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Causality relations and causality direction of shallots price changes in east java province, Indonesia

Laila Nuzuliyah[1+]
Nuhfil Hanani[2]
Hery Toiba[3]
Sujarwo Sujarwo[4]

[1,2,3,4]*Faculty of Agriculture, University of Brawijaya, Malang 65145, Indonesia.*
[1]*Email: nuzuliyah23@gmail.com*
[2]*Email: nuhfil.fp@ub.ac.id*
[3]*Email: htoiba@ub.ac.id*
[4]*Email: sujarwo@ub.ac.id*

(+ Corresponding author)

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ABSTRACT

This study examines the existence of market integration and causality between prices at the consumer level and other locations in the shallot market. The time-series price data observed every month from 2013 to 2018 regarding the price level of consumers originating from farmers in Probolinggo, Nganjuk, and Malang districts were analyzed. Additionally, consumer price data was collected in Probolinggo Regency, Nganjuk Regency, Malang Regency, and Surabaya City. The data was analyzed using the Granger causality test. The results revealed significant findings at the producer level, indicating a negative causality between Nganjuk and Probolinggo producer prices. On the other hand, producer markets in Nganjuk, Probolinggo, and Malang districts influence consumer prices in Surabaya City. Finally, Nganjuk Regency, Probolinggo Regency, and Malang Regency's consumer markets had a negative influence on the Surabaya City consumer market. Market participants, such as farmers and traders, need to be aware of these price dynamics to effectively coordinate their activities and respond to market changes.

Contribution/ Originality: This research contributes to the existing literature by examining the causal relationships and market integration between producer and consumer prices in the shallot market, thereby providing valuable insights for market participants and policymakers.

1. INTRODUCTION

Agribusiness faces various pressures, such as natural factors, farmer socioeconomic factors, and price volatility, both at the farm level and at the consumer level (Adebusuyi, 2004; Jayathilake, De La Porte, Chang, Edwards, & Carrasco, 2023; Kustiari, Sejati, & Yulmahera, 2018; Udoh & Akpan, 2007). Shallots are one of the essential horticultural commodities that often experience price fluctuations and even always increase (Annisa, Asmarantaka, & Nurmalina, 2018; Asmara & Ardhiani, 2010; Kustiari et al., 2018; Nuraeni, Anindita, & Syafrial, 2015). An increase in the price of shallots results in a trend towards inflation in food commodities (Kustiari et al., 2018; Sahara, Utari, & Azijah, 2019), which can create price distortions and price uncertainty (Blanchard & Johnson, 2017). Shallot price fluctuations commonly result in an increase in the price gap between the farmer gate and the consumer gate. Moreover, it tends to harm the profitability of the farmer.

Shallot Farmers make efforts to obtain decent profits from their farming. Most of the farmers control arable land around 0.2-0.3 hectares, and only a small proportion of farmers control land over 1 hectare. Farmers have limited access to price information at the market level. The price determination for shallot farmers comes from the traders.

It implies that farmers are price takers in the shallot market (Abriani, Lestari, & Haryono, 2023). Farmers consider the previous shallot price as a reference for getting the expected price when they are harvesting the shallot.

The concept of causality is a basic idea for analyzing the dynamic relationship of time series data (Droumaguet, Warne, & Woźniak, 2017; Song & Taamouti, 2019; Torun, Chang, & Chou, 2019). These studies consider two sources of predictive relationships between variables. The first prediction uses the linear relationship between the price of shallot at the producer level and the price of shallot at the consumer level. Second, the fact that there is a causal relationship between the price of shallots at the producer level and the price of shallots at the consumer level. This analysis will also reveal Granger-causality in onion macroeconomic activities in a dynamic context. This study examines the hypotheses represented by a limited number of models. This study makes a dynamic differentiation of the causal chain to build a framework in the context of the interaction between two multivariate variables: the price of onion producers and consumer prices of onions. Granger causality is expected to provide evidence of problems in the relationship between producer prices and consumer prices. For this purpose, we use monthly shallot price data in a time series from 2013-2018 at the producer and consumer levels. The Granger Causality Method has been widely used by previous researchers to analyze time series for completing research objectives (Bahadori & Liu, 2012; Barrett, Barnett, & Seth, 2010; Bİlen, Yİlancİ, & Eryüzlü, 2017; Bressler & Seth, 2011; Chen, 2016; Droumaguet et al., 2017; Dumitrescu & Hurlin, 2012; Emirmahmutoglu & Kose, 2011; Götz & Hecq, 2019; Gregorova, Kalousis, & Marchand-Maillet, 2015; Hsueh, Hu, & Tu, 2013; Krumin & Shoham, 2010; Law, Lim, & Ismail, 2013; Li, Zhang, & Yuan, 2019; Papagiannopoulou et al., 2017; Shahbaz, Lean, & Shabbir, 2012; Song & Taamouti, 2019; Sun, Gao, Wen, Chen, & Hao, 2018; Tekin, 2012; Yang, Chen, Song, & Gong, 2017).

Granger (1969) came up with a basic idea for analyzing the dynamic relationship between time series that underlies the idea that one variable causes other variables in terms of influence. The main idea about GC (Granger Causality) is that X 'Granger causes' Y if X contains information that helps predict the future of Y better than information that already existed in the past Y. The most common GC implementation is through modelling linear time series data vector autoregressive (VAR), which allows testing of statistical significance and estimation of GC quantities (David et al., 2006; Friston, Moran, & Seth, 2013; Kiebel, Garrido, & Friston, 2007; Seth, 2010). Knowledge of the Granger Causality relationship can enable researchers to formulate an appropriate model and get a better estimate of the variables of interest. In practice, researchers often investigate Granger's causality for bivariate processes. However, considering more than two variables can lead to different conclusions. In other words, even if a variable is a Granger-cause in a bivariate model, it may not be a factor that causes Granger in a larger model that involves more variables. Ignoring this causal effect can lead to incorrect economic analysis and, consequently, inaccurate policy decisions. We also underline that, in general, Granger's causality is not related to the causal relationship implied by structural economic theory as well.

