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Market Integration and Price Formation of Chili in Indonesia

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Abstract

This paper examines the markets integration of chili in Indonesia uses monthly prices data from 2011-2016. Market integration was analyzed by the Johansen, co-integration model. The results of EG causality test show that producer price and wholesale price Granger cause consumer price. There is a causal relationship between one way. Therefore, the causality approach accepts the hypothesis of the Law of One Price (LOP). Whereas co-integration models provide evidence for a well-integrated chili market. The analysis of variance decomposition shows that Padang, as one of the center of red chili production area, becomes the reference market (price leader) of Chili price in Indonesia.

***Keywords*:** Market; integration; price formation; variance decomposition; causality.

1. Introduction

Prices of agricultural commodities, especially horticultural products, always fluctuate and tend to increase. This leads to food price volatility and inflation. Agricultural commodity price fluctuations are attributable, among other things, by natural disasters, yearly production, inadequate storage facilities and inadequate farmer response to price signals. Favorable prices spur production increased. However, the majority of farmers have limited capital to react to price changes [1].

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Efficient agricultural marketing is essential for producers and consumers' profits since a surplus of production in one region can be channeled to another deficit area [2]. Market efficiency is an equilibrium condition in which all profitable opportunities can be used. If the price difference between markets is smaller than the transfer cost, then it can be stated that the market is running efficiently. However, if the price difference between markets is greater than the transfer cost, then it is possible to conclude that the market is running inefficiently [3].

Spatial market integration refers to price movements in spatially segregated markets or the extent to which demand and supply shocks that emerge in one market are transmitted to other markets in geographically separate locations. Market integration is defined as the ability to sell products in markets where demand, supply and transaction costs in different markets determine the prices and trade flows simultaneously and the transmission of price shocks from one market to another. Price signals transmission and market integration are crucial in determining marketing performance.

Spatial market integration is of high relevance to agriculture because agricultural products are often bulky, perishable and production concentrated in one location while consumption is focused elsewhere resulting expensive transportation costs [4]. Also, the functioning of markets and marketing channels is critical to know the impact of various economic policies such as macroeconomic and trade policies. Spatially segmented markets isolate market participants and limit the transmission of price incentives.

Market integration is determined by merchant behavior and market conditions, marketing infrastructure related to transport, communication, credit, and storage facilities leading to high marketing margins due to transfer costs. Government policies can also affect markets through price stabilization policies, trade restrictions, regulations on credit and transportation. The authors in [5] noted that oligopoly behavior and collusion between traders could determine market integration. Traders can maintain price differences between markets higher than the transfer cost.

Red chili is considered one of the most important vegetable commodities for Indonesian people. Based on the calculation of Susenas 2014 data, the average consumption of red chili (converted to fresh red chili) is about 1.58kg / capita/year. The participation rate of red chili consumption is around 65.3% [6]. The price elasticity of red chili is about -0.82 (inelastic). This price elasticity indicates that red chili is a non-substitutes commodity known as staple foods. The demand for red chili is less affected by price changes.

Vegetables, including red chili, are highly perishable due to water content. The price of red chili is often high due to the high cost of agricultural production, the high transaction costs of red chili marketing from small, remote and scattered farmers to market. Chili prices are usually low during the main harvest period and increase dramatically in the time before the next crop. In the main production area, red chili has a low and peak harvest season where prices are low during the peak harvest season, when farmers sell the produce immediately after harvest, usually between April and June. Small harvest season occurs in September to November. Therefore, the price of red chili tends to fluctuate by season. To reduce volatility government should market products from surplus areas (producer areas) to deficit areas (consumers) and improve chili processing industry.

Production center of red chili in Indonesia is still concentrated in Java and Sumatera, while consumers of red chili spread all over Indonesia. Therefore, the distribution of red chili to the consumption region will have an impact on the price at the consumer level. This study evaluates spatial integration between the producer and consumer centers. Besides, this paper also analyzes vertical integration, integration of producer market to the consumer market. Market integration analysis is done to gain information for among market trading activities and the price movements [1].

2. Methods

Problems in the marketing of agricultural products among others are weak infrastructure condition, inadequate market information, relatively small agricultural market scale, lack of farmers' knowledge about grading and handling, and high transaction costs. High transaction costs faced by farmers in developing countries are mainly due to high transportation costs as a result of distance from production centers to consumption centers, poor road conditions and payment of services to intermediate traders.

The concept of marketing efficiency is at the core of the agricultural economy and closely linked to the idea of market integration. The operational definition of market integration is known as the Law of One Price (LOP). The same product is sold at relatively the same price in various markets, only differentiated by transportation costs [7].

Market integration relates to the long-term relationship between prices. Market integration is also a signal of price and information transmission of separate markets [5]. The analysis of market prices increase the understanding associated with price signals, the direction of change and the transmission of prices from the production center to the consumption region.

2.1. Tool of analysis

The data used in this paper are time series data of the monthly producer price, wholesale price and consumer price from 2011-2016, published by Directorate General of Horticulture, Ministry of Agriculture. Time series data is generally not stationary. The time series data are said to be stationary if the average and variation are constant over time [8]. Data that are not stationer will result in spurious regression. Therefore, the parameter estimation is not stable [9]. The approach was taken to deal with the spurious regression equation is to differentiate the data series used, so that the variable is obtained with a stationary degree I (n).

