



UDC 332

ASYMMETRY OF PRICE TRANSMISSION ON THE RED CHILI MARKET IN JAMBI PROVINCE, INDONESIA

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ABSTRACT

High price fluctuations for red chili commodities indicate that price changes are occurring quickly. Market players must respond to these rapid price changes as quickly as possible which indicates efficiency in the supply chain of the commodity. However, high price fluctuations are often used by market players to manipulate information on price changes. This can be seen from inconsistent price movement patterns in price relationships between market levels when responding to shocks of price increases and price decreases. The question to be answered is how quickly and to what extent prices are transmitted up and down the supply chain. The phenomenon when an increase or decrease in prices is responded to differently by a market indicates the occurrence of asymmetric price transmission. This research aims to: (1) analyze market integration between the red chili market levels in Jambi Province, and (2) to analyze asymmetric price transmission between market levels in the red chili supply chain. Market integration and asymmetric price transmission are analyzed using the Asymmetric Error Correction Model approach. The data used to analyze market integration and asymmetric price transmission is time series data on red chili prices for the period 1 June 2022 to 31 May 2023 (261 days) which was formed at the producer, wholesaler and retailer level in Jambi Province. The price data source was obtained from the Indonesian national strategic food price information center. The research results show that there is cointegration which concludes that there is market integration between red chili market levels in Jambi Province. The results of testing the asymmetric price transmission model show that there is short-term symmetric price transmission in the relationship between retailer prices and wholesalers' prices. However, long-term price transmission found an asymmetric relationship where wholesalers' prices were quicker to adjust to deviations from price increases than price decreases. Asymmetric conditions indicate abuse of market power at the wholesale level which causes red chili prices in the market to tend to increase prices more easily and make it difficult for prices to decrease.

KEY WORDS

Red chili, market integration, asymmetric price transmission, market power.

Jambi Province is one of the 6th largest red chili production areas in Indonesia together with: West Java, North Sumatra, Central Java, East Java and West Sumatra. According to data from the Indonesian Central Statistics Agency (2022), red chili production in Jambi Province has tended to increase in the last 5 years since 2022; the highest production increase was 63.99% in 2022 from the previous year. Apart from increasing production, the level of consumption of red chilies in Jambi Province also tends to increase every year. Consumption of red chilies in Jambi Province in 2021 was recorded at 19,789.86 tonnes per year, an increase of 12.79% (2,243.86 tonnes) from the previous year which was recorded at 17,546 tonnes. With the population trend continuing to increase every year and the growing development of the food and restaurant sector, it is estimated that red chili consumption will continue to increase.

Based on a macroeconomic perspective, red chilies are one of the horticultural commodities that contribute to inflation in Jambi Province. In the July 2022 period, Jambi City has month to month inflation of 1.30% and Bungo Regency of 1.05%. The inflation rate for the period July 2022 year on year is 6.96% and 8.55%. This inflation rate is the highest of the 90 cities that calculate the Consumer Price Index in Indonesia. The main commodity that



contributed to the high inflation was red chilies. Fluctuations in red chili prices generally have a psychological impact on the market. Increases in this commodity prices often cause a domino effect and are able to provoke public expectations of increases in prices of other foodstuffs, resulting in inflation.

High fluctuations in red chili commodity prices are often used by market players to manipulate signals of price changes so that price transmission tends to be asymmetrical. As can be seen in Figure 1 which shows the daily price movements of red chilies in Jambi Province at 3 market levels. Figure 1 shows that there are fluctuations in the daily price of red chilies all the time during the period June 2022 – May 2023. It can be seen that there are inconsistencies in price movement pattern in price relationships between producer, retailer, & wholesaler level when responding to shocks of price increases and price decreases. In a vertically integrated market, prices formed at various levels of the marketing chain will be positively correlated with each other, where price shocks that occur in reference market can be transmitted symmetrically to the market level above. This results in an efficient marketing system and creates price stability so that inflation does not occur.

