

## IS THERE J-CURVE PHENOMENON AND ASYMMETRIC EFFECTS OF EXCHANGE RATE ON TRADE BALANCE IN EAST JAVA?

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### ABSTRACT

*This study aims to analyze the effect of exchange rate asymmetry on the trade balance between East Java Province and the largest trading partner countries (China, Japan, and the United States) in the short-run and long-run and to detect the J-Curve phenomenon. This study uses the Nonlinear Autoregressive Distributed-Lag (NARDL) method with 2010Q1 - 2023Q1 time-series data. The results of the study show that in the short-run, both the appreciation (NEG) and depreciation (POS) of the exchange rate have no effect on East Java's trade balance in all models. However, in the long-run, exchange rate appreciation and depreciation have a significant negative effect on East Java's trade balance across all models. Based on the estimation results, it can be concluded that there is no J-Curve phenomenon in East Java's trade balance with trading partner countries. Because in the asymmetry model, the J-Curve phenomenon can occur if depreciation or appreciation has a significant positive effect and is cointegrated in the long-run, regardless of the short-run coefficient being positive or negative and significant or not significant. From these conditions, it can be concluded that the trade industry in East Java is called inelastic. That is, price changes do not affect demand for export and import volumes. Therefore, the policy of depreciating the Rupiah exchange rate is not the best strategy to be implemented as an export promotion for East Java because only a few sectors benefit.*

**Keywords:** Trade Balance, Exchange Rate, J-Curve Phenomenon.

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### ABSTRAK

*Penelitian ini bertujuan untuk menganalisis pengaruh asimetri nilai tukar terhadap neraca perdagangan antara Provinsi Jawa Timur dengan negara partner perdagangan terbesar (Cina, Jepang, dan Amerika Serikat) dalam jangka pendek dan jangka panjang serta untuk mendeteksi adanya fenomena J-Curve. Penelitian ini menggunakan metode Nonlinear Autoregressive Distributed-Lag (NARDL) dengan data time-series 2010Q1 - 2023Q1. Hasil penelitian menunjukkan bahwa dalam jangka pendek, baik itu apresiasi (NEG) maupun depresiasi (POS) nilai tukar tidak memiliki pengaruh terhadap neraca perdagangan Jawa Timur di seluruh model. Akan tetapi, dalam jangka panjang, apresiasi dan depresiasi nilai tukar memiliki pengaruh negatif signifikan terhadap neraca perdagangan Jawa Timur di seluruh model. Berdasarkan hasil estimasi tersebut dapat disimpulkan bahwa tidak terdapat fenomena J-Curve pada neraca perdagangan Jawa Timur dengan negara partner perdagangan. Karena pada model asimetri fenomena J-Curve dapat terjadi jika depresiasi atau apresiasi berpengaruh positif signifikan dan terkointegrasi dalam jangka panjang, terlepas dari koefisien jangka pendek bernilai positif atau negatif serta signifikan atau tidak signifikan. Kondisi tersebut mengindikasikan bahwa industri perdagangan*

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*Jawa Timur disebut inelastis. Artinya, perubahan harga tidak memiliki pengaruh terhadap permintaan volume ekspor dan impor. Oleh karena itu, kebijakan depresiasi nilai tukar Rupiah bukan menjadi strategi terbaik untuk diterapkan sebagai promosi ekspor Jawa Timur karena hanya sedikit sektor yang mendapatkan manfaat.*

**Kata Kunci:** Neraca Perdagangan, Nilai Tukar, Fenomena J-Curve.

**JEL:** E51; E52; F31; E31

## Introduction

Exchange rate adjustments are part of a country's economic stabilization program. During periods of recession, countries with fixed exchange rate systems try to devalue and countries with managed floats try to depreciate currencies to stimulate exports to improve the trade balance. However, the short-term effect of devaluation or depreciation remains an unresolved issue due to the delay in price adjustment and response to changes in exchange rates. Therefore, long-term effects must determine the decisions of policymakers because devaluation or depreciation can increase exports and ultimately increase the trade balance, this condition is called the J-curve phenomenon (Magee, 1973; Bahmani-Oskooee, 1985).

Based on data from the [Badan Pusat Statistik \(2023\)](#), Japan, America, and China have been East Java Province's largest trading partners for more than ten years. These trading partners occurred because of the ASEAN-China Free Trade Agreement (ACFTA) which was agreed upon in 2004 and the Indonesia-Japan Economic Partnership Agreement (IJEPA) which was agreed upon in 2007 ([Alleyne et al., 2020](#); [Ibrahim et al., 2010](#); [Indriyani, 2016](#); [Avivi & Siagian, 2020](#)). This economic collaboration succeeded in increasing East Java's exports to Japan by 15.9%, America by 20.3%, and China by 20.5% in 2021. The increase in exports was influenced by an increase in East Java's non-oil and gas exports to the United States of USD 350.86 million, Japan amounted to USD 260.11 million, and China amounted to USD 207.39 million ([BPS, 2023](#)).

