Analysis of the Relationship between the Production and the Price through Development Pattern of Ginger Production in Simalungun Regency, North Sumatra

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Abstract

The harvested area of ginger plants in Simalungun Regency, North Sumatra Province has increased significantly from 2019 to 2020. Of course, this will affect the demand for and fluctuations in the price of ginger. The purpose of this study is to analyze how to forecast ginger production in 2022-2023 and to analyze the causality between ginger production and ginger prices. This research was conducted in Simalungun Regency which is a ginger production centre in North Sumatra Province. The population in this study is production data and monthly ginger prices from 2019-2021, namely 36 months. The analytical method used is a scaled series analysis method or ARIMA (Autoregressive Integrated Moving Average) using Eviews 12. The results of the study show that the best ARIMA model used for forecasting ginger production in Simalungun Regency, North Sumatra is model (1,1,0). Ginger production in Simalungun Regency has a positive trend, namely increasing with the highest forecasting results occurring in December 2023. The results of the Granger Causality Test show that the price variable significantly affects production. There is no reciprocal relationship between the production variable and the price variable; there is only a one-way relationship between price and production.

Keywords: Ginger, ARIMA, development pattern, production, price analysis.

Introduction:

At the end of 2019 and early 2020, the world was taken aback by a new virus that could outbreak massively, which first originated in China, to be precise, Wuhan. This virus is a type 2 coronavirus (SARS-CoV-2) which can rapidly spread throughout the world. Various things have been done in terms of combating the dangers of this virus such as implementing health protocols socialized by the government such as wearing masks, washing hands, maintaining distance and of course avoiding crowds. But that on its own is not enough, it is necessary to increase the

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body's immunity by consuming healthy food and consuming spices or herbs that can clinically increase the body's immunity. Herbal plants are used such as ginger, turmeric, *kencur* (aromatic ginger), lemongrass, galangal and others. One type of spice, namely horticultural plants, which is used as an ingredient to increase body immunity, is processed from ginger. Ginger in this case is one of the types of plants that have been used as herbal medicine for generations.

Ginger (*zingiber officinale*) is one of the most widely consumed spices by the public because it has a distinctive aroma so ginger can also be used as a flavoring agent. Ginger has a volatile content of about 2% which can be efficacious for treating various diseases such as colds, headaches, rheumatism, and cancer, antimicrobials and can increase the body's immunity because it contains *shogaol* and gingerol. The most common of the group is *shogaol*. *Shogaols* are pungent constituents of ginger similar in chemical structure to gingerol. Like zingerone, it is produced when ginger is dried or cooked. Zingerone, also called vanillylacetone, is a major flavor component of ginger, providing the sweet flavor of cooked ginger. (Aryanta, 2019)

Ginger is a biopharma plant of the rhizome group. Ginger is one of the ingredients used as a spice and raw material for treatment. Ginger is a herbal plant, it can be seen that processed ginger can be made for drinks as a warmer, this can be felt because ginger has a spicy taste caused by a ketone compound called zingerone. Ginger has a variety of substances that are good for the body such as preventing cancer, overcoming respiratory problems, improving digestion, and treating bruises and pain. The many benefits of ginger make people, especially farmers, plant a lot of ginger for cultivation.

Currently, from BPS data, the region with the highest ginger production is East Java Province, followed by West Java and Central Java Provinces. North Sumatra Province is the province with the third largest production outside Java Island after Bengkulu and South Sulawesi. On the island of Sumatra, North Sumatra has the highest ginger production after Bengkulu Province, namely with a total production of 7,194,287 kg in 2020 (BPS Provinsi Sumatera Utara, 2022).

Judging from the data above, ginger production on Sumatra Island is concentrated in Bengkulu Province at 13,874,568 (Kg) and in North Sumatra at 7,194,297 (Kg). Ginger production is centered on the island of Sumatra, specially developed in North Sumatra and Bengkulu. Ginger production needs to be considered for the needs of the community, as we know the various benefits of ginger for health. The total ginger production in North Sumatra is 7,194,297 kg in 2020 which is the second largest amount of ginger production on the island of Sumatra after Bengkulu. The amount of ginger production cannot be separated from the ginger planting area.

