Assymmetric effect exchange rate to Indonesian agriculture subsector

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Abstract

This study explores the asymmetric effect on the rupiah exchange rate on every subsector agriculture export in Indonesia during 2006-2020. The non-linear ARDL method is used in this study to analyze the asymmetric relationship between exchange rate and export. NARDL method includes short-run and long-run coefficient estimates and embraces the asymmetric effect. The previous studies generally used the linear models on the aggregated data and ignored the differences in each export of the agricultural sub-sector, then they offered ambiguous results. The latest studies have preferred to use the method of NARDL on the agricultural sector in general data. Instead of using agricultural export data for each subsector, this paper considers subsector export data of agriculture. The estimated NARDL results indicate an asymmetric effect of the rupiah exchange rate on exports of the agricultural sub-sector in the long run. In general, there is no asymmetric effect in the short run. Generally, depreciation and appreciation of the Rupiah have a negative effect on exports of the agricultural sub-sector in the long run. However, rupiah appreciation positively impacts lag 2, and depreciation caused a different effect on each sub-sector. The NARDL results suggest that positive movements have lesser impacts than those of negative movements in the exchange rate on the agriculture sector both in the short and long run.

Keywords: *Asymmetry effect, Exchange rate, Export, Agriculture, Nonlinear ARDL*

JEL Classification: C22, F14, F31

INTRODUCTION

Since mid-July 1997, Indonesia has come under great economic stress, which causes the weakening of the rupiah exchange rate against the US dollar. After the collapse of the Bretton Woods system, the subject of the impact of floating exchange rates on international trade becomes an interesting study as the shift from fixed exchange rates that exposed currencies to exchange rate volatility, which might affect trade flows. Exchange rate volatility could potentially lead to market uncertainty, volatility in traders' profits, increase in risk, inflation uncertainty, unfavorable balance of trade, and impacts on production and transaction cost (Juhro & Phan, 2018).

The exchange rate is the main determinant of world trade, and unstable exchange rate movements create global imbalances. Over the last few decades, the global economic system has caused trade and exchange rates (Umaru et al., 2016). Exports are one of the economic sectors that play an important role in expanding the industrial sector market, encouraging other industrial sectors and the economy (Meier, 1996).

According to Simorangkir and Suseno (2014), the exchange rate has a close relationship with exports because the exchange rate determines the price or value of an item to be traded with other countries. If the exchange rate appreciates, commodity exports will also increase, and vice versa; if the exchange rate depreciates, the export rate will decrease.

Data on the role of agriculture in the COVID-19 pandemic era shows that the agricultural sector holds a crucial role in Indonesia's current economic growth. Agriculture has a role in providing food, providing job opportunities, producing raw materials for industry, consuming industrial products in addition to generating foreign exchange (Muhammad-Lawal et al., 2009). The agricultural sector is the only sector with positive export growth in 2020. The Central Statistics Agency (BPS) reported export achievements and increased production in the agricultural sector during the Covid-19 pandemic. From 2019 until now, agricultural exports grew 14.3 percent, with the food crop sub-sector as the highest contributor to the distribution and economic growth of the agricultural sub-sector in 2020. Meanwhile, the agricultural sector is the leading sector that contributes to Indonesia's foreign exchange (Syafa'at et al., 2005). Thus, it is important to analyze the relationship between exchange rate movements and Indonesian agricultural exports.

Changes in the export value of the Indonesian agricultural sector create different responses on the appreciation and depreciation effects. It means that export movements did not follow exchange rate movements when compared from month to month (ITC and IFS, 2020). Based on this, there are indications that the rupiah exchange rate has an asymmetric effect on exports of the Indonesian agricultural sector. Previous researchers have commonly studied the effect of the exchange rate on exports. However, these studies did not consider the asymmetric effect since they used a linear model.

The asymmetrical relationship between the exchange rate and international trade in the Indonesian agricultural sector was difficult to explain. Based on the results of Fadillah's research (2021), changes in Indonesia's agricultural sector exports had a negative effect on changes in exchange rates, depreciation, and appreciation. It could be because, in previous studies, all commodities in the agricultural sector were considered the same. All agricultural sub-sectors have different characteristics and conditions in international trade, which cause different responses to changes in exchange rates. In Indonesia, the agricultural sector in a broad sense is divided into five sub-sectors, namely the food crops sub-sector, the plantation sub-sector, the fisheries sub-sector, the livestock sub-sector, and the forestry sub-sector (Dummary, 1996).

The difference in export conditions of each agricultural sub-sector shows a big difference between the mainstay export sub-sectors such as the plantation, forestry, and fisheries sub-sectors against the sub-sectors, including imported products of Indonesia, namely the food crops and livestock sub-sectors (ITC, 2021). The policies and strategies implemented by the government in the export mainstay sub-sector tend to be different from the sub-sector that still relies on imports. The government tends to increase the added value of sub-sector products from the mainstay of exports. In contrast, the government implements policies to increase production to fulfill domestic needs for products that are not the mainstay of exports.