Market integration and price transmission are indicators for measuring market performance. Spatial market integration assesses the extent to which markets in geographically distant locations (such as between regions) have the same long-term price and are differentiated only by transportation/distribution costs and marketing margins [10].

Analysis of market integration is done through three stages of analysis, namely: (1) unit root test; (2) Co-integration/integration test; and (3) causality test. Unit root test to determine the stationarity of time series data used in the model and to know the order of time series data. A co-integration test is conducted to identify the short-term and long-term linkages and relationships of time series data. The detection of co-integration can be analyzed by [11, 12]. The causality test is performed to see the mutual relationship between two price variables [13].

2.2. Stationarity test

This paper will test the stationarity of the data utilizing the Augmented Dickey Fuller (ADF) test since the ADF test limits the presence of explosive roots. The Augmented Dickey Fuller (ADF) unit roots test formulation can be written as follows:

$$\Delta y_t = a_0 + a_1 y_{t-1} + \sum_{i=1}^{k} a_2 \, \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

The null hypothesis is that the y time series data integrated of degree one can be tested by the t-statistic value of the estimated coefficient a1. If the hypothesis is rejected, that is, if the t-statistic estimation of the a1 coefficient is greater than the ADF critical value, then the null hypothesis is rejected and the time series data y is stationary is acceptable.

2.3. Co-integration Test

In this paper, the cointegration test is performed with the Johansen model based on the maximum likelihood estimation which is better than the Engle-Granger and Ravallion models [14]. The Johansen co-integration test can indicate the number of cointegration vectors. If variables are co-integrated than a standard autoregressive vector (VAR) could be applied, and the result will be identical to the OLS, after making sure the variables are stationary by the same order. If the test results indicate that there is a cointegration vector, it can be concluded that the variables in the equation have a long-term relationship and can apply error correction model (ECM) for the single equation and vector error correction model (VECM) for the system of equations. This paper will use error correcting mechanisms in the form to test short-term dynamics or speed adjustment to long-term balance. The equations used are as follows:

$$\Delta Y_t = A + \sum_{i=1}^{k} \Pi_i \Delta Y_{t-1} + \delta DRM_t + \varphi DPN_t + \theta DKP_t + E_t \qquad (2)$$

$$\begin{bmatrix} X_t \\ Y_t \\ Z_t \end{bmatrix} = Y_t, \ \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} = A, \ \begin{bmatrix} \Pi_{11} & \Pi_{12} & \Pi_{13} \\ \Pi_{21} & \Pi_{22} & \Pi_{23} \\ \Pi_{31} & \Pi_{32} & \Pi_{33} \end{bmatrix} = \Pi_i, \ \begin{bmatrix} X_{t-1} \\ Y_{t-1} \\ Z_{t-1} \end{bmatrix} = Y_{t-1}, \ \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \\ \epsilon_{3t} \end{bmatrix} = E_t \qquad (3)$$

where X = producer price (Rp/kg), Y = Wholesale price (Rp/kg), Z = consumer price (Rp/kg) DRM = dummy Ramadhan variable, DPN = dummy harvest variable, DKP = dummy policy variable Government, D = ΣΠi-1 is a multiplication between the single co-integration vectors β = (1, β2, β3) 'and the adjustment speed parameters α = (α1, α2) and Et = error components.

2.4. Causality test

The causal relationship of between market price is done by Granger causality approach. The equation model used for the Granger causality test can be written as follows:

$$\Delta X_t = \sum_{j=1}^{m} \propto_{1j} \Delta X_{t-j} + \sum_{j=1}^{m} \beta_{1j} \Delta Y_{t-j} + \sum_{j=1}^{m} \gamma_{1j} \Delta Z_{t-j} + \varepsilon_{1t} \quad (4)$$

$$\Delta Y_t = \sum_{j=1}^{m} \propto_{2j} \Delta X_{t-j} + \sum_{j=1}^{m} \beta_{2j} \Delta Y_{t-j} + \sum_{j=1}^{m} \gamma_{2j} \Delta Z_{t-j} + \varepsilon_{2t} \quad (5)$$

$$\Delta Z_t = \sum_{j=1}^{m} \propto_{3j} \Delta X_{t-j} + \sum_{j=1}^{m} \beta_{3j} \Delta Y_{t-j} + \sum_{j=1}^{m} \gamma_{3j} \Delta Z_{t-j} + \varepsilon_{3t} \quad (6)$$

2.5. Analysis of variance decompositions

Analysis of variance decompositions to see the short-term dynamics of the red chili market and provide the proportion of price movements in individual markets caused by price shocks in related markets and those caused by price shocks in other markets. In other words, Variance decompositions are utilized to predict the contribution of the variety of each price because of price changes in a particular market, so that the dominant market can be identified in the formation of prices in other markets. Analysis of variance decompositions using the Vector Auto Regressive (VAR) system can be written as follows [8]:

$$y_t = Bx_t + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \epsilon_t \quad (7)$$

Where yt = the vector of endogenous variables; Xt = vector of exogenous variables; and t = error vector. The analysis of variance decomposition describes the effect of shocks by the standard deviation of residuals.

2.6. Price formation analysis

The analysis of price formation can be done through (1) The approach of demand and supply. The equilibrium price is determined by the existing level of demand and supply by calculating the price that the consumer can afford and the price that the producer can accept, the quantity demanded will be equal to the volume supplied; (2) Cost-oriented approach. Price is established by calculating the cost bear by the producer plus the desired profit level based on markup pricing and break even analysis; and (3) Market Approach. Formulate prices by calculating the variables affecting markets and prices, such as the situation and condition of infrastructure, production, stock, and other commodity prices.

