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Vertical Integration of Chicken Egg Prices in Central Java (An Error Correction Model (ECM) Analysis)

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Abstract

Despite high production levels, chicken egg prices in Central Java experience significant volatility. This study analyzes the degree of vertical price integration and identifies the price leadership structure among producers, wholesalers, and retailers in the chicken egg market in Central Java Province. While previous research has examined market integration, a gap remains in understanding price leadership dynamics amid recent post-pandemic economic shifts. This study addresses this gap by providing empirical evidence of vertical price transmission using updated time-series data (2021–2024) across producer, wholesaler, and retailer levels. The ECM approach was employed, with data stationarity first verified via the Augmented Dickey-Fuller (ADF) test. Price leadership was then identified through a two-step analysis of short-term regression and the error correction term. The ADF results indicate that the chicken egg market in Central Java is vertically integrated in both the short- and long-run. The ECM result demonstrates that price adjustments originate at the producer and wholesaler levels and are transmitted forward to retailers in both the short and long run ($p < 0.05$), confirming a supply-led price leadership structure. These findings contribute to the literature by clarifying that upstream segments dictate price formation in the regional market. Consequently, policymakers should prioritize stabilization efforts at the producer level, particularly through feed-cost subsidies and wholesale distribution management, to effectively mitigate volatility across the value chain.

Keywords: fluctuations; market integration; price; purebred chicken eggs.

1. Introduction

Chicken eggs are an important and affordable source of animal protein, widely consumed across income groups in Indonesia (Matsuoka & Sugano, 2022; Pal & Molnár, 2021). Despite their nutritional value and relatively stable demand, egg prices are highly volatile, particularly at the consumer level (Girsang et al., 2023). Previous studies indicate that price instability is driven by rising input costs such as feed and day-old chicks (DOC), seasonal demand during religious holidays, income variability, and external shocks such as disease outbreaks and climate-related disruptions (Lu, 2023; Rahman et al., 2024; Selmi et al., 2023; Nafaati et al., 2021). These factors create frequent price fluctuations, raising concerns about market efficiency and price transmission along the supply chain.

Central Java is one of Indonesia's major egg-producing provinces, ranking second after East Java, with production increasing between 2021 and 2023. However, rising production has not translated into stable prices. Egg prices in Central Java continue to fluctuate significantly throughout the year, particularly during religious holidays and year-end periods, suggesting potential inefficiencies in market coordination. Persistent price volatility despite ample supply indicates that price formation may not be driven solely by production conditions, but also by structural relationships among market actors.

One key approach to assessing market efficiency is vertical price transmission analysis, which examines how price changes at one level of the supply chain are transmitted to other levels.

Efficient markets are characterized by symmetric, timely price transmission, whereas weak or asymmetric transmission may reflect information asymmetry, market power, or imperfect competition. In agricultural markets, such conditions often disadvantage small-scale producers and distort consumer prices.

Several studies have examined egg market integration in Indonesia, focusing on spatial integration or price relationships between selected market levels and regions. Prior research has documented cointegration among producer, wholesaler, and retail prices in regions such as Banda Aceh, Banyumas, and selected areas of Central Java (Nafaati et al., 2021; Setiadi et al., 2022; Arifin & Ahmad, 2016; Abdussalam & Fakhriyana,2024). However, these studies primarily rely on pre-pandemic or short-period data and do not explicitly investigate vertical price leadership across the entire supply chain.

While previous studies have examined egg market integration in specific regions, limited research has analyzed vertical price leadership in Central Java using recent post-pandemic data and an Error Correction Model (ECM) framework. This gap is critical, given structural changes in food markets following the COVID-19 pandemic and rising input prices. Therefore, this study aims to (1) analyze the degree of vertical price integration in the chicken egg market in Central Java Province and (2) identify the price leadership structure among producers, wholesalers, and retailers using monthly time-series data from 2021 to 2024. By applying the ECM approach, this study provides updated empirical evidence on both short-run and long-run price transmission dynamics, offering policy-relevant insights for price stabilization and market governance.

