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Modeling the Farmer Exchange Rate in Indonesia Using the Vector Error Correction Model Method

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ABSTRACT

The agricultural sector plays a crucial role in the Indonesian economy. However, the farm sector still has serious problems, including agricultural product prices, which often fall when the harvest supply is abundant. So often, the income obtained is not proportional to the price spent by farmers, which has an impact on decreasing the welfare of farmers. An indicator to observe changes in the interest of Indonesian farmers is the Farmer Exchange Rate Index (NTP). **This study aimed** to form a model and project the welfare level of farmers in Indonesia, focusing on NTP indicators, which are caused by the influence of variables such as inflation, Gross Domestic Product (GDP), interest rates, and the rupiah exchange rate. **The method used** was the Vector Error Correction Model (VECM), used when there are indications that the research variables do not show stability at the initial level and there is a cointegration relationship. **The results of this study** showed that in the long run, significant factors affecting NTP are inflation, interest rates, and the rupiah exchange rate. Meanwhile, in the short term, the variables impacted were GDP and the rupiah exchange rate. The resulting VECM model showed a MAPE error rate of 1.79%, indicating excellent performance, as the MAPE error rate was below 10%. **The implication of this research** is to provide information related to NTP projection that can be used to formulate strategies to strengthen Indonesia's agricultural sector.

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1. INTRODUCTION

Indonesia is known as a country that has extraordinary natural resources. Some of these crops are in great demand in various countries and managed to rank the best in the world. Judging from its abundant produce, Indonesia is known as an agricultural country where most of the population uses the farm sector as a livelihood. The agriculture industry plays a crucial part in Indonesia's economic development. Its contribution to the success of the country's development, among others, includes the formation of Gross Domestic Product (GDP), increasing people's income, and absorption of labor [1]. Indonesia's agricultural sector's contribution to GDP during 2016 - 2020 continues to grow, from 13.14% in 2016 to 15.46% in 2020. This increase occurs because the output of sectors contributing to GDP increases yearly [2]. Realizing the critical role of the agricultural sector in Indonesia, the government has made various development efforts and established policies to regulate and control aspects of development in the farming sector to achieve a better level of economy and welfare.

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The Farmer Exchange Rate (in Indonesia, namely Nilai Tukar Petani (NTP)) serves as a measuring instrument for assessing the dynamics of farmer welfare. The NTP stands as the sole viable choice for agricultural development analysts seeking to evaluate the welfare status of farmers, given the scarcity of dedicated indicators available for measuring farmers' well-being [3]. The farmer exchange rate, also known as the NTP, is a methodology employed to assess the degree of interest among farmers. It involves comparing farmers' exchange value of agricultural goods or products with the expenditure on goods and services related to farm output and household consumption [4]. Some factors, such as inflation, GDP, interest rates, and the rupiah exchange rate, have a discernible impact on NTP [4–7]. Inflation is defined as an overall increase in prices, where inflation decreases the purchasing power of a currency. Previous studies have explained the relationship between inflation and NTP and stated a significant influence, but others said there is no considerable influence. The interest rate is the percentage lenders charge on borrowed money. The benchmark interest rate in Indonesia is called the Indonesian Bank rate, and the BI rate is used as a benchmark for interest rates in the money market, such as loan rates. Because of its broad influence, interest rates are one of the economic factors that continue to be studied. A previous study stated that interest rates affect the Farmer Exchange Rate (NTP) because if loan interest rates are lower, farmers can increase purchases of inputs and other capital to increase their productivity and income [8].

Researchers also use gross Domestic Product (GDP) to explain the relationship with NTP. GDP refers to the monetary value of all products and services generated within a country's borders over a specified time frame. The GDP is a metric used to quantify the total value of products and services produced inside a country's borders, regardless of the ownership or nationality of the entities involved. The correlation between GDP and overall well-being can be assessed by examining the aggregate economic income and spending allocated toward consuming goods and services. GDP per capita represents a person's average income and expenditure in the economy and is a relatively natural measure of the average individual's well-being. The GDP of the agricultural sector makes a considerable contribution to the formation of total GDP. Therefore, the higher the GDP, the higher the average income of each farmer in an economy and a certain period [4]. The currency exchange rate and the rupiah exchange rate can influence the NTP in conjunction with inflation, interest rates, and GDP. This discovery is considered novel as only a few studies have elucidated the correlation between the rupiah exchange rate and NTP.