This paper will require a market approach. The commodity price at the consumer level is heavily dependent on the efficiency of distribution activities of the commodity concerned. The distribution activities are very much influenced by the length of the distribution chain and some profit margins of marketing actors along the distribution chain. The shorter the distribution chain and the smaller the profit margin, the more efficient the distribution activity.

Also, the efficiency of commodity distribution is also influenced by transportation conditions. Disruptions to the transport sector resulting in increased costs and delivery time periods will have negative consequences for distribution efficiency. In simple terms the formation of prices will be influenced by the factors that affect production and marketing costs can be formulated as follows:

$$P_t = f(P_{t-1}, P_{mt}, P_{st}, Q_t, X_t, D_t, Z_t) \qquad (8)$$

Where Pt = the price of a commodity in a particular market; Pmt = commodity prices in other markets; Pst = price of commodity substitution; Qt = production volume; Xt = demand side factors; Zt, = factors affecting the distribution are represented by fuel prices, and Dt = dummy variables that describe harvest, important day and government policies affecting commodity price formation.

3. Discussion and result

Like other vegetable commodity prices, the price of red chili always fluctuates. The margin between consumer prices, wholesale prices, and producer prices tends to narrow in September to November, during a small harvest time. The average margin between consumer prices and wholesale prices in the period January 2011 to May 2017 was Rp 5956 / kg or 21.2% of the consumer price, while the average margin between wholesale prices and producer prices reached Rp 5306 / kg or 23, 9% of the wholesale price. The high level of margin indicates that market participants in the distribution channel have a substantial market power that can determine the price (price maker) and of fixing the price above its marginal cost. Thus, it can be possible to conclude that the red chili market leads to imperfect competitive market. Between January 2011 and May 2017, consumer prices, wholesale prices, and producer prices show the same movement pattern with distinct fluctuation rates (Figure 2). Commodities price volatilities are measured by the coefficient of variation (CV). It is seen that the producer prices are the most volatile compared to wholesale and consumer prices. A coefficient of variation of producer prices reached 53%, while the CV wholesale prices and consumer prices were 48% and 35%, respectively. Disparities in variations of producer price and consumer prices are closely linked to the function of the supply chain. The growth rate of producer, wholesale and consumer prices during January 2011-May 2017 was 1.08%; 0.92% and 0.54% per month, respectively.

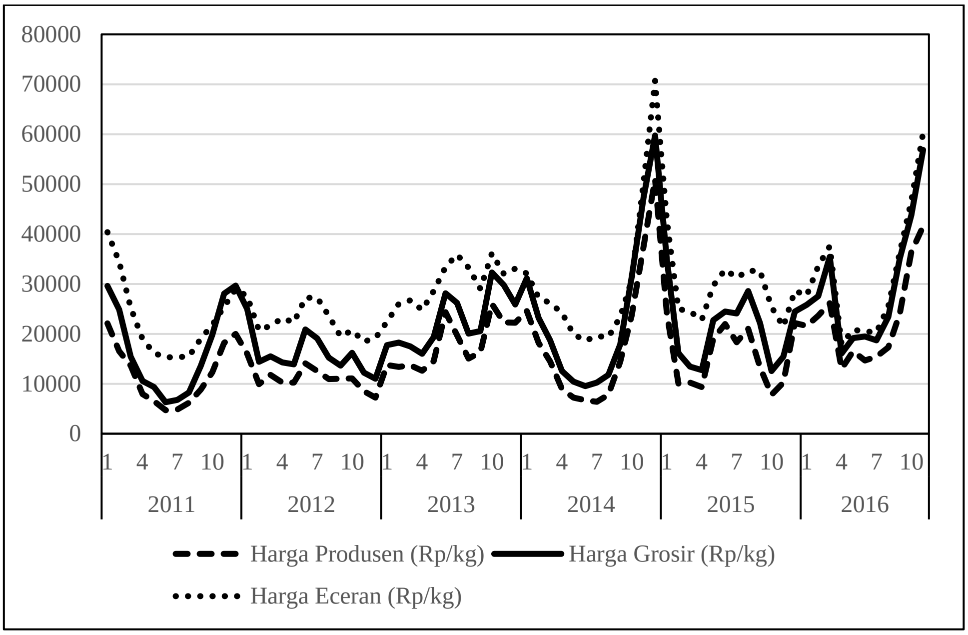

Figure 1: Trend of Producer, Wholesale and Consumer Prices of Red Chili in Indonesia, 2011 - 2017

To fulfill domestic demand, Indonesia imports red chili from red chili producing countries, such as India, China, Vietnam, Thailand, and Austria [15]. The volume of imports fluctuated with a declining trend. The rate of import decreased during the period 2010-2016 was -46.37%/year. This import decrease is partly due to the issuance of Ministry of Agricultural Regulation no. 3/2012 on Horticultural Product Import Recommendation (RIPH) on February 1, 2012, in parallel with the Ministry of Trade no 30/2012 on Provisions on the import of Horticultural Products (KIPH). The new RIPH sets the reference price for imports of red chili and cayenne chili fix by the Ministry of Trade. The reference price of red chili and cayenne chili is Rp 26300/kg and Rp 28000/kg, respectively.