According to [Guo \(2020\)](#), one of the indicators that affect the value of a country's trade balance is the exchange rate. Several previous studies stated that if the Marshall-Lerner Condition occurs, currency devaluation under a fixed exchange rate system and currency depreciation under a floating exchange rate system will increase the trade balance in the long-run ([Bahmani-Oskooee & Baek, 2015](#); [Bahmani-Oskooee & Aftab, 2018](#)). According to [BPS \(2023\)](#), the rupiah exchange rate depreciated by IDR 117.57 against the Yen, IDR 15,731 against the US Dollar, and IDR 2,245.67 against the Yuan.

Research on the effect of the exchange rate on the trade balance and the J-Curve phenomenon varies greatly depending on the data and estimation techniques used. For example, [Noland \(1989\)](#) found a J-Curve phenomenon in Japan, [Rose \(1990\)](#) did not find a J-Curve phenomenon in the 30 countries studied, [Lal & Lowinger \(2002\)](#) found a J-Curve phenomenon in several countries in Asia, including Indonesia, and [Prawoto \(2007\)](#) found the J-Curve phenomenon in several countries that were the object of research. The effect of changes in exchange rates, both directly and indirectly, on the trade balance can be measured symmetrically and asymmetrically. The effect of symmetry shows that there is no difference between positive exchange rates (depreciation) and negative exchange rates (appreciation) in influencing the trade balance, while the effect of asymmetry shows this difference ([Greenwood & Shin, 2013](#)). The effect of asymmetry is considered more effective because it produces many effects on the trade balance both positive and negative ([Pham, et al. 2020](#); [Nasir, et al. 2020](#)).

Based on previous research, there has been no research that simultaneously examines the effect of symmetric exchange rates on trade balance at the provincial level, while policymakers need research recommendations in a smaller scope. Therefore, this research aims to bridge this knowledge gap by detecting the effect of exchange rates on the trade balance in East Java and to investigate whether there is a J-Curve phenomenon. This research is important because the trade balance data for East Java province has monthly data available. Not only that, this research is able to provide effective policy recommendations because of its small regional coverage and the selection of the East Java Province sample based on the large contribution of East Java's exports to the national export value of 9.94% (BPS, 2023).

This research tries to examine the asymmetric effects of exchange rates on the trade balance in East Java and to investigate whether there is a J-Curve phenomenon. This study uses the Nonlinear Autoregressive Distributed-Lag (NARDL) method with 2010Q1 - 2023Q1 time-series data. The results show that in the short-run, the exchange rate does not affect East Java's trade balance in all models. However, in the long-run, the exchange rate has a significant negative effect on East Java's trade balance. Based on the estimation results, it can be concluded that there is no J-Curve phenomenon in East Java's trade balance with trading partner countries. Because in the asymmetry model, the J-Curve phenomenon can occur if depreciation or appreciation has a significant positive effect and is cointegrated in the long-run, regardless of the short-term coefficient being positive or negative and significant or not significant. From these conditions, it can be concluded that the trade industry in East Java is called inelastic. That is, price changes do not affect demand for export and import volumes. Therefore, the policy of depreciating the Rupiah exchange rate is not the best strategy to be implemented as an export promotion for East Java because only a few sectors benefit. The structure of this research is an introduction, literature review, data and methodology, results and discussion, and conclusion.

## Literature Review

### *The Asymmetric Effects of Exchange Rate on Trade Balance*

According to Krugman et al. (2018), the exchange rate is very important for international trade because it can compare the prices of goods and services produced in one country to other countries. Economic actors use exchange rates to change foreign prices in terms of domestic currency. When the prices of domestic goods and imported goods have been converted into the same currency, economic actors can calculate the relative prices that affect the flow of international trade. In general, a country's exchange rate is divided into two, namely the nominal exchange rate and the real exchange rate. According to Salvatore (2013), the nominal exchange rate is the price of the domestic currency for one unit of foreign currency. Meanwhile, the real exchange rate is the nominal exchange rate multiplied by the ratio of the foreign consumer price index (CPI) to the domestic consumer price index (CPI) (Krugman et al., 2018). The relationship between the nominal exchange rate and the real exchange rate is as follows.

$$RER = (NER \times P^*) / P \quad (1)$$

Explanation:

RER = real exchange rate

NER = nominal exchange rate

P\* = foreign price level

P = domestic price level

The trade balance is measured based on export demand minus a country's import demand which is determined by two main factors, namely the domestic real exchange rate and domestic disposable income, assuming other factors are held constant (Krugman et al., 2018). The function of the trade balance is as follows.

$$TB=TB(EP^*/P, Y^d)/P \quad (2)$$

Explanation:

TB = trade balance

$EP^*/P$  = real exchange rate

$Y^d$  = domestic disposable income

Changes in real exchange rates affect the trade balance because they reflect changes in the relative prices of domestic goods and services to foreign goods and services. Meanwhile, disposable income affects the trade balance through total domestic spending. The trade balance can be seen in the demand for exports and imports as follows.

$$TB=EX-IM \quad (3)$$

Explanation:

TB = trade balance

EX = export

IM = import

When  $EP^*/P$  rises or depreciates, foreign products become more expensive than domestic products. Foreign consumers will respond to these price shifts by increasing export demand (EX) so that the trade balance also increases, and vice versa. The effect of depreciation on the trade balance depends on the volume effect or value effect which is more dominant than changes in the real exchange rate. Krugman et al. (2018: 490) states that the volume effect of changes in the real exchange rate is always greater than the value effect so that the real depreciation of the domestic currency will increase the trade balance.