Previous research states that various factors influence the NTP value; most were analyzed from one direction only, namely, how the variables affect NTP. These variables can influence each other (have a causality relationship), but such research is still scarce. This research proposes to take this opportunity to analyze the causality of NTP with various factors that are thought to influence it, so this is the difference between this research and the previous study. Therefore, we need a method that can be used in modeling two or more variables that have a reciprocal or interrelated relationship (multivariate time series); this method is the Vector Autoregressive (VAR) or Vector Error Correction Model (VECM). The VAR model is widely regarded as versatile and understandable for analyzing multivariate time series data. The VAR model can elucidate historical and causal connections between many variables across different periods and predict future observations [9]. In VAR analysis, a cointegration test is helpful to find out whether there is balance in the long term. If cointegration is detected in the variables, it is necessary to use the VECM for further analysis. The VECM is a time series model that exhibits stationarity at the first differential and incorporates an error correction term (ECT) [10–12].

Prior studies using the VAR/VECM, such as research by Hasbunallah and Darmansyah [3], used VECM to analyze the correlation between Islamic bank funding in agricultural enterprises and the NTP in the West Java Province between 2017 and 2021. The findings research showed that the variable Total Amount Financing (TAF) affected NTP over the long run. Nevertheless, TAF and NTP had no appreciable effect in the near run. **On the other hand**, it is doubtful that NTP will be much impacted shortly by TAF [3]. Wulandari et al. [13] used the VECM model to test the causal relationship between production inputs and rice prices in East Java. The results showed that while population, rice production, and changes in people's income positively affect price stability over the long term, they have an inversely proportional effect when looking at price stability in the short term. On the other hand, the fluctuating farmers' exchange rate has a favorable short-term impact on price stability but a negative long-term impact on it. Armanto and Yahya [14] used the VAR model to investigate the effect of agricultural financing on the NTP, GDP, Inflation, and NPF. The findings indicated that only the GDP factors had a favorable impact on Agriculture Financing out of the four independent variables. Conversely, agricultural financing is unaffected by the NTP, inflation, and NPF (Non-Performing Financing).

However, previous NTP studies are minimal, as researchers generally come from Indonesia because NTP is only used in Indonesia. Most researchers only analyze NTP from one direction: how the variables influence NTP. These variables can affect each other (have a causality relationship). This research takes **this opportunity as novelty research,** which analyzes the causality of NTP. So, **this study aims** to investigate the effects of inflation, GDP, interest rates, and rupiah exchange rates on NTP and explore a prediction model for NTP using the VECM method. The NTP forecast data from this study **can be utilized** to develop plans for bolstering Indonesia's agriculture industry.

2. RESEARCH METHOD

This research employs quantitative analysis. Quantitative research aims to collect numbers or numerical data, which is then analyzed statistically to look for patterns, relationships, or trends in the studied phenomena. The steps of this research are as shown in the flowchart in Figure 1:

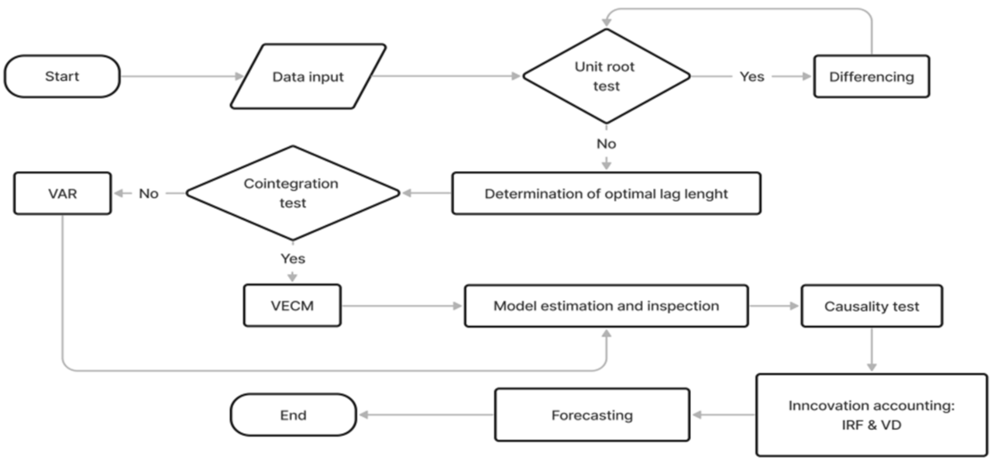
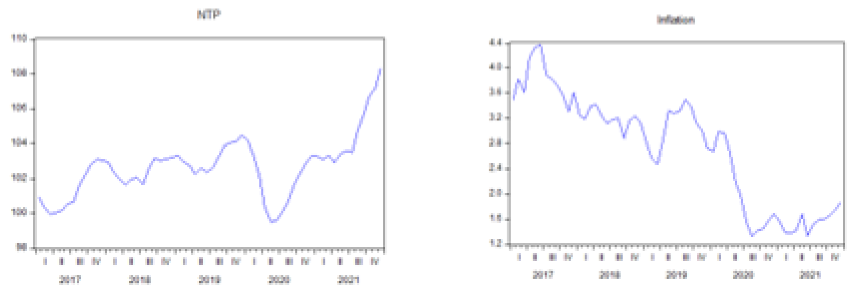


