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ABSTRACT

Indonesia's real effective exchange rate has shown an upward trend over the past three decades. This condition indicates a weakening price competitiveness of Indonesian products in the international market, potentially impacting the dynamics of bilateral trade in the long term. This variable indicates the real exchange rate against all trading partners, adjusted for price levels between countries. Many studies on the relationship between exchange rates and the trade balance often use symmetric techniques, as is common in economic modeling. However, this technique can produce biased empirical results because changes in a variable in the real world are often asymmetric. This study uses the Nonlinear Autoregressive Distributed Lag method for the period 2002 Q1 to 2023 Q4. The estimation results show that in the long run, there is an asymmetric effect on the exchange rate in Indonesia, where the impact of real depreciation has a greater influence than real appreciation. This indicates that real depreciation in the long term has a negative impact that can disrupt domestic production and hinder export performance.

Keywords: Real Effective Exchange Rate, Trade Balance, NARDL

JEL Classification: F1, F4, C1

ABSTRAK

Nilai tukar efektif riil Indonesia menunjukkan tren peningkatan selama tiga dekade terakhir. Kondisi ini mengindikasikan melemahnya daya saing harga produk Indonesia di pasar internasional, sehingga berpotensi memengaruhi dinamika perdagangan bilateral dalam jangka panjang. Variabel ini menunjukkan nilai tukar riil terhadap seluruh negara mitra dagang, yang telah disesuaikan dengan tingkat harga antar negara. Banyak penelitian tentang hubungan nilai tukar terhadap neraca perdagangan sering kali menggunakan teknik simetris sebagaimana pemodelan ekonomi pada umumnya. Padahal, teknik tersebut dapat memberikan hasil empiris yang bias karena perubahan suatu variabel dalam dunia nyata seringkali bersifat asimetris. Penelitian ini menggunakan metode Nonlinier Autoregressive Distributed Lag selama kurun waktu 2002 Q1 sampai dengan 2023 Q4. Hasil estimasi menunjukkan bahwa dalam jangka panjang, terdapat efek asimetris nilai tukar di Indonesia, dimana dampak dari depresiasi riil memiliki pengaruh lebih besar daripada apresiasi riil. Hal ini menunjukkan bahwa depresiasi riil dalam jangka panjang memberikan dampak negatif yang dapat mengganggu produksi dalam negeri dan menghambat kinerja ekspor.

