In East Java, the price of beef before and after the Breakpoint is always lower than the reference price. Before the Breakpoint, the average price of beef in East Java was IDR 108,295 per kg, increasing to IDR 113,709 per kg after the Breakpoint. The fact that beef prices are increasing especially ahead of Ramadan and Eid al-Fitr is similar to a previous study by Wulandari *et al.* (2023).

The beef price data used in the further analysis for the discussion of this study is data timeseries in the form of daily data for the period 1/01/2020 – 19/11/2024. As for data testing Price Variability and Beef Market Integration in Java (Andriansyah et al., 2025)

timeseries has several stages in determining the model, namely testing *unit root test* to see the level of stationarity of the data. The results of the ADF test with the Natural Logarithm (LN) equation by processing data using software StataMP 17 shows the existence of a unit root for all price series in level $I(0)$ dan difference $I(1)$. This shows that stationarity has been achieved for all price series in levels and spreads according to the area of analysis performed. The statistical root unit test showed that each pair of beef price series considered in the four provinces was integrated at the same level of data stationery.

Cointegration is one of the stages in the timeseries data test which aims to find out how the long-term relationship between the variables used. The coercion test carried out focuses on determining the relationship between markets in the object of discussion. The results of the cointegration test show that the stationary research variables at the level and difference can be seen in Table 3.

Table 3. Cointegration Rank Test Results

$r \leq$	Banten	West Java	Central Java	East Java
0	110,62	141,01	95,98	136,43
1	15,10*	37,15	37,39	55,17
2	3,37	2,92*	1,85*	2,39*

Source: Data processing results using Stata MP17 Software

The table shows that West Java, Central Java and East Java have two cointegration relationships that show a more complex long-term relationship between these variables while Banten only has one cointegration relationship that reflects the existence of a simpler long-term relationship of the variables tested. The difference in the co-integration relationship of each province shows the level of market integration and different variables in each province.

The Causality Test in this study is used to analyze the relationship between variables that have been explained by the cointegration relationship from the results of the cointegration test in the previous discussion. Based on the test, it shows that there are several significant similarities at each market level in Banten, West Java, Central Java, and West Java Provinces (Table 4).

Table 4. Causality Test Results

Province	Was	Prob.	Causality	Province	Was	Prob.	Causality
Banten	1	0.0000	PB changes PP, PP changes PB (PB↔PP) PT changes PP, PT changes PT (PT↔PP) PP changes PB, PB changes PT (PP↔PB)	West Java	2	0.0000	PT changes PP, PP changes PT (PT↔PP) PP changes PB (PP→PB) PT changes PB, PB changes PT (PT↔PB)
Province	Lag	Prob.	Causality	Province	Lag	Prob.	Causality
Central Java	2	0.0000	PB amends PP (PB→PP) PT changes PB, PB changes PT (PT↔PB) PP changes PT, PT changes PP (PP↔PT)	East Java	2	0.0000	PT changes PP, PP changes PT (PT↔PP) PP changes PB (PP→PB) PT changes PB (PT→PB)

Source: Data processing results using Stata MP17 Software

The results of the coefficient and P-value estimation are smaller than the Chi-square value and the ECM approach for the four provinces. The ECM approach carried out has the advantage of consistent parameter estimation results both in terms of signs and sizes. The level of significance used is the level of five percent where the related variable is a variable related to the current time when the price rises and when the price drops significantly (Table 4). This study shows that there are fluctuations in beef prices at the producer level due to changes in market prices at the wholesaler level and traditional markets and vice versa in the same time period. The number of lags related to the variables of price increases and decreases is two, and there are the provinces of West Java, Central Java, East Java, and Banten.