The interruption in international trade and finance leads to various uncertain effects on foreign trade. The exchange rate uncertainty on trade flows can be categorized as a small impact attached to the very high volatility of exports and imports. There is no doubt that this high volatility in trade flows has a major influence on the export and import decision-making process (Baum, 2009). So far, previous studies have

generally used an asymmetrical approach in evaluating the effect of the agricultural export exchange rate and only concerned the agricultural sector in general. Thus, this research was intended to investigate the effect of the exchange rate on agricultural exports in each sub-sector with an asymmetric approach. This research aims to observe whether there is an asymmetric exchange rate effect in each agricultural sub-sector and investigate the different effects caused by the interruption of the rupiah exchange rate towards exports in each agricultural sub-sector. Therefore, this research has become a consideration for the government to determine the correct policy when the Indonesian rupiah exchange rate depreciates or appreciates.

METHODS

The dependent variable used in this study is the export value of each agricultural sub-sector which is accessed through the ITC (International Trade Community). The independent variable is the real exchange rate obtained from the ITC (International Trade Community). This study used secondary data in monthly time series (quarterly times series) for 180 months from January 2006 to December 2020. The method used in this study is Nonlinear Autoregressive Distributed Lag (NARDL) with an asymmetric approach.

Nonlinear Autoregressive Distributed Lags (NADRL) method was used to assess the asymmetric relationship between the exchange rate and exports in each agricultural sub-sector. The cointegration test is used in the model because it is found that there is no stationarity in the level, but the first difference. Model variations are used to get the best model. The stationarity test was the first stage of testing on time series data, which aims to test the stationary of the data. Determining the optimum lag on the dependent and independent variables aims to determine the best model using the minimum lag.

Suppose exports in each agricultural sub-sector and exchange rates were cointegrated in the cointegration context. It means that although they were temporarily away from each other, they tend to return to equilibrium in the long period. There are three possible cointegration cases: the presence of linear cointegration, the presence of non-linear cointegration, and the lack of cointegration. In a recent study, Shin et al. (2011) developed the asymmetric ARDL cointegration methodology, which used positive and negative partial sum decomposition to detect asymmetric effects in both the long and short run. ARDL's asymmetric specification allows for joint analysis of non-stationarity and non-linear issues in the context of an unrestricted error correction model.

The new variable described the occurrence of appreciation and depreciation. According to this approach, the time series of the rupiah exchange rate was decomposed into two parts, namely ERt^+ and ERt^-, and was described in the following formula;

$$ERt^+ = \sum_{j=1}^{t} \Delta ER_t^+ = \sum_{j=1}^{t} \max(\Delta ER_{t,0}) \quad \ldots \ldots (1)$$

$$ERt^- = \sum_{j=1}^{t} \Delta ER_t^- = \sum_{j=1}^{t} \min(\Delta ER_{t,0}) \quad \ldots \ldots (2)$$

Where ΔER_t^+ dan ΔER_t^- are partial sum processes of appreciation and depreciation of rupiah exchange rate. Therefore, the formulation of the model in the research of exchange rate effect on the value of agricultural exports in each sub-sector in Indonesia with an asymmetric approach. Equation models were developed for each sub-sector. Therefore there were five equation models to evaluate the asymmetric effect of the rupiah exchange rate on exports of each Indonesian agricultural sub-sector. The following is a general NARDL model between the rupiah exchange rate and exports in

each sub-sector concerning the research of Shin et al. (2014), which is shown in the following equation;

$$\Delta LNX_t = \mu + \rho LNX_{t-1} + \theta^{+} LNER^{+}_{t-1} + \theta^{-} LNER^{-}_{t-1} + \sum_{j=1}^{p-1} \gamma j \ \Delta LNX_{t-j} + \sum_{j=0}^{p-1} \pi j \ ^{+}\Delta LNER^{+}_{t-j} + \sum_{j=0}^{p-1} \pi j \ ^{-}\Delta LNER^{-}_{t-j} + et \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

This study conducted estimation using the following model five times to observe the asymmetric effect of the rupiah exchange rate on exports of each agricultural sub-sector. This model incorporates an asymmetric approach in the short and long run. ΔLNX_t shows changes in the natural logarithm of the export value in each of Indonesia's sub-sectors affected by changes in the rupiah exchange rate. In the long-run relationship, LNX_{t-1} shows the natural logarithm of exports in each sub-sector. LNER+t-1 and LNER-t-1 symbolize the long-run exchange rate variable in the equation. In the short-run relationship, ΔLNX_{t-j} is the changes the natural logarithm of food crop exports. The natural logarithm of exports in each sub-sector is differentiated and takes a positive or negative LNX value. Meanwhile, the exchange rate variable in the short run is symbolized by $\Delta LNER^{+}_{t-j}$ and $\Delta LNER^{-}_{t-j,}$ which are changes in the natural logarithm of the positive exchange rate in the short run, where the natural logarithm of the exchange rate is differentiated, and a positive or negative LNER value is taken.