Kata Kunci: Nilai Tukar Efektif Riil, Neraca Perdagangan, NARDL

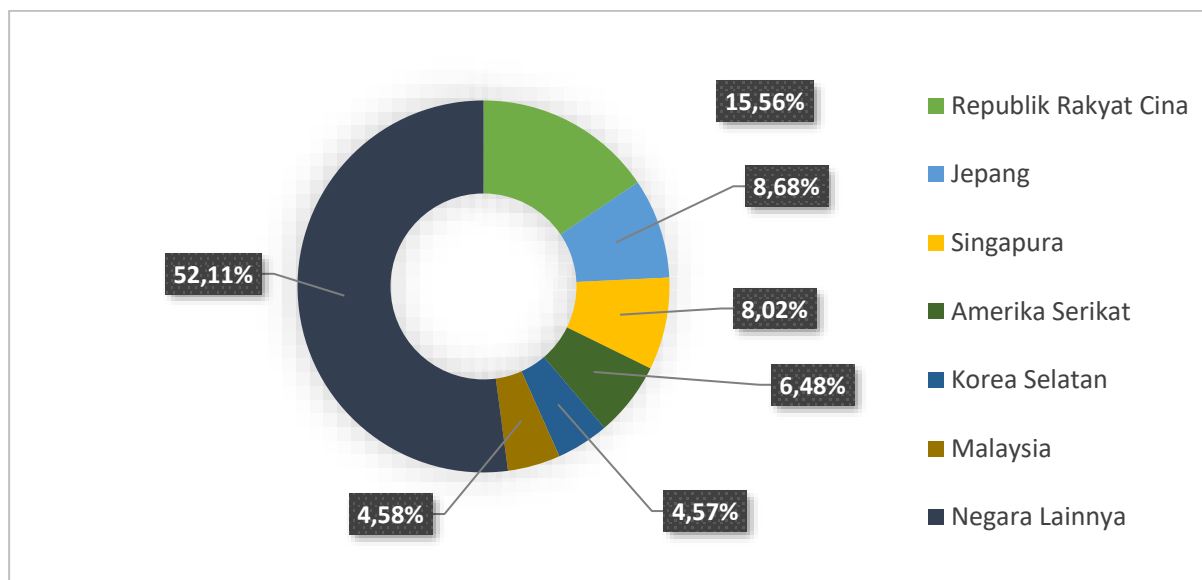
JEL Classification: F1, F4, C1

INTRODUCTION

Globalization has increased the interaction between countries, one of which is economic interaction. Globalization is a process where the flow of ideas, people, goods, services and capital becomes increasingly free and leads to economic integration (IMF, 2002). Indonesia, as a small open economy, applies a free-floating exchange rate system, which means that this open economy is not only influenced by internal domestic factors but is also influenced by the economic conditions of other countries, especially those that trade with Indonesia. Countries that adhere to an open economic system tend to have a higher sensitivity to external factor shocks

compared to countries that adhere to a closed economic system. In the end, the trade balance becomes an important indicator in an open economic system as a tool for measuring export and import activities. Firdaus (2020) states that a trade balance surplus that is considered good is when there is an increase in both exports and imports provided that the value of exports is greater than imports. Based on IMF data (2023), Indonesia has experienced a trade surplus over the last 2 decades with an equally increasing trend in exports and imports. Apart from that, the value of Indonesia's exports is above the value of imports. This shows that Indonesia's trade performance is in good condition.

Figure 1: Average Percentage of Indonesian Trading Activity 2011 - 2023



Source: Bank Indonesia, 2024 (processed)

Based on Figure 1, there are six of Indonesia's largest trading partner

countries which contribute almost 50% of Indonesia's total export and import

activities. These countries are China, Japan, Singapore, United States, South Korea and Malaysia. The Fred (2024) shows the

movement of Indonesia's real effective exchange rate from January 1994 to February 2024.

Figure 2: Indonesia's Real Effective Exchange Rate January 1994 – February 2024



Source: The Fred, 2024

Figure 2 shows that Indonesia's real effective exchange rate has generally strengthened after the Asian financial crisis, although it experienced a sharp decline during 1997–1998. This indicates a real appreciation of the rupiah relative to Indonesia's trading partners. However, this pattern may differ from the nominal exchange rate movement, since REER also reflects inflation differentials between Indonesia and its trading partners. Therefore, even when the nominal rupiah depreciates, the REER may appreciate if domestic prices increase faster than foreign prices. This condition creates an empirical puzzle, since real appreciation is generally expected to reduce export competitiveness,

while Indonesia's exports have continued to increase over time. This suggests that the relationship between the exchange rate and trade performance may not be linear or symmetric, and may also depend on other factors such as import dependence, production structure, and global demand.

Unlike research on nominal exchange rates, studies on real effective exchange rates in Indonesia are still rarely conducted. This is because data regarding the real effective exchange rate provided by institutions such as Bank Indonesia, the Central Statistics Agency and other government agencies is still limited (Brilliant et al., 2020). Many studies on the relationship between exchange rates and

the trade balance often use symmetric estimation techniques as one of their main characteristics. This means that currency depreciation and appreciation will have the same impact on the trade balance. However, Hanif (2019) shows that each trading player can have different reactions and expectations when the exchange rate experiences depreciation or appreciation. Price rigidity can also produce different responses to the trade balance due to changes in exchange rates (Bahmani-Oskooee and Fariditavana, 2015). Due to price rigidity, the validity of symmetric estimation results becomes questionable. Kapetanios et al. (2003) explains that most economic and financial data have a nonlinear relationship. The use of linear models can produce biased empirical results. Therefore, it is possible that the impact of exchange rate changes on the trade balance is asymmetric.

A study conducted by Truong and Vo (2023) shows that the exchange rate has an asymmetric impact on the trade balance in both the long and short term. This means that a decrease and increase in the exchange rate of the same magnitude have different impacts on the trade balance.