Referring to the results of the causality test, it can be concluded that there is a simultaneous correlation between prices in the producer-level market, wholesalers and traditional markets in Banten, West Java, Central Java and East Java provinces. The results are different from previous studies where the results for the relationship test can estimate some equations for each province, namely the equation related to the market price at the producer level causes the price at the wholesaler level market and vice versa ($PP \leftrightarrow PB$), the producer level market price causes the price at the traditional market level and vice versa ($PP \leftrightarrow PT$), the market price at the wholesaler level causes the price in the traditional market and vice versa ($PB \leftrightarrow PT$), in addition there is also a one-way correlation from each market level such as the market price at the producer level causes the price at the market at the wholesaler level ($PP \rightarrow PB$), such as the traditional market price causes the price at the market at the wholesaler level ($PT \rightarrow PB$), and like the market price at the wholesaler level causes the price at the producer level market ($PB \rightarrow PP$). The results of the test are in accordance with the results of research by Komiawati (2021) which stated that changes in beef prices at one market level can affect prices at other levels due to the integration relationship between markets. Based on this, the equations related to the price relationship between the markets can then be analyzed related to price asymmetry in the ECM and Houck approaches in Table 5 and Table 6.

Table 5. Empirical Results of the ECM Approach on Beef in Java Island Period 1/01/2020 – 19/11/2024

	Banten			West Java		
	PP	PB	PT	PP	PB	PT
Intercept	0,0107068a (0,795) ^b	-0,0687895 (0,022)	11,81223 (0,000)	0,0001411 (0,424)	0,0000831 (0,527)	0,0000782 (0,558)
PPt		0,0058345* (0,022)	-0,0582259 (0,797)		-0,0312286 (0,135)	0,0354762 (0,094)
PBt	0,000209 (0,996)		0,7119900* (0,021)	-0,0563537 (0,135)		0,1846309* (0,000)
PTt	-0,0008986* (-0,0077)	0,0001119 (0,9960)		0,0621665 (0,0940)	0,1792891* (0,0000)	
R square	0,0001	0,0041	0,0053	0,0087	0,0348	0,0348
R2-ADJ	-0,0015	0,0026	0,0030	0,0064	0,0325	0,0325
Test F for symmetry	0,9670	0,0713	0,0790	0,0112	0,0000	0,0000

	Central Java			East Java		
	PP	PB	PT	PP	PB	PT
Intercept	0,0001089 (0,228)	0,0001278 (0,478)	0,0000938 (0,557)	0,0000562 (0,621)	0,0000393 (0,763)	0,0000513 (0,610)
PPt		-0,01602 (0,739)	-0,030561 (0,538)		0,0321607 (0,762)	0,0165016 (0,506)

	Banten			West Java		
	PP	PB	PT	PP	PB	PT
PBt	-0,0047002 (0,739)		0,0734582* (0,003)	-0,0074329 (0,762)		0,0898362* (0,000)
Ptt	-0,0098041 (0,0538)	0,0932667* (0,003)		0,021133 (0,5060)	0,1510181* (0,0000)	
R square	0,0017	0,0086	0,0093	0,0242	0,0137	0,0140
R2-ADJ	-0,0006	0,0062	0,0070	0,0219	0,0113	0,0117
Test F for symmetry	0,5344	0,0122	0,0078	0,0000	0,0006	0,0004

a) Parameter Estimate | b) P-Value

Source: Data processing results using Stata MP17 Software

Based on the ECM approach, it can be seen that the increase in beef prices exceeds the effect of the overall price increase. In Banten Province there is a price asymmetry relationship at the level of traditional markets to wholesalers, then in the Provinces of West Java, Central Java and East Java there is a price asymmetry relationship that is interconnected between the level of wholesalers to the traditional market and vice versa. The dominant similarity of the relationship between PB↔PT and the ECM approach shows that the ECM test results are significant at the alpha level of five percent, which means that the H1 hypothesis is accepted. This study shows that there is a price asymmetry between wholesalers (PB) and traditional markets (PT) and vice versa in the period of January 1, 2020-November 19, 2024 (West Java, Central Java, and East Java). Then, in the same period in Banten Province, the relationship between the level of traditional markets and wholesalers was not significant. This shows the possibility of price increases and decreases at the same speed.

