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EXCHANGE RATE AND TRADE BALANCE OF EAST JAVA PROVINCE: J-CURVE EVIDENCE AND ARDL APPROACH

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ABSTRACT

The primary objective of this study is to examine the impact of exchange rate fluctuations on the trade balance between East Java Province and its principal trading partners—namely China, Japan, and the United States—while also assessing the presence of the J-Curve phenomenon. The Autoregressive Distributed-Lag model estimation indicates that the exchange rate has an insignificant effect on East Java's trade balance in the short run, while exerting a statistically significant negative influence in the long run. The empirical findings indicate the absence of a J-Curve phenomenon in East Java's trade balance with its main trading partners. This outcome implies that the region's trade flows are predominantly price-inelastic, as exchange rate depreciation fails to generate the expected short-run deterioration followed by long-run improvement. Therefore, currency depreciation is not an effective policy instrument for enhancing export performance, as its benefits are confined to a limited subset of sectors.

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

ABSTRAK

Tujuan utama dari penelitian ini adalah untuk mengkaji dampak fluktuasi nilai tukar terhadap neraca perdagangan Provinsi Jawa Timur dengan mitra dagang utamanya—yaitu Tiongkok, Jepang, dan Amerika Serikat—serta menilai keberadaan fenomena Kurva-J (J-Curve). Estimasi model Autoregressive Distributed-Lag menunjukkan bahwa nilai tukar tidak berpengaruh signifikan terhadap neraca perdagangan Jawa Timur dalam jangka pendek, namun memiliki pengaruh negatif yang signifikan secara statistik dalam jangka panjang. Temuan empiris menunjukkan tidak adanya fenomena Kurva-J dalam neraca perdagangan Jawa Timur dengan mitra dagang utamanya. Hasil ini mengindikasikan bahwa arus perdagangan di wilayah tersebut cenderung tidak responsif terhadap perubahan harga, karena depresiasi nilai tukar tidak mampu menghasilkan pola penurunan jangka pendek yang diikuti perbaikan dalam jangka panjang sebagaimana diharapkan. Oleh karena itu, depresiasi mata uang bukanlah instrumen kebijakan yang efektif untuk meningkatkan kinerja ekspor, karena manfaatnya hanya terbatas pada sejumlah sektor tertentu.

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

JEL: E51; E52; F31; E31

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Introduction

On August 14, 1997, Bank Indonesia officially transitioned from a fixed exchange rate regime to a freely floating exchange rate system. According to Krugman et al. (2018), a free-floating exchange rate system allows the value of a currency to be determined entirely by market forces without direct government intervention. The Indonesian government undertook this policy shift as a strategic response to safeguard its foreign exchange reserves amid the escalating Asian financial crisis. The crisis itself originated from a speculative attack on the Thai Baht, which subsequently triggered severe financial instability across the region. In Indonesia, this led to a sharp depreciation of the Rupiah, weakening by approximately 75% (Suseno & Simorangkir, 2004).

The depreciation of the Rupiah had profound consequences on the domestic economy. As the currency lost value against foreign currencies, the cost of imported goods, particularly raw materials needed for production, increased significantly. As a result, industries that heavily relied on imported inputs were forced to reduce their production output due to rising input costs (Hartarto, 2014). This decline in production contributed to a broader contraction in national output, adding upward pressure on inflation rates and exacerbating the economic downturn. However, from another perspective, the depreciation presented a potential advantage. The weakening of the Rupiah made Indonesian products more competitively priced in international markets, which opened up greater opportunities for exports (Adiningsih et al., 2013; Bahmani-Oskooee et al., 2016; Iqbal et al., 2015). As domestic goods became relatively cheaper and foreign goods more expensive, consumer preference shifted toward local products. This shift in consumption behavior led to an increase in demand for domestically produced goods and a corresponding reduction in imports (Guo, 2020; Harvey, 2018; Iqbal et al., 2015).

As exports gradually rose, the improvement helped to alleviate the trade imbalance that the currency depreciation had exacerbated. A healthier trade balance contributes positively to overall economic recovery, especially when supported by appropriate fiscal and monetary policies (Ari et al., 2019; Bahmani-Oskooee & Fariditavana, 2016; Nhung et al., 2018). Over time, this adjustment mechanism enabled the Indonesian economy to stabilize, although the road to recovery remained a challenging one. The shift to a floating exchange rate system thus marked a pivotal point in Indonesia's economic policy framework, illustrating both the vulnerabilities and the adaptive capacities of emerging markets in the face of global financial shocks.