During the period of 2011-2015, red chili production in Indonesia tends to increase with an average growth of 4.35 percent per year. The highest production achieved in 2014, amounting to 1.07 million tons (Table 1). In addition to importing red chili, Indonesia exports red chili, including for Singapore, Malaysia, Saudi Arabia, Japan, and Vietnam. The volume of red chili exports appears fluctuating with a downward trend. The rate of decline in exports during the period of 2011-2015 was about -31.62%/year. This drop in exports could be attributed to the price of the Indonesian uncompetitive red chili in the world market. The price of red chili at the farm level increases from about Rp 11100 in 2012 to 17800 / kg in 2013, and to 24100 / kg in 2016 [16].

Table 1: Trends in Production, Import and Export of Red Chili in Indonesia, 2011-2015 (ton)

Year	Production1)	Import2)	Export2)
2011	888852	7501	1448
2012	954310	2822	545
2013	1012879	294	570
2014	1074602	30	250
2015	1045182	43	536
Trend (%/year)	4.35	-82.84	-31.62

Figure 2 shows fluctuations in wholesale prices in several cities of producer and consumer region of red chili, namely in Medan, Padang, DKI Jakarta, Bandung, and Semarang. Padang as a red chili production center, still bring in red chili from Medan (North Sumatra), Semarang (Central Java) and Bandung (West Java). On the contrary, red chili from Padang is also mostly shipped to DKI Jakarta and North Sumatra [17]. Therefore, it is very likely that these markets are integrated with each other.

During January 2011-December 2016, the highest coefficient of variation of wholesale price occurred in DKI Jakarta, the consumption center region of red chili. The coefficient of price variation in Jakarta reached 82%, as well as the growth rate of prices, showed the highest increase in the average rate of about 2% per month. The smallest coefficient of variety of wholesale prices occurred in Medan, is one of red chili production center is about 44% with an average price growth rate of 0.47% per month. The growth rate of wholesale prices in Medan is larger than that of Bandung (0.42%/month), but less than that of Padang (0.55%/month) and Semarang

(0.95%/month).

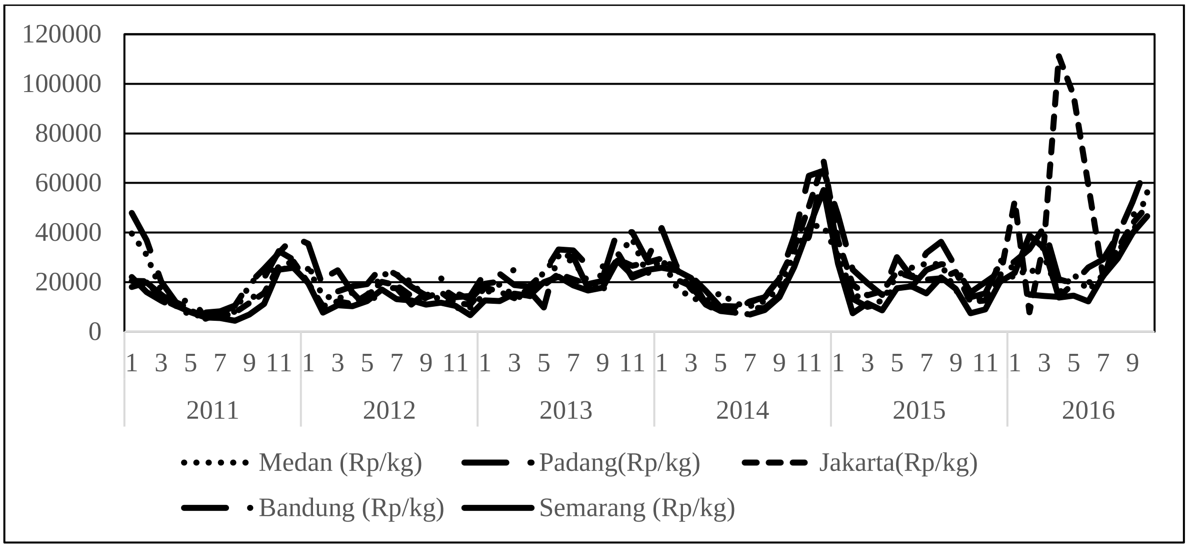

Figure 2: Trends of Wholesale Prices in Several Cities, 2011-2016

3.1. Vertical integration

This paper analyzes the vertical integration between producer, wholesale and consumer price. Two markets are considered to be integrated if a price change in a market is responded to changes in prices in other markets. This link is because price changes in a market are partly or entirely transmitted to prices in other markets, both in the short and long term. The long run cointegration relationship between producer, wholesale, and consumer prices are measured by using the Johansen cointegration test. The result in table 2 shows the level and first difference value for intercept and intercept with the trend of the ADF unit root test. It is seen that producer and consumer price are non stationary at their level value, but all price is significant in the first difference. The significance is explained by the value of the ADF test that is less than test critical value at the actual level of 1 percent, 5 percent, and 10 percent. Therefore, all variables prices are I (1).

