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DYNAMICS OF PRICE TRANSMISSION AND THE EFFECT OF COVID-19 ON THE BROILER INDUSTRY IN INDONESIA: PANEL ARDL APPROACH

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Abstract

Broilers are strategic food commodities that contribute significantly to fulfilling animal protein needs. This study aimed to analyze the dynamics of price transmission in the broiler industry through vertical and horizontal integration. It also intended to determine the price transmission's relationship with corn input and the impact of COVID-19 on broilers. The study used panel monthly time series data from 2010M01-2020M12 and cross-section data from 28 provinces. It also employed the Panel Autoregressive Distributed Lag (PARDL) – Pooled Mean Group (PMG) approach. The results showed short- and long-term vertical integration between the broiler market at the producer and consumer levels. The negative price transmission in producer and consumer markets is probably caused by market power in the broiler industry. Furthermore, there is short- and long-term horizontal transmission between broilers and eggs. The results indicated no co-integration of corn input with broiler output in the short and long term. However, there is short-term integration between producer and consumer-level corn prices and consumer-level broiler prices in several provinces. COVID-19 significantly and negatively affects consumer-level broiler prices in the short and long term. Therefore, the study recommended issuing a mandatory export policy for large companies to overcome the oversupply of broiler products in the country

Keywords: Price transmission, vertical and horizontal integration, broilers, PARDL, market power

1. INTRODUCTION

Price dynamics in the food market significantly impact welfare levels, with long-term implications for food security. According to [1] food price shocks disrupt the four pillars of food security. These pillars are the upstream-downstream supply chain, economic growth, and poverty. [2] Found that a 50% increase in food prices would lead to a short- and medium-term poverty impact of $1.25 per day in 31 countries. Broilers are one of the strategic foods with an essential role in a country's food security. According to [3] the broiler industry's sustainability would impact Malaysia's food security.

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Broilers are strategic food commodities that significantly fulfil Indonesia's animal protein needs. [4] Data showed that these chickens contributed 66.34% to meat production. Broilers are included in volatile food because the prices tend to fluctuate. This supports data from [5] that broiler prices decreased by -0.09% in August and increased by 3.25% in October, causing inflation. One contributor to inflation is the volatile food group. As an underlying mechanism for food inflation, price transmission also has a critical macroeconomic dimension and contributes to increased competition.

Data from [6] showed that broiler production increased by 6.43% in 2021, but consumption decreased by 3.4%. This is due to increased broiler prices, limiting chicken meat consumption to only certain people. Subsequently, this condition causes the Indonesian broiler industry to experience oversupply. [7] Stated that for the last 30 years, Indonesia's broiler market structure has been oligopolistic and oligopsonistic in the input and output markets, respectively. Furthermore, the industry's vertical integration leads to a monopoly or oligopoly. This finding is reinforced by data from [4] that the poultry industry comprises 85% large companies and 15% independent smallholder farms. [8] Stated that food cartels have existed in Indonesia with variations in monopoly practices.

Since the issuance of Law Number 18 of 2009 concerning Livestock and Animal Health, corporations have engaged in the cultivation sector through partnerships or self-employment. This condition complicates the pattern of broiler farming pattern because companies are entering the cultivation sector through partnerships or plasma. According to the Indonesian Poultry People Association in [9] the number of independent farmers has decreased from 100,000 in 2008 to 6,000. The decrease was caused by the decline in the market share of independent farmers from 70% in 2008 to 18% in 2016, weakening the independent farmers' bargaining position. The presence of these companies has changed the structure of the broiler industry. It is estimated that 60% of poultry production comes from industrial agriculture or closed-cage systems. In contrast, 40% remains with small and medium players or open cage systems. The role of farmers independent of larger poultry companies has declined significantly. Consequently, this could threaten the survival of independent farmers that do not partner with the companies.