While there have been studies examining market integration and causality in various agricultural markets, there is a dearth of research specifically focusing on the shallot market, particularly in East Java, Indonesia, which is a major center for shallot production. Furthermore, existing studies often lack comprehensive analysis across different market levels and fail to explore the implications for consumer prices. This research aims to fill this gap by examining the causal relationships and market integration between producer and consumer prices in the shallot market, thereby providing valuable insights for market participants and policymakers. Previous studies' findings have served as inspiration and have opened up new research opportunities regarding the macroeconomics of shallots. Various researchers have previously conducted studies using different methodologies to address research objectives. However, there is a need for additional investigation into the relationship and direction of price changes, as well as the influence of producer prices on consumer prices. Specifically, this study aims to analyze the causality relationship and direction of price changes at three levels: (1) the producer level, (2) the consumer level, and (3) the producer and consumer levels.

2. MATERIALS AND METHODS

2.1. Research Data

This study chose the locations of Probolinggo Regency, Nganjuk Regency, Malang Regency, and Surabaya City in East Java Province (Figure 1). Achievement of goals uses onion prices at the producer level in Probolinggo Regency, Nganjuk Regency, and Malang Regency, while the consumer level is in Probolinggo Regency, Nganjuk Regency, Malang Regency, and Surabaya City. Each price data has a monthly time series from 2013 to 2018, so the number of samples is 72 in Rupiah. Data processing utilizes Eviews 10 software, which produces stationary tests of producer prices and consumer prices, then tests integration and continues with the Granger causality test.

All data were obtained from the District Agriculture Office and Market Information publications in Probolinggo, Nganjuk, Malang, and Surabaya City Regencies. The districts of Probolinggo, Nganjuk, and Malang were selected as sample districts because the three districts are the production centres of shallots in East Java Province. While the City of Surabaya was chosen to represent East Java as a consumer of shallots, Producer- and consumer-level data are summarized in the descriptive statistics presented in Table 1.

This study likely selected data from 2013 to 2018 to ensure a comprehensive and complete dataset. By utilizing data from this specific time frame, researchers can obtain a detailed understanding of the shallot market dynamics and trends within Probolinggo Regency, Nganjuk Regency, Malang Regency, and Surabaya City in East Java Province. This duration allows for a sufficient analysis of production levels, market fluctuations, pricing patterns, and other relevant factors that could influence the identification of these locations as potential shallot market centers. By using a complete dataset, researchers aim to provide a reliable and accurate assessment of the selected areas' suitability for shallot production and distribution.

Table 1. The statistical description of research data.

Descriptive statistics	Producer price (Rupiah)			Consumer price (Rupiah)			
	Probolinggo	Malang	Nganjuk	Probolinggo	Malang	Nganjuk	Surabaya
Mean	15,183	16,014	13,421	21,608	23,875	22,222	24,159
Median	13,962	13,407	13,200	20,621	22,723	21,060	23,427
Std. dev	6,294	7,206	5,988	7,205	7,989	8,014	7,943
Min	6,000	3,468	4,125	9,022	11,634	10,344	13,320
Max	40,000	37,067	30,785	41,043	45,242	40,056	42,684
N	72	72	72	72	72	72	72

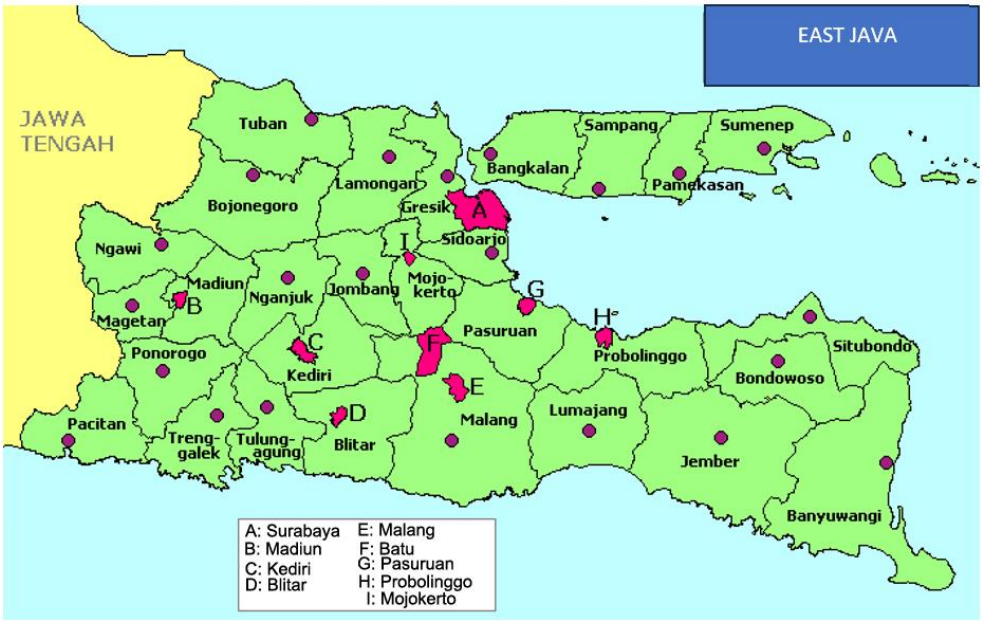

Figure 1. The map of Probolinggo, Nganjuk, Malang Regency and Surabaya City, East Java, Indonesia.

