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TRANSMISSION OF BROILER EGG PRICES BETWEEN SURPLUS AND DEFICIT AREAS: EXPLORING THE DYNAMICS

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ABSTRACT
Broiler chicken eggs are one of the main and strategic foods for the people of Indonesia and contribute to regional and national inflation. Broiler egg production in Indonesia differs between regions. Areas with a surplus of eggs tend to have lower prices than areas with a deficit. This research is to measure the transmission of broiler egg prices between markets in surplus and deficit areas, using weekly price time series data for the period January 2018-December 2021. Areas of surplus broiler eggs, East Java Province (the highest broiler egg production in Indonesia) which become one of the main suppliers to the Province of East Nusa Tenggara as a deficit area. Using the Johannsen cointegration test it is found that there is no cointegration or there is no relationship between the surplus and deficit regions in the long term but not in the short term. Factors of marketing infrastructure, market information systems, and geographical conditions can be obstacles to the absence of cointegration. The VAR (Vector Auto-Regressive) Vector Error Correction model (VECM) test, found that price transmission occurred between surplus and deficit areas, meaning that between the two regions, there was market integration prior to Covid. The transmission has weakened, and due to the Covid situation, there have been restrictions on the movement of people and goods. The government and other market players need to study the response of the broiler egg market, in the short and long term so that market players can make the right policies.

KEY WORDS
Broiler eggs, surplus-deficit, cointegration, vector error correction model, price transmission.

Broiler chicken eggs are an essential food product consumed by Indonesians. The price of broiler eggs is volatile and subject to frequent fluctuations, influenced by various factors such as market supply and demand. Despite egg production exceeding 5 million in Indonesia, there are significant differences in production levels between regions. While some areas produce more than they need (surplus), other regions have demand that exceeds local production (deficit). According to BPS data (2022), East Java province is the surplus area with the highest egg production in Indonesia, while Nusa Tenggara Timur (NTT) province is a deficit area with low production of broiler eggs.

Surplus areas, such as East Java, tend to offer lower prices for broiler eggs due to their abundant supply, while deficit areas like Nusa Tenggara Timur (NTT) typically offer higher prices due to limited supply. This difference in prices can affect the transmission of broiler egg prices between regions. The production of broiler eggs in Indonesia is predicted to reach 1.58 million tons this year, while consumption is only 1.52 million tons, resulting in a surplus of 55 thousand tons. The per capita consumption of broiler eggs in Indonesia has been increasing on average by 3.57% per year from 1987 to 2017. In 1987, the consumption of broiler eggs was only 2.55 kg/capita/year, but this increased to 6.53 kg/capita/year by 2017 (Databoks.katadata.co.id, 2021). In September 2021, the per capita consumption of eggs in Indonesia reached 9.98 pieces per month, which was a 2.16% increase from March 2021 when it was 9.77 pieces per month, according to Central Bureau of Statistics (BPS) data.

The price of broiler eggs in traditional markets in East Java has experienced significant fluctuations in recent years, with a decrease in prices at the end of 2020, allegedly caused by low demand due to restrictions and business closures during the COVID-19 pandemic. In contrast, the price of broiler eggs in the NTT market increased during the same period due to increased demand and limited supply from Surabaya.

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Supply shocks, such as those caused by natural disasters, weather, or disease outbreaks, can also affect broiler egg prices, as can demand shocks, which can result from population growth, industrial expansion, or events such as holidays or panic buying. In spatially connected markets, price changes in one market can rapidly impact other markets, depending on the speed of distribution and information. Variance decomposition analysis can be used to predict the percentage contribution of specific variable changes to broiler egg prices in East Java and NTT markets.

Broiler eggs are a type of food with volatile prices that are subject to fluctuations. Price fluctuations occur due to disruptions in demand or supply in a market. Figure 1 (b) shows the dynamic monthly price movements of broiler eggs from 2018 to 2020. In markets that adhere to the Law of One Price, symmetric price transmission will occur well, meaning that if prices in one market increase, the market selling the same product will respond to the price change following the market price. This indicates that the market is well integrated and efficient because the information is evenly distributed, which can be seen through the response raised to the price change, in order to avoid the possibility of abnormal returns.

