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Analysis of Factors Affecting Farmers' Exchange Rate (NTP) in the Java Region

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Abstract: *This study examines the determinants of the Farmers' Terms of Trade (NTP) in Java, emphasizing the role of food inflation as reflected in the Consumer Price Index (CPI), the Gross Regional Domestic Product (GRDP) of the agricultural sector, and rice prices as a strategic commodity. The study employs quarterly data from 2017–2024 obtained from the Central Statistics Agency and other official sources. The Autoregressive Distributed Lag (ARDL) approach is applied to analyze both short-run and long-run relationships. The stationarity test results indicate that all variables are stationary at the first difference. The ARDL(1,1,1,1) estimation produces an R^2 of 0.9916, with a significant Error Correction Term (ECT) of -0.9527, confirming the presence of cointegration and a strong adjustment mechanism toward long-run equilibrium. Empirically, CPI, GRDP, and rice prices have a positive and significant impact on NTP in the long run, while their short-run effects are not statistically significant. Diagnostic tests confirm that the model is free from classical assumption problems, stable, and consistent. Causality tests reveal the dominant role of rice prices in influencing other variables. Robustness checks using the VECM approach further validate these findings, offering important policy implications.*

Keywords: *Farmer Exchange Rate, Consumer Price Index, Gross Regional Domestic Product, rice prices, ADRL*

Abstrak: Penelitian ini mengkaji faktor-faktor penentu Rasio Perdagangan Petani (NTP) di Jawa, dengan menekankan peran inflasi pangan sebagaimana tercermin dalam Indeks Harga Konsumen (IHK), Produk Domestik Regional Bruto (PDRB) sektor pertanian, serta harga beras sebagai komoditas strategis. Penelitian ini menggunakan data triwulanan periode 2017–2024 yang diperoleh dari Badan Pusat Statistik dan sumber resmi lainnya. Pendekatan Autoregressive Distributed Lag (ARDL) diterapkan untuk menganalisis hubungan jangka pendek dan jangka panjang. Hasil uji stasioneritas menunjukkan bahwa semua variabel bersifat stasioner pada selisih pertama. Estimasi ARDL(1,1,1,1) menghasilkan nilai R^2 sebesar 0,9916, dengan Error Correction Term (ECT) yang signifikan sebesar -0,9527, yang menegaskan adanya kointegrasi dan mekanisme penyesuaian yang kuat menuju keseimbangan jangka panjang. Secara empiris, CPI, GRDP, dan harga beras memiliki dampak positif dan signifikan terhadap NTP dalam jangka panjang, sementara efek jangka pendeknya tidak signifikan secara statistik. Uji diagnostik menegaskan bahwa model ini bebas dari masalah asumsi klasik, stabil, dan konsisten. Uji kausalitas mengungkapkan peran dominan harga beras dalam memengaruhi variabel-variabel lainnya. Pemeriksaan ketahanan menggunakan pendekatan VECM semakin memvalidasi temuan-temuan ini, yang memberikan implikasi kebijakan yang penting.

Kata Kunci: Nilai Tukar Petani, Indeks Harga Konsumen, Produk Domestik Regional Bruto, harga beras, ADRL

INTRODUCTION

Agriculture is one of the strategic sectors that contributes significantly to Indonesia's economy through its role in ensuring food security, providing employment, and supporting rural livelihoods. Java, as the largest agricultural production center in Indonesia, plays a crucial role in maintaining national agricultural output and improving farmers' welfare. However, farmers

continue to face various challenges, including inflation, fluctuations in commodity prices, rising production costs, and climate change, which may reduce their purchasing power and income. Therefore, improving farmers' welfare remains an important issue that requires comprehensive policy support.

The Farmer Exchange Rate (NTP) is an important indicator in measuring farmers' welfare because it reflects their purchasing power for goods and services. This indicator is calculated by comparing the price index received by farmers for agricultural products with the price index paid by farmers for consumer goods and production inputs. On the island of Java, which is the center of agriculture as well as the engine of Indonesia's economy, the dynamics of NTP are influenced by various factors, including production, distribution, food prices, and government policies. BPS data (2022) shows that the NTP in Java has fluctuated quite sharply, for example increasing from 98.7 in 2020 to 102.5 in 2021. The increase reflects the improvement in purchasing power, Although structural challenges such as climate change, rising production costs, and selling price imbalances still limit the sustainable improvement of farmers' welfare.

A number of previous studies have highlighted the determinants of NTP, although the results are still mixed. Murdy (2017) found that the price of grain has a significant effect on increasing NTP. Farida et al. (2024) through the VECM approach show that inflation, exchange rates, and interest rates have an effect in the long term. In Eastern Indonesia, Tupamahu et al. (2023) emphasized that inflation is suppressing the NTP, but the structure of the agricultural economy contributes positively. In East Java, Kusumastuti et al. (2023) showed that rice prices and production costs are significant to the NTP of rice farmers, while Nur Indah et al. (2021) found variations between agricultural subsectors. However, some findings differ; Syafrudin (2021) stated that rice prices have a positive effect on the welfare of farmers, but the Ministry of Agriculture (2021) noted that the increase in rice prices accompanied by an increase in production costs actually weakens its impact on NTP. However, previous studies have reported inconsistent findings regarding the determinants of the Farmers' Exchange Rate (NTP). While some studies found that inflation, rice prices, and agricultural production significantly affect NTP, others reported different results depending on the study area and analytical approach. In addition, most previous studies focused on specific regions outside Java or did not distinguish between short-run and long-run relationships. Therefore, empirical evidence examining the determinants of NTP in Java using the ARDL approach remains limited. This study addresses this gap by analyzing both the short-run and long-run effects of CPI, GRDP, and rice prices on the Farmers' Exchange Rate in Java. The following is a graph of the Farmer Exchange Rate Index in 2017-2024.