2.2. Procedures

Causality relationships have the potential to (1) influence, (2) influence, or (3) not influence each other. Causality indicates the relationship between the price of shallots at the producer level and the prices of shallots at the consumer level for Probolinggo Regency, Nganjuk Regency, Malang Regency, and Surabaya City. The relationship between causality and the direction of price development is obtained by a series of data processing steps using Software Eviews 10. The analysis of consumer and producer price data follows the steps presented in Figure 2.

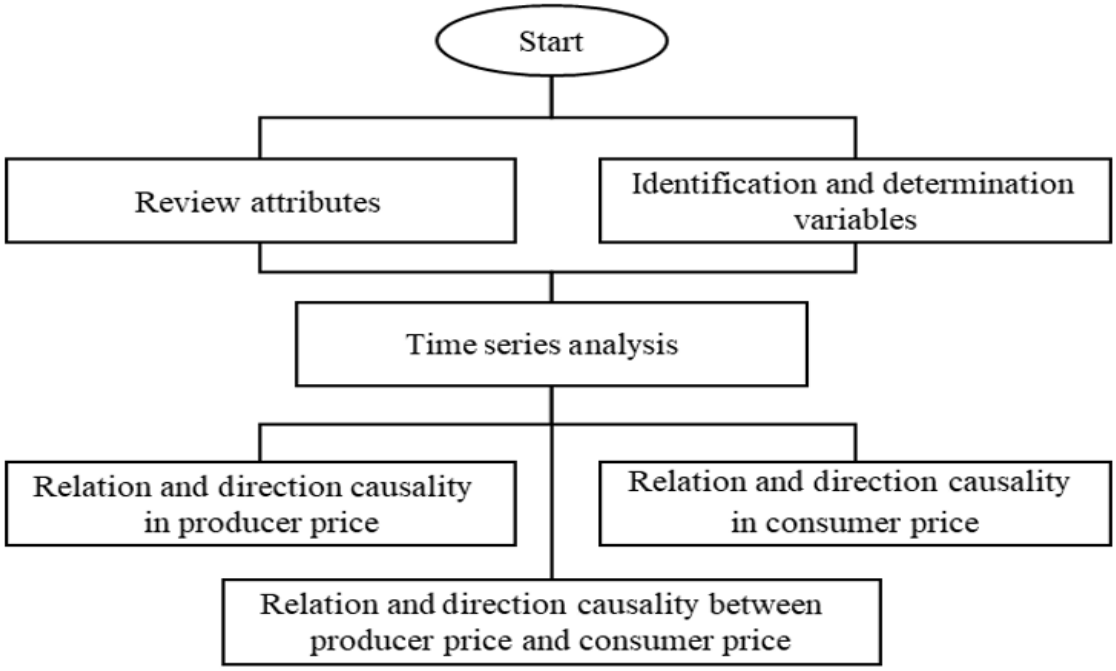

Figure 2. The stages of the analysis of causality and direction of changes in the price of shallots in East Java Province, Indonesia.

2.3. Method

This study considers the causality between producer prices and consumer prices using the Granger causality test (GC). The GC test produces a relationship between producer prices and consumer prices and determines the direction of the relationship between the two. Granger causality test involvement has the objective of examining whether producer prices affect consumer prices, whether consumer prices affect producers, whether producer prices and consumer prices have a mutually influential relationship (two directions), or whether producer prices and consumer prices do not affect each other. Granger Causality test follows Equation 1 and Equation 2 (Lin, Liu, Li, & Zhou, 2016; Sun et al., 2018; Torun et al., 2019).

$$LP_t = \sum_{i=1}^{m} a_i \, LP_{t-1} + \sum_{j=1}^{m} b_j \, LK_{t-1} + \mu_t \qquad (1)$$

$$LK_t = \sum_{i=1}^{n} c_i \, LK_{t-1} + \sum_{j=1}^{n} d_j \, LP_{t-1} + v_t \qquad (2)$$

Keterangan:

LP = Producer Price (IDR).

LK = Consumer Price (IDR).

μ, ν = Error term.

LP_t and LK_t are time series, and μt and νt are error terms that are considered uncorrelated; m and n indicate the maximum number of lags. If the null hypothesis $b_1 = b_2 = \cdots = b_m = 0$ in Equation 1 is rejected, or there is at least one $b_j \neq 0$ (j = 1,2, .., m) it means Consumer prices (CP) Granger causes LP. The same thing if the null hypothesis d_1

$= d_2 = \cdots = d_n = 0$ in the Equation 2 is rejected, meaning that Producer Price (PP) Granger causes LK. If both of the two null hypotheses are rejected at the same time, there is a two-way causality between LP and LK. And if both null hypotheses are accepted at the same time, there is no causal relationship between LP and LK. Granger Causality (GC_{ij}) is defined to represent Granger causality between price index *i* and price index *j*, which are different price indexes. Equation 1 and Equation 2 produce 4 possibilities which are presented in Table 2.

Table 2. The possible relationship between granger causality.

Case	$\sum_{j=1}^{m} b_j$	$\sum_{j=1}^{n} d_j$	Granger causality (GC_{ij})	Direction causality
1	$\neq 0$	$= 0$	Consumer prices affect producer prices	One way
2	$\neq 0$	$\neq 0$	Producer and consumer prices influence each other	Two way
3	$= 0$	$= 0$	Producer prices and consumer prices are not compatible	Zero way
4	$= 0$	$\neq 0$	Producer prices affect producer prices	One way

The Casual Loop (CL) method is used to describe the causal relationship between the development of shallot prices at the producer and consumer levels. CL illustrates a feedback diagram (feedback), which is a visualization of the causal relationship of price developments at both producer and consumer levels in an onion economic system. Causal Loop Diagrams (CLD) represent the interrelationships between variables and the feedback process. Feedback determines the characteristics of the shallot price dynamics system for each price development in Probolinggo Regency, Nganjuk Regency, Malang Regency, and Surabaya City.