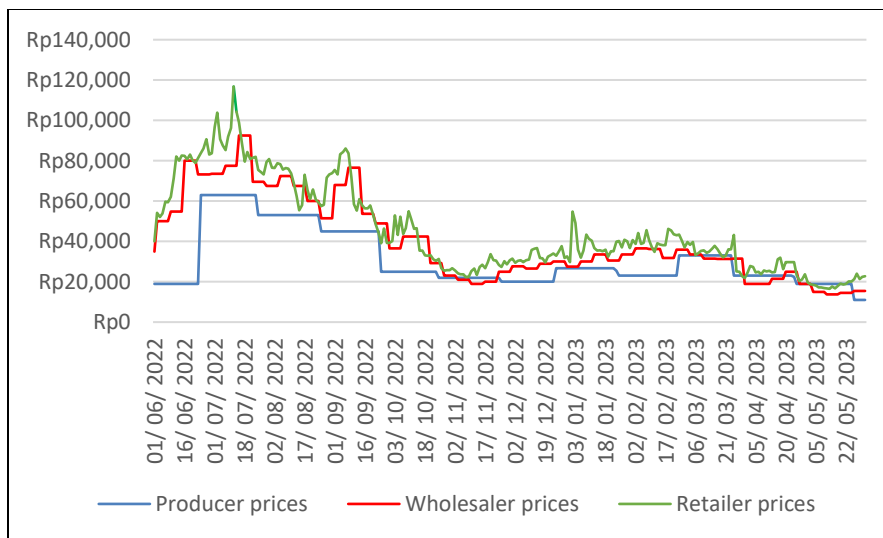


Figure 1 – Fluctuations in red chili prices (daily) at the producer, wholesaler and retailer levels in Jambi Province for the period June 2022 – May 2023

An imperfect market structure provides opportunities for market players to transmit price increases quickly to the consumer level and hold prices when prices decrease at the producer level. This is reflected in the price of red chilies at the consumer level, which tends to be easier to increase prices and more difficult to reduce prices. Meyer and von Cramon-Taubadel (2004) state that asymmetric price transmission allows consumers not to benefit from price reductions at the producer level, or producers may not benefit from price increases at the retailer level. Asymmetric analysis of price transmission is carried out to better understand overall market functioning. The question to be answered is how quickly and to what extent price shocks are transmitted up and down the supply chain.

Meyer and von Cramon-Taubadel (2004) stated that in oligopoly markets, asymmetric price transmission can occur positively or negatively, depending on the market structure. Positive asymmetric price transmission is a condition where the shock of a price increase will be responded to more quickly and/or more perfectly than when a price decrease occurs. Meanwhile, negative asymmetry is a condition where the shock of a price decrease will be responded to more quickly and/or more completely than when a price increase occurs. Serra and Goodwin (2002) state that one of the causes of asymmetric price transmission is the existence of market power. Even though the market is in a perfect competitive structure, asymmetric price transmission can occur due to adjustment costs. Asymmetric price transmission due to market power and adjustment costs have fundamental differences in terms of time. According to Karantininis, Katrakilidis, and Persson (2011), asymmetric price



transmission can occur in the short and long term. In the short term, asymmetric price transmission is caused by the adjustment cost factor, where without market power, prices will readjust towards their long-term equilibrium. Meanwhile, asymmetric price transmission caused by market power be afoot in the long term, because it not only influences in terms of time of adjustment but also in terms of magnitude (Meyer and von Cramon-Taubadel 2004).

Some researchers hypothesize that the long-term price relationship between market levels may be asymmetrical, which can occur if traders in the supply chain respond to increases in market prices above them more quickly than price decreases. As in research, Ruslan JA (2016) explains that the marketing of shallots in Indonesia occurs inefficiently between production center areas and consumer areas, as can be seen from the asymmetric price transmission between market levels. Then Nasution SKH (2022) analyzed price transmission and price formation factors for Arabica Coffee in North Tapanuli Regency. The research results show that the price transmission pattern between Arabica coffee market levels in North Tapanuli Regency is asymmetrical in the wholesaler-producer and wholesaler-consumer relationships in the short and long term. Different results in Sahara and Wicaksana (2013) who analyzed price transmission between farmers and modern retailers in the chili supply chain in Indonesia using the Houck model and the Engle-Granger Error Correction Model (ECM-EG). Both models show that there is no proven asymmetric price transmission of chili prices between farmers and modern retailers, which indicates price efficiency in the chili market in Indonesia. The data used in the research is monthly chili price data for 18 years on the island of Java.

This research use a different approach and data source from the previous author, red chili price transmission will be analyzed using the Asymmetric Error Correction Model approach, using daily time series price data from June 1 2022 to May 31 2023 (261 days) in producers, wholesalers, and retailers market in Jambi Province. The aim of this paper is to review the asymmetric mechanism of price transmission in the red chili supply chain in Jambi Province, and measure asymmetric price transmission empirically, how quickly and to what extent prices are transmitted up and down the supply chain. The study begins by testing the existence of cointegration in price variables at various levels of the marketing chain. Cointegration analysis is concerned with estimating long-term economic relationships between integrated variables are not stationary. Next test the possibility of asymmetry as seen from the differences in price adjustment responses during positive shocks and negative shocks, then reviewing the main reasons that explain the existence of asymmetric price transmission.

