

AGRICULTURAL FOREIGN DIRECT INVESTMENT AND FARMER EXCHANGE RATE: AN ARDL APPROACH IN INDONESIA

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Abstrak

This study aims to analyze the effect of Foreign Direct Investment (FDI) in the agricultural sector, inflation, and land area on the Farmer Exchange Rate (FER) in Indonesia during the period 1995–2024. This study uses secondary time series data obtained from Badan Pusat Statistik, Bank Indonesia, and other related institutions. The analytical method used is the Autoregressive Distributed Lag (ARDL) model to examine the short-run and long-run relationships among variables. The results show that agricultural sector FDI has a positive and significant effect on FER in the short run, but no significant effect in the long run. Inflation has a positive and significant effect on FER in the long run. Meanwhile, land area only has a significant effect in the short-run lag period and is not significant in the long run. These findings imply that policies should not only encourage foreign investment in the agricultural sector but also ensure that such investment is sustainable and effectively translated into productivity gains. Furthermore, maintaining price stability is essential to support long-term improvements in farmers' welfare.

Keywords: agricultural sector FDI, inflation, land area, Farmer Exchange Rate, ARDL

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INTRODUCTION

Farmers, as the main actors in the agricultural sector, should become an integral part of sustainable development. Increasing farmers' income is important in order to strengthen the foundation of sustainable development for society as a whole. According to Pigou's Theory in McCain (2020) improving welfare plays an important role in supporting economic sustainability. Farmers' welfare is essential for the sustainability of a country's food and

agricultural system. Improving farmers' welfare is also one of the objectives of agricultural development in achieving food self-sufficiency.

One of the indicators used to measure farmers' welfare is the Farmer Exchange Rate (FER). According to Badan Pusat Statistik (2024), the Farmer Exchange Rate is the ratio between the price index received by farmers (I_t) and the price index paid by farmers (I_b), expressed as a percentage. According to Flukeria (2022), FER is an index based on the Modified Laspeyres Index Formula. The Laspeyres Index is an index used in economics to track changes in the cost of a fixed basket of goods and service. The price index received by farmers reflects the commodity prices obtained by producers from agricultural outputs, while the price index paid by farmers reflects the prices of goods and service needed for household consumption and agricultural production processes before transportation and packaging costs are included in selling prices. The success of farmers' economic activities can be observed through an increase in FER. If FER is above 100, farmers are considered prosperous; conversely, if FER is below 100, farmers are considered less prosperous. Therefore, changes in FER are important to analyze because they reflect the dynamics of farmers' welfare resulting from changes in prices, production costs, and economic conditions faced by farmers.

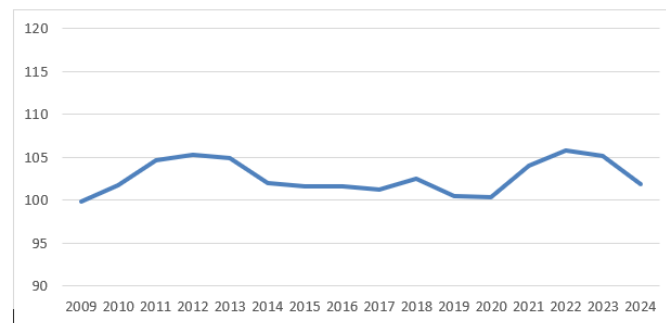


Figure 1. Farmer Exchange Rate

Source: BPS Indonesia

The development of FER during 2009–2024 shows fluctuations in farmers' purchasing power. In 2009, FER was still below 100, indicating that the prices received by farmers were not yet sufficient to cover the prices they had to pay. Afterward, FER increased and remained mostly above 100, particularly during 2011–2013, reflecting a relative improvement in farmers' terms of trade. However, during 2014–2020, FER tended to stagnate and remained close to 100, indicating strong pressure from production costs and household consumption expenses faced by farmers. The increase observed in 2022–2023 reflected an improvement in farmers' purchasing power.

One of the factors influencing FER is inflation. According to the study conducted by Aulia & Syafa'at (2025) Inflation has a negative effect on the Farmer Exchange Rate. Furthermore, land area generally affects FER because it determines the scale of farming activities and farmers' ability to generate income. This finding is consistent with the study conducted by Yasfa et al. (2025) which states that larger agricultural land areas lead to higher production output and increased farmers' income, thereby improving farmers' welfare. Another factor affecting FER is climate change, which significantly influences FER because it directly impacts agricultural production and farming costs. This is supported by the study conducted by Rozci (2021) which explains that weather uncertainty, such as changes in rainfall patterns, increasing frequency of droughts and floods, and rising temperatures, can reduce agricultural productivity and increase the risk of crop failure.