The effect of asymmetry shows that there is a difference between positive exchange rates (depreciation) and negative exchange rates (appreciation) in influencing the trade balance (Greenwood & Shin, 2013). Based on research from Bahmani-Oskooee & Fariditavana (2016) which analyzes the effect of exchange rate asymmetry on the trade balance using the Nonlinear Autoregressive Distributed Lag (NARDL) method. The results showed that there was an asymmetry relationship in all research objects and the J-Curve phenomenon was found except for Japan. Then, Fang et al. (2009), measured the effect of exchange rate risk on exports in eight countries from 1979M1 – 2003M4. The results showed that the effect of unfavorable exchange rate risk on exports proved significant in five countries, namely Indonesia, Japan, Korea, the Philippines, and Taiwan during depreciation and unfavorable during appreciation in Japan, Singapore and Thailand. Meanwhile, Korea and the Philippines produced unfavorable exchange rate risk effects on exports in both appreciation and depreciation.

Harvey (2018) analyzed the effect of asymmetry between the exchange rate and the Philippines' bilateral trade balance with 10 major trading partners, including Indonesia, and identified the J-Curve phenomenon. The results of the study show that there is an asymmetrical relationship between the exchange rate and the trade balance and there is a J-Curve phenomenon in Indonesia, Japan, and Singapore. Then, Bahmani-Oskooee & Harvey (2017) analyzed the effect of asymmetry between exchange rates and Indonesia's trade

balance with 12 main trading partners and analyzed the J-Curve phenomenon using the NARDL method. The results of the study prove that there is an asymmetric relationship between the exchange rate and the trade balance and there is a J-Curve phenomenon between Indonesia and Australia, Britain, Japan, South Korea, and Singapore.

### ***The Evidence of J-Curve Phenomenon***

Research on the J-Curve phenomenon was first introduced by [Magee \(1973\)](#) who explained that exchange rate devaluation would reduce the value of the trade balance in the short-run, after some time it would improve, this pattern can be called the J-Curve phenomenon. Then, according to [Blanchard \(2017\)](#), real depreciation results in an increase in exports and a decrease in imports. However, this condition did not occur in a short period. At the beginning of the period, depreciation has more effect on price than quantity. The price of imported goods increases so that exports decrease. However, the quantities of exports and imports adjust slowly because consumers do not respond quickly to changes in relative prices. At the beginning of the period, the real depreciation caused a decrease in the trade balance ([Adiningsih et al., 2013](#)). According to [Cambazoglu & Günes \(2016\)](#), the effect of changes in the relative prices of exports and imports becomes stronger over time. Cheaper domestic goods lead to an increase in export demand and a decrease in imports. If the Marshall-Lerner conditions are met, then the effect of export and import volume will eventually become stronger than the price effect. Therefore, real depreciation causes an increase in the trade balance.

Research on the J-Curve phenomenon varies greatly depending on the data and estimation techniques used. For example, [Bahmani-Oskooee \(1985\)](#) analyzed the J-Curve phenomenon in four developing countries, namely India, Korea, Thailand, and Greece using the Almond Lag Structure method from 1973Q1 – 1980Q4. This study uses aggregate data that compares a country's trade balance with the world trade balance. The results show that the J-Curve phenomenon is seen in all countries, except for Thailand. Then, [Rose & Yellen \(1989\)](#) analyzed the J-Curve phenomenon using bilateral data between countries. The strength of the bilateral approach is to avoid the aggregation bias that occurred in previous studies. The results showed that there was no J-Curve phenomenon between America and six partners, namely England, Italy, Japan, Germany, Canada, and France. Meanwhile, [Bahmani-Oskooee & Brooks \(1999\)](#) found evidence of the effect of the exchange rate on the trade balance and the existence of the J-Curve phenomenon in the long run between the United States and all trading partner countries, except the UK.

Based on the theoretical and empirical framework established previously, the hypothesis formulated in this study is that within the asymmetric J-Curve model, depreciation or appreciation significantly affects and is co-integrated in the long term, irrespective of whether short-term coefficients are positive or negative and whether they are significant or not. This is crucial to investigate in the context of international trade in East Java, which experiences a trade deficit and undergoes depreciation of the exchange rate against the US Dollar.

## **Data and Methodology**

### ***Data Analysis***

This study uses time series data covering quarterly intervals from 2010Q1-2023Q1. There are four variables used in this study. First, the percentage of the Trade Balance sourced

from the Badan pusat Statistik. Second, the index form of the Real Effective Exchange Rate sourced from the Bank for International Settlements (BIS). Third, the percentage of East Java's Gross Regional Domestic Product sourced from the Badan pusat Statistik. Finally, the percentage form of Gross Domestic Product of trading partner countries sourced from Federal Reserve Economics Data.