METHODS OF RESEARCH

Secondary data used to analyze market integration and asymmetric price transmission is red chili price data (Rp/kg) daily time series from 1 June 2022 to 31 May 2023 (261 days) which is formed at the producers, wholesalers, and retailers market in Jambi Province. Data obtained from the Indonesian National Strategic Food Price Information Center. Market integration and asymmetric price transmission analysis is tested using the Asymmetric Error Correction Model (AECM). To achieve the objectives of this research there are several analysis steps. Research follows the stages outlined in AECM modelling:

- Stationarity Test:

The stationarity test is carried out by unit root testing to determine the stationarity of the time series data used. Time series data sometimes has stochastic processes that are stationary and non-stationary. A stochastic process that is not stationary (containing a unit root) will produce data trends that are also non-stationary so that if regressed it will give rise to a spurious regression. Stationarity testing was carried out using the Augmented Dickey Fuller Test (ADF Test). The Equation Model is as follows (Enders 1995):

$$\Delta P_t = \alpha_0 + \gamma P_{t-1} + \sum_{i=1}^j \alpha_i \Delta P_{t-i+1} + \epsilon_t$$



ΔP_t is the first difference of the variable being tested ($P_t - P_{t-1}$), t is the time period, j is the lag length used and ε is the error term. The hypothesis tested is as follows:

- $H_0: \gamma = 0$; Time series data contains a unit root which is not stationary;
- $H_0: \gamma \neq 0$; Time series data is stationary.
- Optimum lag test:

Determining the optimal lag length in the model is critical to avoid problems related to autocorrelation. Determining the optimal lag is carried out using the Schwarz Information Criterion (SIC) to identify the lag with the smallest value.

- Cointegration test:

The Cointegration Test is used to test whether there is long run equilibrium in the relationship between the price variables being analyzed. Cointegration testing was carried out using the Johansen Cointegration Test (Johansen, 1991). This method uses Trace Test (TS) and maximum eigenvalue (ME) to test the existence of a long-term relationship. Decision making is done by looking at critical values and trace statistics. If the trace statistic > critical value, then the null hypothesis is rejected, which means cointegration has occurred.

- Granger Causality Test:

The causality test aims to ensure the direction of the causal relationship between the variables being tested. The causality test is used to determine the direction of price transmission. This test makes it possible to see the relationship between variables, whether the causality is formed in two directions (demand and supply sides) or only in one direction.

- AECM Test:

The existence of asymmetry in red chili price transmission is tested using the Asymmetric Error Correction Model (AECM) developed by Von Cramon-Taubadel and Loy (1996). The AECM model used in this study is as follows.

When producer prices (HP) influence wholesaler prices (HPB):

$$\Delta HPB_t = \alpha_0 + \sum_{i=1}^n \beta_{HPB}^- \Delta HPB_{t-i}^- + \sum_{i=0}^n \beta_{HP}^- \Delta HP_{t-i}^- + ECT^- + \sum_{i=1}^n \beta_{HPB}^+ \Delta HPB_{t-i}^+ + \sum_{i=0}^n \beta_{HP}^+ \Delta HP_{t-i}^+ + ECT^+ + \varepsilon_t$$

When wholesaler prices (HPB) influence producer prices (HP):

$$\Delta HP_t = \alpha_0 + \sum_{i=1}^n \beta_{HP}^- \Delta HP_{t-i}^- + \sum_{i=0}^n \beta_{HPB}^- \Delta HPB_{t-i}^- + ECT^- + \sum_{i=1}^n \beta_{HP}^+ \Delta HP_{t-i}^+ + \sum_{i=0}^n \beta_{HPB}^+ \Delta HPB_{t-i}^+ + ECT^+ + \varepsilon_t$$

When wholesaler prices (HPB) influence retailer prices (HE):

$$\Delta HE_t = \alpha_0 + \sum_{i=1}^n \beta_{HE}^- \Delta HE_{t-i}^- + \sum_{i=0}^n \beta_{HPB}^- \Delta HPB_{t-i}^- + ECT^- + \sum_{i=1}^n \beta_{HE}^+ \Delta HE_{t-i}^+ + \sum_{i=0}^n \beta_{HPB}^+ \Delta HPB_{t-i}^+ + ECT^+ + \varepsilon_t$$

