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PRICE TRANSMISSION BETWEEN INPUT AND OUTPUT MARKETS: THE COVID-19 EFFECT ON LAYING HENS' INDUSTRY IN INDONESIA

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Abstract: Corn and poultry are two strategic commodities supporting food security and highly dependent on one another. This study analyses the short-term and long-term relationship between the price variables for eggs, broiler, and corn. It determines the effect of COVID-19 at the producer and consumer levels on the price of eggs in 28 provinces in Indonesia using the Panel Autoregressive Distributed Lag (PARDL) – Pooled Mean Group (PMG) approach. The PARDL estimation showed a short-term relationship between egg, broiler, and corn price variables at the producer and consumer levels, and this is shown by a significant positive and negative relationship in several provinces. There is a substitution relationship between laying hens and broiler in North Sumatra, Riau, South Sumatra, West Java, Central Java, Banten, West Nusa Tenggara, North Sulawesi, and West Papua, while the complementary relationship only occurs in Bali. In addition, the Indonesian laying hen industry should be supported by integrated policies from upstream to downstream. This is a policy of the lowest and the highest retail price and those that regulates the creation of corn supply balance inputs as the main feed for laying hens.

Keywords: corn, COV-19, laying hens, PARDL, price transmission

Abstrak: *Jagung dan unggas merupakan dua komoditi strategis dalam menunjang ketahanan pangan dan mempunyai ketergantungan tinggi antara satu dengan lainnya. Penelitian ini bertujuan untuk menganalisis hubungan jangka pendek dan jangka panjang antar variable harga telur, ayam ras dan jagung serta melihat pengaruh covid19 baik di tingkat produsen dan konsumen terhadap harga telur ayam di 28 provinsi di Indonesia. Penelitian ini menggunakan pendekatan Panel Autoregressive Distributed Lag (PARDL) – Pooled Mean Group (PMG). Hasil estimasi PARDL terdapat hubungan jangka pendek antara variable harga telur, broiler dan jagung baik ditingkat produsen maupun tingkat konsumen yang diperlihatkan oleh hubungan positif dan negatif yang signifikan di beberapa provinsi. Dalam jangka panjang harga telur tingkat produsen, harga broiler dan harga jagung tingkat konsumen dan Cov-19 memberikan pengaruh yang positif terhadap harga telur ayam di tingkat konsumen. Terdapat hubungan subsitusi antara ayam petelur dan ayam pedaging di Provinsi Sumatera Utara, Riau, Sumatera Selatan, Jawa Barat, Jawa Tengah, Banten, Nusa Tenggara Barat, Sulawesi Utara, dan Papua Barat dan hubungan komplementer hanya terjadi di Bali. Rekomendasi kebijakan yang disarankan dari hasil penelitian ini adalah pemerintah harus dapat membuat kebijakan yang terintegrasi dari hulu ke hilir dalam mendukung industri ayam petelur di Indonesia. Kebijakan bukan hanya kebijakan harga eceran terendah dan harga eceran tertinggi tetapi juga kebijakan yang mengatur terciptanya keseimbangan pasokan input jagung sebagai pakan pokok dari ayam petelur.*

Kata kunci: *Cov-19, jagung, telur ayam ras, transmisi harga, PARDL*

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INTRODUCTION

Price transmission is a very important economic analysis that discusses the micro and macro aspects. This is because the spike in commodity prices is the mechanism underlying the inflation process. Leibtag (2009) stated that the spike in price has led to food price inflation, while Sinaga et al. (2020) stated that highly volatile strategic food prices cause volatility. Corn and poultry are two strategic commodities supporting food security and highly dependent on one another. Central Bureau of Statistics (2019) showed national inflation of 3.1%, one of which is caused by the prices of the foodstuffs group. Inflation in the foodstuffs group reached 1.45%, with the share of broiler eggs at 0.09%. Furthermore, eggs as a source of protein will greatly affect food availability and security. According to Arifin and Ahmad (2016), eggs are animal food source of protein easily accessible at affordable prices, including in low-income communities.