The results of the analysis of price transmission in the four provinces can be compared with several similar studies to understand the pattern and causes of price asymmetry differences in Indonesia. Research by Komalawati *et al.* (2021) shows that the transmission of beef prices between consumer areas (Jakarta) and producers (Bandung, Semarang, Surabaya) tends to be asymmetrical, with two-way transmission only occurring between Jakarta and Bandung and Semarang. This is consistent with the results in West Java, Central Java, and East Java where the relationship between market levels shows a strong price transmission of $R^2 > 0.9$) but accompanied by a significant asymmetry pattern ($p = 0.000$).

The research conducted is different from the research of Sahara & Wicaksono (2013) which concluded that there is an asymmetric price food on the island of Java. Because of this, price changes at each market level are transmitted directly to other market levels. This is because agricultural commodities are perishable and prices fluctuate so that prices cannot be determined at the level of producers, wholesalers, or traditional markets. In Banten, most associations did not show a different price asymmetry ($P > 0.05$) than the Sahara and Wicaksono studies. This is due to different market structures such as a lower concentration of wholesalers in Banten. However, this result is in line with the research of Dewi & Sahara (2018) which mentions the transmission of price asymmetry in red chili in the parent market and the research of Tri (2020) which reveals that the transmission of beef prices in East Java affects the formation of prices at the consumer level. These results describe the dynamics of price transmission that vary between commodities and regions, influenced by the nature of the commodity, market structure, and the length of the distribution chain. In general, the results of this study state that price asymmetry is highly dependent on the market structure, the length of the

distribution chain, and the nature of the commodity. More research is needed to understand other factors, such as trade regulations and the level of competition in each region, that can affect price transmission patterns.

Table 6. Elasticity of Beef Price Transmission with the Houck Approach

Province	Var	Elasticity					
		PB → PP	PT → PP	PP → PB	PT → PB	PP → PT	PB → PT
Banten	ΔPP+			-0,3157371		-0,0248387	
	ΔPB+	0,9864738					1,554217
	ΔPT+		0,0475342		-0,8367227		
	ΔPP-			-0,3932698		-0,1137888	
	ΔPB-	-0,726399					-0,5555347
	ΔPT-		-0,1518779		0,3945394		
West Java	ΔPP+			-0,1708955		0,0024557	
	ΔPB+	-0,03999209					-1,008977
	ΔPT+		-0,8802519		0,230096		
	ΔPP-			-0,2850066		0,2573533	
	ΔPB-	-0,912064					0,2573533
	ΔPT-		0,4041523		-1,364819		
Central Java	ΔPP+			-0,3078413		-0,151611	
	ΔPB+	0,1437958					0,9054325
	ΔPT+		-0,051742		0,6551694		
	ΔPP-			0,5690052		0,4745148	
	ΔPB-	-0,3964772					-0,935151
	ΔPT-		-0,3048269		-1,609228		
East Java	ΔPP+			-0,0216312		0,0340003	
	ΔPB+	0,102437					0,8999258
	ΔPT+		-0,4103999		0,4636821		
	ΔPP-			0,351434		0,3919623	
	ΔPB-	-0,372791			-1,226476		-0,6823089
	ΔPT-		0,1589575				

Source: Data processing results using Stata MP17 Software

Elasticity in the Houck and Error Correction Model (ECM) approach aims to measure the responsiveness of dependent variables (affected variables) to changes in independent variables (influencing variables) in the short and long term. This approach allows for the analysis of the dynamics of price adjustments or other variables that occur in the short term as well as the long-term relationships between these variables. This is in line with the research of Granger & Yoon (2002), ECM is used to identify long-term relationships between integrated economic variables, while allowing for the analysis of short-term adjustments to equilibrium. The elasticity value in Table 6 shows significant differences in price response between PP, PB, and PT in various provinces in Indonesia. The highest elasticity value was found in Banten where the elasticity between PB and PT showed a very strong relationship with a positive elasticity of 1.554. This means that the increase in prices in PB will cause a significant price increase in PT. Conversely, the negative elasticity between PP and PB of -0.316 indicates that an increase in PP prices will reduce prices in the PB market.