Based on the background described above, the agricultural sector remains the primary source of livelihood for a large proportion of Indonesia's population. However, farmers' welfare, as reflected by the Farmer Exchange Rate (FER), continues to fluctuate and often remains at an unfavorable level. This condition suggests that increases in agricultural production and economic growth do not necessarily translate into improved farmers' welfare. Despite the government's efforts to promote Foreign Direct Investment (FDI) in the agricultural sector, the extent to which such investment contributes to improvements in FER remains uncertain, particularly when considering macroeconomic factors such as inflation and structural factors such as rainfall and land area. While previous studies have examined the relationship between agricultural FDI and farmers' welfare, limited attention has been given to simultaneously analyzing the short-run and long-run effects of agricultural FDI alongside inflation, rainfall, and land area within a single analytical framework. Therefore, this study contributes to the literature by employing the Autoregressive Distributed Lag (ARDL) approach to examine both the short-run and long-run effects of agricultural FDI on the Farmer Exchange Rate in Indonesia during the period 1995–2024.

THEORITICAL REVIEW AND HYPOTHESIS DEVELOPMENT

Welfare theory

Welfare theory, as developed by Arthur Cecil Pigou, emphasizes that economic welfare can be measured through the level of utility or satisfaction individuals derive from the consumption of goods and services. Pigou argued that welfare increases when income distribution becomes more equitable, as an additional unit of income provides greater utility to low-income groups than to high-income groups. He also highlighted the existence of externalities, namely the effects of economic activities that are not reflected in market prices, which may require government intervention through taxes or subsidies to achieve optimal social welfare. The Farmer Exchange Rate (FER) is an indicator used to measure the welfare level of farmers. It is calculated as the ratio between the price index received by farmers (output prices) and the price index paid by farmers (input costs and household consumption expenditures). FER reflects farmers' purchasing power over goods and services. A FER value above 100 indicates that farmers' income is relatively higher than their expenditures, implying an improvement in welfare. Conversely, a FER value below 100 suggests that farmers' expenditures exceed their income, indicating a decline in welfare. Therefore, FER is widely used as a proxy for farmers' welfare in agricultural economics research.

The Multiplier Effect Theory

The Multiplier Effect Theory explains that an increase in investment generates a greater increase in national income and economic activity than the initial amount invested. According to Keynesian economics, investment stimulates production, creates employment opportunities, and increases income, which subsequently leads to higher consumption and further economic expansion. The multiplier process occurs because the income received by one economic actor becomes expenditure for another, creating a chain reaction throughout the economy. In the context of Foreign Direct Investment (FDI), the multiplier effect suggests that foreign capital inflows can enhance economic welfare through increased production capacity, job creation, technology transfer, and infrastructure development. In the agricultural sector, FDI can improve productivity by introducing modern technology, better farming practices, and greater access to markets. These improvements may increase farmers' income

and purchasing power, which are reflected in a higher Farmer Exchange Rate (FER). Therefore, the multiplier effect provides a theoretical foundation for understanding how FDI can indirectly contribute to improvements in farmers' welfare.

Inflation Theory

Inflation refers to a sustained and general increase in the prices of goods and services over a certain period, resulting in a decline in purchasing power. Economic theory identifies **two primary causes of inflation: demand-pull inflation, which occurs when aggregate demand exceeds production capacity, and cost-push inflation, which arises from increases in production costs such as wages and raw materials.** High and uncontrolled inflation can adversely affect welfare, particularly for fixed-income groups such as farmers, by increasing both living expenses and production costs.

Production theory

Production theory explains the relationship between inputs (factors of production such as labor, capital, and land) and the resulting output. In microeconomic theory, the production function illustrates how specific combinations of inputs can generate a certain level of output efficiently. This theory also incorporates the law of diminishing returns, which states that continuously increasing one factor of production while holding other factors constant will eventually lead to progressively smaller increases in output. In the agricultural sector, production theory is essential for understanding how the utilization of inputs such as land, fertilizer, and labor affects agricultural output and, ultimately, farmers' welfare.