This condition has also changed the broiler market in Malaysia, whose poultry industry structure differs from the 1990s. Vertical coordination and integration have dominated marketing and production systems in recent years. The independent activities that dominated the production system have been replaced by contracts and direct ownership by integrators. Therefore, the structure uses an integrated production-marketing system with a single company owning and operating all production aspects. A single company conducts the importing, holding stock, and marketing of meat packaged at company-owned outlets. The integrated production system enables companies to achieve economies of scale, reduce transaction costs, and monitor product quality at all production stages by controlling all inputs and processes. However, this condition has created unhealthy competition for independent smallholders. [10] Stated that broiler farms in Malaysia decreased by 49% from 1986 to 2009, especially among small farms with less than 10,000 heads. The industry's broiler segment produces more than

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680 million heads, with the largest ownership being Leong Hup Poultry (LHP). This integrated company accounts for more than 17% share of total broiler production in Malaysia. It is trailed by Charoen Pokphand (CP), the second-largest Thai-based company with a share of more than 12% of the poultry market in Peninsular Malaysia. Analysis shows that integrator companies account for over 62% of total farmer farms through ownership and contract of poultry production in Malaysia.

[11] Stated that the growth and development of cartel practices prevail in an oligopoly market structure. The concentration of business in certain groups damages the national economy, causing natural, human, and economic resource inefficiency. Moreover, it impacts determining prices based on agreements between business actors, leading to unfair competition and adversely affecting consumers. This broiler market structure causes the division of margins and price transmission. In this case, independent farmers become overwhelmed by unfair competition from large Poultry Farmers Association member companies.

Previous studies on broilers focused more on vertical price transmission, Structure Conduct Performance, and input-output relationships separately. In contrast, this study aimed to analyze vertical and horizontal price transmission. The analysis was based on Indonesia's market structure, input and output between broilers and corn, and the impact of COVID-19 on the broiler industry. Furthermore, Panel ARDL analysis was used to determine the short and long-term price transmission in broilers and analyze the heterogeneity of the cross-section data. ARDL was used by [12] to analyze the co-integration and causal relationship between oil and food prices in 21 countries. Furthermore, [13] used Panel ARDL to examine financial development's long-term and short-term contributions in 38 Sub-Saharan African countries. [14] analyzed the relationship between oil production and economic growth in the main oil-exporting countries of Eurasia. Moreover, [15] examined the transmission of input-output prices to broilers in America by emphasizing asymmetric price transmission. [16] Also investigated vertical transmission in the broiler industry in Malaysia. [17] Studied the price transmission elasticity in the Sao Paolo market, while [18] investigated the asymmetric price relationship in the U.S broiler industry. Additionally, [19] explored the effect of financial strength on vertical and horizontal integration in broiler companies.

This study aimed to analyze the dynamics of price transmission in the broiler industry through vertical and horizontal integration. It also intended to determine the price transmission's relationship with corn input and the impact of COVID-19 on broilers. The study contributes to the empirical literature related to the topics covered. Moreover, it discusses price transmission from the perspective of market power, which has not been conducted before on the same topic and location. The period used is large, and the analytical tool also analyzed the heterogeneity of individuals from the study location, which has not been used for the same commodity.

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2. MATERIALS AND METHODS

2.1. Data and Variables

This study used panel monthly time series data from 2010M01-2020M12 and cross-section data from 28 provinces. According to [20] the panel model has many advantages compared to time series and cross-section data. First, the model presents more information, making it more efficient. Second, it analyzes long-term relationships while assessing the short-term heterogeneous dynamics of different panel members. Third, the panel model identifies effects that cannot be detected by time series. Table 1 shows the data used in this study.

Table 1: Data and Variables

No	Variable	Data Sources
1	Consumer-level broiler prices (HBK)	Central Statistics Agency, Ministry of Agriculture (price sim), Strategic Food Price Information Center
2	Producer-level broiler prices (HBP)	Central Statistics Agency, Ministry of Agriculture (price sim), Strategic Food Price Information Center
3	Consumer-level egg prices (HTK)	Central Statistics Agency, Ministry of Agriculture (price sim), Strategic Food Price Information Center
4	Producer-level corn prices (HJP)	Central Statistics Agency, Ministry of Agriculture (price sim), Strategic Food Price Information Center
5	Consumer-level corn prices (HJK)	Central Statistics Agency, Ministry of Agriculture (price sim), Strategic Food Price Information Center
6	COVID-19 (COVID-19)	Dummy

The study model is presented based on the Pooled Mean Group (PMG) estimator developed by [21] PMG was used to detect long and short-term relationships between the variables used. It was also employed to investigate dynamic problems that may occur in the 28 provinces studied. PMG estimation provides the best analysis between consistency and efficiency.