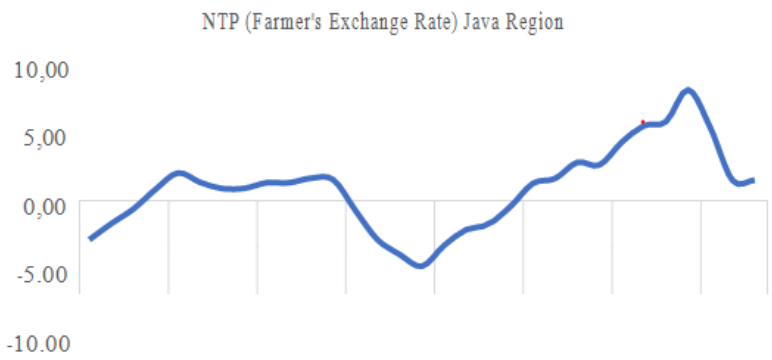

Figure 1. Farmers' Exchange Rate Trends in Java Island in 2017-2024

The graph shows the trend of the Farmer Exchange Rate (NTP) on the island of Java in the 2017-2024 period. During this time span, there were significant fluctuations, especially in 2020, which showed a drastic decline to negative values. This decline is most likely due to the impact of the COVID-19 pandemic that has affected the economy as a whole, including agricultural sector. After 2020, there was a recovery with a sharp increase in 2021, followed by stabilization until 2024. This trend reflects the challenges faced by the agricultural sector amid global economic conditions and recovery efforts.

The Consumer Price Index (CPI) is one of the key macroeconomic indicators that reflects changes in the prices of goods and services consumed by households and may influence the Farmers' Exchange Rate (NTP). Changes in the CPI affect farmers' purchasing power by increasing household consumption expenditures and agricultural production costs, thereby potentially reducing farmers' real income. Consequently, fluctuations in inflation are expected to influence the level of farmers' welfare as measured by NTP. During the study period, the CPI in Java exhibited varying trends, indicating changing inflationary conditions that may have affected farmers' economic performance. Therefore, examining the development of the Consumer Price Index is essential to understand its potential relationship with changes in the Farmers' Exchange Rate in Java. The Consumer Price Index on the island of Java can be seen in the following graph.

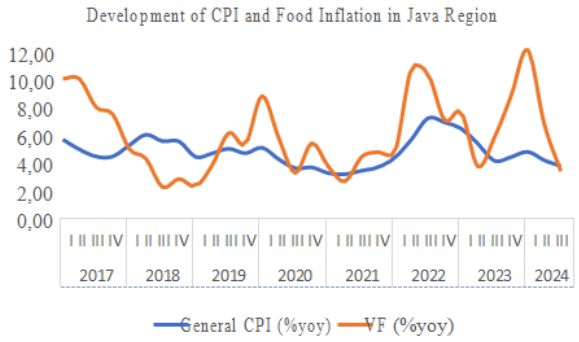

Figure 2. Trends of the Consumer Price Index in Java Island in 2017-2024

The graph shows the trend of the Consumer Price Index (CPI) on the island of Java during the 2017-2024 period in the form of an annual percentage (% yoy). At the beginning of the period, the CPI was stable in the range of 2-4%, but in 2020 there was a decline close to 2% due to the impact of the COVID-19 pandemic. After that, the CPI increased sharply in 2022 to close to 6%, which is likely influenced by economic recovery and rising energy and food prices. In 2023-2024, the CPI will decline and stabilize in the range of 2-3%, reflecting efforts to stabilize inflation through monetary policy. This also happens to food inflation. These fluctuations indicate economic challenges and success in keeping inflation under control at the end of the period.

Gross Regional Domestic Product (GRDP) is an important indicator of regional economic performance that may influence the Farmers' Exchange Rate (NTP) through its effects on income, agricultural production, and market demand. During the 2017–2024 period, GRDP in Java showed a generally increasing trend, reflecting improvements in regional economic activity. Nevertheless, improvements in regional economic performance do not necessarily lead to higher farmers' welfare, as reflected by fluctuations in the Farmers' Exchange Rate over the same period. This indicates that the relationship between GRDP and NTP requires further empirical investigation. Therefore, the trend of GRDP in Java during the study period is presented in Figure 3.