When retailer prices (HE) influence wholesaler prices (HPB):

$$\Delta HPB_t = \alpha_0 + \sum_{i=1}^n \beta_{HPB}^- \Delta HPB_{t-i}^- + \sum_{i=0}^n \beta_{HE}^- \Delta HE_{t-i}^- + ECT^- + \sum_{i=1}^n \beta_{HPB}^+ \Delta HPB_{t-i}^+ + \sum_{i=0}^n \beta_{HE}^+ \Delta HE_{t-i}^+ + ECT^+ + \varepsilon_t$$

When producer prices (HP) influence retailer prices (HE):

$$\Delta HE_t = \alpha_0 + \sum_{i=1}^n \beta_{HE}^- \Delta HE_{t-i}^- + \sum_{i=0}^n \beta_{HP}^- \Delta HP_{t-i}^- + ECT^- + \sum_{i=1}^n \beta_{HE}^+ \Delta HE_{t-i}^+ + \sum_{i=0}^n \beta_{HP}^+ \Delta HP_{t-i}^+ + ECT^+ + \varepsilon_t$$

When retailer prices (HE) influence producer prices (HP):

$$\Delta HP_t = \alpha_0 + \sum_{i=1}^n \beta_{HP}^- \Delta HP_{t-i}^- + \sum_{i=0}^n \beta_{HE}^- \Delta HE_{t-i}^- + ECT^- + \sum_{i=1}^n \beta_{HP}^+ \Delta HP_{t-i}^+ + \sum_{i=0}^n \beta_{HE}^+ \Delta HE_{t-i}^+ + ECT^+ + \varepsilon_t$$

Where: HP_t = The price of red chili at the producer level on the t day period (IDR/Kg); HPB_t = The price of red chili at the wholesale level on the t day period (IDR/Kg); HE_t = The price of red chili at the retailer level on the t day period (IDR/Kg); HP_{t-1} = The price of red chili at the producer level on the $t-1$ period (IDR/Kg); HPB_{t-1} = The price of red chili at the wholesaler level on the $t-1$ period (IDR/Kg); HE_{t-1} = The price of red chili at the retailer level on the $t-1$ period (IDR/Kg); ECT = Error correction term; ε = Error term.



The AECM approach refers to the price phenomenon that occurs when red chili prices in the follower market react to price changes (shocks) in the reference market. The ECT coefficient basically describes price conditions at market that are not in accordance with equilibrium conditions. ECT⁺ describes the condition of price deviation when it is above the long-term equilibrium line, or when the price decreases in the reference market is not followed by the follower market. On the other hand, ECT⁻ describes the condition of price deviations when they are below the long-term equilibrium line, or when price increases in the reference market are not followed by price increases in the follower market. The existence of asymmetric price transmission in the model above needs to be proven by using the Wald test to test the significance between the positive shock coefficient and the negative shock coefficient of the independent variables as well as between the ECT⁺ and ECT⁻ coefficients.

The AECM model estimation results were tested statistically using the Wald test by comparing the significance of positive coefficients with negative coefficients. The long-term state of price transmission can be seen from the comparison between the ECT⁺ and ECT⁻ coefficients. If the comparative probability value between ECT⁺ and ECT⁻ is statistically significant, it means that there is asymmetric of price transmission in the long term. Meanwhile, the comparison between the coefficient of the independent variable (β_{HPB}^- with β_{HPB}^+ , β_{HP}^- with β_{HP}^+ , β_{HE}^- with β_{HE}^+) describes short-term price transmission. If the probability value between the positive shock and the negative shock of the independent variable is significant, it means that there is asymmetric of price transmission in the short term. Hypothesis testing with the Wald test is as follows:

- H₀: $\sum_{i=0}^n \beta_H^- = \sum_{i=0}^n \beta_H^+$: Symmetrical in the short term;
- H₁: $\sum_{i=0}^n \beta_H^- \neq \sum_{i=0}^n \beta_H^+$: Asymmetric in the short term;
- H₀: ECT⁻ = ECT⁺: Symmetrical in the long run;
- H₁: ECT⁻ \neq ECT⁺: Asymmetrical in the long run.

RESULTS AND DISCUSSION

Based on the ADF test values in table 1, it can be concluded that the price variable is not stationary at the level stage, but is stationary at the first differential condition. This is in line with research on various agricultural commodities such as Sahara and Wicaksana (2013), Acquah and Dadzie (2010), and Purwasih (2017) that agricultural commodity data is generally not stationary at level but is stationary at first difference conditions or order stage, which indicates the existence of a long-term relationship between variables. So it is necessary to carry out a cointegration test to ensure that the market is integrated where there is a long-term relationship between the price variables used.