### Methodology

This study uses the Nonlinear Autoregressive Distributed Lag (NARDL) method in estimating and analyzing the determinant impact of the Real Effective Exchange Rate, Gross Regional Domestic Product, and Gross Domestic Product trading partner countries on the trade balance. The NARDL framework is used to analyze asymmetric effects in both the short-run and long-run without assuming a constant speed of adjustment over time (Shin et al., 2014). In addition, it is also able to track asymmetric adjustment patterns after positive and negative shocks to the independent variable by reducing the effect of Asymmetric Dynamic Multipliers. The following is the long-term NARDL model used in this study:

$$TB_t = \alpha_0 + \alpha_1 YP_t + \alpha_2 YE_t + \alpha_3 REX_t + \varepsilon_t \quad (4)$$

Explanation:

$TB_t$  = East Java trade balance and trading partners,

$\alpha_0$  = constant,

$\alpha_1, \alpha_2, \alpha_3$  = coefficients of the independent variables,

$YP_t$  = GDP trading partners at time t,

$YE_2$  = GRDP of East Java at time t,

$REX_t$  = real exchange rate at time t,

$\varepsilon_t$  = error term at time t.

Exchange rate variables include positive changes (depreciation) and negative changes (appreciation). Therefore, the two changes produce two new variables as follows:

$$POS_{t-1} = \sum_{j=1}^t \Delta LnREX_t^+ = \sum_{j=1}^t \max(\Delta LnREX_t, 0) \quad (5)$$

$$NEG_{t-1} = \sum_{j=1}^t \Delta LnREX_t^- = \sum_{j=1}^t \min(\Delta LnREX_t, 0) \quad (6)$$

The above equation shows that the POS variable is the partial sum of the positive changes in  $\Delta LnREX$  and only represents the rupiah's depreciation, while the NEG variable is the partial sum of the negative changes in  $\Delta LnREX$  and only represents the rupiah's appreciation. The error-correction model of ARDL is as follows.

$$\begin{aligned} \Delta TB_t = & \beta_0 + \beta_1 TB_{t-1} + \beta_2 YP_{t-1} + \beta_3 YE_{t-1} + \beta_4 POS_{t-1} \\ & + \beta_5 NEG_{t-1} + \sum_{i=1}^{n1} \beta_{6,i} \Delta TB_t + \sum_{i=0}^{n2} \beta_{7,i} \Delta YP_t + \sum_{i=0}^{n3} \beta_{8,i} \Delta YE_t \\ & + \sum_{i=0}^{n4} \beta_{9,i} \Delta POS_t + \sum_{i=0}^{n4} \beta_{9,i} \Delta NEG_t + \varepsilon_t \end{aligned} \quad (7)$$

**Explanation:**

- $\Delta TB_t$  = changes in East Java’s trade balance and trading partners,
- $\beta_0$  = constant,
- $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$  = coefficients of the independent variables,
- $\beta_6, \beta_7, \beta_8, \beta_9$
- $\Delta TB_{t-i}$  = changes in East Java’s trade balance lag i,
- $\Delta YP_t$  = changes in GDP trading partner lag i,
- $\Delta YE_t$  = changes in GRDP East Java lag i,
- $\Delta POS_t$  = changes in the real exchange rate depreciation of the Rupiah against the exchange rate of the trading partner lag i,
- $\Delta NEG_t$  = changes in the real exchange rate appreciation of the Rupiah against the exchange rate of the trading partner lag i,
- $TB_{t-1}$  = East Java trade balance lag 1,
- $YP_{t-1}$  = GDP trading partner lag 1,
- $YE_{t-1}$  = GRDP of East Java lag 1,
- $POS_{t-1}$  = real exchange rate depreciation of the Rupiah against the 1st trading partner lag exchange rate,
- $NEG_{t-1}$  = real exchange rate appreciation of the Rupiah against the 1st trading partner lag exchange rate,
- $\epsilon_t$  = error term at time t,
- n1, n2, n3, n4 = upper limit of the lag for each variable,
- i=1, i=0 = lower limit of lag.

The analytical techniques employed in this study include stationary tests, followed by the selection of the optimal lag length, and subsequently, the NARDL bound test. Afterward, diagnostic tests are conducted, encompassing  $ECM_{t-1}$  testing, autocorrelation examination, model specification verification, and model fitness assessment. Finally, robustness testing is carried out.

**Result and Discussion**

**Stationary Test**

**Table 1: Stationary Test Result**

Variable	Level (0)		First Difference		Stationary Level
	t-statistic	Probability	t-statistic	Probability	
TB	-9.6049**	0.0000	-9.0473**	0.0000	I(I)
REX	-2.5109	0.1190	-5.5951**	0.0000	I(I)
YE	-2.7686*	0.0698	-5.4150**	0.0000	I(I)
YP-China	-4.5227**	0.0006	-5.8403**	0.0000	I(I)
YP-Japan	-9.6851**	0.0000	-6.2656**	0.0000	I(I)
YP-US	-8.8141**	0.0000	-6.0637**	0.0000	I(I)

Noted : (\*\*) significant at 5%; (\*) significant at 10%

The stationarity test in this study uses the Augmented Dickey-Fuller (ADF) unit root test to see whether the variable is stationary or not. Variables that are stationary at the level I(0) or

first difference level I(1) can be used in the ARDL model, while variables that are stationary at the second different level I(2) cannot be used because they are considered invalid (Guo, 2020; Ari et al. al., 2019; Panda & Reddy, 2016). The null hypothesis indicates that the variable is not stationary (contains a unit root), while the alternative hypothesis indicates that the variable is stationary (contains a unit root). The estimation results in this study indicate that the probability value of both the dependent variable and the independent variable is significant at the 5% level. This means that all variables are stationary at the first difference level.