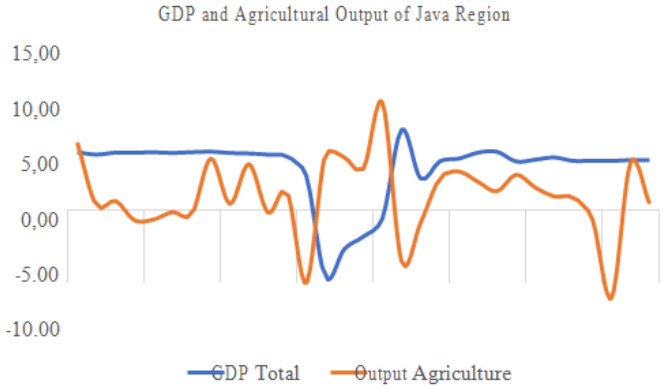

Figure 3. Trends of Gross Regional Domestic Product (GRDP) and Agricultural Output in Java, 2017–2024

Unlike previous studies, this research simultaneously examines CPI, GRDP, and rice prices using the ARDL approach to capture both short-run and long-run effects on the Farmers' Exchange Rate in Java Based on the background, research gap, and the empirical phenomena described above, this study aims to analyze the effects of the Consumer Price Index (CPI), Gross Regional Domestic Product (GRDP), and rice prices on the Farmers' Exchange Rate (NTP) in Java during 2017–2024 using the Autoregressive Distributed Lag (ARDL) approach. The findings are expected to provide empirical evidence to support policies aimed at improving farmers' welfare and maintaining agricultural economic stability.

METHODS

This study uses descriptive and quantitative analysis methods that aim to determine the factors that affect the Farmer Exchange Rate (NTP). The data used in this study is quarterly data (time series). The analysis tool used in this study uses the Error Correction Model (ECM) to analyze the long-term and short-term relationship between independent variables, namely the Consumer Price Index (CPI) especially in the food and beverage group, Gross Regional Domestic Product (GDP) especially in the output of the agricultural sector, and Rice Prices, with a dependent variable, namely the Farmer Exchange Rate (NTP). The data used is secondary data in the form of a quarterly time series from 2017 to 2024, obtained from the Central Statistics Agency (BPS) and the Strategic Food Price Information Center (PIHPS).

Data analysis was carried out in the stages of basic assumption test, which included the stationarity test, the degree of integration test, the cointegration test, and the analysis of short-term and long-term relationships. Once the model meets the basic assumption criteria, estimates are performed using the Error Correction Term (ECT) component to see the speed of adjustment into the long-term equilibrium. The ARDL model used is formulated in the form of the following equation:

$$NTP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i NTP_{t-i} + \sum_{j=0}^{q_1} \beta_j CPI_{t-j} + \sum_{k=0}^{q_2} \gamma_k GRDP_{t-k} + \sum_{l=0}^{q_3} \delta_l RicePrice_{t-l} + \varepsilon_t$$

This model allows for dynamic relationship analysis in both the short and long term, making it suitable for time-series data with variables that are potentially not stationary at the level but stationary at the first differentiation. Data Management Stages for Autoregressive Distributed Lag

(ARDL) Test, 1) Stationariness Test (Unit Root Test), The stationarity test is an important initial stage in the analysis of time-series data. Unstationary can lead to autocorrelation, heteroscedasticity, and biased estimation. Therefore, unit root testing is carried out using methods such as Augmented Dickey–Fuller (ADF) or Phillips–Perron (PP). The results of this test determine whether the variable is stationary at the level or requires differentiation. The main requirement before building a dynamic model, such as an Error Correction Model (ECM) or ARDL, is that the variable must be stationary at the level or at the first differentiation. 2) ARDL Cointegration and Estimation Test, Once the stationarity of the variables is known, the next step is to test the cointegration to see if there is a long-term relationship between the variables. If cointegration is detected, then the ARDL Bounds Testing Approach can be used to analyze short-term and long-term relationships simultaneously. ARDL estimation is very flexible because it is able to accommodate variables that are stationary at the level (I(0)) and the first differentiation (I(1)). 3) Diagnostic Tests, The validity of the ARDL model was tested through various diagnostic tests, including autocorrelation tests (Breusch Godfrey), heteroscedasticity tests (White Test or ARCH Test), residual normality tests (Jarque Bera), and multicollinearity tests. If the results of the diagnostic test show no serious problems, then the model can be declared suitable for further analysis. 4) Stability Test, Model parameter stability testing was performed using the CUSUM and CUSUMSQ methods. The model is declared stable if the test line is within the 5% confidence limit. This test is important to ensure the consistency of the model parameters throughout the observation period, so that the estimation results are reliable. 5) Robustness Checks (Internal Robustness), This stage aims to assess the robustness of the estimated results to variations in model specifications, lag length, and sample period. If the estimated results remain consistent under various specifications, then the model can be considered robust internally, thereby increasing the reliability of the research conclusions. 6) Causality Test, Causality analysis, usually carried out with the Granger Causality Test, aims to determine the direction of the cause-effect relationship between variables. This test provides information on whether a variable can be used to predict other variables, both in the short and long term. 7) External Robustness, The final stage is to make comparisons with similar empirical studies in different contexts, periods, or regions. External robustness aims to assess the generalization of research results, so that the findings are not only applicable to the analyzed sample, but are also relevant in the broader economic context.

RESULT AND DISCUSSION

Overview of Java Island

The island of Java is the most populous area in Indonesia with a population of more than 153 million people or around 56–57% of the total national population (BPS, 2024) and plays a role as a center of government, economy, as well as a national food barn with a contribution of more than 31% to Indonesia's agricultural production (Ministry of Agriculture, 2021). However, the agricultural sector in Java faces serious challenges in the form of urbanization and land conversion that reduces productive land, high consumption due to large populations, and fluctuations in food prices that affect the welfare of farmers through the Farmer Exchange Rate (NTP). Previous studies have confirmed the role of macroeconomic factors in influencing NTP, but the results are still inconsistent and rarely highlight Java Island in particular, even though this region has a dual role as the largest food producer and consumer in Indonesia. In addition, most studies have not clearly distinguished between short-term and long-term effects. Therefore, this study analyzes the influence

of the Consumer Price Index (CPI), Gross Regional Domestic Product (GDP) of the agricultural sector, and rice prices on NTP in Java using the Autoregressive Distributed Lag (ARDL) approach to capture short-term and long-term dynamics, so that the results are expected to make an empirical contribution to the literature as well as relevant policy recommendations for improving farmers' welfare and national food security.