3. RESULTS AND DISCUSSION

3.1. Stationary Test of Producer and Consumer Prices

The stationary test involves the augmented dickey-fuller (ADF) method to determine the Consumer price Surabaya (CPS) Consumer price Nganjuk (CPN) Consumer price Probolinggo (CPP) Consumer price Malang (CPM) Producer price Nganjuk (PPN), Producer price Probolinggo (PPP), and Producer price Malang (PPM) CPS, CPN, CPP, CPM, PPN, PPP, and PPM root unit tests. All time-series data have significance at $\alpha = 5\%$ besides CPP and PPM (Table 3). The ADF statistic accepts the null unit root hypothesis at a significance level of 5%, whereas the CPS, CPN, CPM, PPN, and PPP reject the null hypothesis at the 5% significance level.

There are some data points that have problems with the unit root because the data is not stationary on the unit root test (in level), so it continues with the calculation of the unit root test first difference. At a 5% confidence level, the calculation results show that the absolute value of the ADF is smaller than the critical value of McKinnon (Table 4). This means that at the first difference level, all of these variables have no unit root problems and have stationary data conditions (Table 4).

Table 3. Unit root test (in level).

Variabels	ADF statistic	Critical value MacKinon 5%	Probability	Note
CPS	-3.088	-2.902	0.032	Stationary
CPN	-2.964	-2.902	0.043	Stationary
CPP	-2.583	-2.902	0.101	Un-stationary
CPM	-3.027	-2.902	0.0371	Stationary
PPN	-3.737	-2.902	0.0054	Stationary
PPP	-3.883	-2.902	0.0035	Stationary
PPM	-2.448	-2.902	0.1327	Un-stationary

Table 4. Unit root test (Fisrt difference).

Variabels	ADF statistic	Critical value MacKinon 5%	Probability	Note
CPS	-7.764	-3.476	0.000	Stationary
CPN	-7.104	-3.476	0.000	Stationary
CPP	-10.116	-3.476	0.000	Stationary
CPM	-7.734	-3.476	0.000	Stationary
PPN	-10.275	-3.476	0.000	Stationary
PPP	-9.301	-3.476	0.000	Stationary
PPM	-11.858	-3.476	0.000	Stationary

3.2. The Producer Price and Consumer Price Co-Integrating Test Results

This research produces a long-term model of onion price trends at the producer level and onion prices at the consumer level. The long-run model between the three onion producers' markets has the producer spatial relationship presented in Equation 3. The long-term model of the four consumer markets has the spatial relationship of consumers presented in Equation 4. While the long-term model between the three producer markets and the four consumer markets has a consumer-producer vertical relationship presented in Equations 5.a, 5.b, and 5.c.

$$PPM_{(t-1)} = -0.009098*PPN_{(t-1)} - 0.997227*PPP_{(t-1)} \quad (3)$$

$$CPM_{(t-1)} = 0.491616*CPP_{(t-1)} - 1.394620*CPN_{(t-1)} + 0.157294*CPS_{(t-1)} - 2.623818 \quad (4)$$

$$CPS_{(t-1)} = -0.787223*PPN_{(t-1)} - 2.632812 \quad (5.a)$$

$$CPS_{(t-1)} = -1.052054*PPP_{(t-1)} \quad (5.b)$$

$$CPS_{(t-1)} = -1.036214*PPM_{(t-1)} - 0.083736 \quad (5.c)$$

The long-term model of producer prices and consumer prices of shallots is stationary and has a Co-Integration relationship because there is a similar long-term movement trend between producer and consumer prices (Lin et al., 2016). The estimation method uses Johansen's maximum likelihood to examine the spatial relationships of producers, spatial consumers, and producer-consumer verticals. This study uses a 95% confidence level.

3.3. Causality Relations and Direction of Shallot Producer Price Changes

Causality and direction of relations at the producer level: Nganjuk producer prices affect Probolinggo producer prices with negative causality. This means that any price increase in Nganjuk Regency will affect the price decline in Probolinggo Regency, and conversely, the price increase at the producer level of Probolinggo Regency will affect the price increase in Nganjuk Regency. Whereas producer prices in Nganjuk and Probolinggo districts affect prices in Malang Regency (Figure 3). The analysis produces information about the causality of producer prices with consumer prices and the direction of their causality. Table 5 presents the results of producer price causality between Nganjuk Regency, Probolinggo Regency, and Malang Regency, along with the direction of causality. Price developments at the farm level have a relationship to prices in the three observed districts. The relationship between price facts in the three districts can be seen as a system that is described as an interaction in a feedback loop (casual loop). which results in price development behaviour at the producer level.

We found a one-way relationship between the three shallot producers in East Java Province. First, the price of shallots in the Nganjuk Regency producer market affects both the Malang Regency and Probolinggo Regency producer markets. Second, the producer market of Probolinggo Regency only affects one market, Malang Regency. Third, the market price for producers in Malang Regency cannot influence the other two markets. This shows that Nganjuk Regency is a producer market, which has a very significant role in the fluctuation of onion prices at the producer level in East Java Province. Nganjuk Regency is the highest red onion production centre in East Java Province, which has implications for the fact that Nganjuk Regency is the largest supplier of red onion to meet the demand for shallots, especially in various markets in East Java. The producer market prices of Nganjuk Regency affect the other two producer markets, but the effect that we have found is negative. This means that a price increase in the Nganjuk Regency producer market will result in price reductions in Probolinggo Regency and Malang Regency. Easy access and wider marketing channels are one reason this happens. When the price of shallots outside East Java is relatively higher, they will tend to sell their products outside East Java. Conversely, when the prices of

onions in East Java Province tend to be higher, they tend to sell them in East Java. This is certainly very influential on the supply of shallots and impacts the price of onions at the producer level.