Figure 1. Stages of Research Using the VECM Method

2.1. Data

This study used secondary data in the form of time series data from January 2017 to December 2021. The data utilized in this study comprise Farmer Exchange Rate (NTP) data obtained from the official website of the Central Statistics Agency (https://www.bps.go.id/), inflation data, interest rates (BI rate), and rupiah exchange rates obtained from the official website of Bank Indonesia (https://www.bi.go.id/), and Gross Domestic Product (GDP) data obtained from the official website of the Ministry of Trade of the Republic of Indonesia (https://www.kemendag.go.id/). The graphic representation of the data in this investigation is depicted in Figure 2.



(a) (b)

Figure 2. Research Data Graphs in Each Variable

2.2. Vector Autoregressive (VAR)

The Vector Autoregressive (VAR) model is well recognized as a versatile and understandable framework for examining multivariate time series data. VAR models are often regarded as user-friendly tools for forecasting and can also be effectively employed in economic analysis [11]. Using impulse response analysis or variance decomposition of forecast mistakes is a prevalent approach in examining the interconnections between variables inside a vector autoregressive (VAR) model [9],[15].

The following definition often characterizes the VAR model. If given K the time series variable, $Y_1 = (y_{1t}, y_{2t}, \ldots, y_{Kt})$, hence the p-lag VAR [VAR(p)] has the following model in Equation (3.4.).

$$Y_1 = c + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \ldots + \Pi Y_{t-p} + \varepsilon_t \tag{1}$$

Where $\Pi_i = (n \times n)$ coefficient matrix; then c= constant vector; and then ε_t= vector residual size $(n1)$ [16].

2.3. Vector Error Correction Model (VECM)

The VECM is a type of VAR model that is specifically designed for capturing and describing the presence of cointegration across variables. The idea of cointegration and error correction was developed by Engle and Granger in 1987. Then, the idea was created, and the concept of the VECM model emerged, initiated by Johansen with Juselius in 1990. The VECM (p) model can be demonstrated in Equation (2) [17]:

$$\Delta y_t = c + \Pi y_{t-1} + \Sigma_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \tag{2}$$

Where Δ = differencing operator (where $\Delta y_t = y_t - y_{t-1}$ = endogenous variable vector with lag-1; ε_t = residual vector; c= constant vector, Π = cointegration coefficient matrix $(k \times r)$; $\Gamma_i =$ matrix coefficient to-I endogenous variables; p indicates the lag of endogenous variables with rank $r \leq k$; r is rank cointegration; and k is the vector size [18].

2.4. Best Model Selection

The Mean Absolute Percentage Error (MAPE) is a quantitative approach for evaluating forecasting accuracy by employing the absolute error methodology for each period, which is then divided by the corresponding actual observed values [19]. Next, the average value of the complete error % is determined. The forecasting model is considered to have exceptional performance when the MAPE is below 10% [20, 21]. The MAPE value is calculated by Equation (3):

$$MAPE = \frac{100\%}{n} \Sigma_{t=1}^{n} |\frac{A_t - F_t}{A_t}| \tag{3}$$

3. RESULT AND ANALYSIS

3.1. Stationary Test

One assumption on VAR modeling is that the data should be stationary. A unit root test is often employed for assessing data stationarity. The Augmented Dickey-Fuller (ADF) test is the most frequently used unit root test [21]. The test criteria are as follows:

1. H_0 received (data is not stationary) if the absolute value of the ADF statistic $<$ Mackinnon critical value or *p-value* $>$ 0,05
2. H_0 rejected (stationary data) if the absolute value of the ADF statistic $>$ Mackinnon critical value or *p-value* $<$ 0,05

The outcomes of the ADF test conducted at the base level are displayed in Table 1.