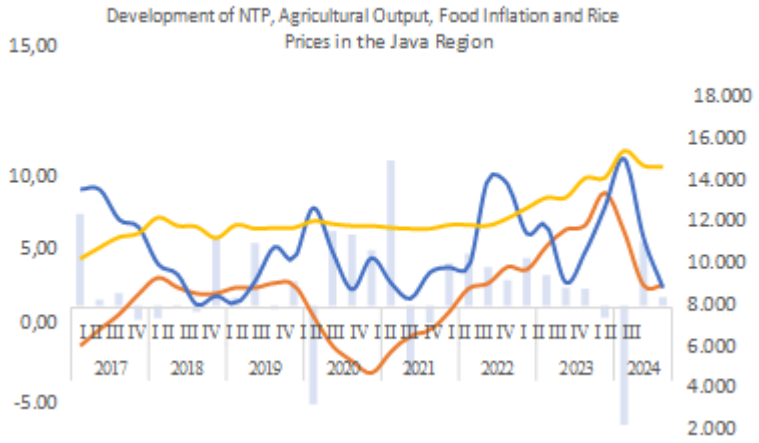

Figure 4. Development of NTP, Agricultural Output, Food Inflation and Rice Prices in the Java Region

As shown in Graph.5, the development of NTP shows an increasing trend from year to year. Although there was a shock in the Covid-19 period due to the non-absorption of agricultural products,thus making moderation in the NTP in that period. However, NTP has recovered along with the opening of borders and food distribution chains as per the government's efforts. Despite the pandemic, the agricultural sector on the island of Java still faces various structural challenges so that it still does not have an optimal impact in supporting the welfare of farmers. Some of the structural challenges that have emerged include climate change, urbanization, and the pressures of converting agricultural land to non-agricultural land. This causes a decrease in the area of agricultural land and has an impact on farmers' productivity. For example, based on the BPS report (2021), the area of rice land in Java has decreased by 1.5% per year in the last five years. This decline results in reduced crop yields and, in turn, affects farmers' exchange rates.

Results Of Data Processing

Stationariness Test (Unit Root Test)

Tabel 1. Stationariness Test (Unit Root Test)

Variable	ADF		Stationary
	T-Statistics	p-value	
Farmer's Exchange Rate (Y)	-5,039	0,0000	Stationary on differentiation First
Consumer Price Index (X1)	-4,363	0,0003	Stationary on differentiation First
GDP (X2)	-4,137	0,0008	Stationary on differentiation First
Rice Price (X3)	-5,608	0,0000	Stationary on differentiation First
Farmer's Exchange Rate (Y)	-5,039	0,0000	Stationary on differentiationFirst

The Augmented Dickey–Fuller (ADF) test showed that all variables, both dependent (NTP) and independent (CPI, GDP, and Rice Prices), were stationary at the first differentiation (I(1)) with

the test statistical value being smaller than the critical value and p-value < 0.05. This means that the zero hypothesis of the existence of root units is rejected, so the data is mean-reverting and does not follow a random walk trend. Thus, the econometric model can be extended to the stage of cointegration analysis or VECM/ARDL without the risk of bias due to root unit problems.

Cointegration test and ARDL estimation

Long - Term Testing

Tabel 2. Long-Run ARDL Estimation Results

Dependent Variable: NTP

Method: ARDL (1,1,1,1) – Long-Run Equation

Sample Period: 2017Q1–2024Q3

Included Observations: 33

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Probability**
CPI (X1)	0.2187	0.0141	15.47	0.000***
GDP (X2)	0.0930	0.0098	9.52	0.000***
Rice Price	0.000568	0.000058	9.83	0.000***
R-squared	0.9916	Mean dependent var	–	R-squared
Adjusted R-squared	0.9893	S.D. dependent var	–	Adjusted R-squared
S.E. of regression	0.0843	Info crit.	–	S.E. of regression
Sum squared resid	–	Schwarz criterion	–	Sum squared resid
Log likelihood	39.386	Hannan-Quinn crit.	–	Log likelihood

Note: ***indicates statistical significance at the 1% level (p < 0.01).

Based on the results of long-term estimates, the CPI variable has a positive and significant effect on the NTP with a probability of < 0.05. The positive coefficient indicates that any increase in the CPI will encourage an increase in the NTP. GDP also has a positive and significant effect on the NTP, meaning that the higher the regional economic growth, the better the exchange rate of farmers. Furthermore, Rice Prices have a positive and significant influence even with a small coefficient, which shows that the increase in rice prices still provides additional benefits for farmers in the long run. The Adjusted R^2 value = 0.9893, which means that about 98.9% of the variation in NTP can be explained by CPI, GDP, and Rice Prices, while the rest is explained by other variables outside the model. This indicates that these three variables are important factors that explain the welfare of farmers in the long term.