The study of price transmission has become increasingly popular among researchers in recent years, using approaches such as the Vector Error Correction Model (VECM). Several studies have been conducted on the price transmission of agricultural commodities, including broiler eggs. Among them are studied by Bao, W., et al. (2023); Singh, N. D., et al. (2022); Deb, P., Dey, M. M., & Surathkal, P. (2022); Fernández-Polanco, J., & Llorente, I. (2019); Zungo, M., & Kilima, F. (2021); Ramsey et al. (2021); Chitete, M., et al. (2021); Zavale, H., & Macamo, R. D. C. (2020); Loginova, D., & Irek, J. (2022); Deb, L., Lee, Y., & Lee, S. H. (2020); Luo, P., & Tanaka, T. (2021); Wang, Y., et al. (2022); Urom, et al. (2021); and Zheng, X., & Pan, Z. (2022).

Based on these conditions, this study examines the price transmission of broiler eggs between markets in surplus areas (East Java) and deficit areas (NTT), before and during the COVID-19 pandemic. This aspect of the study has not received previous research attention. Price transmission analysis is useful in describing market efficiency in every market condition and as a form of price forecasting in a market by utilizing price information that occurs in the reference market. Price transmission analysis is used in conjunction with the concept of price competition between markets, spatially or vertically, and refers to the phenomenon where a shock in one market affects other interconnected markets. Studying price transmission in various market situations and characteristics, it will benefit market players.

METHODS OF RESEARCH

This study utilizes weekly time series data on the price of broiler chicken eggs, sourced from the National Strategic Food Information Center (PIHPSN), for the periods prior to (January 2018-December 2019) and during the COVID-19 pandemic (January 2020-December 2022). Figure 1 illustrates the egg surplus region (East Java) and the egg deficit region (East Nusa Tenggara).

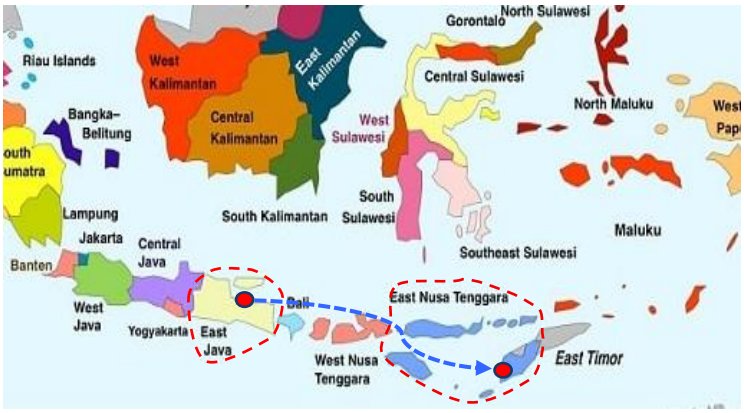

Figure 1 – Map of surplus areas (East Java province) and deficit areas (ENT province) of broiler eggs

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To determine the presence of price transmission, the VECM approach is used. Price transmission is used to assess the nature of the price relationship and the causal direction of the relationship between agricultural prices in surplus and deficit. The stages for VECM analysis include testing for stationarity using the Augmented Dickey Fuller Test (ADF Test). If the Prob. value is less than 0.05, then the data does not contain a unit root (is stationary). Generally, time series data are non-stationary, so data stationarity is needed to avoid spurious regression. The ADF test is necessary to prove the presence or absence of a trend in the data being tested (Widarjono, 2018). The formula for the ADF test is:

$$\Delta P_t = \alpha_0 + \gamma_1 P_{t-1} + \beta_l \sum_{l=1}^{m} \Delta P_{t-1} + \varepsilon_{it}$$

Where:

- P_t =Price in surplus/deficit area in period t;
- P_{t-1} = Price in surplus/deficit area in the previous period $(t-1)$;
- $\Delta P_t = P_t - P_{t-1}$;
- $\Delta P_{t-1} = P_{t-1} - \Delta P_{(t-1)-1}$;
- m =number of lags;
- α_0 = intersep;
- α, β, γ = Coefisien parameter;
- ε_t = Error term.

Hypothesis test:

- $H_0: \gamma = 0$ time series data is not stationary;
- $H_1: \gamma < 0$ stationary time series data.

Test rule:

- If ADF I t-statistic I>ADF I t-critical I then reject Ho means that the data is not stationary;
- If ADF I t-statistic I ≤ ADF I t-critical I then accept Ho means that the data is stationary.