Harvested area for Cities/Regencies in North Sumatra in 2019 and 2020:

In this case, the harvested area of ginger plants has increased significantly from 2019 to 2020. In North Sumatra Province, Simalungun Regency is a district with a very large harvest area. Area compared to other districts in North Sumatra. In the Simalungun district in 2019 the harvested area (m2) is 349,602 then in 2020 the harvested area (m2) is 1,672,931. There was an increase in the harvested area in Simalungun Regency, namely 1,323,329 m2. This increase in harvested area is the impact of the high community need for ginger, in which case the community understands the need to maintain the body's immunity during the ongoing pandemic. Ginger is a herbal plant that has a good function in increasing immune data.

In North Sumatra Province, especially in Simalungun Regency, there was an increase of 1,504,599 kg from 2019 to 2020. Where ginger production in Simalungun Regency in 2019 was 349,602, and in 2020 it was 1,854,201 kg. However, the problem is that ginger production in Simalungun Regency has increased significantly. Since the Covid-19 pandemic was declared to have entered Indonesia in March 2020, the increase in consumption of ginger in society has increased. Of course, this will affect demand and price fluctuations. If it is assumed that household consumption of ginger is a demand, this will have a major effect on the price of the ginger itself. Thus, where the production and consumption needs of ginger are, it is necessary to make efforts to predict the right products in the future to balance the pattern of demand for ginger consumption, especially during a pandemic. The development of the production of an agricultural commodity must be in line with the development of the price of the commodity in question. This is because the high or low income of farmers is determined by the number of products sold and the commodity price of ginger received at harvest time. There is a problem that the price of ginger suddenly soared; it will affect the number of farmers for the production of ginger. So it is necessary to predict future production to balance the production and consumption of ginger. The phenomenon due to the spread of Covid-19 has increased the demand for ginger consumption patterns; this can be seen from the significant increase in the price of ginger in society because ginger is believed to be able to maintain the immunity of the human body. With the high commodity price of ginger, the government needs to anticipate the production of ginger plant. Therefore the forecasting of ginger production and the relationship that occurs between the price and production of ginger is very interesting to study.

Research Methods:

This research was conducted in Simalungun Regency which is a ginger production centre in North Sumatra Province. The research method used is the analysis of production and price time series data. Periodic data (time series) is data that is arranged based on time sequence or data collected from time to time. The population in this study is all monthly ginger production and price data from 2019-2021, namely monthly data for 2019-2021 with a total of 36 months.

The ARIMA (Autoregressive Integrated Moving Average) method is a scaled series analysis method known as BoxJenkins. This method comes from a combination of Autoregression (AR) and Moving Average (MA) models developed by George Box and Gwilym Jenkins. To test the ability to describe the pattern of development of production and sales, the calculation of season index variables is carried out on time series data. This method does not build a single equation model or simultaneous equation but analyzes the probability or stochastic (random) properties of a time series data itself. The BJ model is a time series model where Yt is explained (regressed) by past values or lagged, from the value of Y itself and the Stochastic error term (residual). The ARIMA model is often called a-theoretical model (a model without theory) because this model is not derived from economic theory.

Time series data generally has a random nature or a stochastic process, namely a set of random variables arranged in time. In this study, the time series used is the monthly production of ginger from 2019 -2021. Then Y=Y1, Y2, Y3, …………., Y36

Description:

Y = ginger production

1 = first-month ginger production

Before forecasting the ARIMA method, production data must first go through a stochastic process. The type of stochastic process that is currently getting attention is the stationary stochastic process. To test the stationarity of the data, it is using the root test (unit root test). Data is said to be stationary if the value of Augmented Dickey-Fuller (ADF) t statistic > critical and significant value with a probability value of 0.0000.

$Yt = pYt\text{-}1 + ut$
Description:
Yt= production period t
P = ρth order parameter
u = error terms

If the results of the root test are not stationary, then the data needs to be transformed into stationary by differencing, namely reducing Yt with Yt-1 for the first difference, so that it can be written using the first difference formula, namely:

$\Delta Yt = \delta Yt\text{-}1 + ut$
Description:
ΔYt= first difference of the variables used.