Government laws meant to protect farmers create difficulties for chicken breeders, making it necessary to analyze the corn and broiler eggs market. There are conflicting interests between corn farmers and chicken breeders, broilers and laying hens. Corn farmers want relatively high prices to increase their income, while chicken breeders desire low prices. Therefore, the animal feed price and production costs are low. The government's policy to stop corn imports has hampered the livestock industry's growth, negatively affecting egg production and supply performance. These two interests can be reconciled when the two markets are analyzed in an integrated manner.

Price transmission analysis is particularly relevant for all stakeholders participating in the value chain. It explains how the value generated by a product or service is distributed among different actors and helps assess the power of negotiations. World Bank (2011) stated that in Indonesia, the price difference could reach 70% between provinces due to differences in remoteness, transportation infrastructure, commodity output, land productivity and per capita income. For the eastern region, the price of eggs for Papua, North Maluku and Gorontalo provinces can reach IDR 40,000/kg (National Strategic Food Price Information Center, 2020). According to Lloyd (2017), one of the most important points in the price transmission analysis is that the degree and dynamics of adjustment as signals are key indicators of the participant's behavior in the chain and their functioning as a whole. Meanwhile, IMF (2011) stated that food inflation is one of the most volatile components of general inflation. This causes the analysis of price transmission in the laying hens' industry to be important in the downstream and price of upstream products.

Hidayanto et al. (2014) stated that the spatial market integration between provinces in Indonesia is 38.46%. The archipelagic demographic position causes the distribution system to become one of the supporting factors in smooth supply from production centers to consumer areas and price stability (Arifin, 2012). Abidin (2003) stated that formulating and implementing a price stabilization policy requires information on disparities due to partial or total price changes. Moreover, price disparities also occur, one of which is due to the gap between regions. Jangam and Akram (2019) analyzed price convergence and focused on the consumer level in Indonesia. Varela et al. (2013) stated that price differences across provinces were caused by distance, infrastructure quality, land productivity and per capita output. The more remote the area, the higher the price. Kouyaté and Cramon-Taubadel (2016) stated that each additional 1000 km distance reduces the probability of cointegration by 7%.

Babula and Bessler (1990) used the VAR technique to examine the dynamic relationship between corn, poultry, and retail prices and how this changed from 1957 to 1989. The study focused on the dynamic attributes of how non-agricultural related prices respond to changes in agricultural crop prices, (1) reaction times for responses, (2) direction, pattern, and duration of responses, and (3) how response patterns for related prices are similar or different between sectors, and (4) the strength of linkages between crop-related prices across various sectors of the economy.

Empirical studies that discussed price transmission in food commodities are increasing. This study discusses the transmission of prices from input to output, namely corn as feed input and eggs as output. The price used is at the producer and consumer levels, and the relationship between egg and broiler prices was also analyzed. According to Singh et al. (2015), the relationship between substitution and complementarity between products can be seen through market integration tested in terms of price transmission across commodities. The other variable analyzed is the COVID-19 effect on the transmission of laying hens' prices. According to Fang et al. (2021), COVID -19 has impacted broiler and egg production, and more than 10% of laying hens' farm close before June in Myanmar. Eggs are critical to the food security and nutrition of low-income households, therefore, it is important to understand the impact of the pandemic on the poultry sector. According to Lambrecht et al. (2020), any shock that affects the supply or price of eggs or broilers will affect food security and nutrition.

This study aims to analyze the short-term and long-term relationship between the corn and the output variables. It also determines the relationship between the price of eggs and broiler at the producer and consumer levels in 28 provinces. In general, previous studies only examined the market partially. Some of the novelty of this current analysis are, First, the corn and egg studied are strategic commodities and contributors to food inflation. Second, it uses cross-sectional data from 28 provinces, which has not been conducted before. Third, it combines horizontal and vertical transmission. Fourth, it also determines the impact of COVID-19, and uses PMG ARDL Panel to analyze the same commodity.