Table 1 – Stationarity test results of red chili prices data in several market levels in Jambi Province

Variable	Level		First Difference	
	ADF test	Prob	ADF test	Prob
Producer prices	-1.7107	0.4246	-16.003	0.000*
Wholesale prices	-1.2024	0.6740	-16.584	0.000*
Retailer prices	-1.6353	0.4631	-11.507	0.000*

* Stationary at the 5% significance level.

The optimal lag length can be determined based on several criteria, including: Sequential modified LR test statistics (LR), Final prediction error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ). The results of the optimal lag length test on red chili price data can be seen in Table 2.

Based on the optimal lag length test results in Table 2, it was found that the most optimal lag in testing red chili price data was lag 1. The criteria chosen are the criteria that have the smallest value among the various recommended lags. The smaller the criterion value, the expected value produced by a model will be closer to reality. Therefore, the optimal lag to be employed in the AECM equation is lag 1 based on the Schwarz Information



Criterion (SC). This finding suggests that the relationship between the variables is linked to both the current day and the preceding day.

Table 2 – Optimum lag test results

Lag	LogL	LR	FPE	AIC	SC	HQ
1	-7316.300	NA	3.56e+21	58.13730	58.26335*	58.18802
2	-7312.126	8.149026	3.70e+21	58.17560	58.42771	58.27704
3	-7283.942	54.35496	3.18e+21	58.02335	58.40150	58.17551
4	-7262.386	41.05904	2.87e+21	57.92370	58.42790	58.12658
5	-7247.423	28.14472	2.74e+21	57.87637	58.50663	58.12997
6	-7215.074	60.07738	2.28e+21	57.69106	58.44737	57.99538
7	-7199.681	28.22036*	2.17e+21*	57.64032*	58.52268	57.99536*
8	-7194.667	9.072167	2.24e+21	57.67196	58.68037	58.07772

* Optimum lag.

The cointegration test method used in this research is the Johansen cointegration test. The results of the cointegration test on price variables at several market levels are shown in Table 3.

Table 3 – Cointegration test results

Variable	Null Hypothesis	Trace Statistic	Critical Value (5%)	Max-eigen Value	Critical Value (5%)
HP → HE	None*	23.1111	12.3209	22.1391	11.2248
	At most 1	0.9719	4.1299	0.9719	4.1299
HP → HPB	None*	26.8760	12.3209	25.8723	11.2248
	At most 1	1.0037	4.1299	1.003	4.1299
HE → HPB	None*	96.6811	12.3209	95.7234	11.2248
	At most 1	0.9577	4.1299	0.9577	4.1299

(*) H_0 is rejected at the 5% significance level.

Based on the results of the cointegration test in Table 3, the trace statistic value and maximum eigenvalue are greater than the critical value at the 5% significance level, so the null hypothesis which states there is no cointegration is rejected. This shows that there is cointegration in all price variables analyzed, which concludes that the red chili market in Jambi Province is integrated where there is a long-term relationship between markets. Fossati et al. (2007) stated that if a price is cointegrated with prices in another market then the two price data series tend to move towards long-term equilibrium, so it can be said that the two markets are integrated. The results of this cointegration test are in accordance with research on several agricultural commodities in Indonesia such as Erviana (2019), Purwasih (2017), Sahara and Wicaksana (2013), and Ruslan JA (2016) which states that there is cointegration in the price variables analyzed, which means that the market is integrated where there is a long-term relationship in the variables used.

Causality tests are carried out to see the direction of price transmission and find out which markets influence price formation. The test was carried out using the Granger Causality Test. The results of the causality test are shown in Table 4.

Table 4 – Granger causality test results

Relationship	F-Statistic	Prob
Producer prices → Retailer prices	0.0270	0.8696
Retailer prices → Producer prices	19.1224	2.E-05*
Wholesaler prices → Retailer prices	3.51411	0.0620
Retailer prices → Wholesaler prices	69.9290	4.E-15*
Wholesaler prices → Producer prices	18.0611	3.E-05*
Producer prices → Wholesaler prices	0.00175	0.9667

*: Significant at 5% level.

→: Influence.