Then identifying the model used for forecasting, identification is carried out to find the best model used for forecasting by looking at the smallest value of the Akaike info criterion and Schwarz criterion between models. Data processing uses Eviews 12 software. The first model is the autoregressive model (AR) which is an autoregressive model based on the assumption that data in the current period is influenced by data from the previous period. The general form of the autoregressive mathematical model with the order p (AR) is formulated in the following formula:

$(Yt - \delta) = \alpha 1(Yt\text{-}1 - \delta) + ut$
Description:
Yt = production period t
α1 = 1st order autoregressive parameter
ut = error terms

The Moving Average (MA) model, which is a general form of the Moving Average model, is a model that can also produce Y. The Moving Average can be formulated as follows:

$Yt = \mu + \beta 0\ u_t + \beta 1\ ut\text{-}1$
Description:
Yt = Production period t
M = Constant
β0 = Moving Average Parameters
Ut = term error

To see the AR or MA model, we can see it by using the Autocorrelation function (ACF) and Partial Autocorrelation Function (PACF).

The second problem formulation is analyzed using the Granger Causality test. This test was conducted to determine the reciprocal relationship between the ginger production variable and the price variable. This study used the Granger Causality Test. The production variable causes the price variable, meaning how much production value in the current period is explained by the previous period's price value and the production value in the previous period. Granger causality only tests the relationship between variables and does not estimate the model, the test can be formulated with the following equation:

Production = $\sum_{i=0}^{N} {}_1 \alpha_i P_{t-i} + \sum_{j=0}^{N} = \beta j \text{ Prod}_{t-j} + U_1 t$
Price = $\sum_{i=1}^{n} \lambda 1 \text{ P}_{t-1} + \sum_{j=1}^{n} {}_1\delta_j \text{ Prod}_{t-j} + U_{2t}$

It is assumed that unit error and u2t are not correlated. The production equation states that this year's production is related to past production and also related to prices. Likewise, the price equation states that prices are related to past prices and production. Based on these two equations, four possibilities can be seen:

i. There is a unidirectional causality relationship from price to production, if the estimated price lagged coefficient in equation (5) is statistically significant as a group ($\sum \alpha i \neq 0$) and the estimated production lagged coefficient in equation (6) is not significant ($\sum \delta j = 0$).
ii. There is an indirect causality relationship from production to price if the price lagged coefficient in equation (5) is not significant ($\sum \alpha i = 0$) and the production lagged coefficient in equation (6) is significant ($\sum \delta j \neq 0$).
iii. Feedback or bilateral causality, if the price and production coefficients are statistically significant in the two equations above.
iv. There is no causality relationship, if the price and production coefficients are not significant in the two equations above.

Production Forecasting:

1. Identification of Model Structure:

Identification of the temporary model is done by comparing the distribution of autocorrelation coefficients and partial autocorrelation coefficients. If the data is not stationary, it is first stationary using the differencing method. Stationarity occurs in data if there is no increase or decrease in the data. The frequency of the data is around a constant average value, not depending on time. Graphically, the non-stationary autocorrelation of data shows a trend in a diagonal direction from right to left along with an increasing amount of time lag. The number of differencing done to reach stationary is denoted as d. Before doing the analysis, we must know in advance whether the time series data we are using is stationary by using the Eviews software version 12 as shown in Figure 1 below:

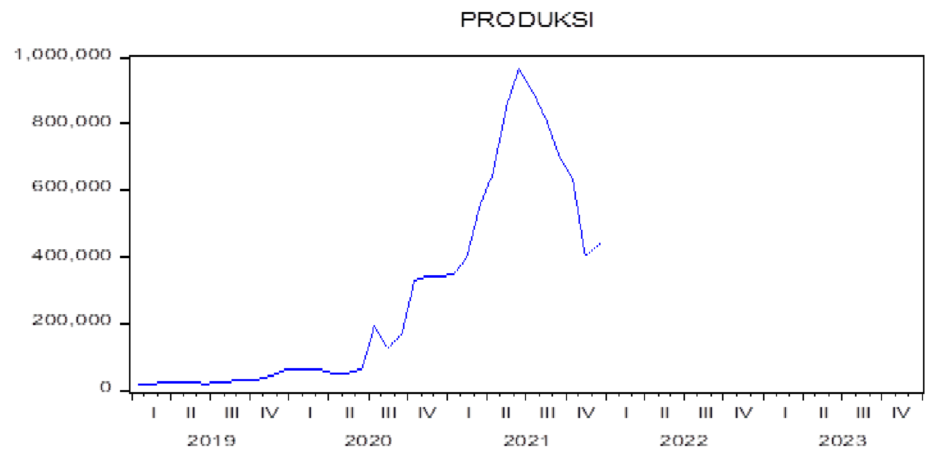


Figure 1. Historical Data Graph

In the picture above you can see the appearance of the development of ginger production in Simalungun Regency. In February 2020, it was first discovered that there were patients infected with the Corona Virus in Indonesia, consumption of ginger increased because ginger is believed to boost the body's immunity and prevent the virus. This had an impact on increasing ginger production starting in July 2020. Production fluctuated but with an increasing trend until July 2021 peaked, but declined again until the end of December 2021.