Krugman et al. (2018) highlight that currency depreciation can lead to two interrelated yet distinct economic effects: the value effect and the volume effect. In the initial or short-term phase following a depreciation, the value effect tends to dominate, where rising prices of imported goods—due to a weaker domestic currency—cause an increase in import spending. This, in turn, deteriorates the trade balance, even when the volume of trade remains constant. The country pays more for the same amount of imports, thereby worsening its external accounts. However, as time progresses and markets adjust, the volume effect begins to take hold. This longer-term adjustment occurs as international trade contracts are renegotiated, supply chains adapt, and domestic exports become more competitive due to relatively lower prices in foreign markets. These developments contribute to an increase in export volumes, gradually improving the trade balance. Nevertheless, this improvement is not guaranteed; it is conditional upon the Marshall-Lerner condition, which asserts that the sum of the price

elasticities of demand for both exports and imports must exceed one for depreciation to have a favorable effect on the trade balance. The combined short-term deterioration and long-term improvement in the trade balance typically form what is known in international economics as the J-Curve phenomenon—a concept well-documented in empirical studies such as those by Ari et al. (2019), Bahmani-Oskooee & Hajilee (2009), and others.

In the context of Indonesia, especially in East Java Province, these theoretical dynamics hold particular relevance. Over the past decade, Japan, the United States, and China have consistently emerged as East Java's top trading partners, as recorded by Statistic Indonesia (BPS). These relationships are not incidental but institutionalized through international trade agreements such as the ASEAN-China Free Trade Agreement (ACFTA), ratified in 2004, and the Indonesia-Japan Economic Partnership Agreement (IJEPA), enacted in 2007. Such agreements have strengthened bilateral and multilateral economic ties, thereby facilitating increased trade flows. Recent BPS data show a notable rise in East Java's exports to these countries in 2021, with growth rates of 15.9% for Japan, 20.3% for the US, and 20.5% for China—primarily driven by non-oil and gas commodities. In February 2022 alone, East Java's non-oil and gas exports to the US reached USD 350.86 million, followed by USD 260.11 million to Japan, and USD 207.39 million to China. These figures illustrate the strategic importance of exchange rate dynamics and external demand in shaping the province's trade performance.

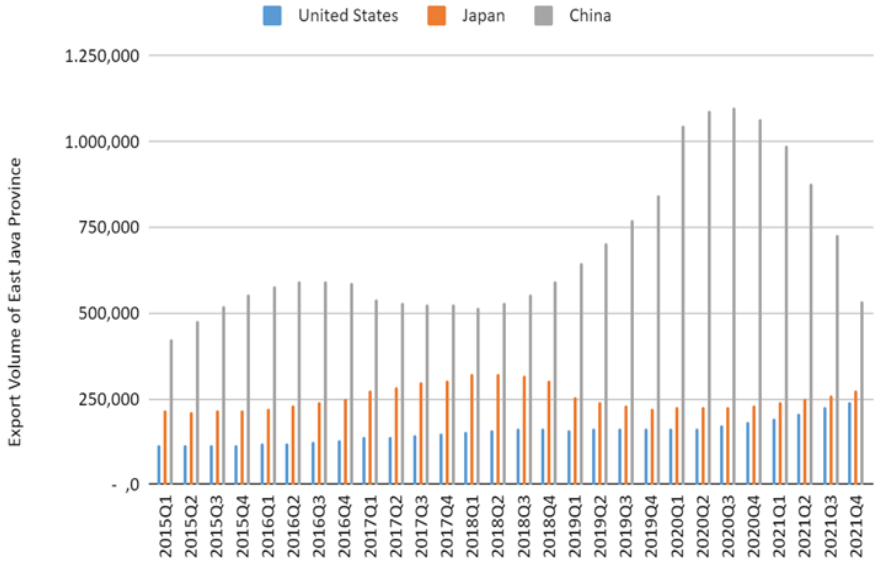

Figure 1: East Java Export Value by Destination Country (2015Q1 - 2021Q4)

Source: Statistic Indonesia (2022)

The role of the exchange rate in influencing trade flows has long been acknowledged in economic literature (Adiningsih et al., 2013; Bahmani-Oskooee & Baek, 2016; Guo, 2020). Under conditions defined by the Marshall-Lerner framework, a depreciation in a floating exchange rate regime—or a devaluation in a fixed regime—can yield favorable adjustments in trade balance over time, provided that price responsiveness in international trade is sufficiently elastic. This theoretical expectation is supported by several empirical studies (Bahmani-Oskooee & Aftab, 2018; Halicioglu, 2007), though real-world outcomes can be more nuanced. Figure 2 in this study visualizes the fluctuation of Indonesia's real exchange rate against the currencies of its main trading partners—namely the Yuan, Yen, and US Dollar—over the observed period.