DATA

This research uses secondary data with the time period 2002 Q1 – 2023 Q4. All data in this research cannot be obtained directly so

Another study by Bahmani-Oskooee and Aftab (2018) tries to investigate the effect of exchange rate asymmetry on the trade balance between Malaysia and China by comparing the Linear ARDL model and the Nonlinear ARDL Model. The study results show that the nonlinear ARDL model is more effective in explaining the influence of the exchange rate on the trade balance. They also found an asymmetric impact of the exchange rate on the trade balance between Malaysia and China.

Until now, literature that specifically examines the influence of the exchange rate on the asymmetric trade balance is still very limited (Safaat, 2020). Research in Indonesia also rarely considers the asymmetric impact of the exchange rate on the trade balance. Most of the existing research on the effect of exchange rates on the trade balance usually uses symmetric estimation techniques. From this background, this research aims to: (1) Analyze whether there is an asymmetric impact of the real effective exchange rate on Indonesia's trade balance; (2) Analyze how the exchange rate influences Indonesia's trade balance.

calculations need to be carried out first based on the components that form the variables. The variables used in this research come from Bank Indonesia, IMF

and World Bank. The following are the variables used in the research:

Table 1: Variable, Notation, Designation

No	Variable	Notation	Designation
1	Trade Balance	TB	Dependent Variable
2	Real Effective Exchange Rate	REER	Independent Variable (Interest)
3	Inflation	INF	Independent Variable (Control)
4	Relative Macroeconomic Activity	RMA	Independent Variable (Control)

Source: Researcher, 2024

In calculating the real effective exchange rate, the countries used are China, Japan, Singapore, the United States, South Korea and Malaysia. This country was chosen because it is Indonesia's largest trading partner, which has contributed more than 50% of export-import activities.

1) Trade Balance (TB)

$$TB_t = \frac{X_t}{M_t}$$

2) Real Effective Exchange Rate (REER)

$$REER_t = \sum_{i=1}^n TAW_i \times RER_{it}$$

$$RER_{it} = NER_{it} \times \frac{CPI_{it}}{CPI_t^{IND}}$$

3) Inflation (INF)

$$INF_t = \frac{CPI_t^{IND} - CPI_{t-1}^{IND}}{CPI_{t-1}^{IND}} \times 100\%$$

4) Relative Macroeconomic Activity (RMA)

$$RMA_t = \frac{\frac{NGDP_t^{IND}}{DGD P_t^{IND}}}{\sum_{i=1}^n EW_i \times \frac{NGDP_{it}}{DGD P_{it}}}$$

Following previous exchange-rate and trade-balance studies by Truong & Vo.,

2023; Jiang & Liu., 2023; Widiyono et al., 2021; Bahmani-Oskoe & Aftab., 2018, trade balance is measured as the logarithm of the export-import ratio, $TB_t = \log(X_t/M_t)$. This ratio is preferred to the difference form $(X-M)$ because it is scale-free, less sensitive to the unit of measurement, and captures the relative performance of exports against imports in a form suitable for logarithmic estimation.

METHODOLOGY

Pesaran and Shin (1999) and Pesaran et. al (2001) developed the ARDL (Autoregressive Distributed Lag) method to deal with variables that are integrated to different degrees. The ARDL method can be used on mixed integrated variables and can also be used if all variables are integrated at the level or first difference. The ARDL model was later developed into NARDL by Shin et. al (2013). The fundamental reason behind the development of the NARDL model is

because there may be differences in the impact of a dependent variable in the form of an increase or decrease (Schorderet, 2003). The real effective exchange rate (REER) variable is decomposed into positive (POS) and negative (NEG). In this case, the real effective exchange rate consists of positive changes (rupiah depreciation) and negative changes (rupiah appreciation). Thus, producing 2 new variables as follows

$$POS = \log REER_t^+ = \sum_{j=1}^t \Delta \log REER_j^+ = \sum_{j=1}^t \max(\Delta \log REER_j, 0) \quad (1)$$

$$NEG = \log REER_t^- = \sum_{j=1}^t \Delta \log REER_j^- = \sum_{j=1}^t \min(\Delta \log REER_j, 0)$$

(2)

Then, the POS and NEG variables are entered into the standard linear ARDL model specification to obtain the following NARDL model:

Equation 3 is a NARDL model that will be used to estimate the effect of the real effective exchange rate asymmetrically on Indonesia's trade balance. The NARDL model estimation is carried out by first estimating the linear ARDL model, then forming an asymmetric variable on the REER (real effective exchange rate). If the coefficient values for the POS and NEG variables have different magnitudes, then it is certain that there is an asymmetric

impact. However, the difference in coefficient values between POS and NEG must go through a Wald test.