This study uses the ARIMA (Autoregressive Integrated Moving Average) method in forecasting ginger production from 2022 to December 2023. Before estimating all models, the time series data must first be stationary. The data stationary test uses the unit root test using *eviews*. The following are the results of the data stationary test with level 0:

Table 1: Stationary Test with a level of level 0

Null Hypothesis: PRODUKSI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.241524	0.6448
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

Table 1 shows the value of the t statistic (-1.241524) < critical alpha 1%, 5%, and 10% then the probability value is 0.6448 > $\alpha = 0.05$ so it is concluded that the data is not stationary. To avoid spurious regression problems that may arise from regressing non-stationary time series data, we must transform the time series data into stationary by differentiating namely reducing the production of period t with the previous production (t-1) to the first difference.

Table 2: Stationarity Test with the First Difference Level

Null Hypothesis: D(PRODUKSI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.804686	0.0066
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

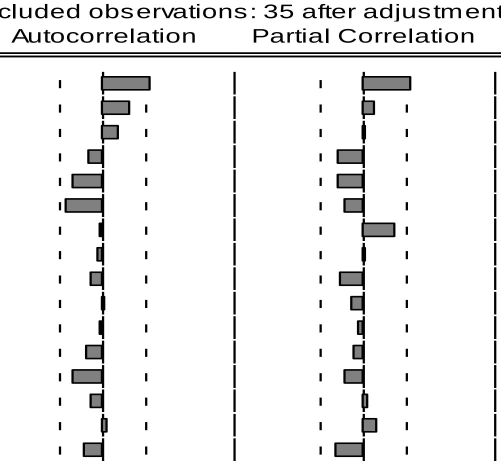
The results of the data stationarity test in Table 2 show the Augmented Dcikey-Fuller (ADF) probability value of 0.0066 < α = 0.05, so it can be concluded that the data is stationary at the 1st difference level.

2. Model Determination

The determination of the model is done by looking at the Autocorrelation Function (ACF) and Partial Correlation Function (PACF) values at the lag to which Cut Off or Dying down occurs.

Table 3: ACF and PACF values

Date: 02/26/23 Time: 22:35
Sample (adjusted): 2019M02 2021M12
Included observations: 35 after adjustments



	AC	PAC	Q-Stat	Prob
1	0.375	0.375	5.3525	0.021
2	0.218	0.090	7.2175	0.027
3	0.119	0.013	7.7926	0.050
4	-0.108	-0.202	8.2773	0.082
5	-0.240	-0.193	10.763	0.056
6	-0.293	-0.149	14.591	0.024
7	-0.022	0.256	14.614	0.041
8	-0.027	0.016	14.649	0.066
9	-0.097	-0.181	15.119	0.088
10	0.000	-0.092	15.119	0.128
11	-0.014	-0.034	15.130	0.177
12	-0.119	-0.073	15.930	0.194
13	-0.234	-0.153	19.159	0.118
14	-0.082	0.028	19.578	0.144
15	0.030	0.101	19.635	0.186
16	-0.150	-0.216	21.173	0.172

Table 3 shows that in ACF and PACF there was a sharp decrease (Cut Off) in the 3rd lag, which means that there is the possibility of the best model in ARIMA (1,1,0), ARIMA (1,1,1), ARIMA (0,1,1), ARIMA (3,1,0), ARIMA (0,1,3), ARIMA (3,1,1), ARIMA (1,1,3), ARIMA (3,1,3).