2. Materials and Methods

Secondary time-series data on monthly chicken egg prices at the producer, wholesale, wholesaler, and retail levels from 2021 to 2024 were used, sourced from national food data. An overview of chicken egg price trends, analyzed descriptively with the aid of graphical representations depicting the monthly price fluctuations of purebred chicken eggs across each marketing institution.

ECM was selected due to its ability to capture both short- and long-term price adjustments in vertically integrated markets. The ECM is well-suited for vertical market integration, as its framework facilitates the examination of both short- and long-run equilibrium relationships across distinct markets. Furthermore, the ECM effectively addresses non-stationary time-series data and multicollinearity, allowing the estimation of the speed of price adjustment between markets over a specific period.

The ECM approach is employed to address the first and second research objectives. The degree of vertical integration in the chicken egg market is analyzed based on data stationarity using the Augmented Dickey-Fuller (ADF) test. To identify the price leadership structure among producers, large-scale traders, wholesalers, and retailers, a two-step process is implemented: evaluating the performance of the short-term regression and analyzing the error-correction term derived from the residuals of the long-term equilibrium regression. Prior to this, a classical assumption test, or Ordinary Least Squares (OLS), was conducted to identify a model with the least possible error, and the ECM analysis was carried out using EViews 13. The short-run equation model in ECM analysis is presented as follows:

$$\Delta \ln TE_t = \beta_0 + \beta_1 \ln TP_{t-1} + \beta_2 \ln TG_{t-1} + \beta_3 \ln TPB_{t-1} + \beta_4 ECT + \mu_t \quad (1)$$

The long-run equation model

$$\Delta \ln TE_t = \alpha_0 + \alpha_1 \ln TP_t + \alpha_2 \ln TG_t + \alpha_3 \ln TPB_t + \alpha_4 ECT + \varepsilon_t \quad (2)$$

Where, TE is the retail (consumer level) chicken egg price, TP is the producer-level chicken egg price, TG is the wholesaler-level chicken egg price, TPB is the price of chicken eggs at the wholesale market level, and μ & ε is the residual value. All price variables were transformed into natural logarithms (Ln) to reduce heteroscedasticity, smooth price fluctuations, and allow coefficient interpretation as elasticities. Based on theoretical expectations, the signs of the parameters α1, α2, α3, β1, β2, and β3 are hypothesized to be positive. The vertical integration flow of the chicken egg market can be illustrated with the following figure.

The optimal lag length for the ECM and Granger causality tests was determined using standard information criteria, including the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). The lag length that minimized these criteria while ensuring model stability

and residual diagnostics was selected to avoid over-parameterization and loss of degrees of freedom.

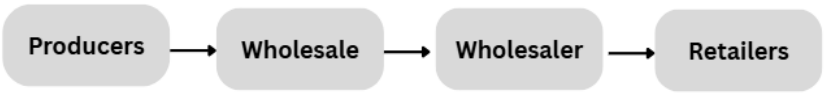

Figure 3. The price change pattern

A unit root test, specifically the Augmented Dickey-Fuller (ADF) test, was conducted to assess the stationarity of the time series data and determine whether the data exhibit constant mean and variance over time. The cointegration approach requires stationary data, making the stationarity test a crucial prerequisite for this analysis. The stationarity of the time series data was assessed using the Augmented Dickey-Fuller (ADF) test. The Granger causality test is a method for examining the relationship between time series variables.

3. Results and Discussion

3.1. The Development of Chicken Egg Prices Across Various Marketing Institutions

The development of chicken egg prices across various marketing institutions, including the producer, wholesaler, and retail levels, is presented in the following figure.