Producer prices in Malang Regency market depend on producer market prices in Nganjuk Regency and Probolinggo Regency. An increase in one unit of producer price in Nganjuk Regency will reduce 0.009098 one unit price in the Malang Regency producer market. An increase in one unit of producer price in Probolinggo Regency will reduce 0.997227 unit prices in the Malang Regency producer market (Equation 3).

Table 5. The causality and direction of shallot producer prices.

Regency		Causality	Direction
Nganjuk	Malang	Nganjuk Regency prices affect Malang Regency prices, and Malang Regency prices do not affect Nganjuk Regency	One way
Nganjuk	Probolinggo	Nganjuk Regency prices affect Probolinggo Regency prices, and Probolinggo Prices do not affect Nganjuk prices	One way
Probolinggo	Malang	Probolinggo Regency prices slightly affect Malang Regency prices, and Malang Regency Prices do not affect prices in Probolinggo Regency	One way

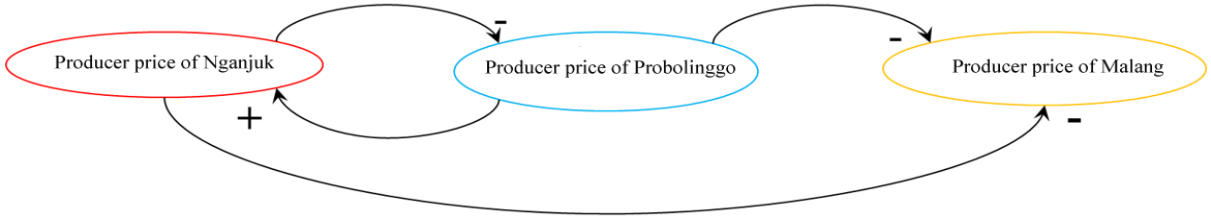

Figure 3. Causal loop diagram (CLD) of shallot price.

3.4. Causality Relations and Direction of Shallots Consumer Price Changes

The causal relationship and the direction of price influence in the consumer market indicate that the consumer markets of Nganjuk and Probolinggo Regencies affect the consumer market in Surabaya City (Figure 4). Table 6 presents the results of consumer price analysis with consumers from Nganjuk, Probolinggo, Malang, and Surabaya Regencies, along with their causality direction.

This study found that there is only one market that has causality with other markets, namely the price of Probolinggo regency producers affecting consumer prices in Surabaya. But on the contrary, the prices of Surabaya City consumers do not affect the producer prices of Probolinggo Regency. This is due to the close distance, health insurance between the two markets is also easier than in the other markets. Infrastructure in terms of roads and transportation flows is more developed between Probolinggo Regency and Surabaya City. The ease of transportation plays a role in the price changes between one market and another. However, there is only a one-way relationship between these two markets. Market prices in Probolinggo Regency only affect changes in prices in the City of Surabaya. This is because Probolinggo Regency is one of the centres of onion production in East Java, and Surabaya City is one of the market locations for shallot producers in East Java.

Malang Regency's shallot price consumer market has a positive relationship with Probolinggo Regency's shallot price consumer market. An increase in one unit of consumer price in Probolinggo Regency resulted in an increase in the price of 0.491616 unit of consumer price in Malang Regency. The Surabaya City consumer market affects Malang Regency consumer prices, which contributed to an increase in the price of 0.157294 one units price (Equation 4). The Nganjuk Regency consumer market responds negatively to the consumer market in Malang district. Every increase in consumer prices in Nganjuk Regency will cause a decrease in consumer prices in Malang Regency by 1.394620 unit prices.

Table 6. The causality and direction of shallot consumer prices.

Regency		Causality	Direction
Nganjuk	Malang	Nganjuk Regency prices do not affect Malang Regency prices, and Malang Regency prices do not affect prices in Nganjuk Regency	Zero Way
Nganjuk	Probolinggo	The price of Nganjuk Regency does not affect the price of Probolinggo Regency, and the price of Probolinggo Regency does not affect the price of Nganjuk Regency	Zero Way
Nganjuk	Surabaya	The price of the Nganjuk Regency does not affect the price of the City of Surabaya, and the Price of the City of Surabaya does not affect the price of the Nganjuk Regency	Zero Way
Malang	Probolinggo	Malang Regency prices do not affect Probolinggo Regency prices, and Probolinggo Regency prices do not affect prices in Malang Regency	Zero Way
Malang	Surabaya	Malang Regency prices do not affect the price of Surabaya City, and Surabaya City Prices do not affect prices in Malang Regency	Zero Way
Probolinggo	Surabaya	The price of Probolinggo Regency does not affect the price of the City of Surabaya, and the price of the City of Surabaya does not affect the price of the Regency of Malang	One way