Mensah et al. (2019) stated that cross-sectional dependence is a common problem in panel estimation, with many observations across time and cross-sectional units. Unless it is addressed, it leads to inconsistencies in estimations, and the ARDL approach estimates the short-term and long-term relationship between the variables. The pooled mean group (PMG) method assumes that the short-term coefficients, rate of adjustment of values, and error variance are heterogeneous. However, the long-term coefficients are constrained to be homogeneous across countries.

METHODS

The panel data approach was used with a time series of 2010M01-2020M12 in 28 provinces, as described in Table 1. This study uses two first-generation unit root tests, Levin Lin Chu (LLC) and Breitung. This test determines the long-term relationship of the dependent and independent variables. The Kao test follows the basic approach, which is more specific in cross-section on the intercept and homogeneous coefficient on the first stage regressor. The Hausman test is used to select between Fixed or Random Effect. It is utilized when the Fixed and Random Effect methods are better. In addition, the test is based on the idea that Least Squares Dummy Variables (LSDV) and Generalized Least Squares (GLS) in the Fixed and Random Effect methods are efficient.

The PARDL model analyzes the long-term and short-term relationships at the PEC. The independent variables in the model are represented by PEP and PBC, PCP and PCC, as well as PPE level. Meanwhile, another independent variable is COV-19.

$$
\begin{aligned}
\Delta PEC_{it} = \mu_i + \big(&\alpha_i PEC_{i,t-1} + \beta'_{1i} PEP_{it} + \beta'_{2i} PBC + \beta'_{3i} PCC_{it} \\
&+ \beta'_{4i} PCP_{it} + \beta'_{5i} COV19_{it}\big) + \sum_{j=1}^{p-1} \lambda^{*}_{ij} \Delta PEC_{i,t-j} \\
&+ \sum_{j=0}^{q-1} \gamma^{*\prime}_{1ij} \Delta PEP_{i,t-j} + \sum_{j=0}^{q-1} \gamma^{*\prime}_{2ij} PBC_{i,t-j} + \sum_{j=0}^{q-1} \gamma^{*\prime}_{3ij} \Delta PCC_{i,t-j} \\
&+ \sum_{j=0}^{q-1} \gamma^{*\prime}_{4ij} \Delta PCP_{i,t-j} + \sum_{j=0}^{q-1} \gamma^{*\prime}_{5ij} \Delta COV19_{i,t-j} + \varepsilon_{it}
\end{aligned}
$$

Hypothesis in this study is that the variable of transmission of input prices, the price of eggs and chicken meat at the produser and consumer levels, and the Covid-19 pandemic variable have positive significant impacts on the output prices of eggs at the consumer level, both short-term and long-terms levels.

RESULTS

Descriptive Statistics

The distribution value and variability of the variables used are described in Table 2. The average value of producer level corn price (PCP), consumer level corn prices (PCC), producer level broiler price (PBP), consumer level broiler price (PBC), producer level egg price (PEP), and consumer level egg price (PEC) is IDR 3905.937 (PCP), IDR 6269.37 (PCC), IDR 33,333.31 (PBC), IDR 19,541.25 (PEP) and IDR 22,013.28 (PEC), respectively.

The value of the standard deviation of the six variables studied is smaller than the average. Therefore, it can be concluded that outliers and extremes were absent, and the value of the correlation matrix shows it is smaller than 0.8, meaning the six variables studied do not have multicollinearity problems.