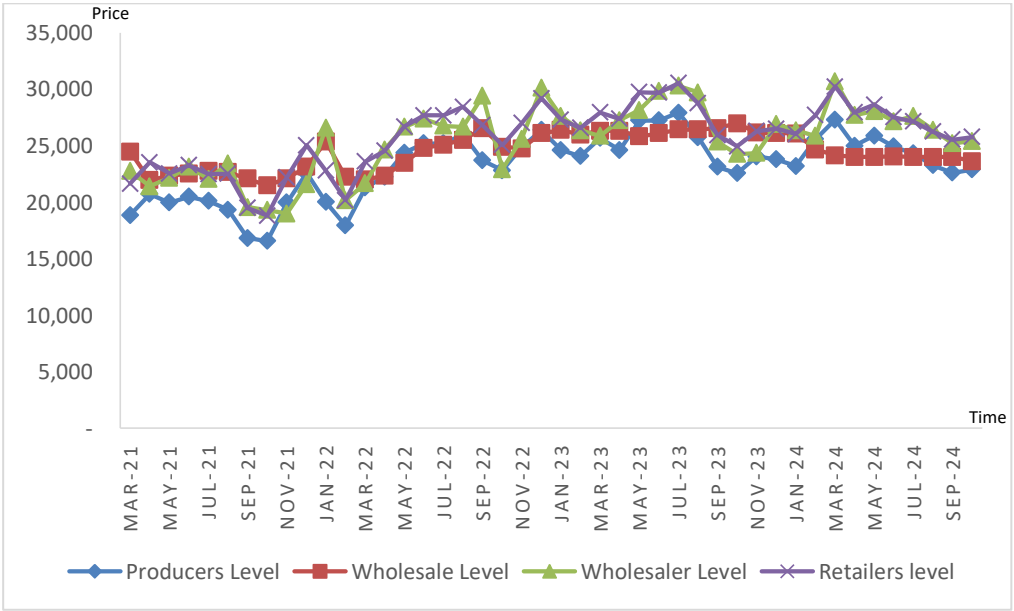

Figure 1. Egg price development in Central Java Province 2021-2024
Source: Secondary data processed, 2024

Figure 1 shows that egg prices across various marketing channels fluctuate, but the changes are not extreme. The prices of eggs at the producer, wholesaler, and retailer levels did not experience significant fluctuations, and similar patterns were observed. The other two marketing institutions followed price increases and decreases at the producer level. From the end of November to January 2021, egg prices declined at the producer level and across all trading institutions. This decline, typically observed at the end of the year and in January, saw prices drop significantly, reaching a range of 16.000 to 17.000 rupiahs per kilogram. Prices again fell from August to September 2022, before rising once more from November to December 2022.

At the beginning of 2023, the price of purebred chicken eggs in Central Java Province decreased. However, it increased again from March to June 2023, coinciding with the holy month of Ramadan and Eid al-Fitr, during which public consumption of animal protein was typically high. The price of purebred chicken eggs declined from July to September 2023 but increased again towards the end of the year, although the increase was not as substantial as in previous months. From February to April 2024, prices rose to the highest level in the previous four years. The increase in chicken egg prices was influenced by various factors, including rising input costs, such as feed, day-

old chicks (DOC), and medicines (Putri et al., 2022). Feed, in particular, represented the most significant proportion of costs in laying hen farming. The primary ingredient in feed was imported corn, and its price was adjusted according to global market conditions and exchange rates. Besides feed, the cost of medicines was another crucial factor. The onset of the COVID-19 pandemic in mid-2020 significantly affected fluctuations in chicken egg prices. In the United States, egg supply chains were severely disrupted, leading to supply shortages in several regions. In addition to these fluctuations, substantial price variations were also observed (Malone et al., 2021).

Changes in demand for eggs were also influenced by fluctuations in the prices of substitute goods and by various demographic factors. According to research conducted by Lantarsih & Kusumastuti (2019), factors influencing egg demand included tilapia price, family size, and the wife's education level. Budiyanti et al. (2024) also noted that inflation contributed to higher egg prices. It impacted the cost of industrial raw materials, including feed prices, particularly for key inputs, such as corn, soybeans, and wheat, which became major components in livestock farming cost structures. Wibowo et al. (2025) further observed that the price sensitivity, regional economic conditions, and consumer preferences influenced the demand for beef, chicken, and eggs. Income inequality also played an important role in shaping substitution patterns: an increase in chicken meat prices led to higher beef consumption, while eggs served as a complement to beef. Mitigating egg price volatility is essential, as continuous fluctuations at the local scale can ultimately lead to macroeconomic shocks (Swanson et al., 2011).