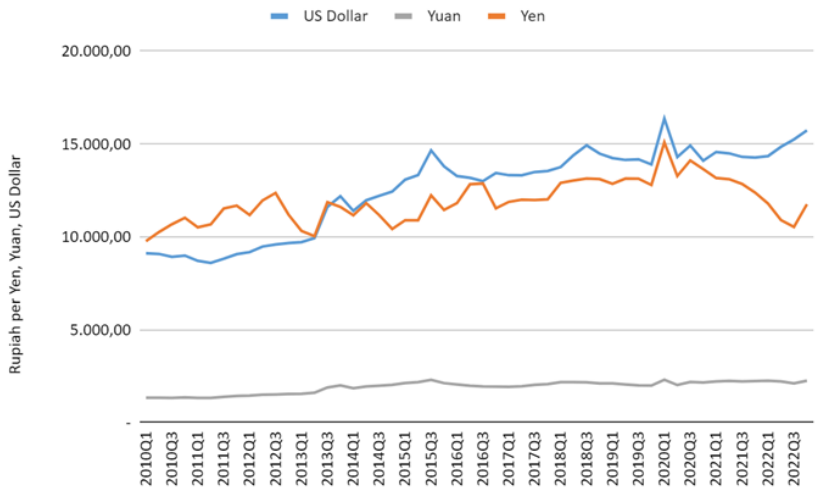

Figure 2: Rupiah per Yen, Yuan, and US Dollar (2010Q1 - 2022Q4)

Source: Statistic Indonesia (2023)

Despite robust theoretical foundations, the empirical evidence regarding the J-Curve effect remains mixed. Several studies, including those by Noland (1989) and Lal & Lowinger (2002), identified J-Curve patterns in Japan and select Asian economies. In contrast, Rose (1990), using broader cross-country data, found little support for the existence of this phenomenon. Meanwhile, Bahmani-Oskooee and colleagues have documented both the presence and absence of the J-Curve across diverse country contexts, emphasizing that the trade balance's response to exchange rate movements is highly dependent on regional and structural characteristics. However, most of these studies have been conducted at the national level, with provincial-level analyses—particularly in developing countries like Indonesia—remaining relatively scarce. Addressing this research gap, the present study examines the extent to which exchange rate fluctuations impact East Java's trade balance and whether the J-Curve effect is observable at the subnational level, where economic policymaking is increasingly taking place.

Drawing on quarterly data from the first quarter of 2010 through the first quarter of 2023 and applying the Autoregressive Distributed Lag (ARDL) model, the analysis finds no statistically significant short-run impact of exchange rate changes on East Java's trade balance. However, over the long term, a significant negative relationship emerges, suggesting that continued currency depreciation does not lead to improvements in the trade balance, as predicted by the J-Curve hypothesis. These findings challenge conventional expectations and underscore the significance of local economic conditions, trade structures, and industrial capabilities in determining the effectiveness of exchange rate adjustments. Accordingly, this paper is structured into five sections: (1) Introduction, (2) Literature Review, (3) Data and Methodology, (4) Results and Discussion, and (5) Conclusion, to provide a comprehensive examination of the subject.

Literature Review

J-Curve Phenomenon

A real depreciation of a currency generally contributes to an increase in exports and a decrease in imports; however, the effects are not instantaneous (Blanchard, 2017). In the

short term, the primary impact of depreciation is observed in changes in prices rather than trade volumes. Specifically, it causes import prices to rise. It may initially suppress export volumes, as both consumers and producers require time to adjust their behavior in response to the altered relative prices (Adiningsih et al., 2013; Bahmani-Oskooee et al., 2016). This time lag in behavioral and market adjustments often leads to a temporary worsening of the trade balance immediately after the depreciation occurs.

Over the longer run, however, the depreciation begins to yield more favorable outcomes. As domestic goods become relatively cheaper in international markets, they gain a competitive edge, which boosts demand for exports. Simultaneously, imported goods become more expensive for local consumers, leading to a natural reduction in import volumes. These changes gradually improve the trade balance as market participants adapt to the new pricing structure. The long-term improvement in the trade balance hinges on the Marshall-Lerner condition, which states that if the combined price elasticities of demand for exports and imports exceed one, then the volume effects (i.e., increased exports and reduced imports) will eventually outweigh the initial negative price effects. When this condition is met, the trade balance begins to recover and potentially achieves a surplus (Bahmani-Oskooee & Karamelikli, 2018; Cambazoglu & Günes, 2016; Guo, 2020).