Model Development

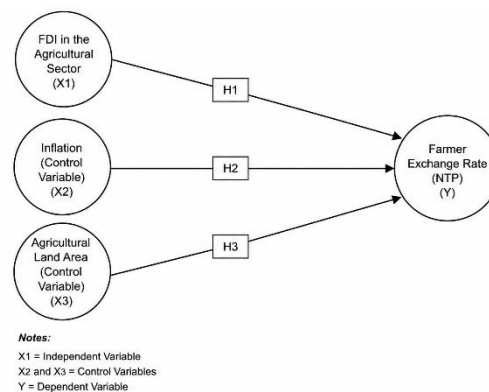


Figure 2
Conceptual Framework

RESEARCH METHOD

This study employs a quantitative approach with an associative research design aimed at analyzing the effect of Foreign Direct Investment (FDI) in the agricultural sector, inflation, and land area on the Farmer Exchange Rate (FER) in Indonesia. The study uses annual time series secondary data from 1995–2024 obtained from Badan Pusat Statistik, Bank Indonesia, and other related institutions. The dependent variable in this study is the Farmer Exchange Rate (FER), while the independent variables consist of agricultural sector FDI, inflation, and land area. The analytical method used is the Autoregressive Distributed Lag (ARDL) model. According to Pesaran, Shin, and Smith (2001), the ARDL model is an

econometric approach used to analyze both short-run and long-run relationships among variables simultaneously. The ARDL approach is widely used because it can be applied to variables with different orders of integration, namely I(0) and I(1), as long as none of the variables are integrated at order two or I(2). The purpose of using the ARDL model in this study is to determine the short-run and long-run effects of agricultural sector FDI, inflation, and land area on the Farmer Exchange Rate in Indonesia. The stages of analysis in this study include stationarity testing using the Augmented Dickey-Fuller (ADF) test, optimal lag selection based on the Akaike Information Criterion (AIC), cointegration testing using the Bounds Test, estimation of short-run and long-run relationships, and classical assumption tests consisting of normality, heteroscedasticity, autocorrelation, and linearity tests. Data processing was conducted using EViews software. The econometric model in this study is formulated as follows:

$$LOG(FER)_t = \beta_0 + \beta_1 LOG(FDI)_t + \beta_2 INFLATION_t + \beta_3 LOG(LAND)_t + \varepsilon_t$$

Where:

- $LOG(FER)$ = Farmer Exchange Rate
- $LOG(FDI)$ = Foreign Direct Investment in the agricultural sector
- $INFLATION$ = inflation rate
- $LOG(LAND)$ = agricultural land area
- ε = error term.

RESULTS AND DISCUSSION

Result

Stationarity testing

Variabel	Level		First Difference		Ordo of Integration
	t-statistics	Prob.	t-statistics	Prob.	
FER	-5.150.879	0.0002	-6.067.791	0.0000	I(0)
FDI	-0.936296	0.7618	-5.680.094	0.0001	I(1)
INFLASION	-3.212.938	0.0328	-4.975.907	0.0007	I(0)
LAND	1.366855	0.9983	-1.500.198	0.0001	I(1)

Table 1. Stationary Testing

The stationarity test was conducted using the Augmented Dickey-Fuller (ADF) test to determine whether the variables are stationary or contain a unit root. In the ARDL model, variables must be integrated at order I(0) or I(1) and not at I(2). The test results show that the Farmer Exchange Rate (FER) and inflation variables are stationary at level form or integrated at order I(0). Meanwhile, Foreign Direct Investment (FDI) in the agricultural sector and land area become stationary after the first difference, indicating that both variables are integrated at order I(1). Therefore, the ARDL model is appropriate for this study because the variables consist of a combination of I(0) and I(1).

Lag Optimum Test

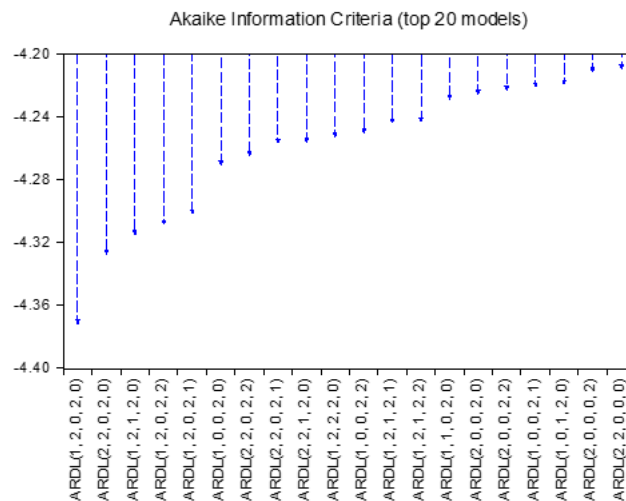


Table 2. Lag Optimum Test

The Akaike Information Criteria (AIC) graph shows the top 20 ARDL models tested in this study. The optimal model is selected based on the lowest AIC value because a lower AIC indicates a better model fit. Based on the graph, the ARDL (2,2,0,2) model has the lowest AIC value, indicating that this model is the most optimal and appropriate for estimating the relationship between the variables in this study.

