

Effects of Supply and Commodity Substitution on Chili Price Volatility at Kramat Jati Wholesale Market, Jakarta, Indonesia

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Abstract. Chili commodity production has been rising and falling over the years. In contrast, prices for chili experience extreme variability. A price fluctuation of more than 40% indicates that something is wrong with supply management. Chili price volatility poses significant challenges for food security and inflation control in Indonesia. This study investigates the factors influencing cayenne pepper prices using daily data from January 2023 to September 2024 at the Kramat Jati Wholesale Market. An Autoregressive Distributed Lag (ARDL) model was applied to estimate the dynamic relationship between prices and supplies of cayenne and curly red chili. The results indicate that previous prices, substitution effects with curly red chili, and supply shocks have a significant influence on cayenne pepper prices. These findings underscore the importance of real-time supply monitoring, market integration, and strategic distribution planning in mitigating price spikes. The study offers empirical evidence to support more responsive government interventions in stabilizing chili prices and reducing inflationary pressure in perishable food markets.

Keywords: cayenne pepper; chili substitution; food inflation; price dynamics; supply chain

INTRODUCTION

Horticultural products are among the most important in the agriculture of any nation due to their economic and food values ([Aryani et al., 2022](#); [Marisa et al., 2023](#)). They are also faster-growing crops, which enables farmers to engage in various farming activities like harvesting more than once in a year. This study is focused on pepper crops. According to the [Kementerian Pertanian \(2024\)](#), cayenne pepper production increased from 1.34 million tons in 2018 to 1.51 million tons in 2023, representing a 12.82% increase. Meanwhile, large chili production also increased from 1.21 million tons in 2018 to 1.55 million tons in 2023, representing a more significant 28.82% increase.

On the other hand, the prices of staple food commodities, especially horticultural commodities, often fluctuate greatly and contribute to inflation. Fresh chilies are an integral part of the Indonesian diet and are one of the 10 primary commodities whose prices are monitored by the government ([Webb & Kosasih, 2016](#)). Rising food price trends can impose tremendous challenges on poor people

who spend much of their income on food ([Green et al., 2013](#); [Tadesse & Braun, 2012](#)). [Nugrahapsari and Arsanti \(2019\)](#) in their research found that chili is a dominant commodity contributing to inflation in Indonesia. For chili, despite the rising demand trend, demand tends to be volatile. Some goods are extremely prone to sudden demand on tremendously significant dates on the calendar, like public or religious holidays. Moreover, as an agri-based commodity, there is a risk that the supply of this product may not meet market demand all year round due to its heavy dependence on weather and climatic conditions. This causes drastic price increases, leading to price instability.

Fluctuations in chili prices can impact all stakeholders in the agricultural industry. Farmers face risks and uncertainties in their income, while traders must deal with rapid price changes and adjust their marketing strategies accordingly. High volatility indicates a significant risk that producers must face. The high risk causes the response of producers to produce these commodities to decline ([Farida & Singagerda, 2021](#)). On the



consumer side, price fluctuations can affect purchasing power and accessibility to cayenne peppers as a daily food ingredient. Although chili production shows an increase, market conditions indicate that a surplus in production does not necessarily lead to stable prices. Price fluctuations in the market remain an issue. This phenomenon has significant implications for national economic stability, particularly since chili is a commodity that can contribute to inflation. Additionally, the stability of chili prices is also part of the national food security strategy, as chili is a staple in household consumption. One possible cause of this is poor supply management (Josine et al., 2018).

In contrast, data from [Badan Pangan Nasional \(2024a\)](#) indicate that in 2023, the average monthly production of cayenne peppers was 125.56 thousand tons, whereas the average monthly consumption was 80.94 thousand tons. The total balance of cayenne peppers for that year reached 532.64 thousand tons. Overall, the balance of cayenne pepper food supply showed a positive value throughout the year. The average monthly production of large chili (a combination of curly red chili and large red chili) in 2023 was 129.54 thousand tons, while the average monthly consumption was 81.57 thousand tons. The total balance of large chili for that year reached 575.72 thousand tons. Overall, the balance of the large chili food supply also showed a positive value throughout the year. The production exceeding the demand, but with high price fluctuations, indicates a problem in the chili supply.

Additionally, Kramat Jati Wholesale Market in Jakarta (PIKJ) is one of the biggest wholesale markets in Indonesia, especially for horticultural products. It serves as the main hub for dealing in all kinds of horticultural markets like vegetables, fruits, and flower plants. In 2023, the average daily supply of chili at PIKJ was 35.7 tons for cayenne peppers, 32.6 tons for curly red chili, and 12.7 tons for large red chili ([Badan Pangan Nasional, 2024b](#)). PIKJ acts as a buffer zone for surrounding areas, particularly the

Jabodetabek region. This is consistent with the results of a study by [Yuditya et al. \(2023\)](#), which showed that based on market integration analysis, the price of large red chili in PIKJ had a long-term relationship with the retail markets in the surrounding areas.