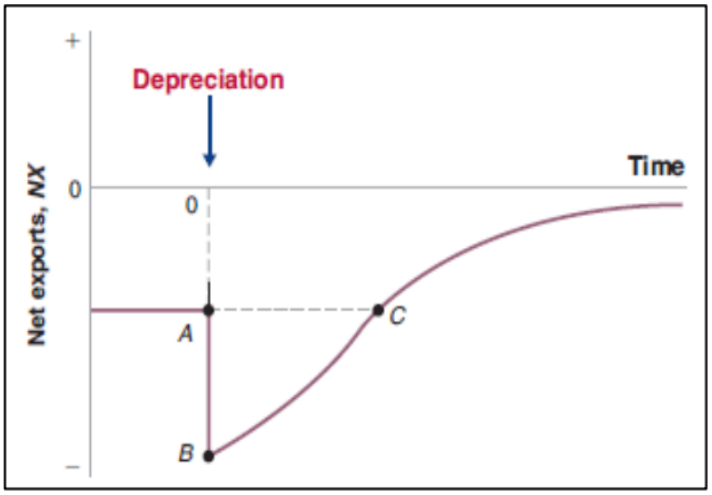

Figure 3: J-Curve Phenomenon

Source: Blanchard (2017:384)

This dynamic adjustment is often illustrated by the J-Curve phenomenon. As depicted in Figure 3, the trade balance initially deteriorates after depreciation—moving from point OA to OB—due to the lag in quantity adjustments. During this initial stage, export and import volumes remain relatively unchanged, while the higher cost of imports contributes to an increase in the trade deficit. However, as time progresses and the price elasticity effects materialize, the trade balance starts to improve, eventually surpassing point C and continuing upward. The shape of this progression resembles the letter "J," hence the term "J-Curve" (Ari et al., 2019; Bahmani-Oskooee & Aftab, 2018; Bahmani-Oskooee & Baek, 2016; Harvey, 2018; Panda & Reddy, 2016). In practical terms, understanding the J-Curve is crucial for policymakers, as it highlights the importance of patience and structural support during periods of exchange rate adjustment. While depreciation may appear detrimental in the short term, its long-run benefits can be significant—particularly when supported by complementary policies such as export incentives, import substitution strategies, and inflation control measures.

The Effects of Exchange Rate on Trade Balance

The exchange rate is a fundamental determinant in international trade, as it facilitates the comparison of prices for goods and services across countries (Krugman et al., 2018). Converting foreign prices into domestic currency enables the computation of relative prices that influence trade flows. The exchange rate comprises two measures: the nominal exchange rate, defined as the rate at which one currency can be exchanged for another (e.g., USD 1 = IDR 15,000) (Salvatore, 2013), and the real exchange rate, which adjusts the nominal rate by the ratio of foreign to domestic consumer price indices, thereby reflecting the relative purchasing power and competitiveness of domestic goods (Krugman et al., 2018).

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

Explanation:

RER = real exchange rate,

NER = nominal exchange rate,

P^{*} = foreign price level,

P = domestic price level.

The trade balance, defined as the difference between export and import demand, is primarily influenced by the real exchange rate and domestic disposable income, assuming ceteris paribus conditions (Krugman et al., 2018). The formal trade balance function is expressed as follows.

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

Explanation:

TB = trade balance,

EP^{*} / P = real exchange rate,

Y^{d} = domestic disposable income.

Fluctuations in the real exchange rate can significantly affect a region's trade balance by reshaping the relative pricing structure between domestic and international goods and services. As domestic products become relatively more expensive or cheaper compared to foreign alternatives, demand patterns shift accordingly, influencing both exports and imports. In parallel, disposable income plays a crucial role in shaping trade outcomes, as it directly affects overall household and business spending within the domestic economy. Consequently, the interaction between real exchange rate movements and domestic consumption levels becomes essential in understanding external trade performance. The theoretical linkage between trade balance and the demand for exports and imports can therefore be expressed through a functional relationship that captures these dynamics.

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

Explanation:

TB = trade balance,

EX = export,

IM = import.

An increase in EP^*/P, indicating a real depreciation, makes foreign goods relatively more expensive, thereby enhancing the competitiveness of domestic goods. In response, foreign demand for domestic exports rises, improving export performance and the trade balance. The extent to which depreciation affects the trade balance depends on whether the volume or value effect dominates. According to Krugman et al. (2018), the volume effect typically outweighs the value effect, implying that real depreciation tends to enhance the trade balance.

Empirical Framework

The J-Curve phenomenon, initially identified by Magee (1973), describes a pattern of short-term deterioration in the trade balance, followed by long-term improvement after currency devaluation. Bahmani-Oskooee (1985) extended this analysis to four developing nations — India, Korea, Thailand, and Greece — using aggregate trade data and the Almon Lag Structure method for the period 1973Q1–1980Q4, finding evidence of the J-curve in all countries except Thailand. Subsequent studies yield mixed results: Noland (1989) observed the J-Curve in Japan, while Rose (1990) did not detect it across 30 countries. In contrast, Lal and Lowinger (2002) identified the phenomenon in several Asian countries, including Indonesia. Further research by Bahmani-Oskooee (1991), Bahmani-Oskooee and Alse (1994), and Prawoto (2007) confirmed the presence of the J-Curve in their respective samples.

