DO EXCHANGE RATES, INFLATION AND AGRICULTURAL CREDIT MATTER FOR FARMERS' TERMS OF TRADE? EMPIRICAL EVIDENCE OF ASYMMETRIC EFFECTS IN INDONESIA

Arintoko*, Herman Sambodo, Rakhmat Priyono
Department of Economics and Development Studies, Faculty of Economics and Business, Universitas Jenderal Soedirman, Purwokerto, Indonesia

*Email: arintoko@unsoed.ac.id

Abstract. The role of farmers in the agricultural sector as food providers is very significant and is still relied upon as a livelihood. This study aims to analyze the determinants of farmers' terms of trade (FTOT) as a measure of welfare for farmers in Indonesia. The study applies the Nonlinear Autoregressive Distributed Lag (NARDL) model for monthly data from January 2010 to December 2023. The NARDL model is applied to capture the asymmetric effects of FTOT determinants. The results show that an increase in inflation decreases FTOT, while an increase in the food industry production index increases FTOT in the long run. Meanwhile, in the short run, rupiah depreciation, an increase in inflation and a decrease in credit decrease FTOT. Inflation is the most significant factor determining farmer welfare. Stabilizing inflation at controlled levels is key to maintaining the purchasing power of farming households. Sectoral linkages with the food industry as users of agricultural sector inputs also support farmer welfare. Monetary policy with a focus on inflation stabilization and agricultural development policies integrated with the industrial sector will greatly encourage farmer welfare.

Keywords: agricultural sector, farmers' terms of trade, Nonlinear Autoregressive Distributed Lag (NARDL) model, asymmetric effects, farmer welfare

A. Introduction

Farmers still survive as a livelihood for some of the Indonesian population as the dominant economic sector shifts from agriculture to industry and services. Farmers, as the main actors in agricultural businesses, have the right to obtain welfare. The farmers' terms of trade (FTOT) is one of the indicators that determine the level of farmer welfare. However, because the current development orientation that focuses on industry and capital tends to ignore rural agricultural development, the FTOT indicator is not included in the development goals.

The sustainability of the agricultural sector cannot be separated from the existence of farmers to continue to engage in agriculture as a source of livelihood. However, the livelihood of a farmer is expected to be able to provide income guarantees to support the lives of farmer households that are almost spread across rural areas. FTOT, as one indicator of farmer welfare, can be influenced by factors that affect the price index received and paid by farmers. The release of Indonesia's FTOT data was carried out by BPS-Statistics Indonesia because data collection and FTOT calculations were also carried out by BPS-Statistics Indonesia.

Several literatures link FTOT with farmer welfare. The price index received by farmers as part of FTOT is a price index that shows the development of commodity prices produced by farmers [1]. Furthermore, FTOT describes the level of exchange capacity/purchasing power of farmers for products purchased/paid for by farmers, including purchased consumption and

production inputs [2]. FTOT is associated with farmers' purchasing power in meeting the needs of farming families [3]. The higher the FTOT, the greater the purchasing power of farming households for consumer products and production inputs. However, this concept simply describes the purchasing power of farmers' income [4]. Therefore, an increase in FTOT indicates an increase in farmer welfare and vice versa [5]. Farmers are the main actors in the agricultural sector who can support food security; of course, the welfare of farmers needs to be a concern, because it is related to the future of rice farming or other food in the sustainability of food production in Indonesia [6].

However, empirically, previous research on farmer welfare measured by FTOT or similar measurements in developing countries is still very limited. Most studies on similar topics only relate to factors that influence the performance of the agricultural sector [7-12]. Most previous studies have not focused on agricultural sector actors, including farmers, in relation to their welfare aspects. Also, existing studies are generally still limited to discussing the determinants of FTOT from a microeconomic perspective [13-15].