The ordinary least square (OLS) equation from equation (3) was used to test the truth of the long-run asymmetric relationship. Technically, we test the null hypothesis, which stated that all variable coefficients are zero ($H0{:}\omega 1 = \omega 2^{+} = \omega 2^{-} = \omega 3 = \omega 4 = 0$), contrary to this hypothesis was these all coefficients are not zero. Rejecting the null hypothesis means that there is an asymmetric effect. The Wald's test was used to see asymmetric tests in the long and short run. In the Wald test, we tested the hypothesis to see whether the long-run coefficients had an asymmetric effect with each other ($H0{:}Lr^{+} = Lr^{-}$). In the short run, it can be tested with the assumption that the sum of the short-run asymmetric coefficients was similar ($H0 = \sum_{j=1}^{q-1} \rho_i{}^{+} = \sum_{j=1}^{q-1} \varepsilon_i{}^{-}$) it was contrary to the alternative hypothesis with different quantities.

RESULTS AND DISCUSSION

Descriptive statistics provide an overview or description of data seen from the average value (mean), standard deviation, maximum, minimum, and coefficient of variation.

Table 1. Descriptive statistics

Variable	Min	Max	Mean	Stdev	Coef. Var
Exchange Rate	8.508	16.367	11.422	2.211.14	0.1936
Food Crop Sub-sector	26.447	215.299	96.309	38.402.10	0.3987
Plantation Sub-sector	511.123	3.047.459	1.778.330	558.483.90	0.3140
Forestry Sub-sector	522.876	1.036.055	772.465	99.268.30	0.1285
Livestock Sub-sector	1.448	10.305	6.836.04	1.581.51	0.2313
Fishery Sub-sector	144.212	553.591	303.971.74	94.450.58	0.3107

N or the amount of data for each valid variable is 180. Rupiah exchange rate (X) as the independent variable, the minimum value is 8,508, the maximum value is 16,367, and the mean value is 11,422. The smallest value of exports of the agricultural sub-sector is the livestock sub-sector, with a value of 1.488. The largest value of exports of the agricultural sub-sector as a whole is the plantation sub-sector, with a value of 3,047,459. The average value for all exports of the agricultural sub-sector has the smallest value in the livestock sub-sector and the highest in the plantation sub-sector.

Comparison of the average value of each variable is greater than the standard deviation or deviation from the datum of these variables shows good results for all variables. The value of the coefficient of variation is only the forestry sub-sector, which has a coefficient of variation below 0.2, which means that only the forestry sub-sector has uniform data. According to Sudjana (1996), if the coefficient of variation value is less than 20 percent or 0.2, it is considered uniform data. In contrast, other sub-sectors have a coefficient of variation above 0.2, which is not uniform. According to Sudjana (1996), if the coefficient of variation value is greater than 20 percent or 0.2, the data is considered non-uniform.

The Phillips Perron Test (PP) test was carried out to assess the availability of stationary in the data. In this test, the automatic lag selection was used based on the Schwarz Information Criterion (SIC) criteria. If the p-value of t-ADF or t-PP is smaller than the critical value of MacKinnon, it can be concluded that the data used is stationary. Data testing was carried out at the level and first difference levels. The data stationarity test is the main thing that must be conducted before further testing on time series data. Table 2 shows that the rupiah exchange rate variable and fishery sub-sector export were not stationary.

In contrast, the export variable from the food crops, plantation, forestry, and livestock sector was stationary. Table 1 data's stationarity test results also indicate that at the first difference level. All variables have a smaller t-statistic than MacKinnon and show significance due to less than 1 percent probability, so all export variables in the agricultural sub-sector are stationary at the first difference.

Table 2. The results of the Phillips and Perron data stationarity test (1988)

Variable	Level		First Difference	
	t-stat	Prob.	t-stat	Prob.
Exchange Rate	-0.8535	0.8008	-12.9491	0.0000***
Food Crop Sub-sector	-3.1708	0.0234**	-24.4506	0.0000***
Plantation Sub-sector	-5.0347	0.0000***	-35.9335	0.0001***
Forestry Sub-sector	-7.3951	0.0000***	-111.0348	0.0001***
Livestock Sub-sector	-7.4295	0.0000***	-36.77534	0.0001***
Fishery Sub-sector	-2.4078	0.1410	-89.14221	0.0001***

*Note : ***, ** significant at the 1 percent, 5 percent*

The lag determination considers the Akaike Info Criterion (AIC) value, including the maximum dependent and independent lag. The program automatically provides lag results to the model with the minimum Schwarz Criteria value. The optimum lag is determined to determine the best model—the optimum lag results from five exchange rate asymmetric relations models for each Indonesia's agricultural sub-sectors. In general, it shows lag differences from all analyzed countries, but the average value of the optimum lag ranges from zero to four.