Table 1. Test ADF Levels

Variable	**Level**			**Information**
	Statistical Value ADF	**Critical Value Mckinnon**	**p-value**	
NTP	-1.4804	-2.9126	0.5365	non-stationary
Inflation	-0.9333	-2.9117	0.7708	non-stationary
GDP	-2.1127	-2.9126	0.2406	non-stationary
Interest Rate	-0.8214	-2.9126	0.8054	non-stationary
Exchange Rate	-3.0814	-2.9117	0.0334	stationary

Based on the ADF level test findings, as displayed in Table 1, it is evident that NTP, inflation, GDP, and interest rate variables exhibit non-stationarity. In contrast, the exchange rate variables have been fixed. So then, to obtain stationary data, it is necessary to differencing data. The non-stationarity of four of the five variables necessitates the examination of data stationarity at the first difference level. This is done to obtain the same level of stationarity on all variables. The ADF test results at the first difference level are shown in Table 2.

Table 2. The First Difference in the ADF Test Level

Variable	**1st difference**			**Information**
	Statistical Value ADF	**Critical Value Mckinnon**	**p-value**	
NTP	-3.5346	-2.9126	0.0104	stationary
Inflation	-6.8759	-2.9126	0.0000	stationary
GDP	-4.8427	-2.9145	0.0002	stationary
Interest Rate	-4.5032	-2.9126	0.0006	stationary
Exchange Rate	-8.6015	-2.9126	0.0000	stationary

According to the findings of the Augmented Dickey-Fuller (ADF) test for the first difference level, as displayed in Table 2, it is evident that the NTP variables, inflation, GDP, interest rates, and exchange rates have been observed to exhibit stationarity at the first difference level. Once the data passes the stationary test at a consistent level, it determines the most suitable lag duration.

3.2. Determination of Optimal Lag Length

It is imperative to specify the correct lag length while employing VAR modeling. Determining the optimal lag assesses the time it takes for a given variable to react to another variable while mitigating any issues related to autocorrelation within the model. The ideal lag length can be determined by considering the values of the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SC) criteria, which pertain to relatively insignificant factors. Table 3 displays the analysis outcomes to determine the best lag length.

Table 3. Test Results Lag Length

Lag	LogL	AIC	SC
0	-991.9198	36.9229	37.1071
1	-936.5725	35.7989*	36.9039*
2	-915.6932	35.9516	37.9774
3	-892.5497	36.0203	38.9670
4	-877.3418	36.3830	40.2505
5	-848.3112	36.2337	41.0220

Based on the lag length examination results in Table 3, the smallest AIC and SC criteria values are indicated by an asterisk. It can be seen that all asterisks are at lag 1. Hence, it may be inferred that the most suitable length is lag 1.

3.3. Cointegration Test

A cointegration test determines whether variables have a long-term relationship or are in equilibrium. The Johansen Cointegration Test is widely used [21, 22]. The conditions for conducting the Johansen cointegration test are outlined as follows.

1. H_0 accepted (no cointegration) if the value of trace statistics $<$ critical value of 5%
2. H_0 rejected (there is cointegration) if the value of trace statistics $>$ critical value of 5%

Table 4 displays the outcomes of the Johansen cointegration test conducted on NTP variables, inflation, GDP, interest rates, and exchange rates.

Table 4. Johansen Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.6151	128.7096	60.0614	0.0000
At most 1 *	0.3837	74.2867	40.1749	0.0000
At most 2 *	0.3246	46.7007	24.2759	0.0000
At most 3 *	0.2336	24.3340	12.3209	0.0003
At most 4 *	0.1486	9.16836	4.12991	0.0029
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.6151	54.4229	30.4396	0.0000
At most 1 *	0.3837	27.5859	24.1592	0.0166
At most 2 *	0.3246	22.3667	17.7973	0.0096
At most 3 *	0.2336	15.1657	11.2248	0.0097
At most 4 *	0.1486	9.1684	4.12991	0.0029

According to the Johansen cointegration test findings in Table 4, all trace statistical values are more significant than the crucial value of 5% in the Trace test. As a result, the test result indicates cointegration. The Maximum Eigenvalue test findings, equivalent to the Trace test, are also shown in the table above. As a result, five cointegrations or long-term correlations between NTP variables, inflation, GDP, interest rates, and exchange rates, can be identified. In VAR modeling, cointegration tests are also used to determine the decision of the model to be used. Because this test discovered a cointegration or long-term link between variables, the VAR model must be updated with the VECM.