2.2. Panel Unit Root Tests

Two unit root tests used in this study were adopted from [22] and [23]. The stages of [22] test are written in equation (1):

$$\Delta y_{it} = \rho y_{it-1} + \alpha_{0i} + \alpha_{1i} t + u_{it}, \; i = 1,2,\ldots,N, \; t = 1,2,\ldots,T. \quad (1)$$

[23] Test equation is written as follows:

$$y_{it} = \mu_i + \beta_i t + x_{it}, \qquad t = 1,2,\ldots,T, \quad (2)$$

2.3. Panel Data Co-integration Test

This test determined whether the dependent and independent variables have a long-term relationship. The Kao test followed the basic approach more specific in cross-section on the intercept and homogeneous coefficient on the first stage regressor. The equation for the two variables is written as follows:

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$$y_{it} = \alpha_i + \beta x_{it} + e_{it}, \qquad i = 1, \dots, N; \qquad t = 1, \dots, T \tag{3}$$

2.4. Hausman Test

Hausman test aimed to select the best model between Fixed and Random Effects models. This test was based on the idea that Least Squares Dummy Variables (LSDV) in the Fixed Effect method and Generalized Least Squares (GLS) in the Random Effect method are efficient.

[24] Test equation is written as follows:

$$m = \hat{q}\, \mathrm{Var}\,(\hat{q})^{-1}\hat{q} \tag{4}$$

$$\hat{q} = (\hat{\beta} - \hat{\beta}_{GLS}) \tag{5}$$

$$\mathrm{Var}\,(\hat{q}) = \mathrm{Var}(\hat{\beta}) - \mathrm{Var}\,(\hat{\beta}_{GLS}) \tag{6}$$

2.5. Panel Autoregressive Distributed Lag (PARDL) Model

The PARDL model was used to analyze long- and short-term consumer-level broiler prices (HBK) relationships. The independent variables were represented by producer-level broiler prices (HBP), consumer-level egg prices (HTK), producer (HJP) and consumer (HJK)-level corn prices, and COVID-19 (COV19).

$$\begin{aligned}\Delta HBK_{it} = {} & \mu_i + \left(\alpha_i HBK_{i,t-1} + \beta'_{1i} HBP_{it} + \beta'_{2i} HTK + \beta'_{3i} HJP_{it} + \beta'_{4i} HJK_{it} + \beta'_{5i} COV19_{it}\right) \\ & + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta HBK_{i,t-j} + \sum_{j=0}^{q-1} \gamma^{*\prime}_{1ij} \Delta HBP_{i,t-j} + \sum_{j=0}^{q-1} \gamma^{*\prime}_{2ij} HTK_{i,t-j} \\ & + \sum_{j=0}^{q-1} \gamma^{*\prime}_{3ij} \Delta HJP_{i,t-j} + \sum_{j=0}^{q-1} \gamma^{*\prime}_{4ij} \Delta HJK_{i,t-j} + \sum_{j=0}^{q-1} \gamma^{*\prime}_{5ij} \Delta COV19_{i,t-j} + \varepsilon_{it}\end{aligned}$$

3. RESULTS

3.1 Panel Data Unit Root Test Results

The panel data unit root tests combined time-series information and information across all cross-section data. Unit root test results of [22] and [23] showed that all variables used are stationary in the first difference. The test results are shown in Table 1.