3.2. The Degree of Vertical Price Integration in The Chicken Egg Market

The degree of integration of the chicken egg market in Central Java Province was examined using the Error Correction Model (ECM) test. The tabulated secondary data were converted into natural logarithms to mitigate excessive fluctuations, normalize non-normally distributed data, and facilitate the interpretation of parameters as elasticities. The data, in logarithmic form, was analyzed using Eviews software version 13. The testing process began with classical assumption tests, followed by several tests, including stationarity tests, Johansen cointegration tests, and Error Correction Model (ECM) tests.

Classical assumption tests were conducted to identify the most appropriate and consistent model. These tests included the normality, heteroscedasticity, multicollinearity, and autocorrelation tests. The results of the normality test indicated that the processed data were normally distributed. The data also exhibited constant variance errors. Subsequently, the data were tested for multicollinearity to assess the correlation between the variables under study. The results revealed no significant correlation between the variables. At the end, an autocorrelation test was performed to examine the relationship between a given period and the preceding one. The results indicated that there was no correlation between any given period and the previous period.

Table 1. The results of the stationarity test of purebred chicken egg price data at the level and first difference with the ADF test

Variable	Test Equation (No Trend and Intercept)	ADF t-Statistics	Critical Value 5%	Prob.	Remark	Status
LnTE	Level	-2.577341	-3.518090	0.2920	ADF t-stats < Critical Value 5%	Not stationary
	First differentiation	-6.290013	-2.933158	0.0000	ADF t-stats > Critical Value 5%	Stationary
LnTP	Level	-2.440119	-3.518090	0.3549	ADF t-stats < Critical Value 5%	Not stationary
	First differentiation	-6.107899	-2.933158	0.0000	ADF t-stats > Critical Value 5%	Stationary
LnTG	Level	-2.086549	-3.518090	0.5384	ADF t-stats < Critical Value 5%	Not stationary
	First differentiation	-7.421542	-2.933158	0.0000	ADF t-stats > Critical Value 5%	Stationary
LnTPB	Level	-3.592102	-3.518090	0.0424	ADF t-stats < Critical Value 5%	Not stationary
	First differentiation	-6.629736	-2.935001	0.0000	ADF t-stats > Critical Value 5%	Stationary

Source: Secondary data processed, 2024

The stationarity of purebred chicken egg price data at the producer, wholesale, and retail levels was examined, with results presented in Table 1. Initial tests at the level form showed that all variables had Augmented Dickey-Fuller (ADF) statistics greater (less negative) than the 5% critical value, indicating non-stationarity.

The Augmented Dickey–Fuller (ADF) test results indicate that chicken egg prices at the producer, wholesaler, wholesale, and retail levels are non-stationary in levels, implying that these price series exhibit time-varying trends and variances. This condition indicates that egg prices are influenced by structural and dynamic factors, such as changes in input costs, seasonal demand fluctuations, and external shocks, leading prices to deviate from a constant mean over time.

After applying first-order differencing, all price series become stationary, confirming that they are integrated of order one. This finding suggests that while egg prices fluctuate in the short run, price changes are mean-reverting and remain within a stable range, indicating that price shocks are temporary rather than persistent. From a methodological perspective, the presence of order one variables validates the application of a cointegration-based framework, particularly the Error Correction Model (ECM), to examine both long-run equilibrium relationships and short-run adjustment dynamics. The stationarity of differenced series also mitigates concerns regarding spurious regression, ensuring the reliability of subsequent estimations. Economically, these results imply that the chicken egg market in Central Java possesses an inherent adjustment mechanism, whereby deviations from long-run equilibrium are gradually corrected over time. This behavior supports the existence of structured price transmission across market levels, providing a foundation for analyzing vertical market integration and price leadership.