A cointegration test was also carried out in this study. The cointegration test was used to identify the long-run relationship between the export value of each agricultural sub-sector and the rupiah exchange rate. Cointegration testing used the bound test on the four research models where F-statistics indicated each test. The cointegration test on the model was carried out by comparing the value of F-statistics with the lower bound I(0) and upper bound I(1) values, following the Cointegration Bound Testing according to Pesaran et al. (2001). The cointegration test results on the ARDL and NARDL models can be seen in Table 3. Table 3 shows that the F-Statistic value of all export variables in each agricultural sub-sector was greater than the upper bound I(1). Thus, it can be concluded that there was cointegration for all export variables of the agricultural

sub-sector and the exchange rate. It means that there is an effect of the rupiah exchange rate on exports of all agricultural sub-sectors in the model that has a cointegration relationship or has a long-run relationship.

Table 3. Cointegration test results

Variable	F-Stat	Prob.	Table Bound Test 99%		Cointegration Result
			I(0)	I(1)	
Food Crop Sub-sector	6,3819	0,0026***	5,15	6,36	Cointegrated
Plantation Sub-sector	8,3180	0,0000***	5,15	6,36	Cointegrated
Forestry Sub-sector	6,9107	0,0002***	5,15	6,36	Cointegrated
Livestock Sub-sector	10,1925	0,0000***	5,15	6,36	Cointegrated
Fishery Sub-sector	6,6480	0,0003***	5,15	6,36	Cointegrated

*Note: *** Significant at the 1 percent*

The estimation of the asymmetric NARDL model aims to observe the relationship between the rupiah exchange rate and exports in each of Indonesia's agricultural sub-sectors, which is shown in Table 3. The estimated model that could show a non-linear relationship in the long run with the short run. The diagnostic test implies that the model was statistically acceptable. The value of AdjR2 in the model of each sub-sector was obtained from 0.2654 to 0.4235, implying that in the model, the effect of the exchange rate on exports of each agricultural sub-sector, there were other factors besides the exchange rate that affect changes in agricultural exports. The number in the LM test is a serial correlation test, where all LM test values indicate that the hypothesis is null. Therefore there is no autocorrelation for all models. The HET test shows a statistical test for heteroscedasticity. In all models, it shows no heteroscedasticity problem at all significance levels. The model stability test is used to see the stability of the variables and errors in the model by comparing CUSUM and CUSUMQ. In the CUSUM test, all export models of the agricultural sub-sector have a CUSUM line within the 5 percent significance line. It can be concluded that the variable in the model was stable. However, for the CUSUMQ test, the livestock sub-sector export model has a CUSUMQ line out of the 5 percent significance line. Therefore it can be concluded that the error in the model was unstable. While the other sub-sector export model has a CUSUMQ line that is within the 5 percent significance line, so it can be concluded that the error in the model was stable.

The lag error correction term test was significant and had a negative value. It was appropriate that the exports of all Indonesian agricultural sub-sectors and the rupiah exchange rate had a cointegration test. The value of the error correction term describes the adjustment speed in the long-run balance as a response to the imbalance due to short-run interruption. The value of the lag error correction term coefficient varies in each sub-sector. The lag error correction term value in each agricultural sub-sector with the smallest value was -0.2118, and the largest value was -0.3662. The smallest error correction term lag value comes from the food crops sub-sector of -0.2118, which means that exports of the food crops sub-sector and the rupiah exchange rate adjust in the long run at a rate of 21.18 percent per month and become the agriculture sub-sector with the slowest adjustment. The plantation sub-sector has the largest error correction term lag value of -0.3662, which means that it is the fastest sub-sector in making adjustments at a speed of 36.63 percent per month. In the second position, the forestry sub-sector with a lag error correction term of -0.3603. Meanwhile, the value of the lag error correction term for the livestock and fishery sub-sectors had a lag error correction of -0.2975 and -0.2967, respectively, so that exports of the livestock and fishery sub-

sectors against the rupiah exchange rate could adjust in the long run at a rate of 29.75 percent and 29.67 percent per month.