The hypothesis for the Wald test is as follows: H_0 : There is no asymmetric effect

H_1 : There is an asymmetric effect

$$\begin{aligned} \Delta \log TB_t = & \beta_0 + \sum_{k=1}^{n1} \beta_{1k} \Delta \log TB_{t-k} \\ & + \sum_{k=0}^{n2} \beta_{2k} \Delta \log REER_{t-k} \\ & + \sum_{k=0}^{n3} \beta_{3k} \Delta INF_{t-k} \\ & + \sum_{k=0}^{n4} \beta_{4k} \Delta \log RMA_{t-k} \\ & + \sum_{k=0}^{n5} \beta_{6k} \Delta \log REER_POS_{t-k} \\ & + \sum_{k=0}^{n6} \beta_{7k} \Delta \log REER_NEG_{t-k} \\ & + \lambda_0 \log TB_{t-1} \\ & + \lambda_1 \log REER_{t-1} + \lambda_2 INF_{t-1} \\ & + \lambda_3 \log RMA_{t-1} \\ & + \lambda_4 \log REER_POS_{t-1} \\ & + \lambda_5 \log REER_NEG_{t-1} + \mu_t \end{aligned} \quad (3)$$

RESULTS AND DISCUSSION

Data Stationarity

To see the stationarity of the data, a unit root test is needed as is a requirement for time series models. This research uses the Augmented Dickey-Fuller (ADF) stationarity test. The results of the stationarity test can be seen in Table 2

Table 2: Data Stationarity Test Results (ADF Method)

Variable	t-statistic	
	Level I(0)	First Difference I(1)
▪ Trade Balance	0.3705	0.0000***
▪ Real Effective Exchange Rate	0.1486	0.0000***
▪ Inflation	0.0000***	0.0000***
▪ Relative Macroeconomic Activity	0.8797	0.0240**

note: ***significant at $\alpha=1\%$; ** significant at $\alpha=5\%$; * significant at $\alpha=10\%$

Source: Author Estimation, 2024

In Table 2, it is known that the trade balance, real effective exchange rate, and macroeconomic activity are relatively not stationary at level, but stationary at first difference. Meanwhile, inflation has remained stationary at the level. Based on the results of the stationarity test, it can be concluded that the main requirements for using the ARDL method have been fulfilled.

Long Run Equilibrium (Cointegration)

To see balance in the long term, a bound test is used by looking at the F-Statistics value. If the F-Statistics value is greater than the upper limit of I(1), then there is a long-term relationship. The results of the cointegration test can be seen in Table 3 below.