Short - Term Test

Tabel 3. Short-Term Tests

Dependent Variable: NTP				
Method: ARDL (1,1,1,1) – Short Run Equation Sample (adjusted): 2017Q1 2024Q3				
Included observations: 33 after adjustments				
Included observations: 33 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔIHK (X1)	-0.0054	0.0583	-0.09	0.927
ΔPDRB (X2)	0.0029	0.0238	0.12	0.903
Δ Harga_Beras (X3)	0.000466	0.0016	0.29	0.772
C	-0.4893	0.1394	-3.51	0.001
ECT(-1)	-0.9527	0.2475	-3.85	0.001
R-squared	0.9916	Mean dependent var	–	–
Adjusted R-squared	0.9893	S.D. dependent var	–	–
S.E. of regression	0.0843	Info crit.	–	–
Sum squared resid	–	Schwarz criterion	–	–
Log likelihood	39.386	Hannan-Quinn crit.	–	–
F-statistic	–	Durbin-Watson stat	–	–
Prob(F-statistic)	–			

In the short term, the variables ΔIHK, ΔPDRB, and ΔHarga Rice had no significant effect on NTP (p-value > 0.05). This shows that short-term changes in prices and economic growth are not strong enough to affect farmers' exchange rates. Nevertheless, the Error Correction Term (ECT) is negative (-0.9527) and significant at the level of 1%, which means that about 95% of the imbalance from the previous period can be corrected in the current period. In the long term, macroeconomic variables (CPI, GDP, and rice prices) have a significant positive effect on the NTP, while in the short term no significant influence is found. Nonetheless, the significant value of ECT suggests that the system will return to long-term equilibrium quickly. This implies that policy interventions that focus only on temporary changes, such as momentary fluctuations in rice prices or CPIs, will not have a direct impact on farmers' welfare. Thus, an effective policy strategy should focus on food price stability, strengthening regional economic growth, and other structural factors that can ensure that farmers' exchange rates remain high and balanced in the long term.

Diagnostic Tests

Table 4. Autocorrelation

Lags (p)	**Chi²**	**df**	**Prob > Chi²**
1	1.039	1	0.3080
With: no serial correlation			

Since the probability value (0.3080) > 0.05, H_0 is accepted → the model does not experience autocorrelation.

Heteroscedasticity

Table 5. Breusch-Pagan/Cook-Weisberg Test Results for Heteroscedasticity

Test Statistics	Value	Probability (p-value)	Conclusion
Chi-square (χ^2)	2.14	0.1435	None heteroskedasticity

H_0: The variance of the error is constant (no heteroscedasticity). With a p-value of > 0.05, H_0 is not rejected, which means that there are no symptoms of heteroscedasticity in the regression model.

Stability Test

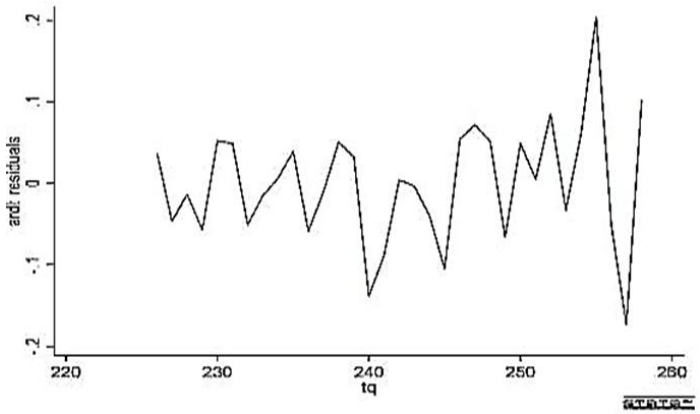

Figure 5. The results of the stability test obtained values that were between -5%-+5%, which showed that this study had stable variables based on the residual measurements

Robustness Checks

Table 6. Estimated Lag Test Results

Lag-order selection criteria

Sample : 229 thru 258 Number of obs = 30

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-309.553				14074.6	20.9035	20.9633	21.0904*
1	-284.870	49.367	16	0.000	7987.9*	20.3246	20.6235*	21.2588
2	-268.193	33.354	16	0.007	8136.86	20.2795*	20.8174	21.9609
3	-260.836	14.714	16	0.546	17145.6	20.8557	21.6327	23.2845
4	-241.781	38.110*	16	0.001	20090.8	20.6521	21.6681	23.8281

Optimal lag
Endogenous : Y x1 dX2 dX3
Endogeneous: _ cons

Based on the results of the optimal lag selection, the lowest AIC and FPE values were found at the 2nd lag, so the ARDL model used lag 2 as the optimal lag. Although HQIC and SBIC show lower lag, AIC and FPE are prioritized in the ARDL model because they are more sensitive to short-term dynamics.

ARDL Model Estimation Results(1,1,1,1)

Table 7. Period 1: Sample 226–240 (n = 15)

Variable	Coefficients	Std. Error	t-Statistics	p-Value	95% Confidence Interval
L.Y.	0.4025	0.3382	1.18	0.275	**-0.4019 to 1.2657**
X1	1.0125	0.3215	3.15	0.008	**0.4271 to 1.4228**
D.X2	0.0286	0.0801	0.36	0.724	**-0.2755 to 0.1495**
D.X1	1.8820	0.2965	6.41	0.000	**1.2595 to 2.7041**
D.X2	-0.2361	0.1931	-1.22	0.246	**-0.6200 to 0.1484**
R^2 = 0.9642 | DJ. R^2 = 0.9052 | Root MSE = 0.2647					

An R^2 value of 0.9642 indicates the model explains 96% of the data variation. A high Adj. R^2 and a low MSE Root (0.2647) indicate that the model has excellent accuracy and fit.