Table 1: Panel unit root tests

Variable	LLC Test		Breitung Test	
	Level	First Difference	Level	First Difference
HBK	0.0000	0.0000	0.0000	0.0000
HBP	0.0000	0.0000	0.0000	0.0000
HTK	0.0000	0.0000	0.0796	0.0000
HJP	0.0649	0.0000	0.9968	0.0000
HJK	0.0000	0.0000	0.3699	0.0000

Source: STATA 17.0 output, processed

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(*) statistical significance at 10%; (**) statistical significance at 5%; (***) statistical significance at 1%

3.2 Panel Data Co-integration Test Results

The panel co-integration test was based on homogeneous and heterogeneous alternatives and aimed to determine whether the variables used were co-integrated. The test using Kao test showed co-integration between the variables used. The p-value is < 0.00, implying co-integration during the study period. Table 2 presents the co-integration results using the Kao test.

Table 2: Kao test for co-integration

	Statistics	**p-value**
Modified Dickey-Fuller t	-1.6073	0.0540
Dickey-Fuller t	-2.1204	0.0170
Augmented Dickey-Fuller t	0.8934	0.1858
Unadjusted Modified Dickey-Fuller t	-31.7107	0.0000
Unadjusted Dickey-Fuller t	-13.4627	0.0000

Source: STATA 17.0 output, processed

(*) statistical significance at 10%; (**) statistical significance at 5%; (***) statistical significance at 1%

3.4 Hausman Test Results

Hausman Test is a statistical test to select the best model between the Fixed and Random Effects. The results showed prob>chi2 = 1, meaning the Pooled Mean Group (PMG) model is the best in estimating the Panel ARDL model compared to the Difference Fixed Effect (DFE). Table 3 shows the Hausman test results.

Table 3: Hausman Test

Variable	**-----Coefficient-----**	
	(b)	**(B)**
	DFE	PMG
HBP	0.0875	0.3655
HTK	0.3168	0.9960
HJK	0.3172	0.0795
HJP	-1.7537	0.2249
COV19	1651.26	-1142.68
Prob > chi2 = 1.0000		

Source: STATA 17.0 output, processed

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3.5 Model-Panel Autoregressive Distributed Lag (PARDL) Test Results

The PARDL-PMG model test results comprised long-term and short-term relationships. The results indicated a co-integration between producer (HBP) and consumer (HBK)-level broiler prices. Furthermore, there is a significant positive relationship between consumer-level egg prices (HTK) in aggregate in the short and long term. There is no co-integration for the producer (HJP) and consumer (HJK) level-corn prices in the short and long term. Individually, there is a significant and negative relationship in the short term in West Kalimantan Province and a negative relationship in Bali. COVID-19 significantly and negatively affects broiler prices in the short and long term. Tables 4 and 5 show the PARDL-PMG results.

4. DISCUSSION

The PARDL-PMG results indicate a significant negative price transmission between producer and consumer-level broiler prices in the short term. This means that the decline in producer-level broiler prices is not fully transmitted to consumer-level prices. According to [25] price transmission occurs when downstream prices respond differently to upstream price fluctuations. [26] Stated that short-term changes in wholesale broiler prices in Surabaya City are not perfectly transmitted to the farmer level. The 1% increase in wholesale broiler meat prices only leads to a 0.308% increase in farmer prices. According to [27] an uncompetitive market causes asymmetric price transmission. This is relevant to [28] that Indonesia's broiler market structure is oligopolistic, monopolistic, and concentrated. A partial significant negative transmission occurs in Aceh Province. [29] Stated that the supply of broilers in this province is dominated by Multinasional Company. According to [30] the broiler sector in Peninsular Malaysia also has asymmetric price transmission between producer and consumer markets due to an uncompetitive market structure.