The determinants of NTP from a microeconomic perspective are not enough to describe the dynamics of NTP that have an impact on farmer welfare. It is necessary to broaden the perspective by emphasizing macroeconomic factors that have the potential to impact FTOT, especially from the perspective of the influence of the exchange rate, inflation, agricultural credit and sectoral linkages for agriculture. The exchange rate has an impact on the prices of imported products from agricultural inputs such as oil, fertilizers, and feed ingredients that are still imported into Indonesia. Empirically, the exchange rate has a significant impact on agricultural production performance [16-17] and farmers' terms of trade [18]. Inflation as a macroeconomic variable also has a significant impact on FTOT through its influence, especially on the price index paid by farmers. Based on previous empirical findings [19-21], inflation has an impact on the performance of agricultural businesses and farmers' terms of trade. Agricultural credit for farmers certainly also has an impact on the performance of farming businesses through increased production and productivity. Empirically, agricultural credit significantly increases farmer welfare, including farmers' terms of trade [22-23]. Finally, the sectoral linkages between agriculture and industry, especially the food processing industry, will increase the demand for input from farmers which will drive farmers' incomes and increase FTOT. Previous empirical results [24-25] prove that sectoral linkages between agriculture and industry have a positive impact on the agricultural sector and farmers' lives.

This study develops the Nonlinear Autoregressive Distributed Lag (NARDL) model to focus on the asymmetric effects of the difference between local currency depreciation and appreciation on farmers' TOT, along with other explanatory variables, particularly inflation and agricultural credit. If the effect of the determinants of farmer welfare is assumed to be symmetric, meaning that the effects of increasing and decreasing predictors are identical, then in this study, the effect is assumed to be asymmetric. Asymmetric effects are more realistic than symmetric effects and have been empirically proven in previous studies [26-27]. This study aims to analyze asymmetric effects of the determinants of farmers' terms of trade (FTOT) as a measure of welfare for farmers in Indonesia. This study applies the Nonlinear Autoregressive Distributed Lag (NARDL) model to capture the asymmetric effects of influential factors on FTOT.

B. Methods

1. Data and Variable

The study analyzes monthly data from January 2010 to December 2023. The variables examined in the model consist of one dependent variable and four independent variables. Each independent variable is distinguished between the effects of an increase and a decrease on the dependent variable to capture the asymmetric effect. The dependent variable in the model is

farmers' terms of trade and is abbreviated as FTOT. The explanatory or independent variables include the exchange rate, consumer price index, agricultural credit, and food industry production index, which are abbreviated as EXR, CPI, AGCRE, and FIPI, respectively.

FTOT is the ratio between the price index received by farmers and the price index paid by farmers expressed as a percentage. FTOT measures the exchange rate of agricultural products produced by farmers for goods and services consumed and production costs. NTP > 100 means that farmers are experiencing a surplus. Production prices increase more than the increase in consumption prices. Farmers' income increases and becomes greater than their expenses. NTP = 100 means that farmers are breaking even. The increase/decrease in production prices is the same as the percentage increase/decrease in consumer goods prices. Farmers' income is the same as their expenses. NTP < 100 means that farmers are experiencing a deficit. The increase in production prices is relatively smaller compared to the increase in consumer goods prices. Farmers' income decreases and is smaller than their expenses.

The consumer price index is a price index as a measure of the average price for all goods and services consumed by households. The CPI used is based on the base year 2012. Agricultural credit is credit for the agriculture, forestry, and fisheries sectors provided by commercial banks. Credit is stated in billions of rupiah. The food industry production index is a medium and large industry production index specifically for the food industry classification. FIPI is expressed in an index with a base year of 2010.

Data for FTOT and FIPI were obtained from BPS-Statistics Indonesia online access. While data for exchange rates and CPI were accessed from Bank Indonesia. The data obtained from the data sources are then transformed into natural logarithms (LN) for each variable in the estimated model.

2. Model

The formulation of the estimated model by the research objectives is to apply the Nonlinear Autoregressive Distributed Lag (NARDL) model to capture the long-run and short-run asymmetric effects. Pre-model testing is carried out through unit root tests on the data, which aims to determine stationary variables at the first level or difference. Model tests carried out include bounds test, serial correlation test, heteroscedasticity test, stability test, and significance tests of the estimated parameters.