Lag of a variable indicate the time it takes for a variable to respond to changes in other variables period before and during covid-19. Optimal lag determination with Akaike Information Criteria (AIC) and Schwarz Criterion (SC.AIC and SIC Formulas:

$$\ln(AIC) = ln\frac{\sum \hat{u}_i^2}{n} + \frac{2k}{n}$$

$$\ln(SIC) = \ln\left(\frac{\sum \hat{u}_i^2}{n}\right) + \frac{k}{n}\ln(n)$$

Where:

- $\hat{u}_i^2$ = sum of squared residuals;
- *K* = number of independent variables;
- *n* = number of observations.

The criterion is to choose the smallest AIC value to determine the lag used.

VAR Stability Test necessary before carrying out further analysis. The VAR model is declared stable if the root has a modulus value < 1 (one).

Cointegration (Johannsen test) conducted to see whether there is a long-term equilibrium relationship between 2 price variables in surplus and deficit areas, the period before and during Covid-19. At the same time to determine whether there is price transmission between surplus and deficit areas.

$$Y = c + b1X1 + b2X2 + b3X3 + \ldots + bnXn + e$$

Where: *Y* = dependent variable; *c* = constant; *b* = coefficient of independent variable; *X* = independent variable; *e* = residuals. If the Prob value < 1 means cointegration occurs.

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Vector Error Correction Model (VECM) using the Wald Statistics testto see the sizerelationship between variables in the long and short term.VECM is used to overcome the non-stationary data, where this model will gradually correct the imbalance, deviation through short-term partial adjustments (Enders, 1995).General form of VECM (p) with lag length (p-1) with the formula:

$$\Delta y_t = \alpha \ddot{e}_{t-1} + + + + \ldots + + \beta_1 \Delta y_{t-1}\ \beta_2 \Delta y_{t-1}\ \beta_2 \Delta y_{t-1}\ \beta_n \Delta y_{t-n+1} \varepsilon_t$$

$$e_{t-1} = -\ (\ \Delta Y_{t-1} \varphi +) \omega X_{t-1}$$

Where:

- Δy_t =vector of the first derivative of the dependent variable;
- y_{t-1} = vectors the first derivative of the dependent variable with the 1st lag;
- e_{t-1} =error obtained from the regression equation between Y and X at the 1st lag;
- A = cointegration coefficient matrix;
- ε_t = vector residuals.

The VECM model used, the price variable for broiler chicken eggs in the surplus area is Y1t and the price in the deficit area is Y2t:

$$Y_{1t} = a_1 + a_{11(1)} Y1t\text{-}1 + a_{12(1)} Y2t\text{-}1 + \mathcal{E}1t$$

$$Y_2 t = a_2 + a_{21(1)} Y1t\text{-}1 + a_{22(1)} Y2t\text{-}1 + \mathcal{E}2t$$

Where: *a*=regression coefficient; $\mathcal{E}nt$ =residual vector (error term 1; time t). Decision criteria: If t hit value I *t*-statistics I < T-tab (t critical) so it has no significant effect. If t hit value I *t*-statistics I < T-tab (t critical) then it has a significant effect.

RESULTS AND DISCUSSION

Analysis of chicken egg broiler price transmission between surplus regions represented by East Java Province and deficit regions represented by ENT Province was conducted in two situations, namely before the Covid-19 pandemic (2018-2019) and during the pandemic (2020-2021). The first case of Covid-19 was found in Indonesia in early March 2020 and then continued to develop, leading to the government declaring a Covid-19 pandemic. Following this declaration, policies to prevent the spread of Covid-19 were implemented. Notable policies included restrictions on the movement of people and goods, which caused disruptions in mobility, transportation, distribution, and food supply chains. Pressure on both the supply and demand sides, or on the production and consumption sides, occurred simultaneously.

To determine whether there was price transmission of chicken egg broiler between surplus and deficit regions before and during Covid-19, the following steps were taken:

- Test for stationarity of egg prices data; it was found to be in first difference, followed by determining the optimal lag by selecting the smallest AIC value;
- The next step was to test the stability of VAR by looking at the modulus value which was less than one;
- This was followed by testing for cointegration to determine the presence or absence of long-run price equilibrium between surplus and deficit regions before and during the Covid-19 pandemic.