Table 1. Data and variables

Variable	Data source
Consumer-level egg price (PEC)	BPS, Ministry of Agriculture (price sim), PIHPS
Producer-level egg price (PEP)	BPS, Ministry of Agriculture (price sim), PIHPS
Consumer-level broiler prices (PBC)	BPS, Ministry of Agriculture (price sim), PIHPS
Producer-level corn price (PCP)	BPS, Ministry of Agriculture (price sim), PIHPS
Consumer-level corn price (PCC)	BPS, Ministry of Agriculture (price sim), PIHPS
COVID-19 (COV-19)	dummy

Table 2. Descriptive statistics 2010M01 – 2020M12

	PCP	PCC	PBC	PEP	PEC
Panel A: Statistical Summary					
Mean	3905.937	6269.377	33333.31	19541.25	22013.28
Std. Dev	1279.209	1862.505	8719.114	4359.666	5103.523
Minimum	1797.59	2490	19932	9924	10774
Maximum	8536.29	14794.04	81536	37536	39837
Variance	1636376	3468926	7.60e+07	1.90e+07	2.60e+07
Skewness	0.8937253	0.5947384	2.439442	0.4488778	0.6716342
Kurtosis	3.440561	3.295077	11.05179	3.326185	3.45689
Obs	3.828	3.828	3.828	3.828	3.828
Panel B: Correlation Matrix					
PCP	1.0000				
PPC	0.6409	1.0000			
PBC	0.3191	0.2963	1.0000		
PEP	0.6727	0.5924	0.4543	1.0000	
PEC	0.6584	0.5390	0.5588	0.8704	1.0000

Panel Data Unit Root Test Results

The study by Levin *et al*. (2002) and Breitung (2000) suggested using unit root tests in panel data models. The most commonly used unit root test in a study that conducts panel data testing by sector is Levin-Liu Chu (LLC). The results of the unit root test of LLC and Breitung proved that the six variables are stationary in the first difference (Table 3).

Panel Data Cointegration Test Results

The results of the cointegration test using the Kao test showed cointegration between the variables used (Table 4). The value ($p<0.00$) means that there is cointegration during the period 2010M01 to 2020M12.

Hausman Test Results

The Hausman statistical test is shown by the value of the Difference Fixed Effect (DFE) and Pooled Mean Group (PMG). The Hausman test results showed that prob>chi2 = 1 means that the PMG is the best estimator in estimating the ARDL Panel model (Table 5).

The Results of Panel Autoregressive Distributed Lag (ARDL)-PMG Model

The PMG model PARDL test results consisted of two long-term and short-term relationships. In the aggregate, there is a significant positive relationship between the variable of PEP, PBC, PCC, PCP and COV-19 on PEC. For the short-term relationship in each province, the results of the PMG PARDL test showed a different relationship, namely a significant positive and negative relationship.

The variable price of PEP has a significant positive relationship in Aceh, South Sumatra, Bengkulu, Bangka Belitung, West Java, Central Java, DI Yogyakarta, Banten, and West Papua, amounting to 41.3% of the total sample. Different short-term relationships can be seen in Bali, East Kalimantan, and Gorontalo, where there are negative and significant relationships.

Table 3. Unit Root Test Panel

Var	LLC Test		Breitung Test	
	Level	First Difference	Level	First Difference
PCP	0.0649	0.0000	0.9968	0.0000
PCC	0.0000	0.0000	0.3699	0.0000
PBP	0.0000	0.0000	0.0000	0.0000
PBC	0.0000	0.0000	0.0000	0.0000
PEP	0.0001	0.0000	0.5124	0.0000
PEC	0.0000	0.0000	0.0796	0.0000

Table 4. Kao Test for Cointegration

	Statistics	p-value
Modified Dickey-Fuller t	-8.5707	0.0000
Dickey-Fuller t	-7.5459	0.0000
Augmented Dickey-Fuller t	-4.5362	0.0000
Unadjusted Modified Dickey-Fuller t	-51.7468	0.0000
Unadjusted Dickey-Fuller t	-18.7544	0.0000

Table 5. Hausman Test

Variable	----- coefficient -----	
	(b)	(B)
	DFE	PMG
PEP	0.6309	0.5622
PBC	0.1143	0.2523
PCC	0.1928	0.0099
PCP	0.6464	0.4818
COV19	1502.9	671.83
Prob > chi2 = 1.0000		