The application of Wald statistic test in the long and short-run aims to assess whether there is an asymmetric effect in the long and short run. The value in brackets which is in the below of the test result is the probability value of the Wald test. In the long run the null hypothesis was H_0: $L^+_r = L^-_r$, and the alternative hypothesis was H_1: $L^+_r \neq L^-_r$. If H_0 is rejected then there is an asymmetric effect in the long run. Based on the estimation results in Table 3, it shows that almost all export sub-sector models have W_{LR} values smaller than 0.05, which means that almost all agricultural sub-sectors have an asymmetric effect in the long run. Except for the forestry sub-sector export model, which has a W_{LR} value greater than 0.05, this sector does not have an asymmetric impact on the long run. In the short run, the null hypothesis is formulated as follows $H_0 = \sum_{j=1}^{q-1} \boldsymbol{\rho}_i^+ = \sum_{j=1}^{q-1} \boldsymbol{\varepsilon}_i^-$, and the formula for the alternative hypothesis is $H_0 = \sum_{j=1}^{q-1} \boldsymbol{\rho}_i^+ \neq \sum_{j=1}^{q-1} \boldsymbol{\varepsilon}_i^-$. With this formula, based on Table 4, only models in the forestry sub-sector have a Wsr test value less than 0.05, so that only models in the forestry sub-sector have an asymmetric effect in the short run. In contrast, models in other subsectors do not have an asymmetric effect in the short run.

The asymmetric relationship between the rupiah exchange rate and exports of each agricultural sub-sector is a double log function, which can be interpreted as elasticity. In the food crops sub-sector, in the long run, the effect of changes in the rupiah exchange rate, both depreciation and appreciation, was not significant and had a negative impact on changes in exports of the food crops sub-sector. When the Rupiah depreciated by 1 percent, the change in the food crops subsector exports decreased by 0.1951 percent. Meanwhile, when the Rupiah appreciated by 1 percent, the food crop sub-sector exports decreased by 1.1110 percent. Based on the theory, changes in the food crop sub-sector exports when depreciation was intended to increase exports. The rupiah depreciation might reduce the price of export products to trigger an increase in exports. Based on Wuryadi's research (2015) changes in food crop exports that were not in accordance with this theory can be caused by other factors besides the rupiah exchange rate that affects exports of the food crop subsector. In addition, the low competitiveness of food crop export products in the international market can also be an influential factor. This is also supported by the fact that the rupiah exchange rate, both when it depreciates and appreciates, did not significantly affect changes in exports of the food crop sub-sector in the long run.

The fact shows that it was difficult for producers and exporters of agricultural products to relocate resources or production factors to export in response to increased price competitiveness (Firdaus et al., 2018). This is because there was no demand for goods in Indonesia. The low competitiveness and demand for exports of the food crops subsector are due to the fact that Indonesian export products have not been able to fulfill the quality standards of the international market and the high selling prices of export products of the Indonesian food crop subsector, which is due to the high prices of production factors. In the short run, the exchange rate during appreciation did not show a significant and positive impact on exports of the food crops sub-sector with a value of 1.0531 at lag 2. This means that when the Rupiah appreciated by 1 percent, the exports of the food crops sub-sector would experience a change of 1.0531 percent. At the same time, the rupiah depreciation has an optimum lag of zero, which means that changes in the exchange rate in the previous period had no impact on the exchange rate when it depreciates in the current and future periods.

Table 4. NARDL estimation of the effect of the rupiah exchange rate on exports of all Indonesian agricultural sub-sectors

Sector 1: Food Crop Sub-sector

lag	ΔXP_t	ΔER^+_t	ΔER^-_t	XP_{t-1}	ER^+_{t-1}	ER^+_{t-1}
1	-0,3915 (0,0000)***		1,0482 (0,1545)	-0,2118 (0,0003)***	-0,0413 (0,6927)	-0,2354 (0,1296)
2	-0,1714 (0,0190)**		1,0531 (0,1357)			

AdjR2	LM	HET	Lpos	Lneg	WLR	WSR	Cusum	Cusum SQ
0,2654	0.8643	0.6124	-0,1951 (0,6965)	-1,1110 (0,1194)	14,6770 (0,0002)***	No Need	stable	stable

Sector 2: Plantation Sub-sector

lag	ΔXPt	ΔER^+t	ΔER-t	XP_{t-1}	ER^+_{t-1}	ER^-_{t-1}
1	-0,4523 (0,0000)***		0,6430 (0,5317)	-0,3662 (0,0000)***	-0,3811 (0,0160)**	-0,7436 (0,0027)***
2	-0,2284 (0,0015)***					

AdjR2	LM	HET	Cusum	Cusum SQ	Lpos	Lneg	WLR	WSR
0,4065	0.4703	0.0756	Stable	Stable	-1,0405 (0,0102)**	-2,0304 (0,0005)	26,3017 (0,0000)***	No Need

Sector 3: Forestry Sub-sector

lag	ΔXPt	$\Delta ER+t$	ΔER-t	XPt-1	ER+t-1	ER+-1
1	-0,3905 (0,0000)***	-1,2585 (0,0004)***	0,8763 (0,0810)*	-0,3603 (0,0000)***	0,0312 (0,6391)	-0,0085 (0,9289)
2	-0,1200 (0,1044)		0,8503 (0,0583)*			