Table 8. Period 2: Sample 241–258 (n = 18)

Variable	Coefficients	Std. Error	t-Statistics	p-Value	Interval 95% Trust
L.Y.	-0.1113	0.4806	-0.23	0.821	-1.1880 to 0.9582
X1	1.2169	0.2002	6.07	0.000	0.7460 to 1.3024
D.X2	0.0932	0.0886	1.05	0.313	-0.0978 to 0.2843
D.X1	0.8923	0.0861	10.4	0.000	0.7160 to 1.0686
D.X2	0.0068	0.0892	0.08	0.938	-0.1807 to 0.1944
D.X3	0.7641	0.0977	7.83	0.000	0.5526 to 0.9756
_cons	-0.5621	0.2555	-2.20	0.050	- 1.1203 to -0.0008
R^2 = 0.9873 | Adj. R^2 = 0.9683 | Root MSE = 0.1863					

The R^2 value = 0.9873 and the Adj. R^2 = 0.9683 indicate that the model is able to explain about 97% of the variation in the Farmer's Exchange Rate. A low MSE root (0.1863) indicates a small rate of prediction error, so the model can be said to be highly accurate and reliable. With a high R-squared (>0.97) and a low MSE root, the model is consistent and shows that rice price stabilization and macroeconomic factors play an important role in maintaining the Farmers' Exchange Rate.

Causality Test

Table 9. Granger causality wald test

Equation	Excluded	chi2	df	Prob > chi2
Y	x1	9.844	2	**0.007**
Y	dX2	13.558	2	**0.001**
Y	dX3	17.361	2	**0.000**
Y	ALL	19.867	6	**0.003**
x1	Y	3.2924	2	**0.193**
x1	dX2	2.9690	2	**0.227**
x1	dX3	2.5917	2	**0.274**
x1	ALL	4.9312	6	**0.553**
dX2	Y	2.5045	2	**0.286**
dX2	x1	3.5484	2	**0.170**
dX2	dX3	2.5412	2	**0.279**
dX2	ALL	4.5717	6	**0.601**
dX3	Y	12.733	2	**0.002**
dX3	x1	13.776	2	**0.001**
dX3	dX2	11.201	2	**0.004**
dX3	ALL	14.349	6	**0.026**

The results of the causality test showed that there was a varied relationship between independent and dependent variables. Specifically, the farmers' exchange rate (Y) is significantly affected by the Consumer Price Index (X1), GDP (X2), and Rice Price (X3), both individually and simultaneously. This is shown by chi-square values of 9.844 (p = 0.007), 13.558 (p = 0.001), and 17.361 (p = 0.000), respectively, as well as a simultaneous test of ALL of 19.807 (p = 0.003), which confirms the causality direction of X1, X2, and X3 with respect to Y. In contrast, the variables X1 (CPI) and X2 (GDP) did not show a significant causal relationship with the other variables or with Y, as reflected by the probability values of > 0.05 in most tests, e.g. X1 against Y (p = 0.193) and X2 against Y (p = 0.286). Interestingly, X3 (Rice Price) seems to have a more dominant role because it has a significant effect not only on Y, but also on X1 and X2. This is shown by the significant chi-square values in various combinations, e.g. X3 against Y (p = 0.002), X3 against X1 (p = 0.001), and X3 against X2 (p = 0.004).

Table 10. External Robustness

Dependent Variable	CE1 (Error Correction Term)	Short-run Coefficient
D_Y (NTP)	4.136 (0.032)*	–
D_X1 (CPI)	–2.233 (0.041)*	0.124 (0.037)*

D_X2 (GDP)	–0.989 (0.278)	0.065 (0.211)
D_X3 (Rice Price)	6.745 (0.009)*	0.218 (0.046)*
Dependent Variable	CE1 (Error Correction Term)	Short-run Coefficient
D_Y (NTP)	4.136 (0.032)*	–

Note: CE1 indicates a long-term adjustment mechanism; * significant at p < 0.05.

The results of the external robustness test using the Vector Error Correction (VECM) model show the existence of short-term dynamics and long-term cointegration relationships between the Consumer Price Index (X1), Gross Regional Domestic Product (X2), Rice Price (X3), and Farmer Exchange Rate (Y). The error correction coefficient at D_Y (4.136; p = 0.032) was statistically significant, indicating that the Farmer Exchange Rate has an effective adjustment mechanism to long-term imbalances, with about 4.1% deviation from the previous period corrected in the current period. In addition, the significance of CE1 in D_X1 and D_X3 (p < 0.05) indicates that the Consumer Price Index and Rice Price play an important role in the adjustment process towards long-term equilibrium. On the other hand, the GDP variable (X2) does not show significance in either the short or long term, indicating that its effect on the Farmer's Exchange Rate is relatively weaker or indirect. The R-squared and chi-square values also reinforce these findings, where the greatest variability is captured by D_Y and D_X3, while other variables have lower explainability.