Furthermore, the PBC has a positive and significant relationship of 37.9% in North Sumatra, Riau, South Sumatra, West Java, Central Java, Banten, West Nusa Tenggara, North Sulawesi, and West Papua. The negative and significant relationship only occurs in Bali, and the PCC only has a positive and significant relationship in Yogyakarta, East Java, and Banten with a significant value of 10.3%. Meanwhile, the PCP has a positive and negative relationship in different provinces. Positive and significant relationships occur in Jambi, West Java, Bali, West Nusa Tenggara, Gorontalo, and North Maluku. A negative and significant relationship is shown in Riau, D.I. Yogyakarta, and North Sulawesi. The PMG model PARDL analysis results is presented in Tables 6.

Short-Term Relationship between Prices and COVID-19 on Transmission of Egg Prices in Indonesia

In the short-term, the variables at the producer level (PEP) has a positive and significant relationship to CPE. This means that when PPE increases, it will be transmitted directly to PEC. This is in line with the study by Ilham and Saptana (2019)data of the study were collected by interviewing officers from related agencies, breeders, associations and egg traders in West Java Province. Price fluctuation was estimated using coefficient of variation. Factors influencing egg price fluctuation was analyzed descriptively. Egg price for the last five years kept increasing. Average egg price in 2018 was higher than those in last four years. High egg price at farm level affected its retail price in Jakarta. Increased egg price was due to increases in feed and DOC prices, and decreased egg production affected by disease attacks. At the same time the demand for egg enhanced along with National Religious holidays, school vacations, and foot ball world cup shows. Biosecurity, hygienic pens, and response to disease attack need improvement. Prohibition of AGP (Antibiotic Growth Promoters, which stated that the high price of eggs in producers of West Java pushed prices at the level of the main consumers of DKI Jakarta to rise. Another study by Nuryati and Nur (2012) stated that the concentration of egg production in certain areas, such as Blitar, Medan and Makassar, will cause disparities in other areas. Meanwhile, Babula and Bessler (1990) stated that the retail price is strongly influenced by the farm level. In the short-term, PEP and PEC have a negative and significant relationship. This condition is appropriate to Ilham and Haryanto (2020), where the impact of the pandemic on income changes only reduced PEC. Baladina et al. (2021) stated that the pandemic, which generally affected the decline in people's income and purchasing power, did not have severe impact on the shock in the consumer market.

PBC has a positive and negative relationship with PEC in the short-term. This indicates a substitution relationship between broiler and laying hens at the consumer level. Based on the study from Fridayanti et al. (2018), the cross elasticity of the broiler price is more than 0, which is 0.911. This is appropriate to Fitriani et al. (2016), which stated that broiler meat substitutes for eggs.