Bound Test

Test Statistic	Value
F-statistic	25.06407
Critical Value I(1) 5%	3.67

Table 3. Bounds Test Results

The Bounds Test result show that the F-Statistic value of 25.06407 is higher than the upper bound critical value I(1) at the 5% significance level (3.67). This indicates the existence of a long-run relationship (cointegration) among the variables, so the ARDL model can be continued to estimate the short-run and long-run relationships.

R-squared	0.933333	Mean dependent var	4.669.696
Adjusted R-squared	0.914999	S.D. dependent var	0.081447
S.E. of regression	0.023746	Akaike info criterion	- 4.370.372
Sum squared resid	0.010150	Schwarz criterion	- 3.894.585
Log likelihood	7.118.521	Hannan-Quinn criter.	- 4.224.919

Table 4. ADRL Estimating

The ARDL estimation results show that the model has a good level of fit, as indicated by the R-squared value of 0.936616, meaning that approximately 93.66% of the variation in

the Farmer Exchange Rate (FER) can be explained by the independent variables included in the model. In addition, the Prob(F-statistic) value of 0.0000 indicates that the variables jointly have a significant effect on FER.

Classical Assumption Test

Classical Test	Test	Result	Threshold	Conclusion
Normality	Jarque-Bera Test	Prob. Value (0.6512)	Prob. > α (0.05)	Normal Distributed
Autocorrelation	Breusch-Godfrey Serial Correlation LM Test	Prob. Chi-Square (0.2788)	Prob. > α (0.05)	No Autocorrelation
Heteroskedasticity	Breusch-Pagan-Godfrey Test	Prob. Chi-Square (0.4164)	Prob. > α (0.05)	No Heteroskedasticity
Linearity	Ramsey RESET Test	Prob. F (0.0671)	Prob. > α (0.05)	Linear Model

Table 5. Classical Assumption Test

The results of the classical assumption tests indicate that the ARDL model satisfies the required assumptions. The normality test produced a probability value of 0.6512, which is greater than the significance level of 0.05, indicating that the residuals are normally distributed. Furthermore, the autocorrelation test yielded a Prob. Chi-Square value of 0.2788, suggesting that there is no autocorrelation problem in the model. The heteroskedasticity test also showed a probability value of 0.4164, which exceeds 0.05, indicating the absence of heteroskedasticity. In addition, the Ramsey RESET test generated a probability value of 0.0671, which is greater than 0.05, confirming that the model is linear and correctly specified.

ECM Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(PMA)	0.016168	0.005298	3.051.683	0.0066
DLOG(PMA(-1))	0.012908	0.004959	2.602.982	0.0175
DLOG(LAND)	1.517.992	1.109.667	1.367.970	0.1873
DLOG(LAND(-1))	1.971.854	0.750711	2.626.647	0.0166
CointEq(-1)*	-0.475880	0.038637	-1.231.680	0.0000

Table 6. ECM Regression

The ECM regression results show that the Error Correction Term, represented by CointEq(-1), has a negative and significant coefficient of -0.475880 with a probability value of 0.0000. This indicates that the model is stable and capable of adjusting short-run disequilibrium toward long-run equilibrium at a speed of approximately 47.59% each period. In the short run, agricultural sector Foreign Direct Investment (FDI) has a positive and significant effect on the Farmer Exchange Rate (FER), both in the current period and the previous period, as indicated

by probability values below 0.05. Meanwhile, the land area variable is not significant in the current period but becomes positive and significant in the previous period. These result indicate that changes in FDI and land area require time to affect farmers' welfare.