### **Optimal Lag Selection**

The optimal lag selection in this study uses four maximum lags for each variable and applies the Akaike Information Criterion (AIC) to select optimal lag specifications (Ari et al., 2019; Bahmani-Oskooee & Karamelikli, 2018). Widarjono (2007) argues that the main advantage of employing the AIC technique is in choosing the most appropriate regression model for forecasting regression model, which can explain the fit of the model with current data (in sample forecasting) and values that will occur in the future (out of sample forecasting). Table 2 shows the optimal lag results obtained in the 3 ARDL models. The results of selecting the optimal lag show the time needed for the dependent variable (trade balance) to respond to changes in the independent variables (exchange rate, Gross Domestic Regional Product, and Gross Domestic Product-trading partner).

**Table 2: Optimal Lag Selection Result**

No.	Trading Partners	Lag Optimal
1.	China	(3,0,0,1,3)
2.	Japan	(3,0,0,1,0)
3.	United State	(3,0,0,1,4)

### **NARDL Bound Test**

Table 3 shows the short-run NARDL estimation results. The estimation results show that in the China model, East Java's Gross Domestic Regional Product variable has a significant negative effect on East Java's trade balance, while in the Japan and United States models, there is no significant effect. This means that the Trade Balance decreased by 114.4% for every percent increase in East Java's Gross Domestic Regional Product. Then, the Gross Domestic Products of China and the United States have a significant positive effect on the East Java Trade Balance, while in the Japanese model, there is no significant effect. That is, the Trade Balance increased by 74.3% and 173.1% for each percent increase in the Gross Domestic Product of China and the United States.

Table 4 shows the long-run NARDL estimation results. The estimation results show that in the models of China, Japan, and the United States, the exchange rate depreciation has a significant negative effect on East Java's trade balance. This means that the Trade Balance decreased by 15.3%, 15.5%, and 15.5% for each percent increase in exchange rate depreciation. Then, in the models of China, Japan, and the United States, exchange rate appreciation has a significant negative effect on East Java's trade balance. This means that the trade balance decreased by 13%, 13.1%, and 15.7% for each percent increase in exchange rate appreciation. Meanwhile, only the United States model, East Java's Gross Regional Domestic Product (GRDP) has a significant positive effect on the East Java Trade Balance. That is, the Trade Balance increased by 21.4%, for every percent increase in East Java's Gross Regional Domestic Product.

**Table 3: Short-Run ARDL Bound Test Result**

Variables	Short-Run Estimation		
	China	Japan	United State
Constant	-1.369 (-0.433)	-1.328 (-0.832)	-4.372** (-2.061)
TB <sub>t-1</sub>	0.900** (3.455)	0.674** (2.418)	0.831** (2.851)
TB <sub>t-2</sub>	0.436** (2.977)	0.310* (1.996)	0.336* (1.943)
TB <sub>t-3</sub>	-	-	-
TB <sub>t-4</sub>	-	-	-
REX_POS	-	-	-
REX_POS <sub>t-1</sub>	-	-	-
REX_POS <sub>t-2</sub>	-	-	-
REX_POS <sub>t-3</sub>	-	-	-
REX_POS <sub>t-4</sub>	-	-	-
REX_NEG	-	-	-
REX_NEG <sub>t-1</sub>	-	-	-
REX_NEG <sub>t-2</sub>	-	-	-
REX_NEG <sub>t-3</sub>	-	-	-
REX_NEG <sub>t-4</sub>	-	-	-
YE	-1.144** (-2.457)	-0.417 (-1.649)	-1.095 (-1.370)
YE <sub>t-1</sub>	-	-	-
YE <sub>t-2</sub>	-	-	-
YE <sub>t-3</sub>	-	-	-
YE <sub>t-4</sub>	-	-	-
YP	-0.065 (-0.409)	-	0.874 (1.303)
YP <sub>t-1</sub>	0.743** (3.091)	-	1.731** (2.394)
YP <sub>t-2</sub>	0.148 (1.058)	-	1.298** (2.035)
YP <sub>t-3</sub>	-	-	0.908* (1.730)
YP <sub>t-4</sub>	-	-	-

Noted : (\*\*) significant at 5%; (\*) significant at 10%  
 Signs in brackets indicate the value of the t-statistic  
 T-table value 5% (1.67); 10% (1.29)