3.3. The Price Leadership Structure Among Producers, Wholesalers, and Retailers

To ascertain the price leadership structure among producers, wholesalers, and retailers at the wholesale level, a two-tiered analytical approach was adopted. This involved evaluating the immediate dynamics through short-run regression performance and incorporating the error correction term (ECT). The ECT is specifically utilized to bridge these dynamics by integrating the residuals derived from the long-term equilibrium regression model. Furthermore, Granger causality tests were conducted to identify directional relationships and mutual dependencies among these different market levels. The results of long-term ECM tests on the vertical integration of purebred chickens are shown in Table 2.

Table 2. Summary of long-term ECM test results of vertical integration of purebred chicken egg prices

Variable	Coefficient	Std. Error	t-stats	Probability
C	1.075534	0.197827	5.436736	0.0000*
LnTP	0.798014	0.020240	39.42788	0.0000*
LnTG	-0.026340	0.027954	-0.942260	0.3517
LnTPB	0.130909	0.022074	5.930374	0.0000*
F-statistic	2802.575			
Prob-F statistic	0.000000			
R^2	0.995265			
Adj. R^2	0.994910			

Source: Secondary data processed, 2024
Note: * significant at α=5%

Based on the results of the data analysis, the following long-term model was established:

$$\Delta \ln TE_t = 1.075534 + 0.798014 \ln TP_t - 0.026340 \ln TG_t + 0.130909 \ln TPB_t + \mu_t \quad (3)$$

This result indicated that the null hypothesis (H0) was rejected, suggesting a long-term relationship between the dependent and independent variables. As further shown in Table 3, the prices of chicken eggs at the producer and wholesale levels were transmitted to prices at the retailer level. Based on the partial (t-test) analysis, the prices of purebred chicken eggs at both the producer and wholesale levels exhibited probability values of 0.0000, which fell below the 5% significance threshold.

The Johansen cointegration test was employed to examine the implications of long-term price relationships among purebred chicken eggs between trading institutions. The results, presented in Tables 2 and 3, indicated that the null hypothesis (H_0), which posited no cointegration among the variables, was rejected. The findings suggested vertical integration between the prices of chicken

eggs at the producer, wholesale, and retail levels. Furthermore, the cointegration results revealed that three variables demonstrated a long-term equilibrium relationship (Abdussalam & Fakhriyana, 2024).

Table 3. Johansen test (trace) cointegration test

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Trace Statistics	0.05 Critical Value	Prob.**
None *	0.732345	55.35833	92.40957	47.85613	0.0000
At most 1 *	0.471667	26.79720	37.05124	29.79707	0.0061
At most 2	0.139449	6.307663	10.25405	15.49471	0.2617
At most 3 *	0.089682	3.946384	3.946384	3.841466	0.0470

Source: Secondary data processed, 2024
Note: * significant at α=5%

Long-term integration indicates that the chicken egg market is relatively efficient in transmitting price signals. There are no persistent price differentials across markets that cannot be accounted for by marketing or distribution costs. Prices at the producer, wholesaler, and retailer levels are interdependent; thus, price changes at one level do not occur in isolation over the long term, as they trigger adjustments across other levels. Shocks such as rising feed costs, seasonal demand surges, or supply disruptions do not result in permanent price distortions, as the market possesses the capacity to return to its long-term equilibrium. This integration further suggests that no single market level can unilaterally dictate prices in the long run without eliciting a response from other levels, even if short-term price leadership may still occur.

Down-up (up-down) movements between producer or wholesale levels and retail prices on the chicken egg market are long-run in nature, revealing the presence of an upstream-led regime in long-run price transmission for chicken eggs. In empirical terms, this means that producer and wholesaler prices are the long-run price leaders of retail, and that such prices tend to adjust over time until they restore equilibrium whenever it has been broken. This trend indicates cost-based price discovery over the long term. Such cost fluctuations, e.g., in feed and labor, transport costs, are permanently transferred to consumers. Retailers, therefore, cannot permanently absorb upstream cost shocks and must adjust their prices to maintain margins and long-run viability.