The price of chili at PIKJ in 2023 showed high fluctuations. The Coefficient of Variation (CV) for cayenne peppers was 45.32%, for curly red chili was 40.15%, and for large red chili was 41.11%. The high price fluctuations of chili have occurred for years. A study by Erwandi (2019) found a CV value for large red chili in DKI Jakarta from 2012 to 2018 of 37%. [Nugrahapsari \(2019\)](#) also stated in her research that chili is a dominant commodity contributing to inflation in Indonesia. The price of a commodity can serve as a leading indicator for inflation because commodity prices can quickly respond to shocks in the economy and those caused by trade barriers ([Nugrahapsari & Arsanti, 2019](#)). The significant price fluctuations of these commodities suggest underlying problems with the consistency of supply at the Kramat Jati Wholesale Market. This condition is further exacerbated by the fact that aggregate food price volatility is influenced by oil prices, global economic activity, and geopolitical risk under varying market conditions ([Zmami et al., 2023](#)).

The supply of cayenne peppers at PIKJ averaged 35.68 tons per day, with a total supply of 12,700 tons in 2023. For curly red chili, the average supply was 32.6 tons, with a total supply of 11.6 thousand tons. For large red chili, the average supply was 12.65 tons, with a total supply of 4.5 thousand tons. With chili prices fluctuating by more than 40%, it is suspected that the actual supply often does not meet consumer demand. Previous research analyzing the factors influencing chili prices has been widely conducted. Nevertheless, there has been limited research examining the influence of chili supply on chili prices using daily data with the Autoregressive Distributed Lag method. This study aims to investigate the factors that influence the price of cayenne peppers at the Kramat Jati Wholesale Market.

Theoretically, this study draws on the laws of supply and demand, as well as the theories of price transmission and market integration. In the law of supply and demand, the price of a commodity is largely determined by the availability of goods and consumer preferences, especially for perishable commodities such as chilies. In addition, the theory of commodity substitution explains that changes in the price of one type of good can affect the demand for other goods that are substitutes, as occurs between cayenne pepper and curly red chilies. Previous studies have extensively discussed chili price volatility using monthly data or a production proxy approach (Fajri et al., 2017; Nugrahapsari & Arsanti, 2019). However, there are still very few studies that use daily data and include supply variables measured directly at the wholesale market level.

This study has novelty in the Indonesian context because it uses more granular daily data and the ARDL model, which is rarely applied in chili price analysis in the wholesale market. The use of daily data enables more accurate detection of short-term fluctuations compared to previous studies, which typically employ monthly or annual data. It also integrates the substitution effects between commodities, between cayenne pepper and curly red pepper, which are rarely analyzed together.

METHODS

Data Sources and Description

The data used in this study are secondary data from the National Food Agency. The data collected in this study consist of daily price and supply data for cayenne peppers, curly red chili, and large red chili at the Kramat Jati wholesale. PIKJ was chosen because it is the largest wholesale market for horticultural commodities in DKI Jakarta and is the main distribution center for the Jabodetabek area. Therefore, data from this market can represent the dynamics of chili prices and supplies on a regional scale that is relevant to national food policy making. Data for each product consists of 628 observations. This study is a time

series study using daily data for 638 consecutive days from January 1, 2023, to September 30, 2024. Therefore, the data used includes the entire observation population in that time period, not a sample of the population. Thus, no sampling technique is needed because the data analyzed is a full-time population, which reflects the dynamics of chili prices and supplies in an actual and continuous manner. This approach is commonly used in time series studies. It should be noted that daily data are susceptible to bias due to non-market factors, such as government policy interventions, media news, natural disasters, or religious holidays, which can cause temporary but significant spikes in demand. The selection of explanatory variables is limited to curly red chili and large red chili because both are the most commonly consumed and traded types in the wholesale market. Moreover, the availability of consistent daily data is only available for these two types.

Research Tool

A regression analysis was performed using the Autoregressive Distributed Lag (ARDL) model to identify the factors influencing the price of cayenne peppers. The functional form of the ARDL model used in this study is shown in Equation (1). The regression parameters were estimated through the Ordinary Least Squares (OLS) method using EViews software. According to Fadhillah and Sukmana (2017), the ARDL model was chosen because of its flexibility in handling variables with different stationary levels ($I(0)$ or $I(1)$), without the need for all variables to be $I(1)$ as required in VECM. In addition, ARDL is more suitable for daily data-based studies that have a high probability of heteroscedasticity and high dynamicity. Previous studies using a similar approach include those conducted by Syafira (2022), who applied the ARDL model to daily agricultural commodity data. Referring to these studies, the methodological approach in this study is considered reliable and appropriate to answer the problem of horticultural commodity price volatility.