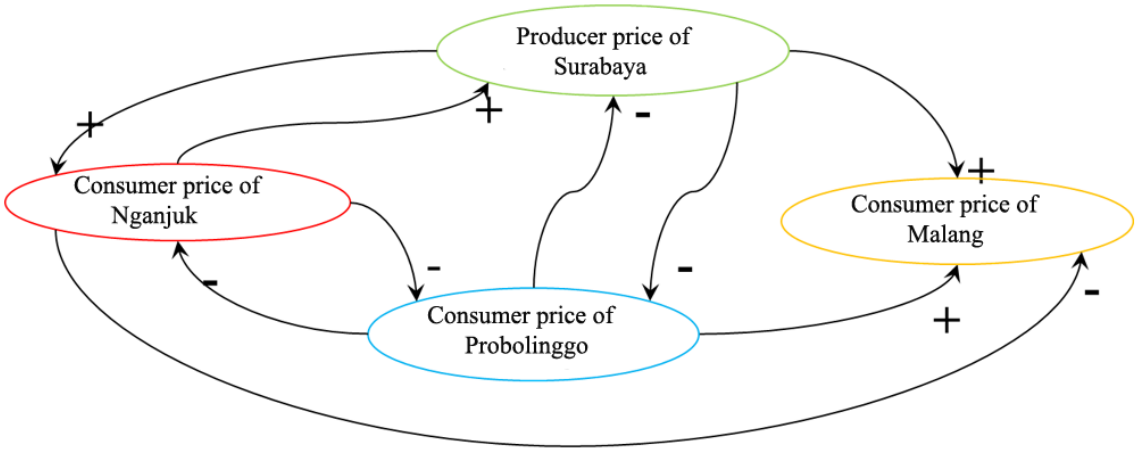

Figure 4. Causal loop diagram (CLD) of shallot price consumer.

3.5. Causality Relations and Direction of Shallots Producer Price Changes and Consumer Price Change

The causal relationship and direction between producer and consumer markets in Nganjuk, Probolinggo, and Malang districts affect consumer prices in Surabaya City (Figure 5). Table 7 presents the results of the causality analysis between the prices of shallot producers in Nganjuk, Malang, Probolinggo, and consumer prices in these regencies, along with the direction of causality.

Producer prices have directional causality with consumer prices in the East Java shallots market, except for producers in Nganjuk and Malang districts. They have a two-way causality that indicates that Malang Regency producer prices affect Nganjuk Regency consumer prices, and Nganjuk Regency consumer prices affect Malang Regency producer prices. Producer prices in Malang Regency and consumer prices in Nganjuk Regency have a two-way causal relationship. This finding implies that prices at the producer level largely determine fluctuations in the price of shallots in East Java Province. The consumer market plays an important role in the price level, both at the producer and consumer level.

All consumer markets in the study area affect the consumer market in Surabaya City (Equation 5.a, b, c). The Nganjuk Regency consumer market has a negative influence on the Surabaya City consumer market (Equation 5.a). Every increase in consumer prices in Nganjuk Regency results in a decrease of 0.787233 unit in the Surabaya City consumer market. Probolinggo Regency consumer prices negatively affect the Surabaya City consumer market (Equation 5.b). The increase in consumer prices in Probolinggo Regency caused a decrease in 1.052054 unit prices in the city of Surabaya. Consumer market conditions in Malang Regency have a negative impact on the Surabaya City

consumer market (Equation 5c). The increase in consumer prices in Malang Regency caused a decrease in consumer prices in the city of Surabaya by 1,036214 unit prices.

Table 7. The causality and direction of shallot producer prices with shallot consumer prices.

Regency / City		Causality	Direction
Producer	Consumer		
Nganjuk	Nganjuk	Nganjuk Regency producer prices affect Nganjuk Regency consumer prices, and Nganjuk Regency consumer prices do not affect Nganjuk Regency producer prices	One way
Nganjuk	Malang	The producer price of Nganjuk Regency influences the consumer price of Malang Regency, and the consumer price of Malang Regency does not affect the producer price of Nganjuk Regency	One way
Nganjuk	Probolinggo	Producer prices in Nganjuk Regency affect Probolinggo Regency consumer prices, and Probolinggo Regency consumer prices do not affect Nganjuk Regency producer prices	One way
Nganjuk	Surabaya	The producer price of Nganjuk Regency influences the consumer price of Surabaya City, and the consumer price of Surabaya City does not affect the producer price of Nganjuk Regency	One way
Malang	Malang	Malang Regency producer prices affect Malang Regency consumer prices, and Malang Regency consumer prices slightly affect Malang Regency producer prices	One way
Malang	Probolinggo	Malang Regency producer prices affect Probolinggo Regency consumer prices, and Probolinggo Regency consumer prices slightly affect Malang Regency producer prices	One way
Malang	Nganjuk	Malang Regency producer prices affect the consumer prices of Nganjuk Regency, and consumer prices of Nganjuk Regency affect producer prices of Malang Regency	Two way
Malang	Surabaya	Malang Regency producer prices affect the prices of Surabaya City consumers, and Surabaya City consumer prices do not affect Malang Regency producer prices	One way
Probolinggo	Probolinggo	Probolinggo Regency producer prices affect Probolinggo Regency consumer prices, and Probolinggo Regency consumer prices do not affect Probolinggo Regency producer prices	One way
Probolinggo	Malang	Probolinggo Regency producer prices affect Malang Regency consumer prices, and Malang Regency consumer prices do not affect Probolinggo Regency producer prices	One way
Probolinggo	Nganjuk	Probolinggo Regency producer prices affect Nganjuk Regency consumer prices, and Nganjuk Regency consumer prices do not affect Probolinggo Regency producer prices	One way
Probolinggo	Surabaya	Probolinggo Regency producer prices affect Surabaya City consumer prices, and Surabaya City consumer prices do not affect Probolinggo Regency producer prices	One way