Table 6. ARDL Panel Estimation – Layer PMG Model

Variable	Short Run Estimation of Layer (Provinces)									
	Aceh	North Sumatera	West Sumatera	Riau	Jambi	South Sumatera	Bengkulu	Lampung	Bangka Belitung	West Java
ECT	-0.5622***	-0.1563***	-0.3642***	-0.6284***	-0.3771***	-0.6312***	-0.0881**	-0.1391***	-0.6678***	-0.6259***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.022)	(0.000)	(0.000)	(0.000)
ΔPPE	0.1603*	-0.1035	0.1104	0.0237	-0.0055	0.5437***	0.5462**	-0.0002	0.4185***	0.5355***
	(0.068)	(0.263)	(0.423)	(0.864)	(0.968)	(0.001)	(0.013)	(0.997)	(0.000)	(0.003)
ΔCPB	-0.0102	0.0554**	0.1808***	0.2415***	0.0295	0.2287***	-0.0124	-0.0027	-0.0326	0.2245***
	(0.773)	(0.033)	(0.000)	(0.000)	(0.261)	(0.000)	(0.832)	(0.886)	(0.224)	(0.000)
ΔCPC	0.2315	0.2819	0.3756	0.1087	-0.1146	-0.3551	-0.0574	-0.0946	0.0807	-0.1403
	(0.238)	(0.376)	(0.252)	(0.718)	(0.735)	(0.500)	(0.882)	(0.405)	(0.559)	(0.660)
ΔPPC	0.0397	-0.0561	-0.4920	-1.1919*	1.3991**	0.9017	12.654	-0.6370	0.3721	2.6427**
	(0.968)	(0.917)	(0.689)	(0.053)	(0.048)	(0.246)	(0.317)	(0.339)	(0.742)	(0.041)
COV-19	-401.38	307.54	-241.64	1374.23	-660.75	615.18	-825.79	81.97	723.63	1318.39
	(0.727)	(0.777)	(0.853)	(0.247)	(0.536)	(0.582)	(0.667)	(0.903)	(0.540)	(0.260)
Variable	Central Java	DI Yogyakarta	East Java	Banten	Bali	West Nusa Tenggara	East Nusa Tenggara	West Kalimantan	East Kalimantan	North Sulawesi
ECT	-0.7622***	-0.0357	-0.0507***	-0.5163***	-0.2219***	-0.1447***	-0.3377***	-0.1130***	-0.0498**	-0.0438**
	(0.000)	(0.206)	(0.007)	(0.000)	(0.000)	(0.001)	(0.000)	(0.002)	(0.048)	(0.032)
ΔPPE	0.3781***	0.0770*	0.0135	0.5819***	-0.1586**	-0.0279	0.0938	-0.0660	-0.1090*	-0.0222
	(0.009)	(0.072)	(0.722)	(0.000)	(0.047)	(0.755)	(0.466)	(0.513)	(0.053)	(0.517)
ΔCPB	0.1148**	0.0217	-0.0008	0.1927**	-0.0618*	0.0906*	0.0225	0.0158	0.0010	0.1276***
	(0.048)	(0.454)	(0.956)	(0.000)	(0.096)	(0.095)	(0.422)	(0.580)	(0.978)	(0.000)
ΔCPC	0.0123	0.6197**	0.2671*	0.3463**	-0.1072	-0.2270	0.4840	14.449	-0.0577	0.3621
	(0.967)	(0.050)	(0.084)	(0.046)	(0.720)	(0.139)	(0.104)	(0.105)	(0.661)	(0.219)
ΔPPC	14.027	-1.5454***	-0.0887	-13.405	1.4389**	1.3254*	-0.0560	0.5457	0.1004	-1.0247**
	(0.195)	(0.003)	(0.412)	(0.128)	(0.040)	(0.098)	(0.949)	(0.657)	(0.856)	(0.027)
COV-19	1499.20	1537.12*	768.36	117.10	1259.62	-225.32	978.63	246.12	131.86	2357.38**
	(0.214)	(0.091)	(0.187)	(0.900)	(0.434)	(0.896)	(0.343)	(0.877)	(0.922)	(0.046)
Variable	Central Sulawesi	South Sulawesi	Southeast Sulawesi	Gorontalo	West Sulawesi	Maluku	North Maluku	West Papua	Papua	
ECT	-0.1787***	-0.1427***	-0.0226	-0.0253	-0.0565*	-0.0310	-0.1136***	-0.1840***	-0.1985***	
	(0.000)	(0.002)	(0.513)	(0.347)	(0.073)	(0.218)	(0.004)	(0.000)	(0.000)	
ΔPPE	0.0715	0.1115	0.0293	-0.0667*	0.0131	0.0327	0.0281	0.3497**	0.0444	
	(0.428)	(0.218)	(0.701)	(0.082)	(0.864)	(0.296)	(0.616)	(0.029)	(0.472)	
ΔCPB	0.0194	-0.0692	0.0071	0.0408	0.0121	-0.0043	-0.0093	0.1755***	-0.0014	
	(0.673)	(0.108)	(0.868)	(0.218)	(0.659)	(0.774)	(0.702)	(0.000)	(0.915)	
ΔCPC	-0.0045	-0.2041	0.4247	-0.0293	0.1280	0.0339	0.0873	-0.3390	0.0134	
	(0.989)	(0.606)	(0.496)	(0.927)	(0.498)	(0.756)	(0.632)	(0.456)	(0.928)	
ΔPPC	-0.8942	0.1663	0.8754	1.8774**	0.2225	-0.0198	0.3263***	10.670	-0.3766	
	(0.185)	(0.867)	(0.242)	(0.019)	(0.758)	(0.927)	(0.001)	(0.444)	(0.567)	
COV-19	672.43	57.38	-384.05	1440.36	302.47	637.54	587.23	-306.00	127.97	
	(0.572)	(0.970)	(0.785)	(0.184)	(0.798)	(0.295)	(0.430)	(0.799)	(0.852)	
Variable	Long Run Estimation of Layer				Variable		Short Run Estimation of Layer			
PPE	0.5622***				ECT	-0.2429***				
	(0.000)					(0.000)				
CPB	0.2523***				ΔPPE	0.1242***				
	(0.000)					(0.002)				
CPC	0.0099				ΔCPB	0.0550***				
	(0.786)					(0.001)				
PPC	0.4818***				ΔCPC	0.1231*				
	(0.000)					(0.060)				
COV-19	671.83***				ΔPPC	0.2843				
	(0.004)					(0.133)				
					COV-19	489.09***				
						(0.001)				