Furthermore, the results of the cointegration confirmed the existence of a stable long-term relationship between the Farmer Exchange Rate and all explanatory variables, as reflected by a statistically significant beta coefficient (β_X1 = –0.233; β_X2 = –0.0989; β_X3 = –0.000659; p < 0.001). This confirms that structural changes in the Consumer Price Index, GDP, and Rice Prices are consistently associated with the dynamics of the Farmer Exchange Rate in the long term. The most prominent finding was the dominance of the role of Rice Prices, which was reflected in the large and significant CE1 coefficient of D_X3 (6.745; p = 0.009), confirming the crucial influence of this variable on the stability of farmers' welfare. Overall, the external robustness test not only strengthens the validity of the VECM model, but also provides important policy implications. Rice price stability needs to be placed as a priority in the strategy of inflation control and the development of the agricultural sector, because it has a direct effect on the purchasing power and welfare of farmers. Food price control policies, inflation control, and sustainable rice production support are key instruments to maintain long-term balance and strengthen rural economic resilience.

Discussion

The results of this study indicate that, in the long run, food inflation as measured by the Consumer Price Index (CPI), agricultural sector Gross Regional Domestic Product (GRDP), and rice prices exert a positive and statistically significant influence on the Farmer Exchange Rate (NTP) in Java. This finding suggests that increases in food prices, agricultural output, and the value of strategic commodities contribute to improving farmers' welfare over time. In contrast, the short-run analysis reveals that the effects of CPI, agricultural GRDP, and rice prices on NTP are not statistically significant. This implies that temporary fluctuations in macroeconomic indicators or commodity prices do not immediately translate into changes in farmers' welfare. Instead, the adjustment process appears gradual and requires time to materialize. A key finding of this study is the negative and significant Error Correction Term (ECT) coefficient, which indicates a strong

adjustment mechanism toward long-term equilibrium. This result confirms the existence of cointegration among the variables and demonstrates that any short-term disequilibrium will be corrected over time, ensuring system stability. These findings collectively suggest that farmers' welfare in Java is more strongly influenced by structural and long-term factors rather than short-term economic shocks. In particular, rice prices emerge as a crucial variable due to their central role in both production and consumption within Indonesia's agricultural economy.

From an academic perspective, this study contributes to the existing literature by providing updated empirical evidence on the dynamic relationship between macroeconomic variables and NTP in Java. By employing the Autoregressive Distributed Lag (ARDL) approach, this research is able to capture both short-run and long-run effects simultaneously.Unlike conventional econometric methods that often focus solely on short-term relationships, the ARDL model offers a more comprehensive analytical framework. It allows for the identification of long-term equilibrium relationships even when variables are integrated at different orders, making it particularly suitable for time-series data in economic studies. Furthermore, this study highlights the importance of integrating macroeconomic variables, such as inflation and GRDP, with micro-level commodity variables like rice prices. This integrated approach provides a more holistic understanding of the determinants of NTP, which has been relatively underexplored in previous research.In terms of policy implications, the findings underscore the importance of maintaining rice price stability. The government should strengthen its role in managing food stocks, improving distribution systems, and implementing effective market interventions to prevent excessive price volatility. Additionally, enhancing agricultural productivity is essential for improving farmers' welfare. This can be achieved by expanding access to modern technology, increasing financial support for farmers, and developing more efficient agricultural infrastructure, particularly in rural areas across Java. Finally, controlling food inflation requires strong coordination between monetary policy and the real sector. At the same time, promoting sustainable economic growth in agriculture-based regions is crucial to ensuring that their contribution to NTP remains optimal and continues to support long-term improvements in farmers' welfare.

CONCLUSION

This study concludes that in the long run, food inflation as reflected in the Consumer Price Index (CPI), agricultural sector Gross Regional Domestic Product (GRDP), and rice prices have a positive and significant effect on the Farmer Exchange Rate (NTP) in Java. Conversely, in the short run, these variables do not show a significant influence, indicating that farmers' welfare does not respond immediately to short-term economic fluctuations. The negative and significant Error Correction Term (ECT) further confirms the existence of a strong adjustment mechanism toward long-term equilibrium, highlighting the stability of the model and the presence of cointegration among variables. These findings imply that the welfare of farmers in Java is predominantly shaped by structural and long-term economic factors rather than temporary shocks. Among the variables examined, rice prices play a central role, underscoring their strategic importance in the agricultural sector and their broader impact on economic dynamics. From an academic standpoint, this study contributes to the literature by providing updated empirical evidence on the dynamic relationship between macroeconomic indicators and NTP using the ARDL approach. The integration of macro-level variables (inflation and GRDP) with micro-level commodity variables (rice prices) offers a more comprehensive analytical perspective compared to previous studies that tended to examine

these factors separately. In terms of policy implications, the results emphasize the need for the government to ensure rice price stability through effective stock management, distribution systems, and market interventions. Additionally, improving agricultural productivity through better access to technology, financing, and infrastructure is essential to support farmers' income growth. Coordinated efforts to control food inflation, alongside policies that promote sustainable economic growth in agriculture-based regions, are crucial to enhancing farmers' welfare in a consistent and long-term manner.