Based on the results of the Granger causality test in Table 4, it shows that there is a one-way relationship between producer prices and retailer prices. Where retailer prices are able to influence producer prices, however producer prices are not able to influence retailer prices. Different results are found in Sahara and Wicaksana (2013), who used monthly red chili price data for 18 years on the island of Java. Their study shows that producer prices and consumer prices have a two-way relationship or influence each other. Then, the results of the Granger causality test on the relationship between wholesaler prices and retailer prices show a one-way relationship. Where retailer prices are able to influence wholesaler prices, however wholesaler prices are not able to influence retailer prices. This condition shows that price formation in the red chili market in Jambi Province is determined more from the demand side or is one-way from downstream to upstream. These results are in line with research by Artika K (2019) which states that price changes at the retailer level have a significant effect on wholesaler prices, however there is a two-way relationship where wholesaler prices also have the power to influence retailer prices based on shallot price data in Jakarta and West Java. Different results were found in the research of Acquah and Dadzie (2010) which stated that retailer prices were unable to influence wholesaler prices, while wholesaler prices had a significant effect on retailer prices in the corn market in Kumasi-Ghana. Ruslan JA (2016) also had different results, who stated that retailer prices were unable to influence prices at the wholesaler level in the Pasar Induk Kramat Jati (PIKJ), while wholesaler prices (PIKJ) were able to influence prices at the retailer in the shallot supply chain in Indonesia. Furthermore, the results of the Granger causality test on the relationship between producer prices and wholesaler prices show a one-way relationship. Where wholesaler prices are able to influence producer prices, but producer prices are not able to influence wholesaler prices. This shows that farmers do not have bargaining power to determine prices, where farmers act more as price takers, not as price setters.

The Asymmetric Error Correction Model (AECM) was developed by Von Cramon-Taubadel and Loy (1996), this model separates short-term and long-term price transmission. In this model, testing for asymmetric conditions is not only carried out on the positive shock and negative shock of the independent variable but also on the ECT^+ and ECT^- coefficients. Based on the results of previous causality tests, the asymmetric price transmission model tested consists of 3 parts: when retailer prices influence producer prices, when retailer prices influence wholesaler prices, and when wholesaler prices influence producer prices. The Asymmetric Error Correction Model (AECM) estimation results are shown in Table 5.

Table 5 – Estimation results of the red chili asymmetric price transmission model

Variable	HE→HP	Variable	HE→HPB	Variable	HPB→HP
C	1442.841 (0.0250)*	C	1402.433 (0.0228)*	C	1336.151 (0.0311)*
ΔHP^+_{t-1}	0.022995 (0.7497)	ΔHPB^+_{t-1}	0.063925 (0.4130)	ΔHP^+_{t-1}	0.035313 (0.6196)
ΔHP^-_{t-1}	0.000131 (0.9991)	ΔHPB^-_{t-1}	0.012968 (0.8566)	ΔHP^-_{t-1}	0.046237 (0.6942)
ΔHE^+_t	-0.008538 (0.9000)	ΔHE^+_t	0.032000 (0.6132)	ΔHPB^+_t	-0.030810 (0.7281)
ΔHE^-_t	0.103336 (0.1986)	ΔHE^-_t	0.029544 (0.6919)	ΔHPB^-_t	0.057626 (0.4476)
ΔHE^+_{t-1}	0.000498 (0.9943)	ΔHE^+_{t-1}	-0.294184 (0.0000)*	ΔHPB^+_{t-1}	-0.073161 (0.3882)
ΔHE^-_{t-1}	-0.027259 (0.7255)	ΔHE^-_{t-1}	-0.161668 (0.0289)*	ΔHPB^-_{t-1}	-0.196596 (0.0102)*
ECT^+	-0.103398 (0.0000)*	ECT^+	-0.342458 (0.0000)*	ECT^+	-0.118990 (0.0000)*
ECT^-	-0.100810 (0.0001)*	ECT^-	-0.338145 (0.0000)*	ECT^-	-0.115222 (0.0000)*
R-adj	0.055059	R-adj	0.299174	R-adj	0.076618
F-statistic	2.879117 (0.004399)	F-statistic	14.76714 (0.00000)	F-statistic	3.675969 (0.000450)

HP is producer prices, HPB is wholesaler prices, HE is retailer prices, ECT is error correction term.

*: significant at the 5% level.

(): Probability.

→: Influence.



First, it will explain the results of asymmetric modeling of short-term and long-term price transmission when retailer prices (HE) influence producer prices (HP). The short-term price transmission pattern can be seen from the significance of the probability value of the independent variable in periods t and $t-1$. Meanwhile, long-term price transmission patterns can be seen from the significance of the ECT^+ and ECT^- probability values. Based on the significance of the probability values of the independent variables at the 5% level, none of them show significant values. This means that in the short term the shock of price increases and price decreases that occurred at the retailer level in the current period (t) and the previous day's period ($t-1$) was not responded to by producer prices. Meanwhile, in long-term price transmission, the coefficient values of ECT^+ and ECT^- show significant values at the 5% level and have a negative sign, which means that price deviations from retail traders will be responded to by producer prices, and price deviations in the short term will be corrected back towards the balance line. the long term. The ECT^+ coefficient has a negative value of 0.103398, indicating that when the deviation is above the balance line (when a decrease in retailer prices is not followed by a decrease in producer prices), it will take approximately 38 days for producer prices to adjust back to the equilibrium price. The negative ECT^- coefficient of 0.100810 indicates that when prices deviate below the balance line (when an increase in retailer prices is not followed by an increase in producer prices), it takes approximately 37 days for producer prices to adjust back to the equilibrium price.