**Table 4: Long-run ARDL Bound Test Result**

Variables	Long-run Estimation		
	China	Japan	United States
Constant	-1.369 (-0.433)	-1.328 (-0.832)	-4.372** (-2.061)
REX_POS	-0.153** (-3.480)	-0.155** (-2.954)	-0.155** (-3.252)
REX_NEG	-0.130** (-3.594)	-0.131** (-3.022)	-0.157** (-3.874)
YE	0.069 (0.763)	0.026 (0.299)	0.214* (1.784)
YP	-0.031 (-0.257)	0.238 (1.618)	-0.403 (-1.197)

Noted : (\*\*) significant at 5%; (\*) significant at 10%  
 Signs in brackets indicate the value of the t-statistic  
 T-table value 5% (1.67); 10% (1.29)

The estimation results above show that in the short-run, the appreciation (NEG) and depreciation (POS) of the exchange rate do not affect East Java's trade balance in all models. However, in the long-run, the appreciation and depreciation of the exchange rate have a significant negative effect on East Java's trade balance. Based on the estimation results above,

there is no J-Curve phenomenon in East Java's trade balance with trading partners. Because the J-Curve phenomenon can occur if depreciation or appreciation has a significant positive effect and is cointegrated in the long-run, regardless of the short-term coefficient being positive or negative and significant or insignificant (Bahmani-Oskooee & Fariditavana, 2016).

The estimation results from this study are in line with research conducted by Rose & Yellen (1989) using bilateral data between countries. This bilateral approach has the advantage of avoiding the aggregation bias that occurred in previous studies. The results of the study show that there is no J-Curve phenomenon in trade between America and six partners, namely Britain, Italy, Japan, Germany, Canada, and France. Then, Bahmani Oskooee & Alse (1994) conducted a study of 19 developed countries and 22 developing countries, including Indonesia using the Error Correction Modeling (ECM) method. The results of the study showed that there was no J-Curve phenomenon in the Indonesian case.

Research on the analysis of asymmetry effects between the exchange rate and the trade balance and the J-Curve phenomenon was also carried out by Bahmani-Oskooee & Fariditavana (2016) using the same method, namely Nonlinear Autoregressive Distributed Lag (NARDL). The NARDL method assumes that the response of the dependent variable to the increase and decrease of each independent variable is asymmetric (Shin et al., 2014). To capture the effect of asymmetry, NARDL decomposes the independent variable into two parts, in this case, the real exchange rate variable which is broken down into positive (appreciation) and negative (depreciation) forms. The results of the study show that there is a J-Curve phenomenon in all countries that are the sample of the study except for Japan. Then, Fang et al. (2009) also used the NARDL method to measure the effect of exchange rate risk on exports in eight countries from 1979M1 – 2003M4. The results showed that the effect of unfavorable exchange rate risk on exports proved significant in five countries, namely Indonesia, Japan, Korea, the Philippines, and Taiwan during depreciation and unfavorable during appreciation in Japan, Singapore, and Thailand. Meanwhile, Korea and the Philippines produced an unfavorable exchange rate risk effect on exports in both appreciation and depreciation.

Furthermore, Harvey (2018) also analyzes the J-Curve phenomenon and the effect of asymmetry on the Philippines' bilateral trade balance with 10 main trading partners, including Indonesia. The results showed that in the ARDL method, the J-Curve phenomenon only occurs in Indonesia and China, while in the NARDL method, the J-Curve phenomenon occurs in Indonesia, Japan, and Singapore. Then, Bahmani-Oskooee & Harvey (2017) analyzed the J-Curve phenomenon between Indonesia and 12 main trading partners by applying two approaches, ARDL and NARDL. The results of the study prove that in the ARDL method, the J-Curve phenomenon only occurs in Indonesia with the United States, the Philippines, the United Kingdom, and Singapore, while in the NARDL method, the J-Curve phenomenon occurs between Indonesia and Australia, England, Japan, South Korea, and Singapore. In another study, Bahmani-Oskooee & Harvey (2017) analyzed exchange rate changes in Indonesia's bilateral trade balance with 12 main trading partners including China using a linear and nonlinear approach. The results showed that the real exchange rate variable has a positive effect on the trade balance in the short-run. In the long run, the linear model states a negative relationship, while the nonlinear model produces "adjustment asymmetry".

### ***NARDL Cointegration Test***

The next step is the cointegration test to find out whether there is a long-term relationship between the variables in the model. This study uses the bound test because it can simultaneously test level  $I(0)$  and  $I(1)$  variables (Pesaran et al., 1996). The null hypothesis

indicates that there is no cointegration, while the alternative hypothesis indicates that there is cointegration between variables. According to [Pesasan et al. \(1996\)](#), the provisions of the bound test are if the calculated F-statistic value is above the upper bound then the null hypothesis is rejected. If the calculated F-statistic value is below the lower bound then the null hypothesis is accepted. However, if the value of the F-statistic is between the upper bound and lower bound then the results are inconclusive. Table 5 shows that all ARDL models (China, Japan, and the United States) are cointegrated in the long run at the 5% level.