The elasticity value between PP and PB shows a small negative elasticity of -0.171 which means that price changes at the producer level have a limited impact on the wholesaler market. Meanwhile, a more significant negative relationship between PB and PT of -1.009 suggests that price changes at the wholesaler level can lower prices at the traditional market level. Central Java Province

has a positive elasticity value found between PB and PT of 0.905, indicating that an increase in prices at the wholesaler level will cause an increase in prices at the traditional market level. However, a smaller negative relationship was seen between PP and PB of -0.308, indicating a limited influence of PP price changes on the PB market. Meanwhile, the province of East Java has a smaller and more diverse elasticity showing a relatively lower price influence between these markets. A significant positive elasticity value seen between PB and PT of 0.899 shows that the increase in prices in the PB market increases prices in PT. Overall, this elasticity illustrates that price relationships between markets can differ significantly between provinces, with some markets having a greater impact on others, while others exhibit smaller or insignificant price responses.

This research is in line with the research of Nggadu (2021) revealing that the elasticity of beef price transmission in Gorontalo Regency has an average value of 0.878 with the meaning that the change in beef prices at the consumer level is smaller than the rate of price change at the producer level while Priyadi *et al.* (2024) show that the elasticity price transmission in Pati Regency has inelastic characteristics with an elasticity value smaller than one that indicates that price changes at the merchant and consumer levels are inefficient in transmitting price changes from the farmer level. This study concludes that the price elasticity between markets in Indonesia is heterogeneous and influenced by various factors, including commodity characteristics, infrastructure, and local market dynamics. An in-depth understanding of price elasticity is important to formulate effective policies in regulating prices and ensuring market stability at the local and national levels. Because of this, according to Zainudin *et al.* (2015), the Indonesian government through the Ministry of Trade should realize a program to maintain the stability of beef prices so that the price of beef becomes more affordable and reduces the level of losses of producers.

CONCLUSION AND SUGGESTION

The results of the study show that the variability and changes in beef prices on the island of Java show significant fluctuations, which are influenced by factors such as seasonal demand, government policies, and supply disruptions. The provinces of Banten, West Java, Central Java and East Java have quite varied beef prices, but these price variations are still relatively low with price changes that are quite volatile in each province on the island of Java. Banten and West Java provinces are areas with price fluctuations that tend to vary on the island of Java compared to East Java which has a very low variation influenced by the supply of beef production as the center of beef production in Indonesia. In addition, prices at each level of the market, i.e. the level of producers, wholesalers and traditional markets, have a significant relationship for one-way and two-way relationships from each level of the market. There is also a clear price asymmetry at every level of the beef market, where the price difference between wholesalers and traditional markets and vice versa in West Java, Central Java and East Java, while in Banten there is only an asymmetry from traditional markets to wholesalers. This indicates that there is still an imbalance in the price distribution that can benefit certain parties, while consumers and farmers are often negatively affected. These factors reflect the complexity of the beef market in Java, which requires better policies to stabilize prices and improve distribution efficiency. To improve the stability and efficiency of the beef market on the island of Java, it is necessary to strengthen the distribution and logistics system through improving infrastructure, such as transportation routes and storage facilities, as well as the application of digital-based technology to monitor the supply chain in real-time. Fair price policies need to be implemented

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by regulating profit margins at every level of the market and providing subsidies or incentives to small farmers to be more competitive. Increasing local production capacity, especially in East Java as a production center, can be done through livestock modernization, while areas such as Banten and West Java need to strengthen farmer cooperatives and access to capital. Market diversification through the development of processed beef products and sustainable consumption pattern education campaigns can help overcome seasonal demand fluctuations. In addition, strict supervision and enforcement of monopolistic or cartel practices are essential to create a transparent and fair market, so that farmers, traders, and consumers can enjoy balanced benefits.

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