$$\ln H_{crmt} = \alpha_0 + \sum_{i=1}^p \alpha_i \ln H_{crmt-i} + \sum_{j=0}^q \beta_j \ln H_{cmkt-j} + \sum_{k=0}^r \gamma_k \ln H_{cmbt-k} + \sum_{l=0}^s \delta_l \ln P_{crmt-l} + \sum_{m=0}^t \theta_m \ln P_{cmkt-m} + \sum_{n=0}^u \lambda_j \ln P_{cmbt-n} + e_t \quad (1)$$

Description:

H_{crmt} : Price of cayenne peppers in rupiah per kilogram (Rp/kg)
 H_{cmkt} : Price of curly red chili in rupiah per kilogram (Rp/kg)
 H_{cmbt} : Price of large red chili in rupiah per kilogram (Rp/kg)
 P_{crmt} : Supply of cayenne peppers in tons
 P_{cmkt} : Supply of curly red chili in tons
 P_{cmbt} : Supply of large red chili in tons
 α_0 : Constant (intercept)
 α_i : Lag coefficient of the cayenne peppers price variable
 β_j : Lag coefficient of the curly red chili price variable
 γ_k : Lag coefficient of the large red chili price variable
 δ_l : Lag coefficient of the cayenne peppers supply variable
 θ_m : Lag coefficient of the curly red chili supply variable
 λ_j : Lag coefficient of the large red chili supply variable
 p : Number of lags for the cayenne peppers price variable
 q : Number of lags for the curly red chili price variable
 r : Number of lags for the large red chili price variable
 s : Number of lags for the cayenne peppers supply variable
 t : Number of lags for the curly red chili supply variable
 u : Number of lags for the large red chili supply variable
 e : residual

Stationarity Test

A key requirement for analyzing the Autoregressive Distributed Lag (ARDL) regression model is that the data variables must be stationary. In this study, the stationarity of the data was tested using the Augmented Dickey-Fuller (ADF) test, which helps determine whether the data is stationary or non-stationary. The stationarity can be seen from the probability value or p-value of the ADF test. If the value is less than 5%, the data is stationary at the level. If the probability value is above 5%, differencing must be applied until the probability value is below 5%.

Optimum Lag Test

The optimal lag is the number of lags (previous time periods) that best fit the ARDL model. In this study, the optimal lag for the ARDL model was determined using the Akaike Information Criterion (AIC).

Model Estimation

After the optimal lag value was obtained, the model parameter estimation was performed using the Ordinary Least Squares (OLS) method.

Cointegration Test

The Bound Test for Cointegration was conducted to determine whether the variables used in the study have a long-term equilibrium relationship. This method is performed by comparing the calculated F-statistic with the critical value. If the F-statistic value is less than the lower bound value, no cointegration occurs. If the F-statistic value is greater than the upper bound value, cointegration occurs, indicating a long-term relationship between the variables.

Stability Test

Model stability was tested to detect if estimated parameters remained consistent over time. The stability tests included the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests ([Syafira, 2022](#)).

RESULTS AND DISCUSSION

Stationarity Test Result

Regression analysis using the ARDL model is conducted to determine the effect of supply on chili prices. In this analysis, the first step is to perform a stationarity test. The

purpose of this test is to verify that the data used in the model are stationary, meaning they exhibit a consistent mean and variance over time. This is crucial because if the data is not stationary, the results of the model's estimation may be unreliable. To test for stationarity, the Augmented Dickey-Fuller

(ADF) test is used. In this study, the stationarity test was applied to the data for the prices of cayenne pepper, curly red chili, large red chili, and the supply of these chili varieties. The ADF stationarity test results for each variable are presented in [Table 1](#).

Table 1. Stationarity test result

No	Variable	Level		First Difference	
		Probability	Description	Probabilitas	Description
1	Price of cayenne peppers	0.1267	Not Stationary	0.0000	Stationary
2	Price of curly red chili	0.1023	Not Stationary	0.0000	Stationary
3	Price of a large red chili	0.3476	Not Stationary	0.0000	Stationary
4	Supply of cayenne peppers	0.0000	Stationary		
5	Supply of curly red chili	0.0000	Stationary		
6	Supply of large red chili	0.0138	Stationary		

[Table 1](#) showed that for the price of cayenne peppers at the level, the t-statistic value was -2.4571 with a probability of 0.1267 (greater than α 0.05). This indicated that the variable was not stationary at the level. After first differencing, the t-statistic value became -1.9623 with a probability of 0.0000, which was less than 0.05. Therefore, this variable became stationary after the first differencing. For the price of curly red chili at the level, the t-statistic value was -2.5589 with a probability of 0.1023 (greater than α 0.05). This also meant that the variable was not stationary at the level. After first differencing, the t-statistic value was -2.1829 with a probability of 0.0000, indicating that this variable became stationary. For the price of a large red chili at that level, the t-statistic value

was -1.8680 with a probability of 0.3476 (greater than α 0.05). This variable was also not stationary at the level. After first differencing, the t-statistic value was -2.2893 with a probability of 0.0000, making this variable stationary. All price variables for chili became stationary at the first difference level. In addition, all supply variables for chili showed stationarity at the level. The t-statistic values and probabilities for the supply of cayenne peppers, supply of curly red chili, and supply of large red chili were -5.4257 with a probability of 0.0000; -7.3493 with a probability of 0.0000; and -3.3360 with a probability of 0.0138, respectively.