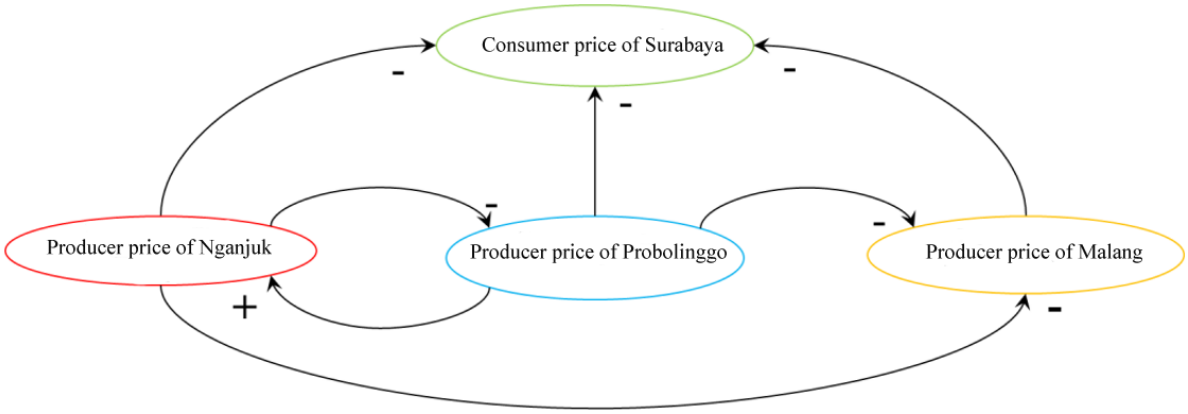

Figure 5. Causal loop diagram (CLD) of shallot price producer and consumer.

4. DISCUSSION

Most farmers control about 0.2–0.3 Ha of land, and only a small proportion of farmers control land over 1 ha. Traders finance the farmers' finances, and only a small proportion of farmers have access to financial institutions. The farmer stated that the selling price of shallots should be at least Rp 10,000 as the lowest price limit. If the price of shallots is less than Rp 10,000, farmers will suffer losses because the cost of production inputs will increase with the product price. In a situation where the price of onions soars, farmers sell all of their products, including seeds, for consumption. Onion production is also influenced by climate, and farmers predict that an inappropriate climate will result in product failure. Failure of production resulted in the price of shallots increasing because the stock of farmers was running low. Traders store the majority of their shallot stock in cold storage facilities. Farmers do not have a means of storing shallots, so farmers do not have a time delay to store their produced shallots. This results in farmers continuing to sell their production to traders. On the other hand, traders do not have enough capital to buy farmers' products because the capital they have spent has been spent on hoarding seeds, which usually occurs in January-February.

The study reveals several key factors that shape the dynamics of the shallot market at the farmer level. It is observed that the majority of farmers possess relatively small landholdings, typically ranging from 0.2 to 0.3 hectares, with only a small fraction controlling land over 1 hectare. Access to financial resources is also limited, as only a small proportion of farmers utilize financial institutions for their agricultural activities, with traders often filling the void by providing financial support. Farmers have established a minimum selling price of at least Rp 10,000 for shallots to ensure profitability, as prices below this threshold result in losses due to higher production input costs compared to the selling price. Moreover, market conditions influence farmers' selling decisions, prompting them to sell their entire product stock, including seeds intended for future cultivation, when the price of shallots surges. Climate also plays a crucial role, as farmers predict potential production failures based on unfavorable weather conditions (Rahman et al., 2023). Consequently, such production failures lead to a scarcity of shallots in the market, driving prices upward. Notably, traders possess cold storage facilities to stockpile shallots, providing them with a strategic advantage over farmers, who lack proper means of storage. As a result, farmers frequently have no choice but to sell their produce to traders. Additionally, traders face capital constraints due to prior expenditures on hoarding seeds, which commonly occur during the months of January and February.

This study's findings shed light on the intricate dynamics of the shallot market at the farmer level, uncovering various factors that influence production, pricing, and selling decisions. The prevailing small-scale nature of farming operations implies that most farmers have limited resources and land holdings, which may hinder their access to financial services and impede their ability to invest in advanced technologies or expand their operations. This highlights the need for targeted support and interventions that address the specific challenges faced by smallholder farmers in the shallot market. Farmers establishing a minimum selling price demonstrates their awareness of production costs and the necessity to ensure profitability. However, this poses a potential challenge when market prices fall below the desired threshold, as farmers may face financial losses. Policymakers and market stakeholders should consider mechanisms to mitigate such risks, such as price stabilization programs, crop insurance schemes, or assistance programs aimed at reducing input costs. The impact of climate change on shallot production highlights the vulnerability of farmers to weather fluctuations and the consequential effects on market supply and prices. Climate-smart agricultural practices, such as improved irrigation systems, crop diversification, and access to climate information, can aid farmers in adapting to changing weather patterns and reducing production risks (Rahman, Huang, Toiba, & Efani, 2022). The disparity in storage capabilities between traders and farmers presents a significant asymmetry in the market. Farmers' limited storage options restrict their ability to strategically time their sales and may result in unfavorable prices during periods of low supply. Initiatives to improve farm storage infrastructure, such as community-based storage facilities or access to affordable cold storage, can empower farmers and enhance their market bargaining power. The capital constraints faced by traders due to their expenditures on hoarding seeds during

specific periods indicate the cyclical nature of market dynamics. Policymakers should consider financial mechanisms or credit facilities to support traders during these critical periods, ensuring stable market operations and enabling them to adequately purchase farmers' produce.

In conditions where farmers experience very high profits, farmers spend part of their profits to expand arable land, and some are spent on transportation. Farmers do not have access to market price information. They get the price amount from the trader based on the previous price. Farmers take advantage of current high onion prices to save money to prepare for the next planting period. Instead, farmers make savings by replacing chemical fertilizers with biological fertilizers. Facts show that only about 10% of farmers use biological pesticides, while the rest still use chemical pesticides. The use of organic pesticides will save up to 15%. Organic pesticides will produce onion products with increased resistance from 3 months to 6 months. While production will increase by up to 10%. Organic pesticides used are ingredients from each farmer, and each farmer keeps the composition of organic material from one another. Each farmer keeps a secret recipe for organic pesticides. This reminds the government to produce organic pesticides and subsidize farmers as production inputs.