**Table 5: ARDL Cointegration Test Result**

Trading Partners	F-Statistic	Explanation
China	10.608**	Cointegration
Japan	8.807**	Cointegration
United States	8.824**	Cointegration

Noted :(\*\*) significant at 5%; (\*) significant at 10%

5% = upper bound (4.01); lower bound (2.86)

10% = upper bound (3.52); lower bound (2.45)

### ***NARDL Diagnostic Test***

In this study, there were four diagnostic tests. First, the  $ECM_{t-1}$  test is used to determine the speed of adjustment toward long-run equilibrium. The coefficient value  $ECM_{t-1}$  must be negative and significant because if it is positive then the model is considered unstable and divergent. The estimation results of the  $ECM_{t-1}$  test shows that the model has a significant negative value at the 5% level in all models. The coefficient value  $ECM_{t-1}$  is (-2.431) in the Chinese model, (-2.147) in the Japanese model, and (-2.416) in the United States model. That is, the speed of adjustment between the long-run and short-run is 243,1%, 214,7% and 241,6%.

Second, the Lagrange Multiplier (LM) test is used to ensure that the residuals are free from autocorrelation. The null hypothesis indicates that there is a serial correlation, while the alternative hypothesis indicates that there is no serial correlation. The estimation results show that there is no serial correlation in all models. Third, the Ramsey RESET test is used to test the model specifications. The null hypothesis indicates that the model used is correct, while the alternative hypothesis indicates that the model used is not correct. The estimation results show that all the models used are correct.

Fourth, the  $Adj.R^2$  value is used to indicate the level of suitability (goodness of fit) of each model or the ability of the independent variables to explain the dependent variable. The estimation results for the Chinese model show that the  $Adj.R^2$  value is 0.758, for the Japanese model it is 0.717, and for the United States model it is 0.714. That is, the variation of the independent variables (exchange rate, Gross Domestic Regional Gross East Java, and Gross Domestic Gross Domestic trading partners) can explain 75.8%, 71.7%, and 71.4% of the variation in the dependent variable (trade balance), while the rest is influenced by other variables that are not included in the models.

Finally, the Wald-SR (short-run) and Wald-LR (long-run) tests to determine the suitability of the research hypothesis ([Ari et al., 2019](#); [Bahmani-Oskooee & Aftab, 2018](#); [Harvey, 2018](#); [Bahmani-Oskooee & Hajilee, 2009](#); [Halicioglu, 2007](#)). The null hypothesis indicates that the exchange rate variable does not have an asymmetric effect, while the alternative hypothesis indicates that the exchange rate variable has an asymmetric effect. The estimation results show that all models have no asymmetrical relationship in both the short and long-run. Because all models are not significant either at the 5% or 10% level.

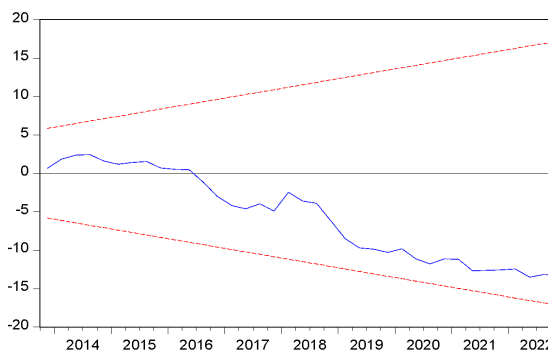
**Table 6: ARDL Diagnostic Test Result**

Trading Partners	$ECM_{t-1}$	LM	RESET	Adj.R <sup>2</sup>	Wald SR	Wald LR
China	-2.431** (-7.656)	0.265	0.071	0.758	0.00	0.064
Japan	-2.147** (-6.952)	0.634	0.004	0.717	0.00	0.001
United S.	-2.416** (-7.001)	0.032	0.013	0.714	0.00	0.017

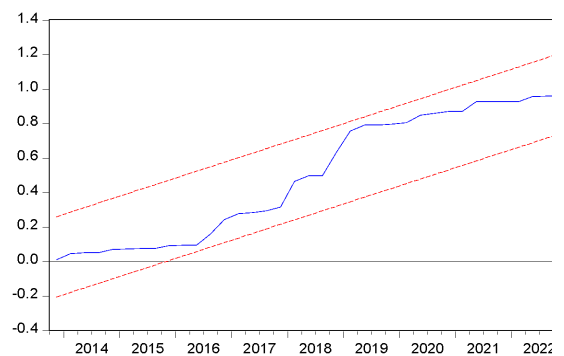
Noted : (\*\*) significant at 5%; (\*) significant at 10%  
 Specifically for , the sign in brackets represents the t-statistic value  
 T-table value 5% (1.67); 10% (1.29)  
 For LM and RESET, it is significant if Prob <0.05