Optimum Lag Test Result

Lag length selection was determined by the smallest AIC value, as shown in [Figure 1](#).

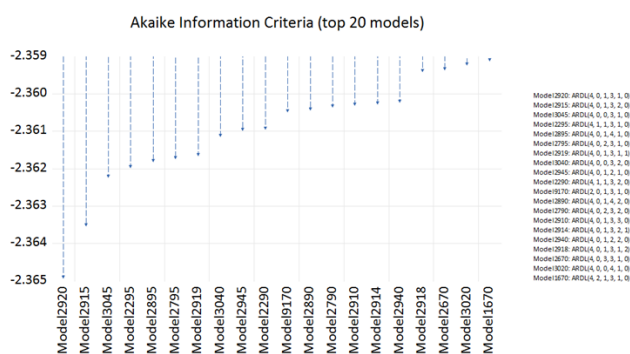


Figure 1. Optimum lag test result

Based on [Figure 1](#), 20 top models were obtained. The selected model was the ARDL

(4, 0, 1, 3, 1, 0) model, based on the minimum AIC value. This meant that the optimal lags

for the variables: price of cayenne peppers, price of curly red chili, price of large red chili, supply of cayenne peppers, supply of curly red chili, and supply of large red chili were 4, 0, 1, 3, and 1, respectively.

Estimation of the ARDL Parameters

Parameter estimation was performed to determine the extent to which the independent variables influence the dependent variable. The probability values determined parameter significance. If the probability value was smaller than α 5%, the parameter was considered significant.

Table 2. Estimation of the ARDL Parameters

No	Variable	Parameter	Std. Error	T-Statistic	Prob.	Description
1	D(price_cayenne peppers (-1))	-0.0050	0.0729	-0.0691	0.9450	Not Significant
2	D(price_cayenne peppers(-2))	-0.0976	0.0335	-2.9152	0.0037	Significant
3	D(price_cayenne peppers(-3))	-0.0201	0.0388	-0.5169	0.6054	Not Significant
4	D(price_cayenne peppers(-4))	-0.0867	0.0345	-2.5173	0.0121	Significant
5	D(price_curly red chili)	0.3533	0.0548	6.4468	0.0000	Significant
6	D(price_ large red chili)	0.1048	0.1096	0.9560	0.3395	Not Significant
7	D(price_ large red chili(-1))	-0.0688	0.0564	-1.2187	0.2234	Not Significant
8	supply_cayenne peppers	-0.2333	0.0389	-6.0059	0.0000	Significant
9	supply_cayenne peppers(-1)	0.0846	0.0396	2.1396	0.0328	Significant
10	supply_cayenne peppers(-2)	0.0820	0.0299	2.7428	0.0063	Significant
11	supply_cayenne peppers(-3)	0.0526	0.0274	1.9168	0.0557	Not Significant
12	supply_curly red chili	0.1068	0.0398	2.6844	0.0075	Significant
13	supply_curly red chili (-1)	-0.0781	0.0387	-2.0166	0.0442	Significant
14	supply_ large red chili	0.0016	0.0052	0.3104	0.7564	Not Significant

In [Table 2](#), it was found that eight variables significantly influenced the price of cayenne peppers: the price of cayenne peppers two days earlier, the price of cayenne peppers four days earlier, the price of curly red chili, the supply of cayenne peppers, the supply of cayenne peppers one day earlier, the supply of cayenne peppers two days earlier, the supply of curly red chili, and the supply of curly red chili one day earlier. Meanwhile, six variables were found to have no significant effect on the price of cayenne peppers: the price of cayenne peppers one day earlier, the price of cayenne peppers three days earlier, the price of large red chili, the price of large red chili one day earlier, the supply of cayenne peppers three

days earlier, and the supply of large red chili ([Table 2](#)).

In addition to considering the probability value (p-value) when assessing statistical significance, it is also essential to examine the practical importance of each variable. For example, the coefficient of the curly red chili price variable, 0.353, is statistically very significant ($p < 0.01$), and is also practically meaningful because it reflects a strong substitution relationship. If the price of curly red chili increases by 10%, then the price of cayenne pepper theoretically increases by 3.53%, or around Rp 1,200– Rp 1,500/kg if the initial price is Rp 35,000/kg. A price increase of that magnitude is quite influential on consumer purchasing power and

purchasing decisions, especially in the context of low-income households.

On the other hand, other variables are statistically significant but have a smaller practical impact, such as the supply of cayenne pepper two days earlier, with a coefficient of 0.082. Although significant, a 10% increase in supply only results in a 0.82% price increase. In the context of market policy or government intervention, this effect may be too small to be used as a basis for large-scale logistics decisions or subsidy allocations. The same applies to the supply of curly red chili peppers, which is one day earlier, with a coefficient of -0.078.