Rose and Yellen (1989) pioneered the use of bilateral trade data for the period 1960Q1–1985Q4, mitigating aggregation bias inherent in prior aggregate analyses. Their findings indicate the absence of the J-Curve effect in trade between the United States and six partners: Britain, Italy, Japan, Germany, Canada, and France. Subsequent research increasingly adopts bilateral data, as aggregate figures may obscure country-specific trade dynamics. This heterogeneity in depreciation effects on trade balances underscores the greater representativeness and precision of bilateral trade analyses (Bahmani-Oskooee & Goswami, 2003; Halicioglu, 2007; Husman, 2005).

Bahmani-Oskooee and Brooks (1999) documented a long-run exchange rate effect on the trade balance and confirmed the presence of the J-Curve phenomenon in US trade with all partner countries except the UK. Supporting evidence from bilateral trade data includes findings by Bahmani-Oskooee and Goswami (2003) for Japan with Italy and Germany, Iqbal et al. (2015) for Pakistan with the US, China, UK, Canada, France, and Saudi Arabia, and Nhung et al. (2018) for Vietnam and Japan. Conversely, Panda and Reddy (2016) reported no J-Curve effect in India-China bilateral trade.

Advancements in exchange rate and trade balance research have utilized industry-level data. Bahmani-Oskooee and Wang (2008) examined the impact of real exchange rate fluctuations on the US-China trade balance across 88 industries using annual data spanning from 1978 to 2002. Their results indicated that in 34 industries, currency depreciation was associated with improvements in the trade balance, while evidence supporting the J-Curve effect was found in 22 industries. These heterogeneous outcomes suggest that specific industries satisfy the Marshall-Lerner condition, exhibiting long-run elasticity in export and import demand relative to real exchange rate changes. Such responsiveness enhances product competitiveness, thereby improving the industry's trade balance (Bahmani-Oskooee & Baek, 2015; Bahmani-Oskooee & Harvey, 2015; Guo, 2020).

Data and Methodology

Data Analysis

This study employs quarterly time series data spanning from 2010Q1 to 2023Q1, selected due to prevailing issues such as East Java's persistent trade balance deficits, depreciation of the Rupiah relative to the currencies of key trading partners, and data availability. The independent variables include the Real Effective Exchange Rate (REER), Gross Regional Domestic Product (GRDP) of East Java, and the Gross Domestic Product (GDP) of major trading partner countries. At the same time, the trade balance serves as the dependent variable. A comprehensive analysis of these variables and their interactions is detailed below to elucidate their impact on East Java's trade dynamics.

Fluctuations in the real exchange rate can significantly affect a region's trade balance by reshaping the relative pricing structure between domestic and international goods and services. As domestic products become relatively more expensive or cheaper compared to foreign alternatives, demand patterns shift accordingly, influencing both exports and imports. In parallel, disposable income plays a crucial role in shaping trade outcomes, as it directly affects overall household and business spending within the domestic economy. Consequently, the interaction between real exchange rate movements and domestic consumption levels becomes essential in understanding external trade performance. The theoretical linkage between trade balance and the demand for exports and imports can therefore be expressed through a functional relationship that captures these dynamics.

This research utilizes quarterly time series data spanning from the first quarter of 2010 to the first quarter of 2023. This timeframe is chosen based on several considerations, notably the persistent trade deficits observed in East Java, the ongoing depreciation of the Indonesian Rupiah against the currencies of major trading partners, and the availability of consistent and reliable macroeconomic data. The selection of this period also aligns with significant global economic shifts, such as post-global financial crisis recovery and trade fluctuations during the COVID-19 pandemic, which may have had measurable effects on regional trade balances.

The independent variables examined in this study include the Real Effective Exchange Rate (REER), the Gross Regional Domestic Product (GRDP) of East Java, and the Gross Domestic Product (GDP) of the province's primary trading partners—namely China, Japan, and the United States. The trade balance of East Java functions as the dependent variable, serving as the primary indicator of external trade performance. A detailed econometric analysis is conducted to explore how these variables interact over time and to identify the extent to which each factor contributes to fluctuations in the trade balance. Through this analytical framework, the study aims to provide a nuanced understanding of East Java's trade dynamics and the macroeconomic forces that influence them.

Table 1: Variable, Notation, and Explanation Data Analysis

Variable	Notation	Explanation
Trade Balance	TB	Quarterly data from the Trade balance in percent.
Gross Domestic Product	YP	Quarterly data on GDP growth as a proxy for economic growth in percent.
Gross Regional Domestic Product	YE	Quarterly data on GRDP growth as a proxy for economic growth in percent.
Real Effective Exchange Rate	REX	Quarterly data from the Effective Real Exchange Rate (REER) in points (index).