The ARDL model in this study is a development of the NARDL model by Shin et al. [28]. The NARDL model developed is as follows.

$$LNFTOT_t = {}_0 + \sum_{i=1}^{k} \alpha_{1i} LNFTOT_{t-i} + \sum_{i=0}^{l} (\alpha_{2i}^{+} LNEXR_{t-i}^{+} + \alpha_{2i}^{-} LNEXR_{t-i}^{-}) + \sum_{i=0}^{m} (\alpha_{3i}^{+} LNCPI_{t-i}^{+} + \alpha_{3i}^{-} LNCPI_{t-i}^{-}) + (\alpha_{4i}^{+} LNAGCRE_{t-i}^{+} + \alpha_{4i}^{-} LNAGCRE_{t-i}^{-}) + \sum_{i=0}^{p} (\alpha_{5i}^{+} LNFIPI_{t-i}^{+} + \alpha_{5i}^{-} LNFIPI_{t-i}^{-}) + {}_t \quad (1)$$

The calculations for exchange rate increase and decrease are stated as follows.

$$LNEXR_t^{+} = \sum_{j=1}^{t} \quad LNEXR_j^{+} = \sum_{j=1}^{t} \quad max(LNEXR_j, 0) \quad (2a)$$

$$LNEXR_t^{-} = \sum_{j=1}^{t} \quad LNEXR_j^{-} = \sum_{j=1}^{t} \quad min(LNEXR_j, 0) \quad (2b)$$

For the increase and decrease of CPI, AGCRE, and FIPI can be calculated similarly to the exchange rate (EXR) calculation as in equations (2a) and (2b).

C. Results And Discussion

1. Model Test Results

The results of the test on the stationarity of the series of each variable are reported in Table 1. The results show that the statistics of the Augmented Dickey-Fuller (ADF) test and its modification, namely the Dickey-fuller Test with Generalized Least Squares (GLS) Detrending (DF GLS), are significant for the data series of the variables in the first difference. This means

that all variables are stationary in the first difference, I(1), and not I(0). There are no variables whose data series are stationary in the second difference, I(2). This property of the data series allows the use of the NARDL model to estimate asymmetric effects.

Table 1. Results of unit root tests

Variable		ADF Test	DF GLS Test
In level	LNFTOT	0.4308	0.9890
	$LNEXR^+$	-0.4085	3.4404
	$LNEXR^-$	0.2614	4.7442
	$LNCPI^+$	-3.2650**	1.1922
	$LNCPI^-$	-1.3577	2.0516
	$LNAGCRE^+$	-6.0855***	1.0877
	$LNAGCRE^-$	0.0503	3.4940
	$LNFIPI^+$	0.2852	5.5631
	$LNFIPI^-$	1.3711	6.0803
In first difference	ΔLNFTOT	-9.1695***	-8.9618***
	$\Delta LNEXR^+$	-11.1154***	-9.5781***
	$\Delta LNEXR^-$	-12.6632***	-1.9660**
	$\Delta LNCPI^+$	-9.9886***	-2.3408**
	$\Delta LNCPI^-$	-11.3050***	-2.1983**
	$\Delta LNAGCRE^+$	-3.0224**	-3.0271***
	$\Delta LNAGCRE^-$	-12.1473***	-11.2613***
	$\Delta LNFIPI^+$	-15.0385***	-15.042***
	$\Delta LNFIPI^-$	-15.0002***	-11.2613***

*** significant at α = 0.01 ** significant at α = 0.05 * significant at α = 0.1

The existence of a long-run relationship in the NARDL model is tested by the bounds test. The results of the bounds test are presented in Table 2. The test results show that the F-statistic exceeds its critical value at p-value 0.01, which means that the null hypothesis stating that there is no long-run relationship is rejected. The results of the NARDL model estimation indicate a long-run relationship between FTOT and the exchange rate, CPI, agricultural credit, and the food industry production index for increases and decreases. This long-run relationship is a theoretically expected relationship between variables.

Table 2. Bound test results for long-run relationship

F-statistic	p-value	I(0)	I(1)	Conclusion
7.4341	0.1	1.85	2.85	Ho is rejected
	0.05	2.11	3.15	
	0.01	2.62	3.77	

H_0: No long-run relationship

Through the Breusch-Godfrey Serial Correlation LM test and ARCH Heteroskedasticity test, it can be concluded that there is no serial correlation and heteroskedasticity in the model with a p-value of $^{2}(6)$. Meanwhile, the model stability test through the CUSUM test shows that the model stability is met as shown in Figure 1.