Therefore, the analysis does not only stop at "whether a variable is statistically significant", but must also consider the magnitude of the impact in its real and economic context. By assessing the coefficient value, price sensitivity, and market distribution context, the results of this study can be used more wisely in formulating price

stabilization strategies. This approach can also prevent the error of making decisions based on numbers that statistically "look important" but have little practical impact.

Bound Test Result

The cointegration test (bound test) was conducted to determine whether a long-term relationship existed between the independent variables and the dependent variable.

The results of the cointegration test in [Table 3](#) showed that the F-statistic value was 45.56, which was much greater than I(1) (upper bound) at various α levels. Therefore, it could be concluded that cointegration occurred. After cointegration was identified, the next step was to calculate the error correction term (ECT). In this study, the ECT indicated the speed at which the system corrected the price of cayenne peppers back to equilibrium, measured in percentage terms per day, after a shock to the system.

Table 3. Bound test result

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	45.55632	10%	2.08	3
k	5	5%	2.39	3.38
		2,5%	2.7	3.73
		1%	3.06	4.15

Table 4. Estimation of ECT

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-1.209389	0.067390	-17.94609	0.0000

The estimation results for the ECT showed a value of -1.21 with a probability value of 0.0000, meaning that the speed at which the system corrected the price of cayenne peppers back to equilibrium was 121% per day ([Table 4](#)).

Model Stability Test

The stability test was conducted to assess model stability, including the

CUSUM test and the CUSUMSQ test. Based on [Figure 2](#) and [Figure 3](#), it was observed that the CUSUM and CUSUMSQ lines were within the 5% critical bounds, indicating that the model exhibited parameter stability. This meant that if the study were repeated with a different period, the estimated parameters would remain relatively unchanged.

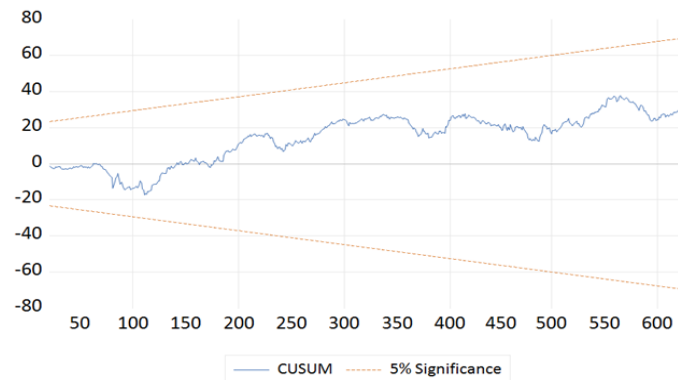


Figure 2. CUSUM Test Result

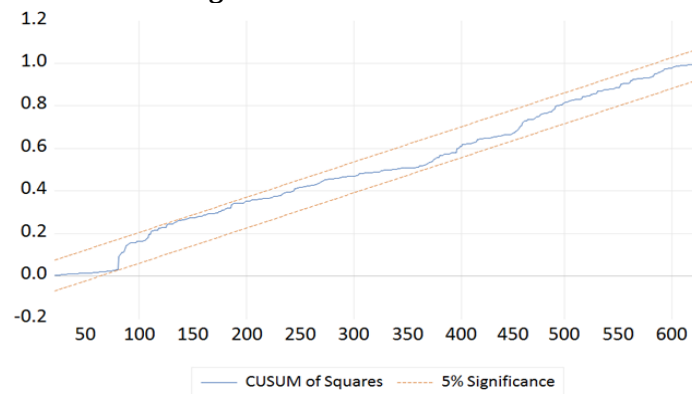


Figure 3. CUSUMSQ test result

Cayenne Pepper Price Plot

Based on [Figure 4](#), the daily cayenne pepper price fluctuations (in units of Rp/kg) during the observation period. It can be seen that the price of cayenne pepper experienced several sharp spikes followed by significant declines. The highest price peak occurred

around the 325th day, with a price approaching Rp90,000/kg. After that, the pattern of price fluctuations continued with a reasonably consistent frequency, reflecting the high volatility of cayenne pepper prices during the period. Seasonal factors, market supply, and demand likely influence this price variability.