This study also analyzed the horizontal relationship between consumer-level egg and broiler prices. [31] Stated that joint price movements in horizontal price transmission are driven mainly by substitution and complementary relationships between commodities that depend on their demand functions and the underlying preferences. Furthermore, the analysis showed that consumer-level egg prices significantly and positively relate to consumer-level broiler prices. In line with this, [32] stated that Pakistan's broiler and layer market has a short-term unidirectional relationship. It implies that government regulation should stimulate price movements across markets to benefit poultry products. A spatial and significant positive relationship occurs in West Sumatra, Riau, Jambi, South Sumatra, West Java, Banten, West Nusa Tenggara, North Sulawesi, West Papua, and Papua. The positive integration relationship is more dominant in western Indonesia, with an average ECT value of 51.3%. This indicates that short-term balance fluctuations would be corrected towards a long-term balance. In this case, 51.3% of the adjustment process occurs in the first month, and 48.7% occurs in the following months. The average ECT value in Indonesia's central and eastern parts is 15.48%. This signifies that the price adjustment is only 15.48% in the first month and 84.5% in the following months.

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Producer and consumer-level corn prices in the aggregate in the short term have no co-integration with consumer-level broiler prices. However, they have a partial and significant positive and negative effect on consumer-level broiler prices. For producer-level corn prices, significant positive and negative relationships occur in Bali and West Kalimantan, respectively. Consumer-level corn prices only have a significant negative relationship in West Nusa Tenggara, East Kalimantan, and West Sulawesi. According to [33] corn prices in West Nusa Tenggara are determined by wholesalers. The current corn market structure is not perfectly competitive, leading to an oligopoly and oligopsony competition market.

COVID-19 has a significant and negative relationship with consumer-level broiler prices. This means that a decrease in the pandemic increases broiler meat prices and vice versa. [34] Stated that the pandemic significantly affects the poultry sector, especially broilers in Indonesia. COVID-19 affects the broilers' upstream-downstream supply chain, as well as supply and demand, causing price fluctuations.

The PARDL-PMG analysis showed that producer-level broiler prices have a long-term significant positive relationship with consumer-level broiler prices. This means that the producer and consumer-level chicken prices have a symmetrical relationship in the long term. [35] Stated that the best market integration is found in East Java Province as a broiler and feed raw material production centre. As a result, prices cannot be fully controlled by wholesalers. [36] Also found that the broiler market in Thailand is characterized by symmetrical price transmission because it is more export oriented. Although there is market power, the exports create a wider competitive environment for the industry, making the market more efficient. Symmetrical price conditions are also reflected in the broiler market in South Africa. [37] Stated that South Africa's broiler industry in the producer and retail markets is integrated, resulting in a symmetrical price transmission.

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Table 4 Panel ARDL-PMG Model Estimation of Broilers