Methodology

The Autoregressive Distributed Lag (ARDL) model, originally formulated by Pesaran and Shin (1996), has become one of the most commonly applied econometric techniques for exploring long-term equilibrium relationships through cointegration among time-series variables. A major advantage of the ARDL methodology lies in its versatility—it is capable of handling explanatory variables that are integrated at different levels, whether stationary at the level [I(0)] or in first difference [I(1)], without the need for pre-transforming them. This adaptability makes ARDL particularly useful in practical empirical research, where the integration order of variables may vary.

Moreover, the ARDL framework allows for the simultaneous estimation of both short-run dynamics and long-run coefficients within a single equation model. Unlike traditional cointegration techniques, such as the Engle-Granger or Johansen approach, the ARDL approach provides reliable t-statistics and mitigates potential issues related to unit root testing, which can often lead to misleading inferences if not carefully addressed (Ari et al., 2019; Bahmani-Oskooee & Karamelikli, 2018). In its conventional form, the ARDL model assumes symmetry in the adjustment mechanism, implying that increases and decreases in explanatory variables have equal and opposite impacts on the dependent variable. However, researchers have increasingly explored asymmetric variants of ARDL when real-world data exhibit non-linearities or threshold effects. The following ARDL specification employed in this study reflects the long-run relationship among the variables under investigation.

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

This research draws upon the analytical model introduced by Bahmani-Oskooee and Harvey (2017), which conceptualizes the trade balance as a function influenced by several core macroeconomic indicators. These include domestic economic growth, the economic performance of major trading partners, and exchange rate volatility. Such a formulation integrates both internal and external macroeconomic forces, offering a more holistic framework for analyzing trade balance movements. By incorporating these key variables, the model aims to capture the multifaceted drivers of trade imbalances and understand how these drivers interact over time. In doing so, it contributes to the broader literature on international trade dynamics, particularly in emerging economies where volatility and structural shifts are more pronounced. A detailed explanation of the empirical model, including its components and specifications, is provided in the subsequent section.

TB_t = East Java trade balance and trading partners,

α_0 = constant,

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

YP_t = GDP trading partners at time t,

YE_t = GRDP of East Java at time t,

REX_t = real exchange rate at time t,

ε_t = error term at time t.

Model error-correction from ARDL as follow:

$$\Delta TB_t = \beta_0 + \beta_1 TB_{t-1} + \beta_2 YP_{t-1} + \beta_4 REX_{t-1} + \sum_{i=1}^{n1} \beta_{5,i} \Delta TB_t + \sum_{i=0}^{n2} \beta_{6,i} \Delta YP_t + \sum_{i=0}^{n3} \beta_{7,i} \Delta YE_t + \sum_{i=0}^{n4} \beta_{8,i} \Delta REX_t + \varepsilon_t \quad (5)$$

Explanation:

ΔTB_t = changes in East Java's trade balance and trading partners,
β_0 = constant,
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8,$ = coefficients of the independent variables,
ΔTB_t = changes in East Java's trade balance lag i,
ΔYP_t = changes in GDP trading partner lag i,
ΔYE_t = changes in GRDP East Java lag i,
ΔREX_t = Changes in the real exchange rate 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,
REX_{t-1} = real exchange rate of the Rupiah against the 1st trading partner lag exchange rate,
ε_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.

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%

This study applies the Augmented Dickey-Fuller (ADF) unit root test to evaluate whether the time series variables exhibit stationarity or are characterized by a unit root. The test plays a crucial role in time series econometrics, as it determines the appropriate treatment of data before conducting regression analyses. The ADF test's null hypothesis suggests that a variable is non-stationary (i.e., contains a unit root), while the alternative hypothesis supports the presence of stationarity.

Given the methodological requirements of the Autoregressive Distributed Lag (ARDL) framework, only variables integrated at level I(0) or at the first difference I(1) are suitable for inclusion in the model. Variables that are integrated at the second difference I(2) must be excluded, as their presence violates key assumptions underlying the ARDL bounds testing

approach and could lead to invalid or biased estimations (Ari et al., 2019; Guo, 2020; Panda & Reddy, 2016). Based on the results of the ADF test, all series used in this analysis—both dependent and independent—were found to be stationary after first differencing and statistically significant at the 5% level. These findings confirm the suitability of the ARDL approach for estimating both short-run and long-run relationships.

Optimal Lag Selection

To determine the optimal lag length, this study utilizes the Akaike Information Criterion (AIC), which is widely recognized for its robustness in model selection. A maximum of four lags is considered for each variable, aligning with the standard procedures followed in similar empirical works, including those by Ari et al. (2019) and Bahmani-Oskooee & Karamelikli (2018). The AIC criterion effectively balances the trade-off between model complexity and predictive performance. By selecting a lag structure that maximizes model fit while minimizing overfitting, the criterion helps ensure accurate in-sample estimation and reliable out-of-sample forecasting (Widarjono, 2007). The lag selection results, presented in Table 2, reflect the temporal responsiveness of the trade balance to shifts in the explanatory variables, such as the real exchange rate, Gross Regional Domestic Product (GRDP), and the Gross Domestic Product (GDP) of East Java's key trading partners. The length of the lag captures how many periods are required for external or internal economic shocks to translate into changes in trade performance, providing insight into the speed and structure of regional trade adjustments.