3. Model Estimation and Verification

After knowing the best possible model, then estimate the model and verify whether the model can be used or not by looking at the residual value of each model. Based on the correlogram Q statistic table, it turns out that all models are not significant (none are outside the 95% confidence interval line). Next, determine the best forecasting model. Look at the comparison of the best model used for forecasting by looking at the smallest value of the Akaike Info Criterion (AIC) and Schwarz Criterion (SC). The following is a table of AIC and SC values:

Table 4: ARIMA Parameters (AIC and SC Values)

Parameter ARIMA	AIC	SC
ARIMA (0,1,1)	25.43342	25.56673
ARIMA (1,1,1)	25.45967	25.63742
ARIMA (1,1,0)	25.40897	25.54229
ARIMA (1,1,3)	25.42381	25.60156
ARIMA (0,1,3)	25.50744	25.64075
ARIMA (3,1,0)	25.51444	25.73664
ARIMA (3,1,1)	25.47704	25.65480
ARIMA (3,1,3)	25.50008	25.56144

Based on Table 4 above, the best model that can be used is the ARIMA model (1,1,0) which is the best model because it has the smallest AIC and SC values of 25.40897 and 25.54229, so the ARIMA model will be diagnosed as an advanced stage of the forecasting process.

4. Forecasting:

It is known that the best model obtained by ARIMA (1,1,0) is then carried out by forecasting with this model and the ginger production forecast for Simalungun Regency, North Sumatra for 2022-2023 is obtained which is informed in the table.

Table 5: Forecasting Results of Ginger Production in Simalungun in 2022-2023[2]

Year	Month	Production Forecasting
2022	January	437550.5
	February	449697.6
	March	461844.7
	April	473991.8
	May	486138.9
	June	498286.0
	July	510433.1
	August	522580.2
	September	534727.3
	October	546874.4
	November	559021.4
	December	571168.5
2023	January	583315.6

[2] Source: Appendix (data processed), 2023

	February	595462.7
	March	607609.8
	April	619756.9
	May	631904.0
	June	644051.1
	July	656198.2
	August	668345.3
	September	680492.4
	October	692639.4
	November	704786.5
	December	716933.6

Table 5 shows ginger production in Simalungun Regency, North Sumatra 2022 - 2023 with a positive trend, namely increasing with the highest forecasting results occurring in December 2023. The forecasting value above is not certain to happen but with a model approach that has been carried out by choosing the best model.

Monthly ginger production 2019 – 2021 shows fluctuations, but the highest increase, occurs in June 2021. If the monthly data is accumulated to be annual from 2019-2021 it shows a positive trend, namely 29133.5 kg (2019), 154516.75 kg (2020) and 637924.08 kg (2021). Research that specifically predicts ginger production was conducted by Sulaehani (2022) in Pohuwato Regency, whose research results concluded that based on the actual value and the predicted value of the red ginger price obtained, the ARIMA model obtained the AIC value with the best model being -3048.61, which is the minimum value. The application that was created can help the community and local government get forecast information or predict the price of red ginger in the future. The results of the red ginger price prediction show that the price of red ginger will fall in June by Rp. 21,932/kg.

Nurjati's research (2022) found that the level of competitiveness of Indonesian ginger exports was lower than that of Thailand and India using both the RCA and CMS methods. The key strategy for increasing the competitiveness of Indonesian ginger exports lies in product availability and quality assurance. Development and dissemination of technology to increase productivity, quality, partnership patterns and expansion of market share is a strategy to support the realization of competitive Indonesian ginger exports.

Sianturi's research (2016) on analyzing forecasting sales of *bandrek* which is a traditional hot, sweet and spicy beverage at CV. Cihanjuang Inti Teknik located in Cimahi, West Java with the ARIMA method shows that forecasting with these three methods shows different results. Forecasting results using the linear exponential method show that sales increased by 9.6% with an MSE error value of 510966679, using the decomposition method, sales increased by 18.6% with an MSE value of 1564450485 while using the ARIMA method (0,1,1), sales decreased by 9.4% with an MSE value of 876651753. These results can be used by the company as a basis for planning and decision-making.

Other research related to forecasting using the ARIMA method is Astuti's research (2021) concerning Forecasting the Amount of Maize Production in North Luwu Regency Using the Arima Model which concludes that the best Arima model is used for forecasting the amount of corn production in North Luwu Regency in the results of data processing using Minitab is the model Arima(1, 0, 0). Forecasting results obtained the amount of corn production annually from 2020 to 2022 in a row of 220,379 tons, 220,946 tons, and 221,514 tons, so from the forecasting results it can be said that the total production of corn has increased the amount of production.

Oktarina's research (2018) also used the same method, namely ARIMA, but different commodities found estimated forecasting values for 24 periods, namely the period January 2018 to December 2019, which experienced an increase every month but based on the year, production yields experienced a decrease in production in 2018 of 295,478 tons from the previous year and experienced an increase in Crude Palm Oil (CPO) production in 2019 of 332,306 tons.