Second, it will explain the results of asymmetric modeling of short-term and long-term price transmission when retailer prices (HE) influence wholesaler prices (HPB). In the short term, based on the significance of the probability value of the independent variable at the 5% level, it can be seen that the shock of price increases and price decreases for retailers on the previous day ($t-1$) will be responded to by prices of wholesalers. The long-term price transmission pattern can be seen from the probability value of the ECT coefficient. The ECT^+ coefficient has a negative value of 0.342458, indicating that when the deviation is above the balance line (when a decrease in retailer prices is not followed by a decrease in wholesaler prices), it will take approximately 125 days for wholesaler prices to adjust back to the equilibrium price. The negative ECT^- coefficient of 0.338145 indicates that when prices deviate below the balance line (when retailers' price increases are not followed by wholesalers' price increases), it takes approximately 123 days for wholesalers' prices to adjust back to the equilibrium price. Based on the two coefficient values above, it shows that wholesaler prices adjust more quickly to deviations from price increases than retailers' price reductions.

Third, it will explain the results of asymmetric modeling of short-term and long-term price transmission when wholesaler prices (HPB) influence producer prices (HP). In the short term, based on the significance of the probability value of the independent variable at the 5% level, it can be seen that the shock to the decline in wholesaler prices that occurred on the previous day ($t-1$) will be responded to by producer prices. However, the shock of the increase in wholesaler prices on the previous day ($t-1$) was not responded to by producer prices. Furthermore, the long-term price transmission pattern can be seen from the probability value of the ECT coefficient. The ECT^+ coefficient has a negative value of 0.118990, indicating that when the deviation is above the balance line (when a decrease in wholesaler prices is not followed by a decrease in producer prices), it will take approximately 43 days for producer prices to adjust back to the equilibrium price. The negative ECT^- coefficient of 0.115222 indicates that when prices deviate below the balance line (when wholesaler price increases are not followed by an increase in producer prices), it takes approximately 42 days for producer prices to adjust back to the equilibrium price. The results of asymmetric modeling of price transmission in the three price relationships above need to be further statistically validated using the Wald test to test the significance between the positive shock coefficient and the negative shock coefficient of the independent variables, as well as between the ECT^+ and ECT^- coefficients.

The Wald test is used to ensure indications of the existence of asymmetry in AECM modeling. Proof is carried out by testing the significance between the positive shock coefficient and the negative shock coefficient of the independent variable as well as between



the ECT⁺ and ECT⁻ coefficients. The Wald test results of the asymmetric price transmission model are presented in Table 6.

Table 6 – Wald test result

Wald test	Null Hypothesis (H ₀)	F-Statistic	Probability
HE-HP	$\Delta HP^+_{t-1} = \Delta HP^-_{t-1}$	0.026812	0.8701
	$\Delta HE^+_t = \Delta HE^-_t$	0.867483	0.3526
	$\Delta HE^+_{t-1} = \Delta HE^-_{t-1}$	0.053312	0.8176
	$ECT^+ = ECT^-$	0.739290	0.3907
HE-HPB	$\Delta HPB^+_{t-1} = \Delta HPB^-_{t-1}$	0.217175	0.6416
	$\Delta HE^+_t = \Delta HE^-_t$	0.000489	0.9824
	$\Delta HE^+_{t-1} = \Delta HE^-_{t-1}$	1.377404	0.2417
	$ECT^+ = ECT^-$	7.482294	0.0067*
HPB-HP	$\Delta HP^+_{t-1} = \Delta HP^-_{t-1}$	0.006305	0.9368
	$\Delta HPB^+_t = \Delta HPB^-_t$	0.536800	0.4644
	$\Delta HPB^+_{t-1} = \Delta HPB^-_{t-1}$	1.124942	0.2899
	$ECT^+ = ECT^-$	0.408838	0.5231

* Significant at the 5% level.