Table 3: Bound Test Results

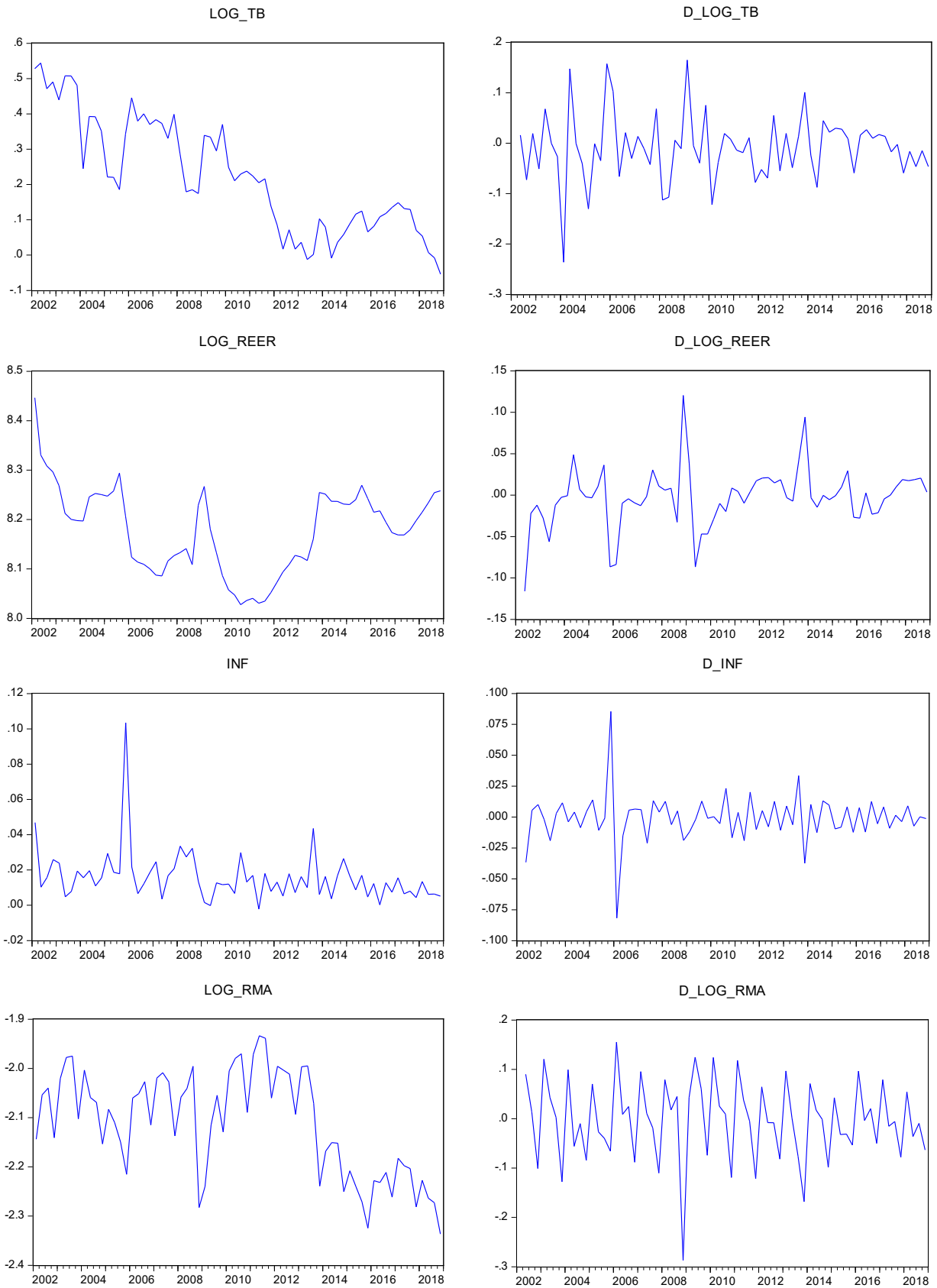
Model	F-Statistic	Bound	Critical Value		
			10%	5%	1%
Nonlinear	4.5058	I(0)	2.20	2.56	3.29
ARDL		I(1)	3.09	3.49	4.37

Source: Author Estimation, 2024

The bound test results show an F-Statistics value of 4.5058, which is greater than the upper limit critical value at 10%, 5% and

1%, so it can be concluded that there is cointegration or a long-term relationship.

Figure 3: Variable Graph at Level and First Difference



Source: Author Estimation, 2024

Estimation of Nonlinear ARDL

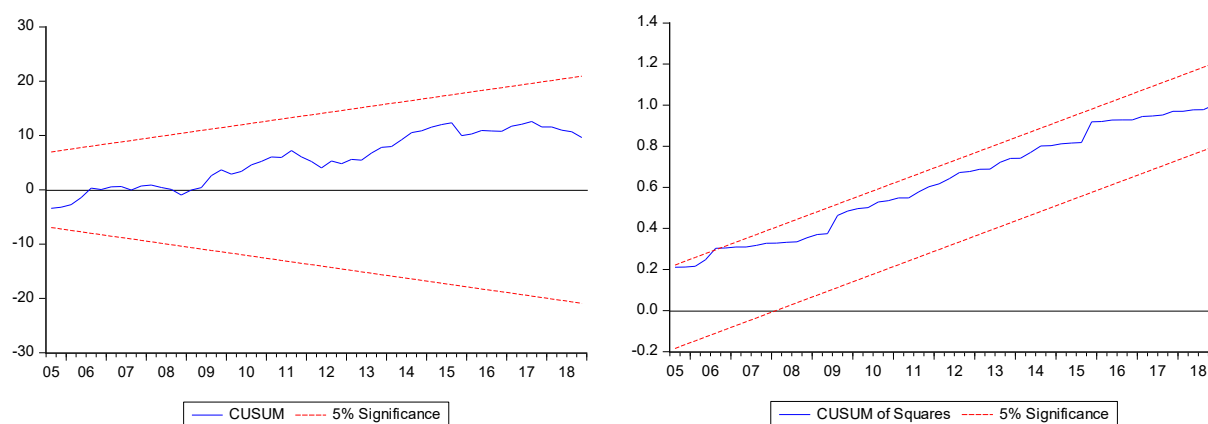
Table 4: ARDL Nonlinear Estimation Results