AdjR2	LM	HET	Cusum	Cusum SQ	Lpos	Lneg	WLR	WSR
0,3827	0.1248	0.5358	Stable	Stable	0,0865 (0,6377)	-0,0234 (0,2628)	1,5175 (0,2197)	9,5431 (0,0023)***

Sector 4: Livestock Sub-sector

lag	ΔXPt	$\Delta ER+t$	ΔER-t	XPt-1	ER+t-1	ER+-1
1	-0,2975 (0,0012)***		0,8330 (0,1295)	-0,4937 (0,0000)***	-0,4524 (0,0003)***	-0,8323 (0,0001)***
2	-0,0809 (0,3303)		1,0972 (0,0743)*			
3	-0,1781 (0,0064)***					

AdjR2	LM	HET	Cusum	Cusum SQ	Lpos	Lneg	WLR	WSR
0,4235	0.0599	0.0789	Stable	Unstable	-0,9164 (0,0000) ***	-1,6858 (0,0000) ***	54,4954 (0,0000)***	No Need

Sector 5: Fishery Sub-sector

lag	ΔXPt	$\Delta ER+t$	ΔER-t	XPt-1	ER+t-1	ER+-1
1	-0,2967 (0.0022)***	-0,5377 (0.2962)	0,7511 (0.3006)	-0,3872 (0,0000)***	-0,0540 (0.5579)	-0,3540 (0.0160)**
2	-0,1372 (0.1334)	0,9409 (0.0974)*	1,0693 (0.0932)*			
3	-0,1473 (0.0516)*					

AdjR2	LM	HET	Cusum	Cusum SQ	Lpos	Lneg	WLR	WSR
0,3300	0.2962	0.3411	Stable	Stable	-0,1392 (0,5624)	-0,9140 (0,0086) ***	44,4775 (0,0000) ***	1,5188 (0,2195)

*Note : ***, **,* significant at the 1 percent, 5 percent, 10 percent*

In the plantation sub-sector, short-run estimation shows the exchange rate when appreciation does not show a significant and positive impact on exports of the plantation sub-sector with a value of 0.6430 at lag 2. It means that when the Rupiah appreciates by

1 percent, the exports of the food crops sub-sector will experience a change of 0,6430 percent, as for the long-run estimation when depreciation was significant and had a negative impact on exports of the agricultural sector with a value of -1.0405. It means that when the rupiah exchange rate depreciated by 1 percent, the change in exports from the agricultural sector decreased by 1.0405 percent. The rupiah exchange rate appreciated significantly and had a negative impact on exports of the plantation sub-sector with a value of -2.0304. It means that when there was an appreciation of the Rupiah by 1 percent, the change in the Indonesian plantation sub-sector exports decreased by 2.0304 percent. It shows that changes in the export of the plantation sub-sector negatively influenced the Rupiah's appreciation and depreciation. This finding contradicts the theory that exports will move according to the exchange rate movement, namely, when the currency is appreciated, exports decrease. In contrast, when the currency depreciates, then exports would be increased. It indicates that Indonesia's plantation sub-sector exports were influenced by factors other than the exchange rate, which means it was not only affected by the exchange rate.

According to Susanti (2017), the rupiah exchange rate did not significantly affect the trade balance in Indonesia. Thus, the policy of seeking a depreciating exchange rate was less effective on Indonesia's trade balance. In addition to the exchange rate, the trade barrier factor that applies to exports of the plantation sub-sector is also a factor that exports of the plantation sub-sector cannot respond to an increase when there is depreciation. The plantation sub-sector, which is the main export sub-sector, faces many barriers, both tariff and non-tariff, from export destination countries. Issues encountered in the palm oil commodity were Renewable Energy Directive (RED). RED is a policy implemented in the European Union to limit the use of palm oil-based biofuels because carbon from CPO-based biofuels exceeds the standards set by the European Union, namely 35 percent (Khairunisa, 2017). Meanwhile, other plantation commodities face high standardization requirements which are also carried out by export destination countries for plantation products such as coffee, cocoa, and nutmeg.