Table 2: Results of the ADF Stationary Test in the Price of Red Chili

Variable	intercept		intercept and trend	
	t-Statistic	Prob.*	t-Statistic	Prob.*
Level				
Producer Price	-2.1222	0.2369	-3.8746	0.0194
Wholesale Price	-4.7214	0.0003	-5.3645	0.0002
Consumer Price	-1.5349	0.5089	-1.1135	0.9176
First Difference				
Producer Price	-6.2427	0.0000	-6.1824	0.0000
Wholesale Price	-5.3071	0.0000	-5.2591	0.0003
Consumer Price	-5.0072	0.0001	-5.1227	0.0005

Co-integration test is conducted since all the integrated variables or stationary in the same order I (1). The co-integration analysis using Johansen test is carried out by comparing the value of trace statistic (TS) and maximal eigenvalue (ME) against statistic. If the value of TS and ME exceeds the t-statistic value, then the null hypothesis is rejected, and this implies that the three prices are mutually co-integrated. From Table 3, it appears that both the TS and ME values are significantly higher than the 5% t-statistics. This value shows that based on TS value there are two co-integration equations at 5% level and based on ME value there is one co-integration equation at 5% level. This integration suggests that some co-integrated equations increase the stability of price linkages between market. These three prices have a long-term equilibrium relationship, and there is a strong integration between the producer, wholesale and consumer market of red chili. Therefore, prices in one market can be utilized to predict prices in other markets.

Table 3: Johansen Test Results for Vertical Integration of Red Chili Market

Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.0500 Critical Value	Prob.**
None *	0.3299	54.4556	42.9153	0.0024
At most 1 *	0.2278	27.2285	25.8721	0.0337
At most 2	0.1323	9.6490	12.5180	0.1440
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.0500 Critical Value	Prob.**
None *	0.3299	27.2272	25.8232	0.0325
At most 1	0.2278	17.5795	19.3870	0.0898
At most 2	0.1323	9.6490	12.5180	0.1440
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

The test of causality is carried out to know the direction of price transmission. In vertical integration, price shocks caused by changes in demand will cause a price transmission effect that is different from the shock due to supply changes. The test of causality in this paper is conducted by using the Granger method.

The result in Table 4 showed that the market links exhibit unidirectional Granger Causality. The null hypothesis that producer and wholesale prices do not cause consumer price of red chili is rejected at 2% and 6%, respectively. However, the null hypothesis of no causality from consumer price to producer and wholesale prices of chili is accepted. This causality result implies that the rural market price determines the urban price of red chili. Price transmission occurs from rural to the urban market and not vice versa. This unidirectional price transmission may lead to an inadequate flow of information between the rural area and urban area. This result differs from the results of a study conducted by [18] indicating that the price of red chili at the producer level and the price at the consumer level in West Java did not affect each other.

Analysis of factors influencing red chili price formation is conducting by using an error correction mechanism (ECM) model approach. Estimation of the ECM model consists of the short term and long-term analysis. In short-run equations, Error Correction Term (ECT) from the results of long-term equation estimation is applied in the model. In the short-term model, the variables used are the differenced variables. The differentiated variables illustrate the "disturbance" of the variable itself. The change in endogenous variables due to changes in exogenous variables in the long-term model will be offset by the error correction component of the previous period (ECTt-1). This error correction component shows short term adjustments allowing for long-term equilibrium [19].

Table 4: Granger Causality Test Results of Red Chili at Farmers, Wholesalers and Consumers Prices

No	Hypothesis			F-Statistic	Prob.
1	Wholesale Price	does not cause	Producer Price	0.1977	0.8211
	Producer Price	>>	Wholesale Price	2.2682	0.1118
2	Consumer Price	does not cause	Producer Price	0.2619	0.7704
	Producer Price	>>	Consumer Price	4.1614	0.0200
3	Consumer Price	does not cause	Wholesale Price	0.3768	0.6876
	Wholesale Price	>>	Consumer Price	2.8524	0.0651

The result of price formation analysis of consumer price in ECM model is adjusted to the causality test which shows that the producer and wholesale price significantly influence the consumer price. Therefore, the price consumer change is caused by the changes of producer and wholesale price. This consumer price change suggests that the wholesale market has a market power in determining the price along with the marketing chain of red chili.

In addition to producer and wholesale prices, this paper includes other variables such as production, fuel prices, lagged producer prices, dummy harvest, critical days and trade policies (Horticultural Product Import Recommendations). However, after the re-specification of the model, the variables utilized in the red chili consumer price model are producer price, wholesale price, and fuel (Table 5).

The estimated ECM model for short-term consumer prices indicates that overall independent variables in the model affect the consumer price of red chili. The adjusted R-squared value on ECM estimates shows that in the short-term the variety of consumer prices can be explained by the producer price, wholesale prices, and fuel prices for 51 percent, the remainder explained by other factors not included in the model.

Table 5: Estimation Results of Short-term Consumer Price Formation

Variable	Parameter	Std. Error	t-Statistic	Prob.
Intercept	0,0069	0,0065	1,0552	0,2961
Producer Price	0,2637	0,1368	1,9270	0,0593
Wholesale Price	0,0951	0,0220	4,3263	0,0001
Fuel Price	0,4061	0,1638	2,4796	0,0164
ECT(-1)	-0,4785	0,1237	3,8678	0,0003
R-squared	0,51			

From the estimation result, it is seen that the price of BBM is the variable which holds the biggest influence on the price formation of red chili. An increase in fuel prices by 10 percent will increase consumer prices by 41 percent. A 10 percent increases in producer price will increase consumer prices by 2.6 percent, while a 10 percent wholesale price increase will only increase consumer prices by 0.9 percent.