Independent Variable	Short Run Estimation		Long Run Estimation	
	Dependent Variable: $\Delta \log TB$		Dependent Variable: $\log TB$	
	Coefficient	Prob	Coefficient	Prob
$\Delta \log TB_{t-1}$	-0.377076***	0.0016	-	-
$\Delta \log REER_POS_t$	-0.104844	0.8282	-	-
$\Delta \log REER_POS_{t-1}$	0.795460**	0.0224	-	-
$\Delta \log REER_POS_{t-2}$	-1.291818***	0.0013	-	-
$\Delta \log REER_NEG_t$	-1.978623***	0.0000	-	-
$\Delta \log INF_t$	-0.750631	0.2345	-	-
$\Delta \log RMA_t$	-0.165356	0.2263	-	-
Constant	-0.234567	0.4154	-	-
$\log REER_POS$	-	-	-0.808327*	0.0754
$\log REER_NEG$	-	-	-0.224796	0.5449
$\log INF$	-	-	-1.990663	0.1683
$\log RMA$	-	-	-0.438522	0.1866
Constant	-	-	-0.622068	0.4020
Observations Number	88			
Adjusted R ²	0.8767			
Heteroscedasticity	0.4701			
Autocorrelation	0.2451			
RESET	0.4373			
CUSUM	Stable			
CUSUMQ	Stable			
Wald	$-(C(3))/-0.377076 = -(C(7))/-0.377076$ Prob: 0.0705*			

note: ***significant at $\alpha=1\%$; ** significant at $\alpha=5\%$; * significant at $\alpha=10\%$

Source: Author Estimation, 2024

Figure 4: CUSUM and CUSUMQ Results



Source: Author Estimation, 2024

Discussion

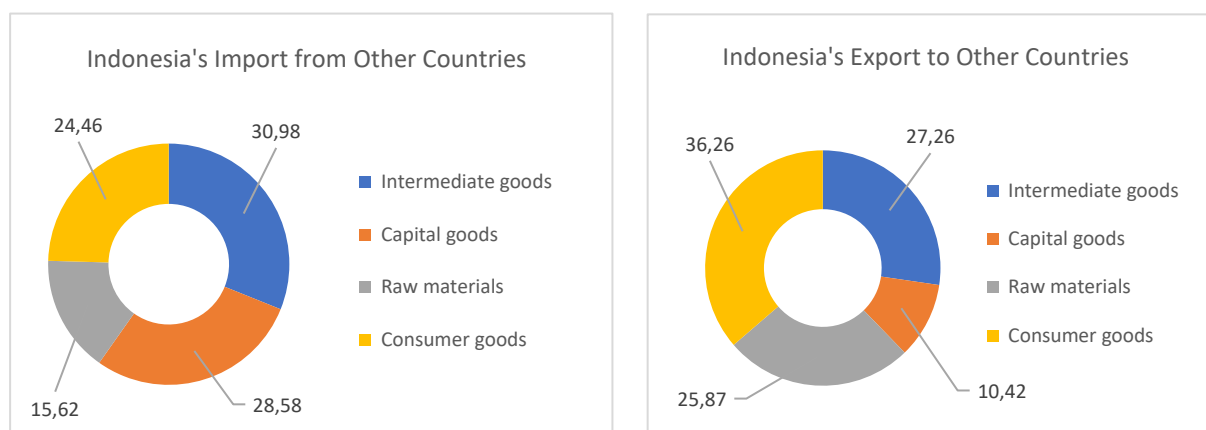
Based on the Wald test, it was found that there is an asymmetric effect on the exchange rate in the long run. This means that there are different effects as the exchange rate experiences depreciation and appreciation. Long-run exchange rate depreciation ($\log REER_POS$) has a coefficient of -0.8083 and has a significant effect on the trade balance. Meanwhile, long-run exchange rate appreciation ($\log REER_NEG$) has a coefficient of -0.2247 but does not have a significant effect on the trade balance.