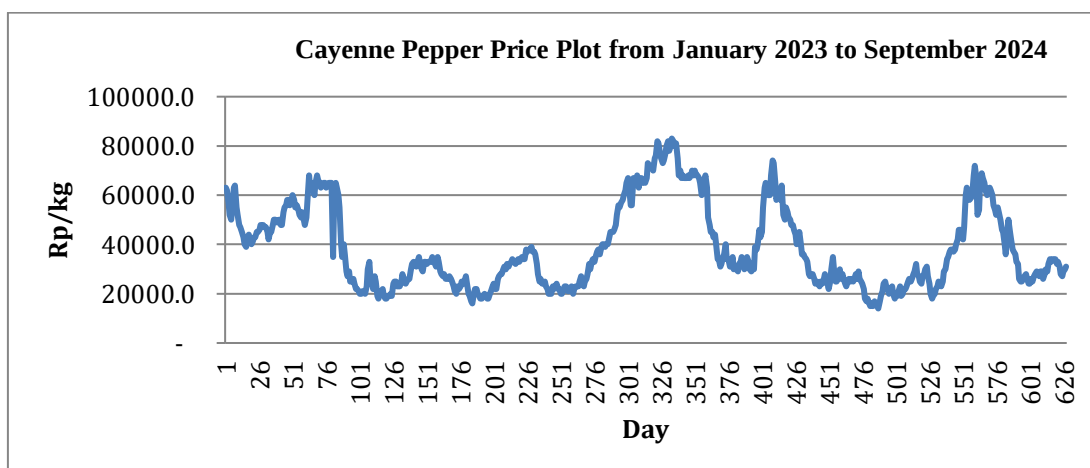


Figure 4. Cayenne pepper price plot

The Effect of the Previous Day's Price of Cayenne Peppers

The parameter value for the price of cayenne peppers two days earlier was -0.098. Its negative value indicated an inverse relationship between the current price of cayenne peppers and the price two days earlier. In other words, if the price of cayenne peppers increased by 1% two days earlier (*ceteris paribus*), the current price of cayenne peppers would decrease by 0.098%. The parameter value for the price of cayenne peppers four days earlier was -0.087. Its negative value indicated an inverse relationship between the current price of cayenne peppers and the price four days earlier. In other words, if the price of cayenne peppers increased by 1% four days earlier (*ceteris paribus*), the current price of cayenne peppers would decrease by 0.087%. This could be explained by the fact that an increase in the price of cayenne peppers would encourage suppliers to increase their supply to the Kramat Jati Wholesale Market, which would ultimately push the price of cayenne peppers down. This finding contrasts with the research by [Himawan and Puryantoro \(2019\)](#), which found that a rise in the previous day's price of chili led to an increase in the current day's price. This may have occurred because there was a delay in market information, so farmers/traders had not yet responded by increasing the supply, or it could have been due to limited production capacity, meaning the supply did not increase and still triggered a price rise. This finding emphasizes the importance of market information for farmers and traders to respond quickly to price changes. Market transparency helps consumers maintain purchasing power ([Farizi & Khoirotunnisa, 2025](#)).

The Effect of the Price of Curly Red Chili

The parameter value for the price of curly red chili was 0.353. Its positive value indicated a direct relationship between the current price of curly red chili and the current price of cayenne peppers. In other words, if the price of curly red chili increased by 1% (*ceteris paribus*), the current price of cayenne

peppers would increase by 0.353%. In other words, the coefficient value of 0.353 indicates that a 1% increase in the price of curly red chili will result in a price increase of approximately Rp1,200/kg for cayenne pepper, assuming the initial price is Rp35,000/kg. This reflects the high market sensitivity to substitution between types of chili and can serve as an early warning indicator for market players and the government. This also aligns with the law of supply and demand, showing that cayenne peppers and curly red chili are substitute goods. When the price of curly red chili increases, consumers are likely to switch to cayenne peppers as a substitute, thereby increasing demand for cayenne peppers and ultimately driving up their price. A similar finding was reported in previous studies, which identified significant positive parameter values, indicating that the relationship between red chili and curly red chili is one of substitutes (Sativa, 2017). This finding suggests that, in efforts to stabilize prices, the government needs to monitor both chili prices simultaneously. Given this substitutive relationship, price changes or interventions in one type of chili will also affect the price of the other type ([Wardhana et al., 2022](#)).

The Effect of the Supply of Cayenne Peppers

The parameter value for cayenne pepper supply was -0.233. Its negative value indicated an inverse relationship between the supply of cayenne peppers and the current price of cayenne peppers. In other words, if the supply of cayenne peppers increased by 1% (*ceteris paribus*), the current price of cayenne peppers would decrease by 0.233%. This is in line with the law of supply and demand, where an increase in the supply of cayenne peppers would trigger a decrease in the price of cayenne peppers. Previous research by [Fajri et al. \(2017\)](#) also yielded similar results, showing that supply (using a production proxy) had a significant and negative impact on the price of chili. The parameter value for cayenne pepper supplied a day earlier was 0.085. Its positive value