Based on the error correction term (ECT), coefficients that are negative and significant, it can be argued that the model specifications used are valid. ECT parameter estimates of 0.47 indicate that the fluctuations of the independent variables in the model deviate from the long-term track, the variables will re-adjust to the equilibrium track. Approximately 47 percent of these adjustments occur in the first period and the rest in a subsequent month. Based on Table 6, in long-term consumer price model estimates, wholesale and fuel price variables show a positive and significant influence on consumer price, while producer prices show an insignificant effect. Long-term estimates show that farmers as producers have a relatively weak bargaining position in setting the selling price of their production. Meanwhile, wholesale prices significantly affect consumer prices both in the short and long-term condition.

Table 6: Estimation Results of Long-term Consumer Price Formation

Variable	Parameter	Std. Error	t-Statistic	Prob.
Intercept	0,0078	0,0072	1,0804	0,2847
Producer Price	0,1783	0,1500	1,1882	0,2399
Wholesale Price	0,1017	0,0243	4,1863	0,0001
Fuel Price	0,3621	0,1816	1,9938	0,0511
R-squared	0,37			

3.2. Spatial Integration

In 2015, the top five provinces of red chili producers in Indonesia were West Java (240864 tons), North Sumatra (178559 tons), Central Java (146100 tons), East Java (95439 tons) and West Sumatra (96255 ton) [16]. Therefore, spatial integration analysis is analyzed for five big cities located in red chili production and consumption center region. Spatial market integration is essential for horticultural commodities, as they are vulnerable and production is concentrated in one location while consumption is focused in other areas causing relatively long marketing channel and expensive transportation costs. Stationary test results indicate that most of the wholesale price data analyzed become stationer after a one-time differenced (Order 1), although there are indications some prices have stationary at the level (Table 7). However, stationary conditions will be more secure if one-time differentiation [20]. Based on the results of the co-integration test in Table 8 it can be seen that the value of trace statistic and maximum eigenvalue at rank = 2 is greater than the critical value with a significance level of 5 percent. Therefore, the null hypothesis states that no co-integration is rejected and the alternative hypothesis stating there is no co-integration is rejected. So it can be stated in all variables there is a significant long-term relationship with the model specification used is no deterministic trend and lag 1. Based on the co-integration test can be said that the red chili market has been integrated spatially. There are three co-integration vectors between wholesale prices in the analyzed markets. These five prices have a long-term equilibrium relationship, and there is a strong integration between the red chili market. Therefore, prices in one market can be utilized to predict prices in other markets. Analysis of spatial integration for agricultural products has been extensively applied, among others by [21, 13].

Table 7: Results of the ADF Stationary Test in the Wholesale Price of Red Chili

Variable	intercept		intercept and trend	
	t-Statistic	Prob.*	t-Statistic	Prob.*
Level				
Medan	-4.1916	0.0014	-5.0405	0.0006
Padang	-4.0611	0.0021	-4.8603	0.0010
DKI Jakarta	-3.2962	0.0188	-4.4413	0.0036
Bandung	-4.2538	0.0011	-4.6713	0.0019
Semarang	-4.1613	0.0015	-5.8207	0.0000
First Difference				
Medan	-6.8327	0.0000	-6.8626	0.0000
Padang	-6.2164	0.0000	-6.2390	0.0000
DKI Jakarta	-7.3088	0.0000	-7.2660	0.0000
Bandung	-7.4688	0.0000	-7.4387	0.0000
Semarang	-6.7625	0.0000	-6.7215	0.0000

Table 9 presents the results of testing the causalities of red chili wholesale prices in several major cities, namely

Medan, Padang, DKI Jakarta, Bandung, and Semarang. Lagged two is utilized in the analysis of causalities of this paper because it is likely that price information between cities can be transmitted within two months. The Granger causality test was performed to detect the direction of possible causal effects of the prices. The result showed that, in the short run, twenty chili market links were investigated for evidence of Granger causality. Twelve red chili market links rejected their respective null hypothesis of no Granger causality. The results of the analysis show that there are six of market link exhibited bi-directional Granger causality or simultaneous feedback relationships. Six market links exhibited unidirectional Granger causality. There are Padang-Medan, Medan-Bandung, Semarang-Bandung, Padang-Bandung, Padang-Semarang, and Medan-DKI Jakarta. Padang market has a strong influence over Medan, Jakarta, Bandung, and Semarang. Padang is the principal market of red chili from West Java (Bandung) and Central Java (Semarang). The weak impact was also observed in Semarang over Bandung, Medan, and Jakarta. Medan exhibits a strong influence over Jakarta and Bandung but exhibits weak influence over Semarang. This impact because the Medan market brings many red chilies from the area of West Java (Jakarta and Bandung).

Table 8: Johansen Test Results for Spatial Co-integration of Red Chili Market

Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.0500 Critical Value	Prob.**
None *	0.5410	120.2420	60.0614	0.0000
At most 1 *	0.3979	68.0728	40.1749	0.0000
At most 2 *	0.2878	34.0863	24.2760	0.0021
At most 3	0.1509	11.3442	12.3209	0.0725
At most 4	0.0057	0.3854	4.1299	0.5979
Trace test indicates 3 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.0500 Critical Value	Prob.**
None *	0.5410	52.1692	30.4396	0.0000
At most 1 *	0.3979	33.9865	24.1592	0.0017
At most 2 *	0.2878	22.7422	17.7973	0.0083
At most 3	0.1509	10.9587	11.2248	0.0557
At most 4	0.0057	0.3854	4.1299	0.5979
Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

Similarly, Semarang exhibits weak influence over Bandung, Medan, and Jakarta. Jakarta exhibits weak influence over Padang and Semarang market. It can be said that Padang is in the leadership position in red chili price formation and transmission among the red chili market investigated. Furthermore, from the result of the analysis, red chili markets are spatially linked by trade. Therefore, there is high market integration between producing and consuming states. This integration implies that price changes in one market are manifested in an identical price response in the other market. There is also adequate free flow of red chili between markets and the market is linked by efficient arbitrage. The absence of inter-market causality can be caused by poor distribution channels, market power, and market failures as a consequence of the market does not run well [22].