REFERENCES

Arhan, T. N., Darma, R., & Munir, A. R. (2024). Analyzing factors influencing farmer term of trade for food crops: A case study of South Sulawesi, Indonesia. *Universal Journal of Agricultural Research, 12*(2), 418–428. https://doi.org/10.13189/ujar.2024.120220

Arintoko, A., Sambodo, H., & Priyono, R. (2024). Do international oil prices, exchange rates, and agricultural credit matter for farmers' terms of trade in Indonesia? *Research on World Agricultural Economy, 6*(1), 71–87. https://doi.org/10.36956/rwae.v6i1.1305

Arintoko, A., Sambodo, H., & Priyono, R. (2025). Determinants of agricultural household business terms of trade in Indonesia. *International Journal of Economics and Financial Issues, 15*(5), 130–138. https://doi.org/10.32479/ijefi.19501

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence. *Food Policy, 33*(4), 299–317. https://doi.org/10.1016/j.foodpol.2007.10.005

Birthal, P. S., Negi, D. S., Khan, M. T., & Agarwal, S. (2015). Is Indian agriculture becoming resilient to droughts? *Food Policy, 56*, 1–12. https://doi.org/10.1016/j.foodpol.2015.07.001

Coelli, T. J., & Rao, D. S. P. (2005). Total factor productivity growth in agriculture: A Malmquist index analysis of 93 countries, 1980–2000. *Agricultural Economics, 32*(S1), 115–134. https://doi.org/10.1111/j.0169-5150.2004.00018.x

Daud, I. K., Baruwadi, M. H., & Akib, F. H. Y. (2025). Analisis faktor-faktor yang mempengaruhi nilai tukar petani di Indonesia tahun 2019–2024. *Jurnal Paradigma Ekonomika, 20*(4). https://doi.org/10.22437/jpe.v20i4.51291

Farida, Y., Hamidah, A., Sari, S. K., & Hakim, L. (2024). Modeling the farmer exchange rate in Indonesia using the vector error correction model method. *MATRIK: Jurnal Manajemen, Teknik Informatika, dan Rekayasa Komputer, 23*(2), 309–322.

Headey, D., & Fan, S. (2008). Anatomy of a crisis: The causes and consequences of surging food prices. *Agricultural Economics, 39*(S1), 375–391. https://doi.org/10.1111/j.1574-0862.2008.00345.x

Ivanic, M., & Martin, W. (2018). Sectoral productivity growth and poverty reduction: National and global impacts. *World Development, 109*, 429–439. https://doi.org/10.1016/j.worlddev.2017.07.004

Jayne, T. S., Chamberlin, J., & Headey, D. D. (2014). Land pressures, the evolution of farming systems, and development strategies in Africa: A synthesis. *Food Policy, 48*, 1–17. https://doi.org/10.1016/j.foodpol.2014.05.014

Kharisma, B., & Indrawan, Z. M. S. (2023). Analysis of rice price transmission in West Java, Indonesia. *Cogent Economics & Finance, 11*(1), Article 2266198. https://doi.org/10.1080/23311932.2023.2266198

Murdy, S. (2017). Do prices affect farmer's terms of trade in Indonesia? *Jurnal Manajemen dan Agribisnis, 14*(3), 264–274. https://doi.org/10.17358/jma.14.3.264

Pingali, P. L. (2012). Green Revolution: Impacts, limits, and the path ahead. *Proceedings of the National Academy of Sciences, 109*(31), 12302–12308. https://doi.org/10.1073/pnas.0912953109

Reardon, T., Timmer, C. P., Barrett, C. B., & Berdegué, J. A. (2003). The rise of supermarkets in developing countries: Implications for agri-food systems and the rural poor. *American Journal of Agricultural Economics, 85*(5), 1140–1146. https://doi.org/10.1111/j.0092-5853.2003.00520.x

Renkow, M., Hallstrom, D. G., & Karanja, D. D. (2004). Rural infrastructure, transactions costs and market participation in Kenya. *Journal of Development Economics, 73*(1), 349–367. https://doi.org/10.1016/j.jdeveco.2003.02.003

Rizal, M. (2021). Pengaruh inflasi terhadap investasi pertanian di Indonesia. *Jurnal Ekonomi Pertanian,* 12(1), 45–60. https://doi.org/10.33476/j.e.k.p.v12i1.1530

Sari, R., et al. (2020). Analisis faktor-faktor yang mempengaruhi nilai tukar petani di Kabupaten X. *Jurnal Pertanian Indonesia, 15*(2), 100–115. https://doi.org/10.33476/j.p.i.v15i2.1743

Suharto, A. (2020). Analisis harga beras di pasar tradisional. *Jurnal Pertanian Jawa Tengah, 8*(2), 23–35. https://doi.org/10.33476/j.p.j.t.v8i2.1589

Supriyanto, A. (2022). Pengaruh PDRB terhadap kesejahteraan petani di Jawa. Jurnal Ekonomi Pertanian, 12(1), 15–28. https://doi.org/10.33476/j.e.k.p.v12i1.1517

Suri, O. T., Chamdra, S., Nendissa, D. R., & Mahendra, B. (2024). Changes in strategic food prices and farmers' terms of trade: Evidence from Indonesia. *Anjoro: International Journal of Agriculture and Business, 5*(2). https://doi.org/10.31605/anjoro.v5i2.4270

Syifa Aulia, S., Sulistiyo Rimbodo, D., & Ghafur Wibowo, M. (2021). Faktor-faktor yang memengaruhi nilai tukar petani (NTP) di Indonesia. *JEBA (Journal of Economics and Business Aseanomics), 6*(1), 44–59. https://doi.org/10.33476/j.e.b.a.v6i1.1925

Timmer, C. P. (2010). Reflections on food crises past. *Food Policy, 35*(1), 1–11. https://doi.org/10.1016/j.foodpol.2009.09.002