This long-run transmission channel captures the structural characteristics of the egg market, where production and wholesale costs determine an underlying price level, while final retail prices take time to converge back due to menu costs, contracting periods, or short-term demand conditions. Crucially, upstream-driven long-run price transmission is not necessarily evidence of inefficient markets or the exploitation of market power, but rather a structural mechanism for cost pass-through appropriate to competitive or oligopolistic markets. Cost pressures at higher stages of production largely determine the sustainability of consumer price stability in the long run. Consequently, policies aimed at controlling retail prices in the long run are likely to be ineffective unless they address structural cost drivers at the producer and wholesaler levels. Policy efforts should therefore focus on reducing production costs (e.g., feed price stabilization and productivity improvements) and on improving distribution efficiency to ensure sustainable price stability for consumers. Fluctuations in egg prices at the producer level are partly driven by disease outbreaks affecting poultry. Such outbreaks lead to high mortality rates, which disrupt both production and egg availability. This supply contraction subsequently triggers price shifts that are transmitted through the marketing channels to the retail level. Consequently, price changes originating at the producer level flow forward through the supply chain until they reach the final consumers (Mitchell et al., 2024).

This result contrasts with the findings of Putri et a. (2022) in West Sumatra, who reported no integration between the broiler chicken market at the consumer and producer levels, a situation attributed to asymmetric information across the two levels. In addition, research conducted by Pargit et al. (2018) concluded that short marketing channels for chicken eggs are the most efficient, as they incur lower costs and allow profits to be more evenly distributed among all involved marketing institutions.

ECM tests were conducted to determine the presence of long- and short-term relationships or integrations. The ECM results reveal that price integration exists in the short run between the producer and wholesale levels and the retail price level. This finding is supported by the probability values for both the producer and significant trader variables, which are below the 0.05 significance level. Consequently, the null hypothesis that no short-term integration occurs is rejected. This suggests that price changes at the producer and significant trader levels are effectively transmitted to the retail level in the short term.

Table 4. Summary of short-term ECM test results

Variable	Coefficient	t-stats	Probability	Information
ECT	0.853274	-0.039903	0.0000	Integrated
LnD(TP (-1))	0.846696	0.0000	0.0000	Integrated
LnD(TG (-1))	-0.013564	0.7327	0.7327	Not integrated
LnD(TPB (-1))	0.128553	0.0000	0.0000	Integrated
C	-4.49E-05	0.9684	0.9684	Not integrated
F-statistic	959.2302			
R^2	0.990193			

Source: Secondary data processed, 2024

The short-term integration model derived from the results of the Error Correction Model (ECM) analysis is as follows:

$$\Delta \ln TE_t = -4.49E\text{-}05 + 0.846696 \ln TP_{t-1} - 0.013564 \ln TG_{t-1} + 0.128553 \ln TPB_{t-1} + 0.853274 ECT + \mu_t \quad (4)$$

The finding that short-run price changes at the producer and wholesaler levels are transmitted to the retail level indicates the presence of upstream-driven short-run price transmission in the chicken egg market. Empirically, this suggests that price adjustments originate at the production and wholesale stages and are quickly passed on to retailers, reflecting a unidirectional short-run price transmission mechanism from upstream to downstream markets. This pattern implies that cost-side factors play a dominant role in short-run price formation. Changes in production costs, such as feed and energy prices or short-term supply disruptions, are first reflected in producer and wholesaler prices and subsequently transmitted to retail prices. Retailers, therefore, act primarily as price takers in the short run, adjusting consumer prices in response to upstream cost signals rather than initiating price changes themselves.