Variable	Short Term Estimation of Broilers (Provinces)									
	Aceh	**North Sumatra**	**West Sumatra**	**Riau**	**Jambi**	**South Sumatra**	**Bengkulu**	**Lampung**	**Bangka Belitung**	**West Java**
ECT	-0.0897** (0.016)	-0.4188 (0.000)	-0.5672*** (0.000)	-0.5405*** (0.000)	-0.5691*** (0.000)	-0.2389*** (0.000)	-0.2351*** (0.000)	-0.4250*** (0.000)	-0.8372*** (0.000)	-0.5231*** (0.000)
ΔHBP	-0.1841* (0.071)	-0.0887 (0.512)	-0.1151 (0.153)	0.0110 (0.840)	-0.0980 (0.412)	0.1036 (0.187)	0.0117 (0.886)	-0.0751 (0.375)	-0.1041 (0.416)	-0.0277 (0.685)
ΔHTK	0.1510 (0.485)	0.5233 (0.040)	0.4266*** (0.001)	0.3009*** (0.002)	0.7800*** (0.000)	0.6142*** (0.000)	-0.1639 (0.191)	0.1757 (0.632)	0.2005 (0.278)	0.2328** (0.028)
ΔHJK	-0.2951 (0.535)	-0.7955 (0.411)	-0.2044 (0.710)	-0.2006 (0.584)	-0.2681 (0.795)	1.4630* (0.053)	0.00006 (1.000)	0.3146 (0.530)	-0.2987 (0.453)	0.4621 (0.277)
ΔHJP	1.0335 (0.665)	-0.1172 (0.943)	-0.3675 (0.858)	0.4485 (0.550)	-0.0173 (0.994)	-0.2746 (0.808)	0.1842 (0.918)	-0.3015 (0.918)	0.6235 (0.849)	-0.1053 (0.953)
COV19	73.00 (0.979)	-2995.35 (0.367)	-780.76 (0.713)	-2213.71 (0.125)	-1934.14 (0.550)	-916.35 (0.567)	-1014.96 (0.706)	-2779.98 (0.346)	-683.02 (0.841)	-1906.58 (0.220)
Variable	**Central Java**	**Yogyakarta**	**East Java**	**Banten**	**Bali**	**West Nusa Tenggara**	**East Nusa Tenggara**	**West Kalimantan**	**East Kalimantan**	**North Sulawesi**
ECT	-0.6226*** (0.000)	-0.0835** (0.017)	-0.1794*** (0.001)	-0.2676*** (0.000)	-0.1016** (0.012)	-0.0456* (0.094)	-0.2034 (0.000)	-0.3554*** (0.000)	-0.0155 (0.296)	-0.0240 (0.117)
ΔHBP	-0.0624 (0.324)	0.0936 (0.174)	0.0389 (0.546)	0.0437 (0.503)	-0.0952 (0.556)	-0.0300 (0.695)	-0.0819 (0.173)	-0.0783 (0.166)	-0.0246 (0.725)	0.0032 (0.970)
ΔHTK	0.1087 (0.268)	0.1289 (0.612)	0.4331 (0.358)	0.6475*** (0.000)	-0.1901 (0.324)	0.2638* (0.053)	0.7907 (0.001)	0.1003 (0.675)	0.0599 (0.759)	1.5679*** (0.000)
ΔHJK	-0.1145 (0.765)	0.5171 (0.583)	-0.8069 (0.354)	0.0962 (0.743)	1.2282* (0.077)	0.0682 (0.786)	-0.3701 (0.698)	-4.4271* (0.074)	-0.0277 (0.926)	-0.4960 (0.622)
ΔHJP	0.1797 (0.897)	-1.3849 (0.385)	0.1182 (0.844)	1.1199 (0.446)	-1.4938 (0.375)	-3.6025*** (0.004)	3.0561 (0.272)	6.4837* (0.060)	-4.1669*** (0.001)	1.9955 (0.212)
COV19	-3970.29*** (0.010)	509.94 (0.852)	-4977.86 (0.124)	-1385.99 (0.368)	1967.71 (0.604)	-88.60 (0.975)	-5048.21 (0.122)	-809.83 (0.856)	167.36 (0.957)	-5551.18 (0.171)

Source: STATA 17.0 output

(*) Significance at 10%; (**) Significance at 5%; (***) Significance at 1%

Table 5 Panel ARDL-PMG Model Estimation of Broilers (continued)

Variable	Short Term Estimation of Broilers (Provinces)								
	Central Sulawesi	**Sulawesi Selatan**	**Southeast Sulawesi**	**Gorontalo**	**West Sulawesi**	**Maluku**	**North Maluku**	**West Papua**	**Papua**
ECT	-0.0756** (0.029)	-0.0909** (0.018)	-0.1020*** (0.006)	-0.1047*** (0.008)	-0.0712** (0.029)	-0.2729 (0.000)	-0.3412*** (0.000)	-0.1450*** (0.002)	-0.3457*** (0.000)
ΔHBP	-0.0774 (0.252)	0.1494 (0.201)	0.0257 (0.758)	-0.0906 (0.363)	0.0057 (0.904)	-0.0227 (0.841)	-0.0117 (0.926)	-0.1109 (0.159)	0.0558 (0.735)
ΔHTK	0.1802 (0.298)	-0.2700 (0.117)	-0.0749 (0.673)	0.1894 (0.393)	0.1780 (0.517)	-0.1546 (0.746)	-0.0378 (0.907)	0.8305*** (0.000)	1.6633*** (0.001)
ΔHJK	-0.2078 (0.733)	0.1968 (0.800)	0.9099 (0.462)	-0.1227 (0.882)	0.8098 (0.199)	-0.1716 (0.775)	-0.4639 (0.510)	0.0873 (0.928)	-0.3734 (0.697)
ΔHJP	-1.3233 (0.299)	-1.1840 (0.545)	-0.4052 (0.783)	-0.5290 (0.800)	-5.1644** (0.015)	-0.1281 (0.913)	-0.3988 (0.296)	0.5335 (0.857)	-0.5414 (0.898)
COV19	-638.25 (0.777)	-320.75 (0.917)	-2052.31 (0.433)	-1754.51 (0.528)	-2225.73 (0.548)	-1263.00 (0.703)	-4627.97 (0.100)	-1331.71 (0.600)	-1535.29 (0.724)
Variable	**Long Term Estimation of Broilers**					Short-Term Estimation of Broilers ECT -0.2722*** (0.000)			
HBP	0.3655*** (0.000)				ΔHBP	-0.0288** (0.041)			
HTK	0.9960*** (0.000)				ΔHTK	0.3329*** (0.000)			
HJK	0.0795 (0.246)				ΔHJK	-0.1203 (0.512)			
HJP	0.2249 (0.103)				ΔHJP	-0.1975 (0.612)			
COV19	-1142.68*** (0.007)				COV19	-1727.18*** (0.000)			