3.4. VECM Model Estimation and Inspection

The estimation of the VECM model comes next. The VECM model estimation will describe the long-term and short-term influence of factors. The results of the VECM model estimate with NTP as the dependent variable are shown in Table 5.

Table 5. VECM Model Estimation

Long-run			**Short-run**		
Variable	**Coefficient**	**t-statistic**	**Variable**	**Coefficient**	**t-statistic**
INF(-1)	-4.1777	-5.7587*	CointEq1	-0.0386	-2.0491*
GDP(-1)	-2.77E-05	-1.5016	D(NTP(-1))	0.5922	6.2619*
IR(-1)	2.7912	3.4081*	D(INF(-1))	-0.0146	-0.0667
ER(-1)	-0.0056	-4.9118*	D(GDP(-1))	2.19E-05	4.2568*
			D(IR(-1))	-0.3827	-1.1886
			D(ER(-1))	-0.0006	-4.0359*

Note: * indicate significance at 5%

Based on the VECM estimation findings in Table 5, the VECM model obtained is as follows:

$$\Delta NTP_t = -0.0386ECT_{t-1} + 0.5922\Delta NTP_{t-1} + 2.19e - 05 * \Delta GDP_{t-1} - 0.0005\Delta ER_{t-1}$$

where :

$$ECT_{t-1} = NTP_{t-1} - 4.1777INF_{t-1} - 2.7911IR_{t-1} - 0.0056ER_{t-1}$$

The Equation's coefficient of determination (R^2) is 0.5974 or 59.74 percent, indicating that the variables inflation, GDP, interest rates, and exchange rates can explain 59.74% of NTP. At the same time, the rest is presented by factors not included in the regression equation. Furthermore, stability tests on the VECM model will assess whether the Impulse Response Function (IRF) and Variance Decomposition analysis results will be valid. The model stability test results are shown in Table 6.

Table 6. Pembagian data untuk Training dan Testing

Root	Modulus
0.526457 - 0.196786i	0.562034
0.526457 + 0.196786i	0.562034
0.533694	0.533694
-0.105910	0.105910
0.095696	0.095696

According to the test findings in Table 6, the values of all modules are less than one. As a result, the VECM model meets the stability requirements to be used in the Impulse Response Function and Variance Decomposition analyses.

3.5. Granger Causality Test

Granger's causality test was also used to determine the variables' causal relationship. Using the ideal lag length discovered in the last test, lag one, and a 5% confidence level. With the following assessment criteria:

1. H_0 accepted (no causality relationship) if the probability value $>$ 0,05
2. H_0 rejected (there is a causality relationship) if the probability value $<$ 0,05

   The findings of Granger's causality test are shown in Table 7.

Table 7. Granger Causality Test Results

Null Hypothesis	Obs	F-Statistic	Prob.
INF does not cause Granger NTP	59	2.4489	0.1232
NTP does not cause Granger INF		0.4555	0.1025
KURS does not cause Granger NTP	59	0.9894	0.0241
NTP does not cause Granger KURS		0.8892	0.2497
PDB does not cause Granger NTP	59	8.0518	0.0063
NTP does not cause Granger PDB		4.1425	0.0466
SB does not cause Granger NTP	59	2.9926	0.0892
NTP does not cause Granger SB		0.0079	0.9291
KURS does not cause Granger INF	59	3.2492	0.0768
INF does not cause Granger KURS		2.1763	0.1457
PDB does not cause Granger INF	59	0.2115	0.0473
INF does not cause Granger PDB		3.1171	0.0829
SB does not cause Granger INF	59	0.8117	0.3715
INF does not cause Granger SB		0.6159	0.0359
PDB does not cause Granger KURS	59	3.84423	0.0549
KURS does not cause Granger PDB		2.8082	0.0994
SB does not cause Granger KURS	59	0.00067	0.9796
KURS does not cause Granger SB		0.4309	0.5142
SB does not cause Granger PDB	59	0.1227	0.0274
PDB does not cause Granger SB		1.4049	0.2409

For the summary, the causality relationship in Table 7 is described in Figure 3.