**Robustness Test**

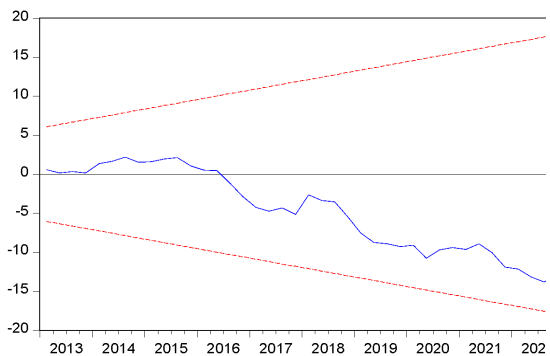
**CUSUM Test China**



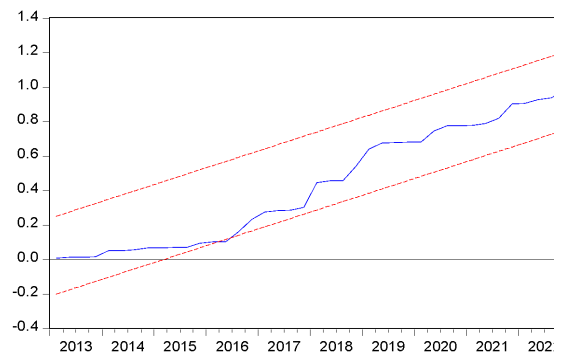
**CUSUMQ Test China**



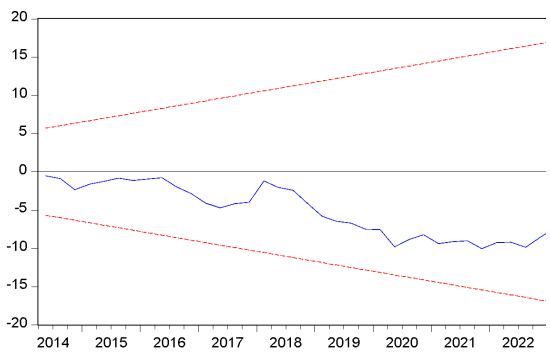
**CUSUM Test Japan**



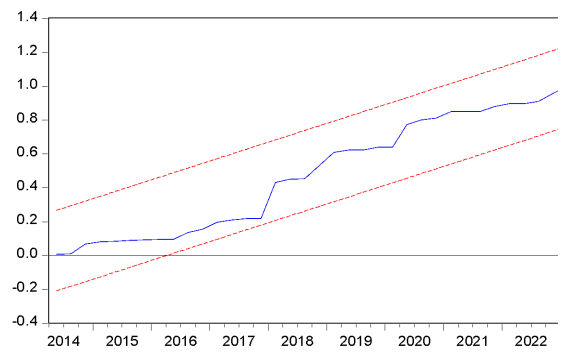
**CUSUMQ Test Japan**



**CUSUM Test United State**



**CUSUMQ Test United States**



**Figure 1: Robustness Test CUSUM and CUSUMQ**

This study used the stability test of the cumulative sum of recursive residuals test (CUSUM) and the cumulative sum of squares of recursive residuals test (CUSUMSQ). The CUSUM test was used to identify systematic changes in the regression coefficients and speed of adjustment, while the CUSUMSQ was used to detect sudden changes in the regression coefficients and speed of adjustment. According to [Pesasan et al. \(2001\)](#), the CUSUM and CUSUMSQ tests are robust enough to test the stability of the bound model. When the CUSUM and CUSUMSQ lines do not cross the 5% significant line, the ARDL model is said to be stable. Based on Figure 1, the results of the CUSUM test on the Japanese model show a stable pattern, while the CUSUMQ test shows an unstable pattern because it crosses the 5% significant line. Then, the results of the CUSUM and CUSUMQ tests on the China and United States models show a stable pattern because they do not cross the 5% significant line.

## Conclusion

This study aims to analyze the effect of exchange rate asymmetry on the trade balance between East Java Province and the largest trading partner countries (China, Japan, and the United States) in the short-run and long-run and to detect the J-Curve phenomenon. This study uses the Nonlinear Autoregressive Distributed-Lag (NARDL) method with 2010Q1 - 2023Q1 time-series data. The results of the study show that in the short-run, both the appreciation (NEG) and depreciation (POS) of the exchange rate have no effect on East Java's trade balance in all models. However, in the long-run, exchange rate appreciation and depreciation have a significant negative effect on East Java's trade balance across all models.

Based on the estimation results, it can be concluded that there is no J-Curve phenomenon in East Java's trade balance with trading partner countries. Because in the asymmetry model, the J-Curve phenomenon can occur if depreciation or appreciation has a significant positive effect and is cointegrated in the long-run, regardless of the short-run coefficient being positive or negative and significant or not significant. From these conditions, it can be concluded that the trade industry in East Java is called inelastic. That is, price changes do not affect demand for export and import volumes. Therefore, the policy of depreciating the Rupiah exchange rate is not the best strategy to be implemented as an export promotion for East Java because only a few sectors benefit.

In addition, variables such as the Gross Domestic Regional Product of East Java and the Gross Domestic Product of trading partners have varying effects on East Java's trade balance. In the short-run, East Java's Gross Domestic Regional Product variable has a significant negative effect on East Java's trade balance in the China model, while in the Japan and United States models, there is no significant effect. Then, the Gross Domestic Products of China and the United States have a significant positive effect on the East Java Trade Balance, while in the Japanese model, there is no significant effect. In the long-run, only the United States model, East Java's Gross Regional Domestic Product variable, has a significant positive effect on East Java's Trade Balance.

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