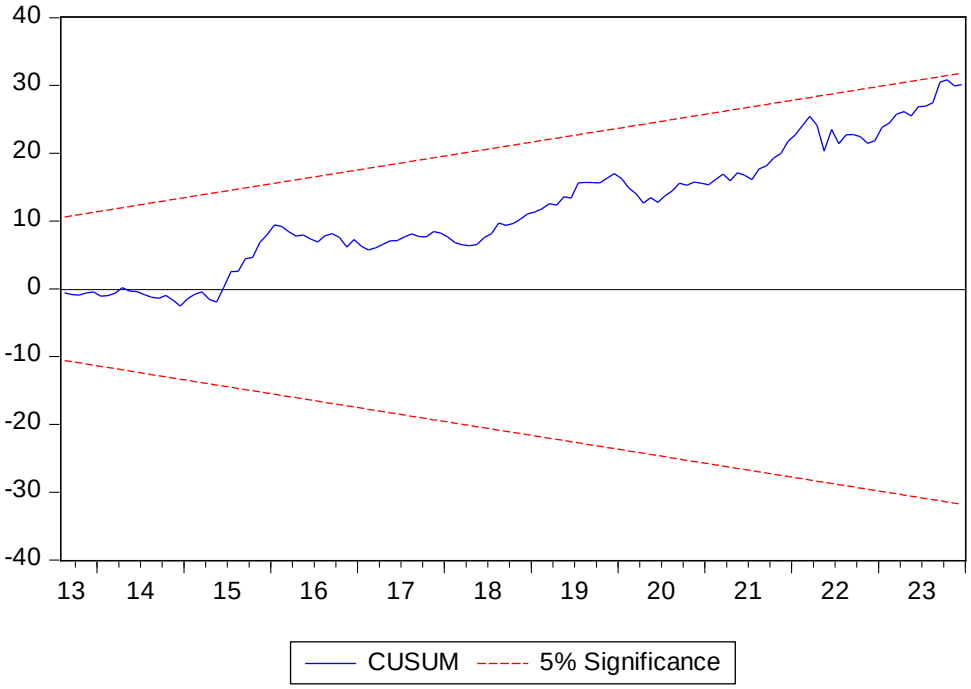

Figure 1. Stability model

2. Model Estimation Results and Discussion

The NARDL model estimation results are grouped into two parts. The first part shows the long-run estimation results summarized in Table 3. The second part presents the short-run estimation results summarized in Table 4. The long-run effect is the effect of an explanatory variable with a stable (constant) coefficient that applies throughout the observation period on the farmers' terms of trade as a permanent effect so that there is only one coefficient (parameter). Meanwhile, the short-run effect is a temporary effect that can change and last for some time.

Table 3. The results of estimated long-run effects

Variables	Coefficients	
	Increasing (+)	Decreasing (-)
Exchange Rates (EXR)	-0.0220 (depreciation)	0.1540 (appreciation)
Consumer Price Index (CPI)	-0.7795*** (inflation)	-2.1835 (deflation)
Agricultural Credit (AGCRE)	-0.0642 (expansion)	0.5946** (contraction)
Food Industry Production Index (FPI)	0.2805*** (grows)	0.0587 (shrinks)

** Significant at α = 5% *** Significant at α = 1%

All variables in natural logarithm

In the long run, rupiah depreciation and appreciation do not significantly affect FTOT. The depreciation of the rupiah decreases the farmers' terms of trade, but not significantly; meanwhile, the appreciation of the rupiah against the US dollar increases the rupiah exchange rate and is also not significant. There is an asymmetric effect on the rupiah exchange rate but it is not significant. Meanwhile, the increase in the consumer price index (inflation) significantly decreases the farmers' terms of trade. Conversely, the decrease in the consumer price index (deflation) does not significantly increase the farmers' terms of trade. There is an asymmetric effect on the influence of the consumer price index on the farmers' terms of trade. If there is 1 percent inflation in the long run, the farmers' terms of trade will fall by 0.7795 percent. Inflation has an impact on lowering the farmers' terms of trade.

The increase in agricultural credit decreases the farmers' terms of trade but not significantly. Meanwhile the contraction (decrease) in agricultural credit significantly decreases the farmers' terms of trade. There is an asymmetric effect on the influence of agricultural credit on the farmers' terms of trade. If there is a contraction in agricultural credit by 1 percent, the farmers' terms of trade rate will fall by 0.5946 percent. The reduction in agricultural credit has an impact on the decline in the farmers' terms of trade.