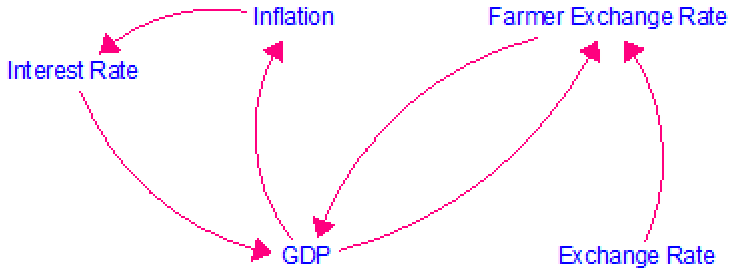


Figure 3. Representation of Causality Granger Test

The findings from the Granger causality test, as depicted in Table 7 and Figure 3, indicate that the exchange rate variable exhibits a unidirectional causal association with the NTP variable. The GDP variable has a bidirectional causal relationship with the NTP variable. On the other hand, there is no causal relationship between the inflation and interest rate variables and the NTP variable.

3.6. Impulse Respons Function (IRF)

The analysis of IRF is employed to characterize the impact of a given variable on another variable within a specified time interval. This analysis allows for the observation of the duration required for the dependent variable to react to the perturbation caused by the independent variable [12, 23]. The results of the IRF analysis are shown in Figure 4.

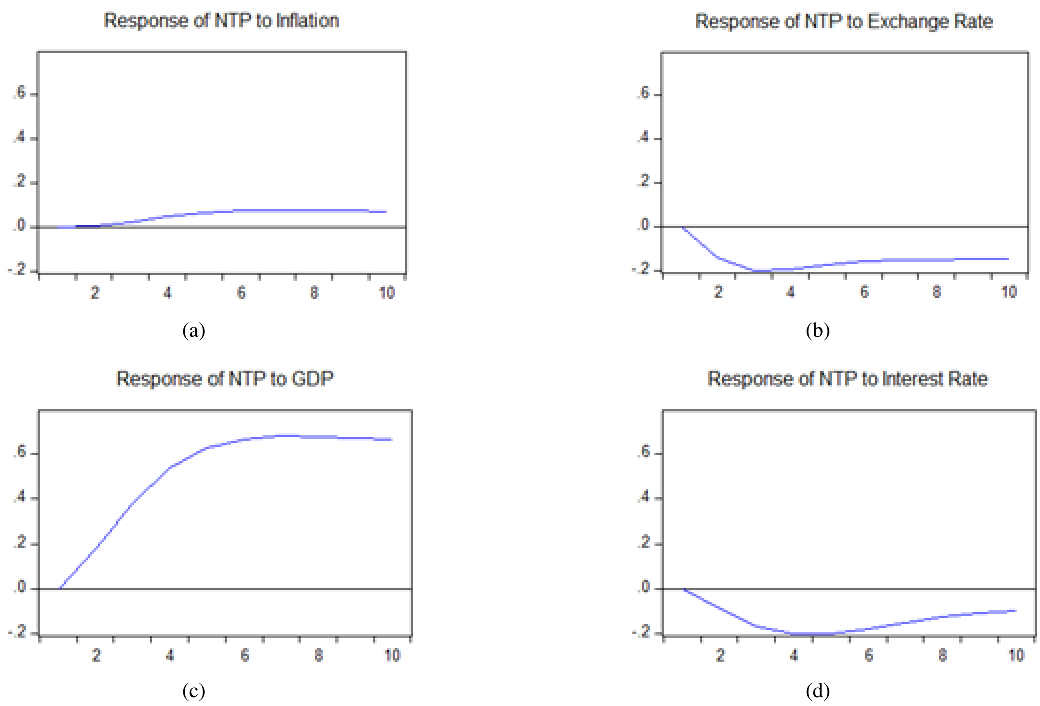


Figure 4. IRF Analysis Chart

According to the graph of IRF analysis results displayed in Figure 4:

1. NTP's response to the shock from inflation showed a positive response and continued to increase slightly until the seventh period and then decreased until the tenth.
2. NTP's response to the exchange rate shock showed an adverse reaction and continued to decline slightly until the seventh period and then increased until the tenth.
3. NTP's response to the shock from GDP showed a positive response and continued to experience a sharp increase until the eighth period, then shared a slight decline until the tenth period.
4. NTP's response to the shock from interest rates showed an adverse reaction and decreased until the fourth period, then increased until the tenth period.