Table 10 presents estimates of the impacts on the decomposition of variance diversity on the price of red chili in some major cities, namely Medan, Padang, Jakarta, Bandung, and Semarang. In the case of Medan, in the second month of the occurrence of price shocks, the variability of the price of red chili is influenced by the price in the Medan market itself (95.9%). The projection of the variability of red chili price in Medan in the next 12 months can be a little influenced by the price in Jakarta (9.03%) and the price of Medan itself (81.6%).

Table 9: Causality Test Results of Spatial Market for Red Chili

No	Hypothesis			F-Statistic	Prob.
1	Padang	does not cause	Medan	4.5103	0.0148
	Medan	>>	Padang	0.8205	0.4449
2	Jakarta	does not cause	Medan	2.0432	0.1381
	Medan	>>	Jakarta	5.9448	0.0043
3	Bandung	does not cause	Medan	2.2157	0.1175
	Medan	>>	Bandung	7.3227	0.0014
4	Semarang	does not cause	Medan	2.4175	0.0974
	Medan	>>	Semarang	4.1451	0.0204
5	Jakarta	does not cause	Padang	2.3705	0.1017
	Padang	>>	Jakarta	4.0375	0.0224
6	Bandung	does not cause	Padang	1.3974	0.2548
	Padang	>>	Bandung	5.9804	0.0042
7	Semarang	does not cause	Padang	1.2696	0.2880
	Padang	>>	Semarang	4.4202	0.0160
8	Bandung	does not cause	Jakarta	1.8378	0.1676
	Jakarta	>>	Bandung	1.7234	0.1868
9	Semarang	does not cause	Jakarta	4.5848	0.0138
	Jakarta	>>	Semarang	3.3953	0.0398
10	Semarang	does not cause	Bandung	3.3038	0.0432
	Bandung	>>	Semarang	1.1821	0.3133

In the event of price shocks in Padang, the first month of price variability in Padang was influenced by its price (37.5%) and prices in Medan (62.5%). In the second month, prices in Padang were marginally affected by prices in Jakarta (3.05%). The projection of price variability in Padang in the 12th month is mainly influenced by prices in Medan for 52.04%. Also, prices in Padang depend on prices in the Padang market itself of 17.4%, prices in Jakarta (15.9%) and prices in Semarang (13.5%). For DKI Jakarta market, in the first month, the price variation was affected by the price in Jakarta itself (65.3%), in Medan (16.5%) and Padang (18.1%). Padang and Medan seem to have explanatory power which turns significant (over 20%), after the 12month horizon. The projection on the 12th month of price variability in Jakarta is still influenced mainly by the price in Jakarta Capital City.

Within 12 months after the price shock, the price variation in Jakarta Capital City can be attributed to itself at 45.6%, the price in Medan is 29.4%, and the price at Padang is 23.1%. This impact of shock indicates that in the long run, the price of red chili in Medan and Padang affects the formation of prices in Jakarta. About Bandung, the price variability in the first month is affected by its price of 69.6%, the price at Medan (13.3%) and the price at Padang (16.6%). In the second month and so on, prices in Bandung are increasingly influenced by that of red chili in other cities. In the 12 months after the shocks, price variation in Bandung was mainly influenced by prices in Medan by 36.4%. Also affected by prices in Bandung itself (29.0%), prices in Padang (14.4%), prices in Jakarta (10.5%) and slightly influenced by prices in Semarang (9.5%). Padang, Medan, Jakarta, and Semarang are an explanatory factor over the whole time horizon, though the most significant effects reveal after the third month.

Table 10: Forecast Error Variance Decomposition of Red Chili Prices

Variance Decomposition of Medan:						
Period	S.E.	Medan	Padang	DKI Jakarta	Bandung	Semarang
1	0.1463	100.0000	0.0000	0.0000	0.0000	0.0000
2	0.2235	95.9552	2.2471	1.6034	0.0635	0.1308
3	0.2818	91.3949	1.8118	5.4101	0.2085	1.1747
4	0.3301	87.5366	1.5723	7.6187	0.1575	3.1149
5	0.3680	84.5497	1.5867	8.4183	0.2124	5.2329
6	0.3997	83.1412	1.6553	8.5768	0.1942	6.4324
7	0.4269	82.5764	1.7880	8.5583	0.2050	6.8723
8	0.4518	82.4320	1.8512	8.6539	0.1836	6.8792
9	0.4769	82.3312	1.8524	8.7919	0.1648	6.8597
10	0.5020	82.1541	1.8454	8.8648	0.1490	6.9867
11	0.5258	81.9134	1.8517	8.9416	0.1361	7.1573
12	0.5481	81.6826	1.8620	9.0294	0.1259	7.3000
Variance Decomposition of Padang:						
Period	S.E.	Medan	Padang	DKI Jakarta	Bandung	Semarang
1	0.1212	62.4932	37.5069	0.0000	0.0000	0.0000