The cointegration test for chicken egg prices between surplus and deficit regions showed that there was a long-term equilibrium relationship between the regions (between East Java and ENT) before the Covid-19 pandemic (table 1). However, during the pandemic, no cointegration was found. The presence of cointegration before Covid-19 may be due to the distribution network and information on prices and goods being sufficient. However, during the Covid-19 pandemic, the situation changed and was not under control, followed by

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government policies on social distancing/physical distancing (tables 1 and 2). These findings support the findings of Wang, Y., et al. (2023) and Ramsey et al. (2021).

Table 1 – Cointegration Test between East Java surplus (PJTMBC) and deficit (NTTBC) areas before the covid pandemic. (cointegration occurs)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.136492	24.88207	15.49471	0.0015
At most 1 *	0.099299	10.35361	3.841466	0.0013

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 2 – Cointegration Test between East Java surplus (PJTMBC) and deficit (NTTBC) areas during the covid pandemic (no cointegration)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.086071	8.920494	15.49471	0.3728
At most 1	0.000103	0.010236	3.841466	0.9191

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

The study by Wang, Y., et al. (2023) found that the COVID-19 pandemic has affected the integration of the carp fish market in China, which has impacted the stability of carp fish prices and food availability in certain regions. On the other hand, policies restricting the movement of people and vehicles during the COVID-19 pandemic may affect trade and market integration in various sectors. The study by Gunwant, D. F., & Rather, S. R. (2021) found that world price fluctuations affect domestic prices in GCC countries, especially oil prices. In addition, the research also found that price transmission is faster and larger in the short term than in the long term. Price transmission can affect the speed of trader responses to moving food from surplus to deficit areas (Zungo, M., & Kilima, F., 2021; Mgale, Y. J., et al., 2021). This study also found long-term cointegration between rice markets in Tanzania, indicating that rice markets in Tanzania are interrelated in the long run. The level of price transmission between regions varies in Tanzania, with some regions having faster and more complete transmission rates than others.

The study found that before the COVID-19 pandemic, there was a stronger transmission of prices between surplus and deficit regions, as evidenced by a transmission coefficient value of 0.523842 and a price transmission elasticity of 0.4603. However, during the pandemic, the long-term transmission coefficient weakened to 0.516428, with a transmission elasticity of 0.4443. Meanwhile, the short-term transmission coefficient was 0.831244, with a transmission elasticity of 0.7151, and an adjustment period in the second period.

These findings suggest that COVID-19 has created a situation of price uncertainty and has weakened the price transmission between markets in both surplus and deficit regions. The analysis indicates that government policies have contributed to the weakening of price transmission, despite being temporary measures taken for health and humanitarian considerations.

The magnitude of the transmission coefficient and transmission elasticity shows that the relationship between price transmission in the two regions is still weak, and factors such as market infrastructure, distance between regions, seasonal effects, geographic factors,

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regulations, production, and consumption systems significantly affect the strength or weakness of price transmission.

A related study by Loginova, D., & Irek, J. (2022) demonstrated that government intervention policies can affect meat price transmission in the Russian market, including reducing price transmission from the international to the domestic market. Therefore, the results of this study can inform policy makers and market players on the need to develop more efficient and effective policies and market infrastructure to improve price transmission between surplus and deficit regions for the benefit of all stakeholders.

CONCLUSION

A study on the transmission relationship of broiler egg prices between surplus areas (East Java) and deficit areas (East Nusa Tenggara) showed that prior to the Covid-19 pandemic, there was a long and short-term balance relationship between the two markets. This means that price changes in one market would affect price changes in the other, and the markets would mutually influence each other in a relatively stable period. However, despite the transmission relationship between the two markets, it was not very strong. This suggests that price changes in the surplus market did not significantly affect prices in the deficit market, and vice versa. The study also showed that during the Covid-19 pandemic, the long-term balance relationship did not occur, and the transmission of broiler egg prices between the two markets became weaker. This was due to disruptions in communication, transportation, distribution, and supply chains caused by the government's social distancing/physical distancing policy. These disruptions caused difficulty in market access, decreased transportation capacity, and difficulties in carrying out distribution activities. In addition, there was a decrease in production and consumption due to pressure on the production and consumption system. In this regard, information about the transmission relationship of broiler egg prices between surplus and deficit markets can be useful for market players and policy makers in developing a more efficient and profitable broiler egg market for the welfare of all. For example, in addressing disruptions in transportation and distribution networks, market players can develop more efficient logistics systems and rely on information technology to expedite distribution processes. Meanwhile, policy makers can consider policies that support smooth transportation and distribution as well as policies that encourage increased production and consumption of broiler eggs.

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