3.7. Variance Decomposition

Variance decomposition analysis can estimate how much a variable contributes or proportion to changes in itself and other variables in future periods, and its value is expressed as a percentage [12, 21]. Table 8 shows the variance decomposition:

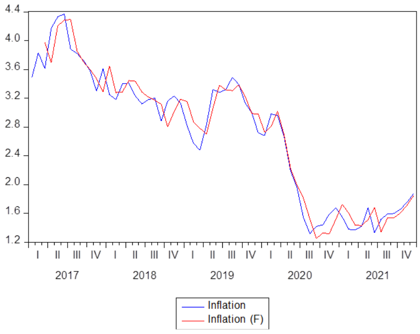
Table 8. Variance Decomposition Analysis

		Variance Decomposition of NTP:				
Period	**S.E.**	**NTP**	**INF**	**ER**	**GDP**	**IR**
1	0.3890	100.0000	0.0000	0.0000	0.0000	0.0000
2	0.7878	90.3530	0.0101	3.2044	5.2289	1.2034
3	1.1881	80.7729	0.0475	4.1991	12.5370	2.4433
4	1.5489	73.5256	0.1277	4.0438	19.1724	3.1303
5	1.8580	68.1968	0.2216	3.6788	24.5687	3.3339
6	2.1189	64.3061	0.3010	3.3815	28.7528	3.2584
7	2.3416	61.4696	0.3575	3.1820	31.9221	3.0686
8	2.5362	59.3908	0.3948	3.0540	34.3041	2.8561
9	2.7110	57.8484	0.4194	2.9692	36.1035	2.6592
10	2.8718	56.6816	0.4365	2.9090	37.4837	2.4890
Average		71.2545	0.2317	3.0622	23.0074	2.4442

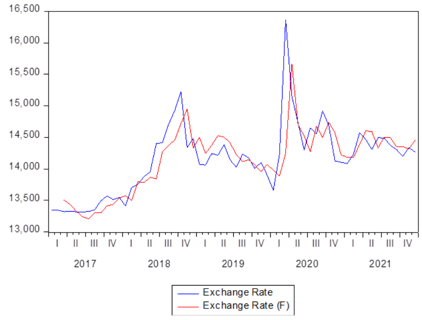
Table 8 reveals that the variable predicted to have the most substantial contribution to the NTP variable in the following ten periods is the NTP variable itself, with an average contribution value of 71.25%. As for other variables, it is known that inflation affects NTP with a moderate proportion of 0.23%, exchange rate variables affect NTP with an average balance of 3.06%, GDP variables affect NTP with an average ratio of 23.01%, and interest rate variables affect NTP with a moderate proportion of 2.44%.

3.8. Forecasting and Model Accuracy Evaluation

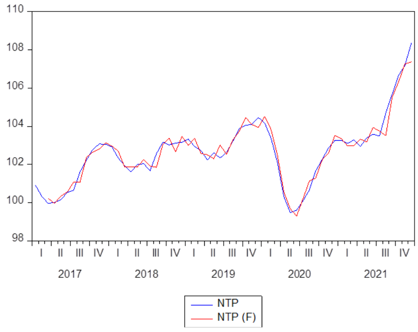
The following plots are the forecast results for January 2017 to December 2021, as shown in Figure 5, and the results of NTP index forecasting are presented in Table 9.



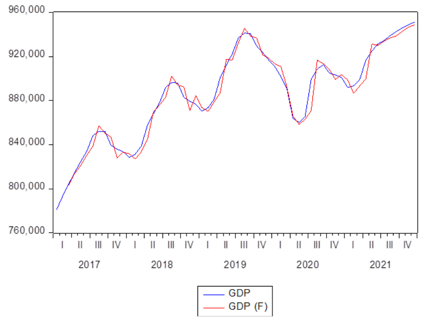
(a)



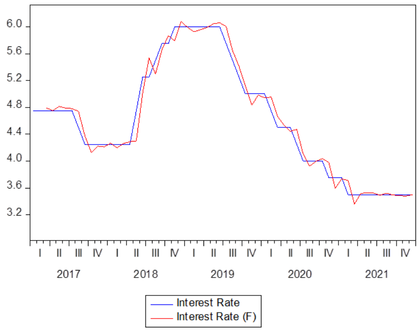
(b)



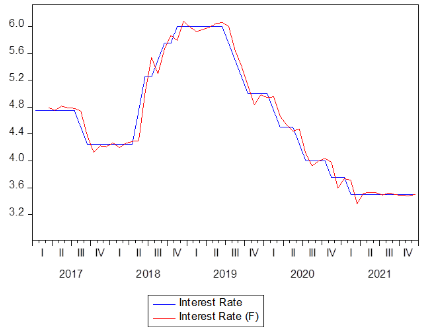
(c)



(d)



(e)



(f)

Figure 5. Comparison of Actual Data and Forecast Data Plot, also Validation Test Results

Figure 5 above shows that the forecasting results are very close to the actual data. The MAPE calculation's error value is 1.79%, showing excellent accurate forecasting results. The NTP forecasting results for the next 12 months are as shown in Table 9.