This form of short-run price transmission reflects a market structure in which retailers have limited ability to absorb cost fluctuations, particularly in markets characterized by thin margins and relatively inelastic demand. Importantly, this mechanism does not inherently signal market inefficiency or market power abuse, but rather indicates efficient cost pass-through along the supply chain. These findings suggest that short-term price volatility at the consumer level is closely linked to upstream cost shocks. Therefore, policies aimed at stabilizing consumer prices should focus on mitigating cost fluctuations at the producer and wholesale levels, for example, through feed price stabilization, input subsidies, or temporary logistical support during supply disruptions. Enhancing coordination and transparency across the supply chain can further reduce the speed and magnitude of price pass-through to consumers. A well-integrated marketing chain can enhance market efficiency, thereby reducing the necessity for extensive government intervention (Etuah et al., 2024). Research conducted by Núñez (2025) demonstrates that raw or unprocessed agricultural products exhibit the highest degree of integration and undergo price adjustments within a relatively short timeframe. Prices for unprocessed foods are consistently integrated across regions. Geographical proximity, road infrastructure, and the similarity in store density significantly accelerate market price convergence toward long-term equilibrium.

The findings of this study aligned with the research of Novrizal et al. (2021), which found a cointegration relationship between wholesale and retail egg prices in Banda Aceh. This suggested that the prices of chicken eggs at the retail, wholesale, and producer levels maintained a stable and balanced relationship, exhibiting similar movements in both the short and long term. Hence, egg prices were integrated across different market levels. Longworth et al. (2019) demonstrated that egg price fluctuations occur primarily at the production level. Outbreaks of avian influenza have resulted in significant poultry mortality, while production input costs (particularly feed) have continued to increase. These factors disrupt egg availability, thereby driving market price volatility. The COVID-19 pandemic significantly impacted chicken egg availability. Beyond Indonesia, other Southeast Asian countries experienced similar disruptions; in Myanmar, for instance, more than 30% of broiler farms and 10% of layer farms were forced to close by June 2020. Furthermore, approximately 42% of the long-term farming workforce was laid off. This acute supply shortage subsequently led to substantial price volatility (Fang et al., 2021).

The Granger Causality test was employed to examine the directional relationship between markets and the direction of vertical price transmission. The causality test, conducted at α=5% significance level, was presented in Table 5.

Table 5. Results of the causality test of chicken egg prices at the producer level, wholesale level, wholesaler level, and retail level

Variables	Probability	Information	Status
TP-TE	2.E-06	Prob Value > 0.05	Not related
TE-TP	0.0001	Prob Value < 0.05	Related
TG-TE	0.0625	Prob Value > 0.05	Not related
TE-TG	0.0007	Prob Value < 0.05	Not related
TPB-TE	0.0355	Prob Value < 0.05	Related
TE-TPB	3.E-10	Prob Value > 0.05	Not related
TG-TP	0.0665	Prob Value > 0.05	Not related
TP-TG	0.0002	Prob Value < 0.05	Related
TPB-TP	0.0383	Prob Value < 0.05	Related
TP-TPB	8.E-13	Prob Value > 0.05	Not related
TPB-TG	0.9355	Prob Value > 0.05	Not related
TG-TPB	0.3564	Prob Value > 0.05	Not related

Source: Secondary data processed, 2024

Table 5 showed that changes in retail egg prices influenced producer-level prices, indicating that retail egg prices were the leading indicator, with every retail price change subsequently followed by a change in the producer price. This implied that the change in egg price was elastic with respect to changes in demand. However, the reverse was invalid; changes in supply did not affect changes in price at the consumer level. These indicate that the price formation mechanism for chicken eggs is primarily demand-driven, particularly in the short run (Rahman et al., 2024). Fluctuations in consumer demand serve as the primary signal triggering price adjustments at the upstream level (Sofyan et al., 2019). This condition suggests that egg prices are relatively elastic to changes in demand, whereas supply-side shifts at the producer level do not directly affect retail prices.