Exports of the forestry sub-sector were the second-largest contribution after the plantation sub-sector to agricultural sector exports. The forestry sub-sector commodity was one of the leading sectors in Indonesia's export commodities (Jose, 2021). In short-run estimates, the presence of an asymmetric effect indicates that changes in depreciation and appreciation should be configured separately because interruptions tend to have different impacts on forestry sub-sector exports. The rupiah appreciation was significant at the 10 percent level and positively impacted forestry sub-sector exports with a value of 0.8503 in lag 1. This means that when the Rupiah appreciates 1 percent, the change in Indonesia's forestry sub-sector exports increases by 0.8303 percent in lag 2, depreciation significant and a negative impact on exports of the forestry sub-sector with a value of 1.2585 at lag 1. This means that when the Rupiah depreciates by 1 percent, the change in the Indonesian forestry sub-sector exports decreases by 1.2585 percent in lag 1. This is in line with research by Baek and Xu (2020) that in the export of the forestry sub-sector, there is an asymmetric effect of changes in exchange rates in the short run. Whereas, it shows that in the long run, the estimated changes in forestry sector exports had a negative effect influenced by the Rupiah's appreciation, and shows a positive effect when the depreciation of the Rupiah influenced it. This is in accordance with the theory that explains the movement of exports following the exchange rate movement, namely, when the currency appreciates, exports would decrease. In contrast, the currency depreciated, exports would increase (Tweeten, 1992).

The livestock sub-sector was a loser sector in Indonesia's export variables (Abdullah & Imran, 2021). The main export commodities from the Indonesian livestock sub-sector are fat, dairy products, animal feed, live pigs, butter, skin, processed meat, and offal. In contrast, the main export destination countries are Hong Kong and China (BPS, 2020). Based on Table 10 in the short run, the estimation results of the exchange rate during depreciation show a significant and positive impact on exports of the livestock sub-sector with a value of 1.0972 at lag 2. It means that when the Rupiah depreciated by 1 percent, the exports of the food crop subsector would experience a change of 1.0972 percent. Depreciation is significant and has a negative impact on exports of the livestock sub-sector with a value of -0.9164. This means that when the rupiah exchange rate is 1 percent, the change in exports of the livestock sub-sector decreases by 0.9164 percent. The rupiah exchange rate appreciated significantly and had a negative impact on exports of the livestock sub-sector with a value of -1.6858. This means that when there is an appreciation of the Rupiah by 1 percent, the change in Indonesia's livestock sub-sector exports decreases by 1.6858 percent. In the long-run estimation, changes in livestock sub-sector exports negatively influenced the Rupiah's appreciation and depreciation. This is presumably because Indonesia is not a major exporting country for livestock commodities. Even though there was a decline in selling prices on the international market due to the depreciation of the exchange rate, it could not encourage an increase in demand for the export volume of the livestock sub-sector. The low competitiveness of export commodities in the livestock sub-sector also caused no increment in exports when there was a rupiah depreciation (Abdullah & Imran, 2021). The low competitiveness of livestock sub-sector commodities was due to the high prices of livestock products so that they could not compete with export commodities from other countries. In this case, farmers still have to struggle with high production costs because the price of animal feed tends to be high.

One of the leading export in Indonesia was the fisheries sub-sector. The main export commodities from the fisheries sub-sector include tuna–skipper–cob (TCT), squid–cuttlefish–octopus (CSG), crab–crab, and seaweed (Seferina, 2019). In the short run, the appreciation was significant and positively impacted exports of the fisheries sub-sector with a value of 2.6969 at lag 1. It means that when the Rupiah appreciates 1 percent, the change in exports of the Indonesian agricultural sector increases by 2.6969 percent at lag 1. Meanwhile, depreciation was significant and positively impacted Indonesia's agricultural export sector of 3.0231 in lag 2. It means that when the Rupiah depreciated by 1 percent, the change in exports of the Indonesian agricultural sector increased by 3.0231 percent in lag 2. It is in accordance with Kesuma's (2018) research on the effect of the exchange rate on Indonesian shrimp exports to the United States. In the short run, the Rupiah exchange rate has no significant effect on the volume of Indonesian shrimp exports to the United States. Meanwhile, the long-run estimation shows that depreciation was not significant and had a negative impact on exports of the fisheries sub-sector with a value of -0.1392. It means that when the rupiah exchange rate depreciates by 1 percent, the change in exports of the fisheries sub-sector decreases by 0.1392 percent. The rupiah exchange rate appreciated significantly and had a negative impact on exports of the agricultural sector with a value of -0.9140. It means that when there is an appreciation of the Rupiah by 1 percent, the Indonesian fishery sub-sector exports decrease by 0.9140 percent. Based on the effect of the rupiah exchange rate on exports of the fishery sub-sector in the long run, changes in the export of the fishery sub-sector were more responsive to the Rupiah's appreciation than depreciation.

In general, the results obtained from the NARDL estimation in this study indicate

an asymmetric export reaction in each agricultural sub-sector in Indonesia. In the long run, exports of the agricultural sub-sector responded negatively to the Rupiah's depreciation. Only exports of the forestry sub-sector responded positively to the Rupiah's depreciation. Only plantation and livestock sub-sectors exports significantly impacted the Rupiah's depreciation. Meanwhile, when the Rupiah appreciates, changes in exports in all agricultural sub-sectors respond negatively. In the long run, the greatest effect of the rupiah exchange rate, both when depreciation and appreciation of the exports of each agricultural sub-sector, occurs in exports of the plantation sub-sector and the smallest on exports of the forestry sub-sector. The Rupiah's appreciation also has a greater influence than when the rupiah depreciation occurs in the long run, except for exports of the forestry sub-sector. Only exports of the livestock and fishery sub-sectors are significant to the Rupiah's appreciation in the long run.