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

Different results were shown in Bali, where there was a negative and significant relationship. PBC and PEC are inversely related, and this indicates that eggs and meat have a complementary relationship. Hermanus et al. (2017) stated that the price elasticity of broiler meat is negative, which means the demand is inelastic. Cross elasticity indicates that broiler meat has a complementary relationship with broiler eggs. According to Atmaja et al. (2019), broiler meat in Bali is one of the main needs in fulfilling animal protein intake for daily and religious holiday consumption.

The variable PCC has a positive and significant relationship in the short-term to the consumer level. Babula and Bessler (1990) stated that egg prices respond to about a third of the percentage change in corn prices. The corn prices seem to affect the modelled transmission mechanism. Breeder and retail price responses directly react to the increase in agricultural corn prices. Egg prices at the farm and retail levels increased after the positive corn price shock. The response of farm and retail egg prices to corn shocks persisted for 17 months. Rahmi and Arif (2012) stated that PCC is more sensitive. Therefore, increased PCC will also increase the prices of eggs.

There is a positive and negative relationship between PCP. The positive and significant relationship indicates that any increase in PCP will be passed on to PEC. This is confirmed by Ilham and Saptana (2019)data of the study were collected by interviewing officers from related agencies, breeders, associations and egg traders in West Java Province. Price fluctuation was estimated using coefficient of variation. Factors influencing egg price fluctuation was analyzed descriptively. Egg price for the last five years kept increasing. Average egg price in 2018 was higher than those in last four years. High egg price at farm level affected its retail price in Jakarta. Increased egg price was due to increases in feed and DOC prices, and decreased egg production affected by disease attacks. At the same time the demand for egg enhanced along with National Religious holidays, school vacations, and foot ball world cup shows. Biosecurity, hygienic pens, and response to disease attack need improvement. Prohibition of AGP (Antibiotic Growth Promoters, which stated that the increase in feed prices was caused by an uncontrolled increase in the price of corn. The strategy of preventing corn imports has contributed to a shortage of domestic output, which has driven up the price of eggs. Furthermore, the price of corn at the farmer level has a negative and significant relationship to eggs at the consumer level. According to Rahmi and Arif (2012), the sensitivity of price changes at the corn farmer level is smaller than at the consumer level since the market is less efficient. The building of margins on collecting traders as market actors who control and prevent price transmission is causing problems. In the short-term, COVID-19 positively affect the price of broiler eggs at the consumer level. This positive effect occurred in Yogyakarta and North Sulawesi. According to data from BPS Yogyakarta (2021), there have been real changes and shifts. Before the pandemic, tourism was Yogyakarta's main commodity, but agricultural took over, with livestock being the leading sub-category.