Source: STATA 17.0 output

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(*) Significance at 10%; (**) Significance at 5%; (***) Significance at 1%

The broiler industry in South Africa is vast, with 404 commercial producers comprising 199 independent and 205 contract farmers. This indicates that the position between independent and contract farmers is almost balanced. Therefore, the market is very competitive and independent farmers have a strong bargaining position. [38] Rose et al. (2019) stated that no long-term price asymmetry was found in the broiler market in the UK and USA during the study period. This shows that the broiler market in both countries was efficient and competitive.

This study also analyzed the consumer level's horizontal transmission between eggs and broilers. According to **[39]** horizontal price transmission refers to the relationship of prices across markets and could occur across different commodities. The Panel ARDL-PMG estimation results indicated that consumer-level egg prices have a significant positive relationship with consumer-level broiler prices in the long term. A positive relationship between eggs and broilers indicates a close substitution relationship in demand between the two commodities. [40] Stated that interaction between commodity prices occurs in the medium and long term due to substitution and complementary phenomena. Additionally, [41] stated that broilers have a substitution relationship with eggs.

COVID-19 shows a long-term significant negative relationship with consumer-level broiler prices. This signifies that the pandemic has a long-term negative impact on consumer-level broiler prices. According to [42] the pandemic has caused a massive economic impact. COVID-19 has caused a significant negative impact on Indonesia's broiler trade through oversupply, reducing chicken market prices. The price disparity between regions is also vast, with implications for business continuity in the broiler farm sector.

5. CONCLUSIONS

This study found a vertical integration between the broiler market at the producer and consumer levels in the short and long term. The negative price transmission in producer and consumer markets is probably caused by market power in the broiler industry. Furthermore, horizontal integration with negative price transmission occurs in Aceh Province. The results also indicated a positive co-integration between consumer-level egg and broiler prices in the short term. This was seen in West Sumatra, Riau, Jambi, South Sumatra, West Java, Banten, West Nusa Tenggara, North Sulawesi, West Papua, and Papua. In aggregate, there is no co-integration between corn input and broiler output in the short and long term. Individually, there is integration in the short term between producer-level corn prices and consumer-level broiler prices in Bali and West Kalimantan. Consumer-level corn and broiler prices are integrated in West Nusa Tenggara, East Kalimantan, and West Sulawesi. The findings also showed that COVID-19 significantly and negatively affects consumer-level broiler prices in the short and long term.

Indonesia's government should implement the Anti-monopoly Law to overcome the growth of market power by large companies and create a competitive business environment in the broiler industry. It should also issue a policy regulating the marketing of stagnant and oversupplied

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broilers. This policy could adapt to the policy implemented by Thailand, where large companies must expand the market through exportation. It is expected that the competitive environment of the Indonesian broiler industry would be more efficient.

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Conflict of interest

The authors declare no conflict of interest

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