Long-Run Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PMA)	-0.002832	0.017589	-0.161011	0.8738
INFLASI	0.012345	0.003665	3.368.180	0.0032
LOG(LAND)	-9.564.238	6.783.351	-1.409.958	0.1747
C	1.642.980	1.133.016	1.450.094	0.1633

Table 7. Long-Run Estimation

The long-run estimation results indicate that inflation has a positive and statistically significant effect on the Farmer Exchange Rate (FER). This is evidenced by a coefficient value of 0.012345 and a probability value of 0.0032, which is below the 5 percent significance level. These findings suggest that an increase in inflation is associated with an increase in FER in the long run. In contrast, Foreign Direct Investment (FDI) in the agricultural sector and land area do not have a statistically significant effect on FER, as their respective probability values exceed 0.05. Although both FDI and land area exhibit negative coefficient values, their effects are not statistically significant. Therefore, changes in FDI and land area cannot be considered important determinants of FER in the long run based on the estimation results.

Cusum Stability Test

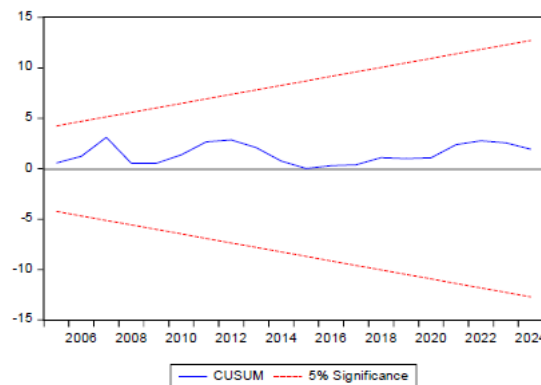


Figure 3. Cusum Test

The results of the CUSUM stability test indicate that the cumulative sum (CUSUM) line remains within the 5% critical boundaries throughout the observation period. The finding suggests that the estimated ARDL model is structurally stable and does not experience parameter instability during the study period. Since the CUSUM line does not cross the critical limits, the null hypothesis of parameter stability cannot be reject. Therefore, the model is considered stable and reliable for analysing both the short-run and long-run relationships among the variables included in the study.

Cusum Square Test

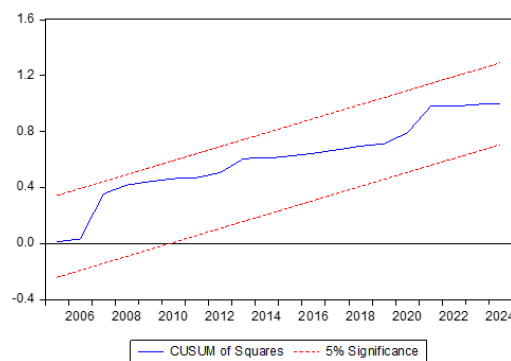


Figure 4. Cusum Square Test

The results of the CUSUM stability test indicate that the cumulative sum (CUSUM) line remains within the 5% critical boundaries throughout the observation period. This finding suggests that the estimated ARDL model is structurally stable and does not experience parameter instability during the study period. Since the CUSUM line does not cross the critical limits, the null hypothesis of parameter stability cannot be rejected. Therefore, the model is considered stable and reliable for analyzing both the short-run and long-run relationships among the variables included in the study.

For discussions

The Effect of Agricultural Foreign Direct Investment (FDI) on the Farmer Exchange Rate (FER)

Based on the estimation results, agricultural sector Foreign Direct Investment (FDI) has a positive and significant effect on the Farmer Exchange Rate (FER) in the short run. The variables $DLOG(PMA)$ and $DLOG(PMA(-1))$ have probability values below 0.05, indicating that increases in agricultural FDI contribute to improving farmers' welfare in both the current and the previous periods. This finding is consistent with the multiplier effect theory, which suggests that foreign investment stimulates economic activity through capital accumulation, technology transfer, employment creation, and productivity improvement. In the agricultural sector, these benefits can increase production efficiency and farmers' income, which is reflected in a higher Farmer Exchange Rate (FER). Since FER measures the ratio between the price index received by farmers and the price index paid by farmers, improvements in agricultural productivity and income resulting from foreign investment can strengthen farmers' purchasing power and welfare.

The result is also consistent with previous studies by Djokoto et al. (2022) and Feryanto (2017), which reported that agricultural FDI contributes positively to agricultural productivity and farmers' welfare. In the Indonesian context, this short-run effect may arise because foreign investment immediately increases access to agricultural machinery, production technology, infrastructure, and working capital, enabling farmers to improve production performance and income within a relatively short period. Consequently, the prices received by farmers tend to increase relative to the costs they incur, leading to an improvement in FER.