indicated a direct relationship between the supply of cayenne peppers one day earlier and the current price of cayenne peppers. In other words, if the supply of cayenne peppers one day earlier increased by 1% (*ceteris paribus*), the current price of cayenne peppers would increase by 0.085%. The parameter value for cayenne pepper supplied two days earlier was 0.082. Its positive value indicated a direct relationship between the supply of cayenne peppers two days earlier and the current price of cayenne peppers. In other words, if the supply of cayenne peppers two days earlier increased by 1% (*ceteris paribus*), the current price of cayenne peppers would increase by 0.082%. This also aligns with the law of supply and demand, where an initial increase in the supply of cayenne peppers would push the price of cayenne peppers down. This price drop would then encourage increased demand, which would eventually lead to a rise in the price of cayenne peppers again. Supply variables have a direct effect on prices, as they represent the quantity of goods available in the market. In contrast, production variables do not necessarily reflect the availability of goods in the market. Several previous studies using production as a proxy for supply have often found the parameter value for production variables to be insignificant. For example, the survey by [Kolibu et al. \(2024\)](#) found that the amount of red chili production did not affect the price of red chili. This finding is consistent with previous research, which states that an imbalance between supply and demand often causes price fluctuations in the market. The concentration of chili production in specific regions and the lack of regulation of supply volumes in response to consumer demand are major factors contributing to price fluctuations ([Naully, 2017](#)). Apart from cayenne pepper, the supply of curly chili also has a significant influence on the price of cayenne pepper, but through a different mechanism: the substitution effect.

The Effect of Supply of Curly Red Chili

The parameter value for the supply of curly red chili was -0.107. Its negative value

indicated an inverse relationship between the supply of curly red chili and the current price of cayenne peppers. In other words, if the supply of curly red chili increased by 1% (*ceteris paribus*), the current price of cayenne peppers would decrease by 0.107%. This can be explained by the fact that an increase in the supply of curly red chili is due to a rise in its price. When the price of curly red chili increases, consumers are likely to switch to cayenne peppers as a substitute, thereby increasing demand for cayenne peppers and ultimately driving up their price. Finally, the parameter value for the supply of curly red chili one day earlier was -0.078. Its negative value indicated an inverse relationship between the supply of curly red chili one day earlier and the current price of cayenne peppers. In other words, if the supply of curly red chili one day earlier increased by 1% (*ceteris paribus*), the current price of cayenne peppers would decrease by 0.078%. This can be explained by the fact that an increase in the supply of curly red chili one day earlier could lead to a decrease in the price of cayenne peppers. Because curly red chili became cheaper, the demand for curly red chili would rise, and the demand for cayenne peppers would fall, causing the price of cayenne peppers to decrease. This finding suggests that when planning the supply of cayenne peppers, the supply of curly red chili should also be considered, as it has a significant impact on the price of cayenne peppers. Research specifically using the price of cayenne peppers as the dependent variable and the supply of curly red chili as the independent variable has not been widely found in journals or academic publications. This finding related to the relationship between the supply of curly red chili and the price of cayenne peppers is expected to provide additional insights into understanding the dynamics of the chili market.

By utilizing the calculation results in this study, intervention can be carried out earlier to prevent prices from soaring too high. One strategy to stabilize chili prices is to distribute supplies from surplus areas to areas of deficit.

In this study, the area of concern is the Kramat Jati Main Market. The condition of chili prices above the Government Reference Price (HAP) indicates an imbalance, where chilies are abundantly available in production center areas but have not been optimally distributed to main markets, such as PIKJ. This finding aligns with the results of research by Kustiari et al. (2018), which demonstrate that the distribution of red chilies from areas experiencing surplus production to deficit areas can help mitigate price fluctuations. Indonesian red chili production centers remain more concentrated in Java and Sumatra, whereas red chili consumption areas are spread throughout Indonesia. Therefore, the distribution of red chilies to consumption centers will affect prices at the consumer level.

Logistics costs, including distribution expenses (such as shipping and loading/unloading costs), are significant components that determine the price of chili. Therefore, providing distribution cost subsidies can be an effective policy instrument to reduce distribution costs, so that chili prices in the market remain within the Government Reference Price (HAP) range. This subsidy can be given to chili farming business actors such as farmers, farmer groups, farmer group associations, cooperatives, or large traders who can distribute chili to PIKJ during the price spike period. The government-run subsidy scheme is in the form of distribution cost reimbursement. With this subsidy, it will encourage an increase in the volume of chili supply from production center areas to PIKJ as an effort to stabilize prices. This finding aligns with Supriadi's research (2018), which identified high distribution costs as the primary obstacle to the inter-island chili trade. Providing transportation subsidies and improving road infrastructure are solutions to reduce distribution costs and stabilize chili prices in various regions.

In the condition of falling chili prices at the Kramat Jati Main Market, the Government in this case, Bapanas, and the Ministry of

Agriculture must coordinate with PIKJ managers and traders to reduce the daily supply of chili to the Kramat Jati Main Market. This step aims to reduce the excess supply, which causes price declines. Incoming supply is calculated based on the ARDL analysis formula. Research producing supply simulations to control prices has not been widely carried out. This research aims to address this gap. This aligns with research conducted by [Reza \(2015\)](#), which emphasizes the importance of the Government's role in intervening in the market to prevent extreme price fluctuations. Stability of supply and demand is key in efforts to maintain stable food prices. An imbalance between supply and demand can cause price volatility that is detrimental to all parties in the supply chain. By regulating the right supply volume, the Government can minimize price fluctuations, promote farmer welfare, and increase price affordability for consumers.