The increase in the food industry production index significantly increases the farmers' terms of trade, and the decrease in the production index does not significantly decrease the farmers' terms of trade. There is an asymmetric effect on the effect of the production index on the farmers' terms of trade. If there is an increase in the food industry production index of 1 percent, the farmers' terms of trade will increase by 0.2805 percent. The increase in food industry production that absorbs agricultural products as input has an impact on increasing the farmers' terms of trade. So, the coefficient (parameter) with a negative sign has the opposite direction of influence, and the coefficient with a positive sign has the same direction.

In the short run, rupiah depreciation, inflation, and changes in the food industry production index have a significant effect on changes in farmers' TOT. The farmers' TOT is more easily changed by changes in these variables.

The effect of rupiah depreciation is distributed up to 3-time lags (3-month lag), but only the depreciation in the current month and the previous month significantly reduces the farmers' terms of trade. Meanwhile, the short-run model estimation does not find (capture) the effect of rupiah depreciation.

The effect of the increase in the consumer price index (inflation) is distributed up to 6-time lags (6-month lag), but only the effect of significantly reducing the farmers' terms of trade in the current month, the previous four months, and the previous six months. Meanwhile, the decrease in the consumer price index increases the farmers' terms of trade rate but is not significant without a time lag.

The model does not find a short-run effect on the increase in agricultural credit. Conversely, the decrease in agricultural credit reduces the farmers' terms of trade with no time lag and one-time lag (one-month lag), but is not significant.

In the short run, the increase in the food industry production index significantly increases the farmers' terms of trade in the current month (without time lag) although its effect is distributed up to 2-time lags (2-month lag). Meanwhile, the decrease in the food industry production index is distributed up to a 5-month lag. However, the effect of the decline in the production index on the decline in the farmers' terms of trade only occurs with a lag of 4 and 5 months.

Compared to the short run, FTOT has a long-run asymmetric relationship with the exchange rate, inflation, agricultural credit, and the food industry production index as expected theoretically. The increase in CPI, indicating significant inflation, reduces farmers' terms of trade as supported by previous research results [22, 29]. The contraction of agricultural credit significantly shrinks farmers' terms of trade and is in line with previous findings [23, 30-31].

The relationship between the food industry and the agricultural sector supports the increase in farmers' terms of trade with the increase in the food industry production index, which has an impact on increasing farmers' income. These results are in line with previous research results [25, 32] related to the sectoral relationship between agriculture and the processing industry.

Table 4. The results of estimated short-run effects

Variables	Coefficients	
	Increasing (+)	Decreasing (-)
Exchange Rates (EXR)	-0.0510** (no lag); -0.0523** (1 lag); -0.0038 (2 lags); 0.0767*** (3 lags)	NA
Consumer Price Index (CPI)	-0.2267** (no lag); -0,0362 (1 lag); 0.1787 (2 lags); 0.0192 (3 lags); -0.3772*** (4 lags); 0.1735 (5 lags); -0.4171***(6 lags)	-1.2904** (no lag)
Agricultural Credit (AGCRE)	NA	0.1695 (no lag); 0.2915*** (1 lag)
Food Industry Production Index (FIPI)	0.0295*** (no lag); -0.0310 (1 lag); -0.0426 (2 Lags)	0.0148 (no lag); 0.0225 (1 lag); 0.0137 (2 lags) ; -0.0134 (3 lags); 0,0308*** (4 lags); 0,0229** (5 lags)

** Significant at α = 5% *** Significant at α = 1%

All variables in natural logarithm

NA means that short-run model estimates cannot capture short-run effects

D. Conclusion

The results show that an increase in inflation decreases farmers' terms of trade, while an increase in the food industry production index increases farmers' terms of trade in the long run. Meanwhile, in the short run, rupiah depreciation, an increase in inflation and a decrease in credit decrease farmers' terms of trade.

Inflation is the most significant factor determining farmer welfare. Inflation impacts farmers' household expenditures relative to the income they receive. Meanwhile, the contraction of agricultural sector credit significantly impacts decreasing farmers' terms of trade through decreasing income due to less productivity due to capital constraints. Furthermore, the increase in food industry production has significantly increased farmers' terms of trade. Increasing the absorption of agricultural products as inputs for the food industry helps increase farmers' income.

Stabilizing inflation at controlled levels is critical to maintaining the purchasing power of farming households. Sectoral linkages with the food industry as users of agricultural sector

inputs also support farmer welfare. Monetary policy focusing on inflation stabilization and agricultural development policies integrated with the industrial sector will greatly encourage farmer welfare.

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