Causality between Production and Producer Prices:

The Granger causality test to analyze the pattern of causality or reciprocal relationship between the two variables studied. Granger suggests the definition of causality is that variable X is said to cause Y if Y variations can be explained better by using X's past values than by not using them (Gujarati, 2004). The two-way relationship between ginger production and price can be explained by a causality test (Granger, 1969).

a. Optimal lag determination:

Before performing regression using Granger causality, the optimal lag must be known from the time series data. The determination of the optimal lag length or interval used is based on AIC (Akaike Information Criteria) criteria. The optimal lag length can be seen in Table 6.

Table 6: Criteria for Optimum Lag of Ginger Production and Prices in Simalungun Regency[3]

Lag	AIC	SC	HQ
0	28.21880	28.13083	28.16153
1	28.15368	28.24255	28.18436
2	25.61131	25.79088	25.67255
3	25.44098*	25.71307*	25.53253*
4	25.56132	25.92776	25.68279

Based on Table 6 it can be explained that the optimal lag that can be used in the above model is lag 3. This is based on the resulting value on the AIC criteria (Akaike Info Criteria) which shows the results at lag 3. Determining the length of the lag is used to eliminate autocorrelation and heteroscedasticity problems that exist in the model to be used (Enders, 1995).

b. Granger Causality Test:

The Granger causality test was conducted to see the causality relationship between the variables in the model. Testing the causal relationship, in the sense of Granger (1969), is used to see the relationship between ginger production and ginger prices in Simalungun Regency. If the test using the Granger test method shows that the causality relationship occurs in both directions, it indicates that the market has been integrated. The results of the Granger causality test can be seen in Table 7.

[3] Source: Data processed, 2023

Table 7: Granger Causality Test Results for Ginger Production and Prices

Pairwise Granger Causality Tests
Date: 02/28/23 Time: 12:21
Sample: 2019M01 2021M12
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
HARGA does not Granger Cause PRODUKSI	33	0.17871	0.9099
PRODUKSI does not Granger Cause HARGA		4.20201	0.0074

Description:

Harga = Price
Produksi = Production

Based on the probability value generated in the Granger causality test, Table 7 shows that the production variable has a probability value of 0.9099 > 0.05 with an F statistic (0.17871) < Ftable (3.295), which means it is not significant. Then Ho is accepted, that is, the production variable does not affect the ginger price variable.

On the contrary, the results of the Granger Causality test show that the price variable has a probability value of 0.0074 <0.05 and the F statistic value (4.20201) > F_{table} (3.295) which means that the price variable significantly influences production. Therefore it can be concluded that there is no reciprocal relationship between the production variable and the ginger price variable, but there is a one-way relationship between the price variable and the production variable.

Price is the key activity of the trading system, the market price of a product affects wages, rent, interest and profit, meaning that the price of a product affects the cost of the factors of production of labour, land, capital and entrepreneurship. So price is the basic measuring device of an economic system because prices affect the allocation of production factors. High wages attract labour, high interest rates attract capital and so on. In its role as produced (supply) and who will get how many goods or services are produced (demand). This is in line with the results of Haryanto's research (2019) which states that domestic natural rubber prices (HKR) affect natural rubber production in Indonesia. This is also consistent with research by Reavindo (2016) which states that the independent variables (crop area and producer prices) simultaneously affect the dependent variable (corn production) in Karo District.

The law of supply shows the relationship between the price level and the number of goods offered. As is the case with the law of demand, this law of supply also applies the assumption ceteris paribus, that is, the other factors that affect supply do not change or remain constant. The law of supply states that there is a positive correlation between prices and the number of goods supplied. Higher prices encourage producers to increase production volumes to gain more profits. Conversely, if the price of goods falls, the number of goods supplied will also decrease.

Conclusion:

The conclusions of this study are as follows:

i. The best ARIMA model used for forecasting ginger production in Simalungun Regency, North Sumatra is model (1,1,0). The application of the ARIMA model to ginger production in Simalungun Regency has a positive trend, namely increasing with the highest forecasting results occurring in December 2023.
ii. The results of the Granger Causality Test show that the price variable significantly affects production. There is no reciprocal relationship between the production variable and the price variable; there is only a one-way relationship between price and production.

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