Meanwhile, in the short run, the rupiah depreciation was only significant in the forestry sub-sector export at the level of 1 percent with a negative sign. In contrast, the rupiah depreciation was significant at the 10 percent level in lag 2 and positive in the fisheries sub-sector. Meanwhile, when the rupiah appreciation occurred, all sub-sector exports were positive. Still, at the 10 percent level, significant sub-sectors were forestry sub-sector exports, livestock sub-sector exports, and fisheries sub-sector exports at lag 2.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In this study, instead of looking for the relationship between the rupiah exchange rate and agricultural exports in general, this study investigates the relationship between the rupiah exchange rate and the exports of each agricultural sub-sector in Indonesia.. In particular, this study evaluates the asymmetric effect of the rupiah exchange rate on each agricultural sub-sector and the magnitude of the effect of changes in the rupiah exchange rate on changes in exports in each agricultural sub-sector in the long and short run. This study also investigated the subsector with the greatest exchange rate influence in the long and short run. In this study, all variables were stationary in the first difference and had cointegration in the long run.

This study used the Nonlinear ARDL (NARDL) method to investigate an asymmetric effect in the long and short-run between the rupiah exchange rate and exports in each agricultural sub-sector. The data used in this study were monthly data on the real exchange rate (Rp/USD) and the export value of the agricultural sub-sector in the period January 2006 to December 2020. The empirical results show various conclusions. It was found that there was an asymmetric exchange rate effect on exports of the food crops sub-sector, plantation sub-sector, livestock sub-sector, and fishery sub-sector in the long run. On the other hand, there was no asymmetric effect between the rupiah exchange rate and exports of the forestry sub-sector in the long run. In the short run, only the export of the forestry sub-sector had an asymmetric effect on the rupiah exchange rate.

The estimation results in this study indicate that in the short run when rupiah depreciation occurs, only forestry sub-sector exports respond significantly and have a negative sign. In contrast, in fisheries sub-sector exports, rupiah depreciation gave a positive but not significant response. Meanwhile, all sub-sector exports positively affected the Rupiah's appreciation. Still, the exports of the sub-sectors that had significance with the Rupiah's appreciation were exports of the forestry sub-sector,

livestock sub-sector, and fishery sub-sector. In the long run, when the Rupiah depreciated, all exports from the agricultural sub-sector responded negatively, except for exports from the forestry sub-sector, which responded positively to the Rupiah's depreciation.

On the other hand, all sub-sectors respond negatively when the Rupiah appreciates. The export sub-sector that provided the greatest response to changes in the rupiah exchange rate both during depreciation and appreciation, in the long run, was the plantation sub-sector. In contrast, the export sub-sector that provided the smallest response was the export of the forestry sub-sector. Meanwhile, when the Rupiah depreciated in the short run, the export of the forestry sub-sector gave the greatest response. When there was an appreciation of the Rupiah, the export of the livestock sub-sector gave the greatest response. Based on this study, it was found that the appreciation of the Rupiah generally gave a greater response than the depreciation.

Recommendations

Based on the estimation results of this study, it shows the existence of a long-run asymmetric effect. On the other hand, the magnitude of the depreciation coefficient is slightly different from the appreciation coefficient, which implies an asymmetric effect. Each sector has a different reaction of exports towards the speed of change in the real exchange rate. Thus, knowing information about these reactions may be useful for increasing exports in each of the agricultural subsectors. The model results imply that the side effects of rupiah appreciation are greater for depreciating than the beneficial effects of depreciation. In other words, currency depreciation is the preferred policy option to increase a country's level of exports. Despite this low significance, the government cannot depend solely on changes in the exchange rate to increase exports in all agricultural sub-sectors. Based on the estimation results on exports of the food crops sub-sector and livestock sub-sector, which are the loser sector in international trade, Indonesian agriculture has low competitiveness in the international market.

Therefore, besides generating policies by relying on rupiah depreciation, it also needs policies that help producers increase production and reduce production costs to ensure the export prices in these sub-sectors can be lower and compete with export products from other countries. In the exports of all agricultural sub-sectors, many obstacles should be encountered by exporting products from the Indonesian agricultural sector in export destination countries regarding product quality standards and environmental issues. Improving the quality of resources and fulfilling environmental quality certification plays an important role in exports of all agricultural sub-sectors. It is recommended that the government conduct more research and development of seed varieties and increase efficiency in applying raw materials and modern technology. Technology transfer in agricultural production plays an important role in increasing agricultural production and economic growth.

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