Table 2: Optimal Lag Selection Result

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

ARDL Bound Test

Short-Run ARDL Bound Test

In the short-run analysis, the estimated coefficients derived from the ARDL models are summarized in Table 3. For the China model, a statistically significant negative relationship is identified between East Java's GRDP and the trade balance. Specifically, a 1% increase in regional output is associated with a 138.1% decline in the trade balance. This suggests that in the short term, growth in domestic output may stimulate import demand more rapidly than export expansion, thus worsening the trade position. Conversely, China's national GDP has a significant positive effect, with a 1% increase contributing to a 70.2% improvement in East Java's trade balance. This highlights the role of external demand conditions in supporting regional export performance.

For the Japan and United States models, the short-run coefficients for East Java's GRDP are statistically insignificant, implying that fluctuations in domestic output do not exert a meaningful short-term influence on trade balances with these countries. However, the US GDP demonstrates a strong and statistically significant positive impact: a 1% rise in US economic output is associated with a 171.3% improvement in East Java's trade balance. These results highlight the asymmetric nature of East Java's trade response to domestic versus foreign economic changes, suggesting that external demand—particularly from key trade partners—plays a more significant role in shaping the region's trade outcomes in the short term.

Such findings have important policy implications. They indicate that while regional economic growth is important, strengthening trade ties and tapping into expanding foreign markets—especially in high-demand economies like the US and China—may offer more immediate benefits for trade performance. Additionally, understanding these short-run dynamics helps policymakers design more responsive trade and industrial strategies that align with external economic conditions.

Table 3: Short-Run ARDL Bound Test Result

Variable	Short-Run Estimation		
	China	Japan	United State
Constant	28.908** (3.061)	22.355** (2.275)	36.880** (3.291)
TB_{t-1}	0.840** (3.358)	0.551** (2.138)	0.835** (2.952)
TB_{t-2}	0.391** (2.774)	0.258* (1.731)	0.338* (2.001)
TB_{t-3}	-	-	-
TB_{t-4}	-	-	-
REX	-	-	-
REX_{t-1}	-	-	-
REX_{t-2}	-	-	-
REX_{t-3}	-	-	-
REX_{t-4}	-	-	-
YE	-1.381** (-3.289)	-0.376 (-1.496)	-1.100 (-1.406)
YE_{t-1}	-	-	-
YE_{t-2}	-	-	-
YE_{t-3}	-	-	-
YE_{t-4}	-	-	-
YP	0.017 (0.129)	-	0.875 (1.323)
YP_{t-1}	0.702** (3.229)	-	1.713** (2.626)
YP_{t-2}	-	-	1.286** (2.139)
YP_{t-3}	-	-	0.904* (1.760)
YP_{t-4}	-	-	-

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)

Long-Run ARDL Bound Test

Table 4 reports the results of the long-run estimates obtained from the ARDL model for the three selected trading partners: China, Japan, and the United States. The analysis reveals that the real exchange rate has a consistently negative and statistically significant effect on East Java's trade balance across all models. More specifically, a 1% depreciation in the real exchange rate leads to a deterioration of the trade balance by approximately 13.2% in the China model, 11.6% in the Japan model, and 15.7% in the United States model. These findings suggest that in the long term, a weaker domestic currency does not enhance trade competitiveness as expected, but instead worsens East Java's trade position. This could be due to structural factors such as a high dependency on imported inputs, inelastic demand for imports, or limited export diversification, which reduce the potential benefits of currency depreciation.

In terms of external economic influence, the Japan model shows that Japan's GDP has a positive and significant long-run impact on East Java's trade performance. A 1% increase in Japan's economic output is associated with a 27.8% improvement in East Java's trade balance. This indicates that stronger economic activity in Japan likely boosts demand for imports, including goods produced in East Java, thereby benefiting regional exporters. On the domestic side, the United States model identifies a significant long-run positive relationship between East Java's Gross Regional Domestic Product (GRDP) and its trade balance. A 1% rise in regional economic output contributes to a 20.9% enhancement in the trade balance. This relationship may reflect improved production capacity and competitiveness of local industries as output grows, enabling East Java to expand exports or substitute imports with domestically produced goods.