Additionally, the model feasibility test showed good results, shown in the RESET, CUSUM, CUSUMQ, Autocorrelation, Heteroscedasticity and Adjusted R^2 . The CUSUM & CUSUMQ presents the stability of the coefficient during the period of estimation. The signs of the POS and NEG coefficients in the long run show the same direction, it asserts that the estimation results are valid/correct based on the characteristics built from the NARDL model.

According to Table 4, this finding presents that depreciation of the exchange rate will reduce trade balance both in the short run and long run, while appreciation of the exchange rate will increase trade balance only in the short run, not in the long run.

Our findings are supported by previous studies such as Jiang and Liu (2023), which exhibit a nonlinear and asymmetric effect between exchange rate and trade balance. Jiang and Liu (2023) reveal that the effect of exchange rate appreciation on the China-US trade balance is more significant than depreciation. Depreciation of the domestic currency will improve the domestic trade balance. In contrast, the opposite effect was found in the case of China towards Japan and the European Union, where currency depreciation actually worsened the China's trade balance. Our findings also supported by Truong and Vo (2023) which show that the exchange rate has an asymmetric effect on the trade balance, in both the long run and short run. In particular, Truong and Vo (2023) found that a 1% depreciation of the exchange rate causes a 4.2607% decrease in the trade balance, while an appreciation of the exchange rate has no effect on the trade balance.

Furthermore, this findings in Indonesia suggest that the composition of the types of commodities traded plays an important role in shaping the pattern of the exchange rate on trade balance. Figure 5 depicts the composition of commodities imported by Indonesia are intermediate goods (30.98%), capital goods (28.58%), consumer goods (24.46%), and raw materials (15.62%).

Figure 5: Average Indonesian Import & Export Based on Type of Commodities 2002 - 2021

Source: World Integrated Trade Solution, 2024 (processed by the Authors)

The commodities imported by Indonesia are not actually dominated by consumer goods, but are dominated by productive goods (intermediate goods and capital goods). Those productive goods are used as input for domestic production, and some of the finished goods are re-exported.

Meanwhile, more than 50% of commodities exported are intermediate goods and consumer goods. It means the exchange rate depreciation actually worsens the trade balance, since the rupiah depreciation reflects an inability to purchase imported goods, making imports, mostly productive goods, unavailable due to high prices. This in turn disrupts domestic production and hampers export performance.

Our finding is consistent with Qiu et al. (2026), who reveal that in the small open economies (e.g. Indonesia), cross-border and input-output linkages make domestic production more sensitive to

external shocks. Since Indonesia's imports are dominated by intermediate and capital goods, depreciation raises production costs and weaken export performance, thereby worsening the trade balance.

CONCLUSION AND RECOMMENDATION

This study finds that the real effective exchange rate has an asymmetric effect on Indonesia's trade balance in the long run. Exchange rate depreciation has a larger impact than appreciation and tends to worsen the trade balance. This result indicates that depreciation does not automatically improve Indonesia's export performance. One possible explanation is that Indonesia's imports are largely composed of intermediate and capital goods, which are used as production inputs. When depreciation occurs, imported inputs become more expensive,

increasing production costs and weakening export capacity.

Based on these findings, several concrete policy recommendations can be proposed. *First*, Bank Indonesia should maintain exchange rate stability, especially during periods of external shocks, to reduce excessive increases in imported input costs. *Second*, the government should prioritize the domestic production of strategic intermediate and capital goods, particularly inputs used by export-oriented industries. *Third*, fiscal incentives, such as tax relief or import-duty facilities, should be targeted toward firms that import essential production inputs for re-export activities. *Fourth*, exporters and import-dependent firms should be encouraged to use exchange-rate hedging instruments to reduce the risk of sudden depreciation. These policies are important to ensure that exchange rate movements do not disrupt domestic production and export performance.

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