Organic pesticides also produce sustainable products in terms of the content of hazardous substances for food consumption. The efficiency of production input costs aims to ensure that in the next planting period, farmers can buy onion seeds. Some farmers receive assistance with production facilities from traders at the start of the planting period. Farmers sell shallots to traders when the prices are low or high. This means farmers have a high dependence on shallot traders. The situation of dependency on farmers has an unfavorable impact on farmers in terms of production profits. The working relationship system between farmers uses farmer institutions such as farmer groups and associations. In terms of pricing, the influence of shallot traders already dominates farmer groups and associations, rendering them irrelevant.

This study's findings provide valuable insights into the dynamics and challenges faced by farmers in the shallot market. Farmers' high profitability drives them to make strategic decisions like expanding their arable land and investing in transportation infrastructure. However, the lack of access to market price information places them at a disadvantage, forcing them to rely on trader-provided price indicators that may not accurately reflect the current market conditions. This highlights the need for improved price transparency and information dissemination mechanisms to empower farmers in their decision-making processes. The study also reveals the potential benefits of adopting organic pesticides in shallot production.

Despite the demonstrated advantages of increased product durability and enhanced resistance, the low adoption rate suggests a need for awareness campaigns and support from the government in promoting organic pesticide use. Government intervention in producing and subsidizing organic inputs can help farmers transition to more sustainable and environmentally friendly agricultural practices. The discussion also highlights the challenges faced by farmers in terms of their dependency on shallot traders. This reliance creates an imbalanced power dynamic, limiting the agency of farmer groups and associations in influencing pricing mechanisms. Efforts should be made to strengthen farmer institutions and foster more equitable relationships between farmers and traders. This can be achieved through capacity building initiatives, promoting collective bargaining power, and establishing fair trade practices that ensure farmers receive a fair share of the profits.

5. CONCLUSION

This study investigated the market integration and causality between consumer prices in the shallot market and various locations. The analysis, which used monthly time-series price data from 2013 to 2018, focused on consumer prices from farmers in Probolinggo, Nganjuk, and Malang districts. We also collected consumer price data from Probolinggo Regency, Nganjuk Regency, Malang Regency, and Surabaya City. We employed the Granger causality test for data analysis. The results revealed significant findings at the producer level, indicating a negative causality between Nganjuk and Probolinggo producer prices. Specifically, an increase in Nganjuk producer prices led to a

decline in Probolinggo producer prices, and vice versa. Additionally, producer prices in Nganjuk and Probolinggo had an impact on prices in Malang Regency. The consumer market analysis revealed that Nganjuk and Probolinggo Regencies shaped the Surabaya City consumer market, while Nganjuk Regency, Probolinggo Regency, and Surabaya City influenced the consumer market in Malang Regency.

Furthermore, the study highlighted the causal relationships and directions between producer and consumer markets, emphasizing how producer markets in Nganjuk, Probolinggo, and Malang districts influenced consumer prices in Surabaya City. Regarding specific price dynamics, the study found that the Malang Regency producer market experienced a decrease of 0.009098 unit price due to an increase in producer prices in Nganjuk Regency and a decrease of 0.997227 unit price due to an increase in producer prices in Probolinggo Regency. Furthermore, an increase of one unit in consumer prices in Probolinggo Regency resulted in a 0.491616 unit increase in consumer prices in Malang Regency. Malang Regency's consumer prices influenced Surabaya City's consumer market, leading to a 0.157294 unit price increase. Additionally, an increase in consumer prices in Nganjuk Regency led to a decrease of 1.394620 units in consumer prices in Malang Regency. Finally, Nganjuk Regency, Probolinggo Regency, and Malang Regency's consumer markets had a negative influence on the Surabaya City consumer market, resulting in unit price decreases of 0.787233, 1.052054, and 1.036214, respectively.

This study's findings have important policy implications for the shallot market. The negative causal relationships between producer prices in Nganjuk and Probolinggo Regencies can inform policy interventions to address price declines in these regions. Policies aimed at improving productivity, reducing production costs, and enhancing market access can help stabilize producer prices and support the livelihoods of farmers in these areas. Furthermore, the influence of Nganjuk Regency, Probolinggo Regency, and Surabaya City on the consumer market in Malang Regency suggests the need for coordinated policies to ensure price stability and affordability for consumers. We can implement market monitoring mechanisms and price regulation initiatives to prevent excessive price fluctuations and safeguard consumers from price spikes. Moreover, the study highlights the interdependence between different market levels, emphasizing the importance of holistic policy approaches. Policies that promote market integration, enhance value chain linkages, and improve market information systems can facilitate efficient price transmission between producer and consumer markets. Additionally, the observed effects of consumer markets in Nganjuk Regency, Probolinggo Regency, and Malang Regency on the Surabaya City consumer market indicate the potential benefits of regional collaboration and cooperation. Policymakers can explore initiatives to strengthen market linkages and foster regional partnerships.

One of the limitations of this study is that it focuses solely on examining the causal relationships and market integration between producer and consumer prices in the shallot market. Other factors that could influence price dynamics, such as weather conditions, input costs, or market demand. This narrow focus may overlook important drivers of market price fluctuations. The study's limitations provide valuable insights for future research directions in the shallot market. Building on these limitations, future studies could investigate other factors that influence market price dynamics, including weather conditions, input costs, and market demand.

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