However, agricultural FDI does not have a significant effect on FER in the long run, as indicated by the probability value exceeding 0.05. This suggests that the positive impact of foreign investment is not sustained over time. One possible explanation is that the benefits of FDI are concentrated in specific agricultural subsectors or large-scale commercial farms, whereas FER is a composite indicator covering food crops, horticulture, plantations, livestock,

and fisheries. As a result, the long-term benefits of FDI may not be distributed evenly across all farmer groups represented by the FER indicator. In addition, structural challenges such as unequal technology adoption, limited institutional capacity, and differences in regional agricultural development may reduce the long-run contribution of FDI to farmers' welfare in Indonesia.

The Effect of Inflation on the Farmer Exchange Rate (FER)

The long-run estimation results indicate that inflation has a positive and statistically significant effect on the Farmer Exchange Rate (FER), as evidenced by a probability value below 0.05. This finding suggests that an increase in inflation is associated with an improvement in FER over the long run.

According to Keynes' Inflationary Gap Theory, inflation occurs when aggregate demand exceeds the economy's production capacity, leading to a general increase in prices. In the agricultural sector, moderate inflation may increase the selling prices of agricultural commodities received by farmers. When the increase in output prices is greater than the rise in production costs, farmers' income and purchasing power improve, resulting in a higher FER. Since FER reflects the ratio between the price index received by farmers and the price index paid by farmers, higher commodity prices can improve FER as long as production costs do not increase proportionally.

This finding is consistent with previous studies by Aulia and Syafa'at, which reported that inflation significantly affects the Farmer Exchange Rate through changes in agricultural commodity prices and farmers' income. In the Indonesian context, this result may reflect the dominance of food commodity price movements in determining farmers' income. During periods of moderate inflation, increases in agricultural commodity prices may provide greater benefits to farmers than the corresponding increases in production costs. Consequently, farmers experience higher income and improved purchasing power, which contributes to an increase in the Farmer Exchange Rate over the long run.

The Effect of Land Area on the Farmer Exchange Rate (FER)

Based on the ECM estimation results, land area does not have a significant effect on the Farmer Exchange Rate (FER) in the current period. However, the lagged variable $DLOG(LAND(-1))$ has a positive and statistically significant effect in the short run, indicating that changes in land area require time before influencing farmers' welfare. In the long run, land area has a negative but statistically insignificant effect on FER.

This finding can be explained by the Cobb-Douglas production theory, which identifies land as one of the primary factors of agricultural production. Although larger land area has the potential to increase agricultural output, improvements in farmers' welfare depend not only on land availability but also on the productivity of that land. Factors such as technology adoption, capital availability, labor quality, irrigation, and farm management determine whether additional land can generate higher income.

This result is supported by Khoirunnisa', who found that land expansion alone does not necessarily improve farmers' welfare unless it is accompanied by higher productivity and efficient land utilization. In Indonesia, agricultural land is often fragmented, unevenly distributed, and continuously converted to non-agricultural uses. Moreover, many smallholder farmers operate on limited land with varying levels of technology and capital. Consequently, expanding land area alone is insufficient to improve the Farmer Exchange Rate unless it is

supported by productivity-enhancing policies, modern farming technology, and effective land management. This explains why land area only exhibits a significant short-run lag effect but does not significantly influence FER in the long run.

CONCLUSION

Based on the ARDL estimation results, this study concludes that Foreign Direct Investment (FDI) in the agricultural sector has a positive and significant effect on the Farmer Exchange Rate (FER) in the short run but has no significant effect in the long run. This indicates that foreign investment can improve farmers' welfare through increased capital, technology transfer, and production capacity; however, these benefits are not sustained over time because they may not be evenly distributed across agricultural subsectors and regions in Indonesia. Inflation has a positive and significant effect on FER in the long run, suggesting that moderate increases in agricultural commodity prices can improve farmers' income and purchasing power, provided that production costs do not increase at the same pace. Meanwhile, land area only has a significant effect in the short-run lag period and does not significantly affect FER in the long run, indicating that land expansion alone is insufficient to improve farmers' welfare without corresponding improvements in productivity, technology, and farm management.

Overall, the findings imply that improving farmers' welfare in Indonesia requires not only policies that encourage Foreign Direct Investment but also efforts to ensure that investment is translated into sustainable productivity gains. In addition, maintaining price stability, promoting technological adoption, improving agricultural infrastructure, and enhancing land productivity are essential for achieving long-term improvements in the Farmer Exchange Rate.

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