2	0.1874	68.0840	27.5825	3.0513	1.0822	0.1999
3	0.2492	66.1332	20.5557	11.4466	0.7813	1.0832
4	0.3049	60.8124	17.1816	14.6443	1.1742	6.1876
5	0.3475	56.9527	16.2752	15.2388	1.4207	10.1126
6	0.3800	54.4808	16.6574	15.3848	1.2288	12.2482
7	0.4061	53.4391	17.1777	15.3893	1.1168	12.8771
8	0.4301	52.9692	17.5490	15.5283	1.1195	12.8340
9	0.4546	52.8174	17.5580	15.6830	1.1165	12.8251
10	0.4792	52.6622	17.4699	15.7716	1.1029	12.9934
11	0.5027	52.3534	17.4310	15.8807	1.0933	13.2416
12	0.5248	52.0430	17.4281	15.9867	1.0782	13.4639
Variance Decomposition of DKI Jakarta:						
Period	S.E.	Medan	Padang	DKI Jakarta	Bandung	Semarang
1	0.1731	16.5984	18.1227	65.2789	0.0000	0.0000
2	0.2609	33.3077	18.5133	47.3876	0.0875	0.7038
3	0.3212	32.1465	24.7232	40.0579	2.5594	0.5131
4	0.3654	31.2168	23.8067	41.9289	2.6316	0.4160
5	0.4118	30.1603	22.2616	44.9990	2.2158	0.3633
6	0.4522	30.2475	21.9302	45.4594	1.8400	0.5229
7	0.4865	30.3622	22.3514	44.7174	1.8930	0.6760
8	0.5166	29.7396	22.9213	44.9139	1.8157	0.6094
9	0.5456	29.3598	22.9959	45.4364	1.6570	0.5510
10	0.5738	29.4357	23.0093	45.5171	1.5369	0.5010
11	0.6009	29.5159	23.0685	45.4823	1.4582	0.4752
12	0.6269	29.4424	23.1052	45.6175	1.3877	0.4472
Variance Decomposition of Bandung:						
Period	S.E.	Medan	Padang	DKI Jakarta	Bandung	Semarang
1	0.1513	13.3122	16.6679	0.3962	69.6237	0.0000
2	0.2153	30.3915	13.3544	3.0034	53.2051	0.0456
3	0.2646	40.9346	13.6923	5.5064	37.2937	2.5730
4	0.3080	39.6701	13.4729	7.4624	34.2582	5.1364
5	0.3456	37.2810	13.0110	9.4609	34.0641	6.1831
6	0.3765	36.9697	13.1894	9.8423	32.0690	7.9296
7	0.4024	36.7986	13.7937	9.6708	30.8898	8.8472
8	0.4256	36.4449	14.2250	9.9159	30.5166	8.8977
9	0.4490	36.4545	14.2972	10.2005	30.1642	8.8836
10	0.4724	36.5466	14.3367	10.2918	29.7639	9.0610
11	0.4945	36.5383	14.4010	10.4020	29.3616	9.2972
12	0.5154	36.4844	14.4646	10.5447	29.0261	9.4803

Variance Decomposition of Semarang:						
Period	S.E.	Medan	Padang	DKI Jakarta	Bandung	Semarang
1	0.1579	37.1343	8.2548	2.6947	4.8913	47.0249
2	0.2269	47.1470	7.9961	8.6074	4.9427	31.3068
3	0.2916	55.2984	5.3096	14.8332	4.6038	19.9550
4	0.3433	54.7841	4.7148	20.1238	5.8359	14.5415
5	0.3807	54.1814	4.5560	22.6507	6.3075	12.3044
6	0.4070	54.3101	5.0103	23.6954	6.0522	10.9319
7	0.4290	54.4241	5.4173	24.3389	5.9790	9.8406
8	0.4521	54.4772	5.5414	24.9312	6.1094	8.9408
9	0.4763	54.7688	5.5393	25.3918	6.2146	8.0855
10	0.5001	55.1367	5.5251	25.7433	6.2586	7.3363
11	0.5224	55.3101	5.5474	26.1415	6.2779	6.7232
12	0.5433	55.3901	5.5805	26.5157	6.2976	6.2161

4. Conclusion

The results of cointegration tests indicate that there is a long-term relationship between prices at the farmers, wholesalers and consumers level. Producer and wholesale prices granger caused consumer price. This relationship implies that the rural market price determines the urban price of red chili. Price transmission occurs from rural to the urban market and not vice versa. This price transmission may result in an inadequate flow of information between the rural area and urban area.

The estimation of factors influencing the formation of red chili price at Consumer Level shows that the price of BBM is the variable that holds the biggest influence on the formation of the price of red chili at the consumer level. Thus, cost of distribution/transportation of red chili determines the price at the consumer level. Meanwhile, wholesale prices significantly affect consumer prices both in the short and long term. This effect suggests that the wholesale market has a market power in determining the price along with the marketing chain of red chili. The results of the analysis of variance decompositions or short-term dynamics of time series data of red chili prices in several major cities indicate that the market in Padang dominates the red chili market, which can affect the formation of prices in other markets. In other words, Padang can be a barometer for the red chili market in other cities. The government should strive for cultivation to be designed in such a way that harvesting can happen throughout the year, little distribution costs, improving post-harvest technology performance as well as red chili processing industry due to the defective nature of red chili. Price stability will lower the risk premium for traders, and other intermediaries and consequently the retail price spread of agriculture will shrink, and the market needs to become more efficient.

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