Based on the results of the Wald test which validates the significance between the positive shock coefficient and the negative shock coefficient of the independent variable in the asymmetric price transmission model, in the short term there is not proven of asymmetric price transmission in the three price relationships between market levels. Meanwhile, long-term price transmission shows that there is an asymmetric relationship between retailer prices and wholesale prices, which is shown in the comparative probability value between ECT⁺ and ECT⁻ which is significant.

The results of the asymmetric analysis of price transmission between retailers' prices (HE) and wholesalers' prices (HPB) in the long term show an asymmetric relationship where wholesalers respond more quickly to adjustments to deviations from retailers' price increases compared to price reductions. This indicates that the price of red chilies in the market is easier to rise and difficult to fall. This long-term asymmetric condition indicates abuse of market power at the wholesale level. The research results are in line with Vavra and Goodwin (2005) who used the Threshold Error Correction Models approach to look at vertical price transmission in the beef, chicken and egg marketing chain in the United States, which concluded that there was asymmetric price transmission regarding positive shocks and negative shocks in each level of marketing chain for these three commodities. The occurrence of asymmetric price transmission is caused by the influence of market power in addition to other factors such as government intervention and adjustments to menu costs. The research results are also in line with Acquah and Dadzie (2010) who analyzed vertical price transmission between retail and wholesale corn prices in Kumasi, Ghana. Using weekly data, the analysis results show that positive wholesale price changes are responded to more quickly by retail prices than negative price changes, which means that there is asymmetry in price transmission in the market being analyzed. Different results are found in Elvina's (2016) research, which concludes that short-term and long-term transmission of wholesaler prices and consumer prices is symmetrical based on weekly red chili price data at the Kramat Jati Main Market (PIKJ) and DKI consumer price data, which concludes that there is no abuse of market power in the red chili marketing chain. The differences in the results of this study could be due to differences in the period and data sources used, where this study used weekly price data sourced from PIKJ, while this study used daily price data sourced from the National Strategic Food Price Information Center. According to Serra and Goodwin (2002), asymmetric conditions can occur if business actors are in an oligopoly market structure. In an oligopoly market, intermediary traders will react more quickly to shocks in the form of price increases compared to price decreases. According to Indonesian Central Statistics Agency (2013), the form of red chili market structure in Indonesia is an oligopoly. In an oligopoly



market, product prices are determined by a few players and often form a cartel in price agreements. In this case, large traders have more market power in influencing price formation compared to other levels of marketing chain.

CONCLUSION

The results of the cointegration analysis show that there is market integration between red chili market levels in Jambi Province, which indicates the existence of a long-run price relationship. The results of price transmission analysis show that short-term price transmission between retailers and wholesalers shows a symmetric relationship, while long-term price transmission shows an asymmetric relationship. Long-run price transmission that occurs in the red chili marketing chain in Jambi Province is more likely to be positive asymmetric, where the price of red chili at the wholesale level responds more quickly to price increases compared to price decreases originating from the demand side. Asymmetric conditions in long-term price transmission indicate abuse of market power at the wholesale level which causes red chili prices in the market to tend to increase prices more easily and make it difficult for prices to decrease.

The research results show that there is asymmetric price transmission in the red chili marketing chain in Jambi Province, which indicates that there is abuse of market power at the wholesaler level. This shows that there is inefficiency in the marketing chain for red chili commodities in Jambi Province - Indonesia. To realize efficiency in the red chili marketing chain, there are several efforts that can be made, including a policy of limiting the highest price which can protect consumers from conditions that can make commodity prices very expensive. Meanwhile, a lower price limit policy that is needed to protect farmers from market prices that are too low. Developing a network of price information and supply information which can then be passed on to the public. This information includes the volume of supplies produced in production centers, as well as supplies going out to other provinces and the price situation for red chilies that is formed in the market every day. Developing new production center areas that are more spread out in the Jambi Province area. This can reduce price fluctuations caused by production anomalies, this effort can reduce marketing margins caused by high transportation costs due to relatively long marketing distances. Stimulating the growth of business competition at the wholesaler level to change the oligopolistic structure into a perfectly competitive market. This of course requires a review of the red chili agribusiness system which includes trade policies and ease of establishing trading companies to stimulate the entry of new wholesalers. Developing effective storage technology, by building large capacity cold storage in chili production centers to store excess production so that chili prices do not fall, this can increase the bargaining position of farmers. Dissemination of post-harvest technology to process chilies into dried chilies or other forms such as paste and powder is important to reduce people's dependence on fresh chilies. The existence of asymmetric conditions in price transmission in the red chili marketing chain can be caused by abuse of market power and imperfect price information. For this reason, the auction market can be an institutional model that is a solution to overcome this asymmetric condition.

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