The producer-level egg price served as the leading indicator for the wholesale price level. Each time a price change occurred at the producer levels, corresponding adjustments were subsequently observed in the wholesale price. Price fluctuations in the chicken egg market frequently originated from the producer side, primarily driven by variations in input costs such as feed prices (Nafaati et al., 2021). The continual rise in feed costs, which often reached levels burdensome for farmers, necessitated adjustments in selling prices to sustain profitability. These producer-level price changes were then transmitted to and reflected in wholesalers' pricing behavior.

The same pattern also occurred in the price interaction between the wholesale and retail levels, with the retail price always following the wholesale price. The wholesaler was the marketing channel immediately following the producer; if a price change occurred at the producer level, the wholesaler followed and then passed it on to the retailer. An exciting finding was that producers followed price changes initiated by the wholesaler. The wholesaler acted as the intermediary between consumers and producers. Fluctuations in demand were met with changes in the wholesale buying price offered to farmers.

The Granger causality test was conducted by Abdussalam & Fakhriyana (2024), who found that not all variables exhibited a bidirectional relationship. Moreover, Ullah et al. (2020) noted that when markets are integrated, prices across markets will influence one another. A unidirectional relationship occurred due to the lack of price transparency. The imbalance in price information often left farmers as the most disadvantaged party. Emediegwu & Rogna (2024) found that the greater the increase in commodity prices, the larger the price differential across market levels, and the smaller the price received by farmers. This was because information about rising commodity prices did not reach farmers. Traders, as intermediaries, exploited this situation to maximize their profits, a condition thatcould persist under monopoly power.

To enhance the market integration of agricultural products, the Chinese government has implemented several strategic initiatives, including the construction of critical infrastructure such as tunnels, bridges, and extensive railway networks. Furthermore, the government has promoted intraregional communication to accelerate economic integration. The development of urban clusters has also emerged as a key factor in strengthening market integration (Zheng et al., 2022). (Li et al., 2025) Further noted that provincial highways significantly bolster intra-regional trade and the development of local industries, particularly within the agricultural and manufacturing sectors. In contrast, national highways contribute more substantially to inter-regional trade and long-term industrial transformation.

4. Conclusions and Suggestions

Two main objectives are addressed in this study. First, the vertical integration of the chicken egg market in Central Java in both the short and long run is confirmed, indicating stable price linkages among producers, wholesalers, and retailers. Second, it is demonstrated that price changes originate at the producer and wholesale levels and are subsequently transmitted to the retail level, confirming an upstream-driven price transmission mechanism. This study contributes to the literature on market integration by providing empirical evidence of upstream-led transmission in a perishable agricultural commodity market, thereby reinforcing the importance of cost-based price formation. Future research is encouraged to explore asymmetric price transmission, incorporate spatial dynamics, and examine institutional arrangements to further the understanding of price behavior in Indonesia's poultry sector. Given that price transmission is driven by producer and wholesaler levels, price stabilization policies should be strategically focused on the upstream sector. The government must prioritize the stability of production inputs, particularly poultry feed, by fostering the development of domestic raw materials and implementing targeted subsidy schemes to mitigate cost-push inflation. Furthermore, strengthening farmer institutions through cooperatives and enhancing access to capital are critical to improving producers' bargaining power and ensuring they are not mere price-takers. Simultaneously, rigorous monitoring of wholesale distribution channels is essential to maintain price transparency and prevent excessive marketing margins, thereby ensuring overall market efficiency throughout the value chain.

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CRediT Authorship Contribution Statement

Nurul Khotimah: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing Original Draft, Review & Editing. Mochammad Yunus Gerry Fitriadi: Data Collection, Review & Editing. Rizky Lutfi Suprabowo: Data Collection.

Declaration of Competing Interest

The author declares that there are no known competing financial or personal interests that could have influenced the work reported in this paper.

Data Availability

The data used in this study are secondary data obtained free of charge from publicly available sources, namely the National Food Agency (Badan Pangan Nasional/Bapanas) and Statistics Indonesia (Badan Pusat Statistik/BPS). The data can be downloaded directly from the official websites of the respective institutions. The processed data and analytical results supporting the findings of this study are available from the corresponding author upon reasonable request.

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