Therefore, the COVID-19 causes an increase in demand for livestock products, including egg prices. In line with the study by Fang et al. (2021), the effect in Myanmar on laying hens has caused egg prices to increase by 30% from May to August. Ilham and Haryanto (2020) mentioned that the price was stable and increased during the pandemic. This is because the price of eggs is more affordable, and the product can last up to 14 days or more. Therefore, during the pandemic, people prefer to buy eggs to meet their animal protein needs. According to Gaisani et al. (2021) COVID-19 does not significantly affect its financial performance.

The Long-Term Relationship between Prices and COVID-19 on the Transmission of Egg Prices in Indonesia

Based on the results of the ARDL-PMG Panel, there is only one variable, namely the price of corn at the consumer level, which has no significant effect on the price of eggs. Muslim (2011) stated that the corn market at the wholesale level is an oligopsony, therefore, the price is controlled by traders with a large capital. In the long-term, this market structure is expected to cause consumer corn prices to have no significant effect on egg prices.

For the variable price of corn at the farmer level, the results of the PMG ARDL panel have a positive and significant effect at the consumer level. Aghabeygi *et* al. (2019) examined the transmission of corn to egg prices and stated that in the long-term, any shocks in corn would be transmitted to egg prices. According to Elvina et al. (2018)wholesale and retail, price changes at the consumer market level will affect the producer market level. The price of corn at the farm level will be transmitted to the consumer level.

The variable price of broiler chickens positively and significantly affects egg prices at the consumer level. Ansyari *et al*. (2013) stated that the coefficient value of broiler eggs is 0.529. Therefore, an increase in the price of broiler eggs by 10% can increase demand for the meat by 5.29%. This is reinforced by Hardiyanti (2017), where the price of other commodities, namely the price of broiler eggs, positively affected the demand for meat.

Xu et al. (2011) stated that a long-term and short-term price relationship exists between corn inputs and eggs in the poultry industry. Sari et al. (2021) reported that the maize market at the feed mill level is integrated into the long-term with those at the farmer and global level, unlike in the short-term, where integration occurs only at the level of feed mills and farmers. Karim et al. (2017) emphasized that the relationship between prices and spatial markets is important in the economic analysis of the egg at the consumer and producer levels. Meanwhile, Palouj et al. (2021) stated that the COVID-19 pandemic had affected input supply as a stage in the poultry supply chain.

The long-term effect of COVID-19 on egg prices at the consumer level is positive and significant. According to Malone et al. (2021), the pandemic did not cause a decrease in margins and marketing for eggs at the consumer level. However, the pandemic increased retail and farm-level prices for eggs by about 141% and 182%, respectively. This condition also occurs in Indonesia, according to data from the Ministry of Trade (2020), eggs would increase production by 615,108 tons. This means that COVID-19 positively affect egg prices at the consumer level.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In the short- and long-term, there is a significant positive relationship between the price of laying hens at the producer level (PEP), the price of broiler chickens at the consumer level (PBC), the price of corn at the consumer level (PCC), the price of corn at the producer level (PCP) and the price of corn at the producer level on the egg prices at the consumer level (PEC). For the short-term, the PMG PARDL test showed a significant positive and negative relationship. There is a substitution relationship between laying hens and broiler in North Sumatra, Riau, South Sumatra, West Java, Central Java, Banten, West Nusa Tenggara, North Sulawesi, and West Papua, and the complementary relationship only occurs in Bali. Based on the results of the PMG PARDL analysis, COVID-19 has a positive effect in the short- and long-term on PEC.

Recommendation

Concerning the policy recommendation, the government should adopt policies integrated from upstream to downstream in supporting the laying hen industry. This is the policy of the lowest and highest price and those regulating the creation of a balanced supply of corn inputs.

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