Table 9. NTP Forecasting Results

Period	Forecasting Results	Period	Forecasting Results
January 2022	108.9841	July 2022	108.2418
February 2022	109.1602	August 2022	108.2012
March 2022	109.0446	September 2022	108.2110
April 2022	108.8010	October 2022	108.2463
May 2022	108.5488	November 2022	108.2871
June 2022	108.3551	December 2022	108.3209

Based on the NTP forecasting findings shown in Table 9, it can be observed that the NTP in Indonesia over the next 12 months has climbed and dropped but stays constant.

3.9. Discussion

The findings of this research are the VECM estimation results, which reveal the presence of both long-term and short-term associations between NTP and many economic indicators, including inflation, GDP, interest rates, and the exchange rate of the rupiah. In the long term, inflation exerts a detrimental and statistically significant impact on the nominal trade balance. When inflation is high, prices will continue rising, making it difficult for people to buy the goods they need. When inflation rises, consumer goods prices and agricultural production costs experience an increase, encompassing farmers as well. This finding is consistent with prior scholarly investigations by research [24, 6, 7, 5]. The study found a negative relationship between inflation and NTP. Inflation can reduce NTP because it causes the index that farmers must pay to be greater than the index received so that farmers' welfare will decrease.

The short-term impact of GDP on NTP is both positive and statistically significant. The high value of GDP shows that income in the agricultural sector is also getting higher. As a result, the average income of farmers has also increased, and their welfare has also been higher. The research conducted by research [7] and [4] demonstrates consistent findings, indicating that GRDP exerts a beneficial and statistically significant impact on NTP.

In the long term, interest rates substantially adversely impact NTP. Based on the findings, it can be inferred that a single percentage point increase in the interest rate during the preceding period has the potential to result in a decrease of around 2.79 points in the NTP over an extended duration. When interest rates on loans are low, farmers can buy more inputs or capital to increase their productivity and income. **It is in line with research**[25], which found that the negative relationship between interest rates and NTP illustrates that farmers find it difficult to respond to increases in the base interest rate in accessing financing and bank credit.

In the long and short term, the rupiah exchange rate negatively and statistically significantly influences NTP. The findings of this study are consistent with previous research [5], which reveals that when the rupiah exchange rate falls against the US dollar, the price of goods and other imported commodities rises. The increase in basic prices will raise the price farmers pay for production and household costs, resulting in a deficit for farmers.

4. CONCLUSION

Based on the findings derived from the analysis and modeling of the Farmer Exchange Rate (NTP) in Indonesia, taking into account the impact of inflation, GDP, interest rates, and rupiah exchange rates through the utilization of the VECM, it can be deduced that the variables that exhibit a statistically significant influence on NTP in the long-term are inflation, interest rates, and the rupiah exchange rate. In the meantime, GDP and the rupiah exchange rate have a substantial short-term impact on NTP. NTP is negatively affected by inflation, interest rates, and rupiah exchange rates. It happens because any increase in these factors can reduce the NTP index. While the GDP factor positively affects NTP, the high value shows an increase in the NTP index. The accuracy level of the model in the NTP variable has a MAPE value of 1.79%, which indicates that the VECM model has perfect accuracy because the error value is less than 10%. The existence of this research is expected to be used as information for the government in preparing strategies or policies to improve the welfare of farmers. Procedures that can be carried out, for example, ensure the availability of agricultural facilities and infrastructure so that no obstacles can increase production costs. In addition, the government must also maintain stable market prices so that the price of goods does not fall drastically when the harvest supply is abundant. This effort is carried out to achieve the success of national development in the agricultural sector. The limitations of this study are that it only uses inflation, interest rates, Gross Domestic Product (GDP), and the rupiah exchange rate as independent variables. Future studies are expected to be analyzed by adding different independent variables. It may be possible to add factors that can influence other NTPs based on previous studies that have been done.

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6. DECLARATIONS

AUTHOR CONTIBUTION

Yuniar Farida: Conceptualization, Methodology, Writing Review & Editing, Supervision. Afanin Hamidah: Original Draft, Investigation, Data. Silvia Kartika Sari: Validation and Interpretation. Lutfi Hakim: Validation and Editing.

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COMPETING INTEREST

The authors declare no conflict of interest.

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