Furthermore, one policy that can theoretically be implemented is to divert supply to alternative markets in other regions. However, in practice, this option is often ineffective because price falls usually do not only occur at one market point, but are regional. Price declines at PIKJ tend to be followed by price declines in secondary markets, such as Pasar Senen, Pasar Minggu, and other retail markets ([Yuditya et al., 2023](#)). This shows that the chili market system is interconnected and very responsive to changes at the wholesale market level.

This condition is exacerbated by limited storage facilities and a lack of diversification of distribution channels, such as to the processing industry or export markets. Therefore, the strategy of channeling supplies to other markets when prices at PIKJ fall is not suitable as the main solution. Therefore, direct intervention in the main market through government absorption of supplies and control of the flow of supplies from production centers is a more realistic approach to slowing the rate of price declines and stabilizing the market. Previous research has shown that post-harvest processing, such as storage using

modified atmosphere techniques or cold storage, can significantly extend the shelf life of chili ([Siswanto et al., 2024](#)).

The government is expected to make direct purchases of chilies from the market when prices fall. The purchased chilies can then be distributed to food aid programs or stored through cold storage technology. Using cold storage can store chilies for a longer period of time. This storage serves to hold excess supply so that it does not immediately flood the market.

As a contribution, this study is unique in several aspects. First, this study uses daily data that allows for more precise identification of short-term impacts of prices and supply, unlike most previous studies that use monthly or annual data. With higher time resolution, this study can capture price responses within days, including the lag effects of prices and supply that are rarely studied in detail. Second, this study also integrates the substitution relationship between cayenne pepper and curly red pepper commodities simultaneously in one model. Most previous studies have analyzed chili commodities separately, without examining the cross-interactions between types of chili that have a significant impact on price volatility. Third, the use of the ARDL model enables the simultaneous estimation of short-term and long-term relationships, which is crucial for designing effective market intervention strategies. This is different from previous studies, such as those by [Himawan and Puryantoro \(2019\)](#), which only discussed the effects of prices on the previous day without considering cross-commodity dynamics comprehensively.

The findings of this study also strengthen the theory of substitution of goods and the law of supply and demand. When the price of curly red chilies increases, consumers tend to switch to cayenne peppers, causing an increase in demand and pushing up prices. Conversely, when the supply of chilies increases drastically, prices decrease as predicted by the classical theory of perfect competition. These relationships strengthen

global findings on food price volatility, as explained by [Pan and Zheng \(2023\)](#), which suggest that perishable commodities in developing countries tend to exhibit rapid transmission of volatility between markets. This also aligns with [Ibrahim \(2015\)](#), who noted that high food prices will persist even if the oil price has corrected downward after the initial increase, reflecting asymmetric price adjustments that may similarly occur in chili markets.

This study uses the ARDL model, which is flexible enough to handle daily data and differences in integration orders between variables. However, there are several limitations that need to be considered. First, this model has not explicitly accounted for seasonal factors, such as religious holidays (e.g., Eid al-Fitr or Christmas), which are known to significantly impact chili demand. Planting and harvest seasons also have the potential to create seasonal patterns. Second, the model does not account for exogenous shocks, such as government policies, extreme weather events, changes in logistics costs, or distribution disruptions. In fact, these factors have the potential to suddenly and significantly affect prices.

Therefore, the results of this study must be interpreted in light of this dynamic context. Further research can develop models that integrate exogenous variables and seasonal dummies to improve accuracy and policy relevance. Additional research is suggested to create dynamic forecasting models, for example, based on the LSTM method, integrating weather data, holidays, and market sentiment from social media to obtain more accurate and realistic price predictions.

CONCLUSION

This study uses the ARDL model on daily data to analyze the volatility of cayenne pepper prices at the Kramat Jati Central Market. The estimation results show that previous prices significantly influence the current price of cayenne pepper, the substitution effect of the price of curly red chili, and the supply of cayenne pepper and

curly red chili. This finding confirms that price dynamics are not only influenced by internal commodity factors but also by interactions between similar commodities. The main contribution of this study is the use of daily data and the integration of substitution effects between types of chili in one ARDL model, which is rarely done in similar studies. With this approach, price stabilization policies can be designed to be more responsive to short-term and long-term market dynamics. This can be one strategy to reduce the level of fluctuation, although its impact depends on many external factors and cannot be considered an absolute causal relationship.

The practical implications of this study are the importance of a real-time supply monitoring system and price coordination between types of chili to formulate more effective market interventions. In addition, these findings support the distribution of surplus areas to primary markets as a means to mitigate price fluctuations. However, this study has limitations because it does not account for seasonal factors, such as holidays, or exogenous variables, including extreme weather and policy interventions. Therefore, further research is recommended to incorporate these variables and develop dynamic prediction models, such as LSTM, that integrate weather data, holiday calendars, and market sentiment. This research is expected to serve as the basis for developing price stabilization strategies based on daily data and analytics, and encourage the government and market players to establish an early response system to fluctuations in horticultural commodity prices.

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