Overall, these long-run estimates underscore the differentiated sensitivity of East Java's trade balance to both external macroeconomic conditions and internal economic dynamics. While partner-country growth (especially Japan's) tends to have a favorable impact, real exchange rate depreciation appears counterproductive, at least in the case of East Java. These results suggest that structural economic reforms, aimed at improving export competitiveness and reducing reliance on imported inputs, may be necessary to enhance the effectiveness of exchange rate policy. Furthermore, fostering stronger trade relationships with emerging economies could serve as a strategic tool for long-term regional trade improvement.

Table 4: Long-run ARDL Bound Test Result

Variable	Long-run Estimation		
	China	Japan	United State
Constant	28.908** (3.061)	22.355** (2.275)	36.880** (3.291)
REX	-0.132** (-3.597)	-0.116** (-2.561)	-0.157** (-3.963)
YE	0.079 (0.927)	0.075 (0.886)	0.209** (2.263)
YP	0.085 (1.041)	0.278* (1.743)	-0.392 (-1.380)

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)

ARDL Cointegration Test

The subsequent stage of the analysis involves conducting a cointegration test to determine whether a stable, long-term equilibrium relationship exists among the variables included in the ARDL model. To address this, the study employs the bounds testing approach developed by Pesaran et al (1996). This method is particularly well-suited for models that contain a mix of variables integrated at level I(0) and first difference I(1), offering a degree of flexibility that makes it advantageous in applied econometric research. This is especially useful when unit root test outcomes are ambiguous or inconclusive, eliminating the need for pre-classifying variables strictly by their integration order before model estimation.

Within this framework, the null hypothesis posits that no cointegration exists—that is, the variables do not share a long-run relationship—while the alternative hypothesis suggests that the variables are cointegrated and thus move together in the long run despite short-term deviations. The decision rule is based on a comparison between the computed F-statistic and the critical bounds provided in the Pesaran tables. If the F-statistic is greater than the upper bound, the null hypothesis is rejected, indicating the presence of a long-run relationship. If the statistic falls below the lower bound, the null cannot be rejected, suggesting no cointegration.

However, when the value lies within the bounds, the result is considered inconclusive, necessitating additional validation through alternative techniques or robustness checks to confirm the cointegration status.

As shown in Table 5, the calculated F-statistics for all three models—representing China, Japan, and the United States—exceed the upper critical values at the 5% significance level. This empirical evidence strongly supports the existence of cointegration among the variables in each country-specific model. In practical terms, this means that although short-run fluctuations and volatility may occur, the variables—such as real exchange rate, regional output, and trading partner GDP—tend to adjust and converge toward a stable long-term relationship over time. These results are of substantial analytical importance, as they validate the underlying assumption that the included macroeconomic indicators do not operate in isolation but are interconnected systematically. Recognizing this cointegrated structure provides the theoretical justification for applying the ARDL model to examine both short-run dynamics and long-run equilibrium effects. Additionally, this evidence underscores the persistence and interdependence of trade balance behavior in response to internal and external economic forces, highlighting the importance of long-term policy planning that considers both domestic performance and international developments.

Table 5: ARDL Cointegration Test Result

Trading Partners	F-Statistic	Explanation
China	13.007**	Cointegration
Japan	10.601**	Cointegration
United State	11.334**	Cointegration

Noted :(**) significant at 5%; (*) significant at 10%
5% = upper bound (4.35); lower bound (3.23)
10% = upper bound (3.77); lower bound (2.72)

ARDL Diagnostic Test

This research conducted a series of four essential diagnostic assessments to confirm the reliability and overall stability of the estimated ARDL (Autoregressive Distributed Lag) models. The initial diagnostic procedure focused on evaluating the Error Correction Model (ECM), which determines the rate at which deviations from long-run equilibrium are corrected following short-term disturbances. A properly functioning ECM is characterized by an error correction term (ECM_{t-1}) that is both negative in sign and statistically significant. This condition signifies that any short-run disequilibrium in the system is self-correcting over time, gradually restoring the model to its long-term path. Conversely, a positive coefficient would imply divergence, raising concerns about the model's stability and predictive validity.

The empirical results affirm that all three models—about China, Japan, and the United States—exhibit ECM coefficients that are not only negative but also statistically significant at the 5% level. This indicates strong evidence of convergence towards a long-run equilibrium. Specifically, the ECM coefficients were estimated at −2.336 for China, −1.981 for Japan, and −2.421 for the US, respectively. These figures suggest that any imbalances in the bilateral trade relationships are corrected at quarterly adjustment rates of 233.6%, 198.1%, and 242.1%. The magnitude of these coefficients reflects a relatively swift adjustment mechanism across the models, highlighting the dynamic nature and resilience of each trade relationship in returning to equilibrium following exogenous or endogenous shocks.

The second diagnostic test employed was the Lagrange Multiplier (LM) test, intended to detect the presence of autocorrelation in the residuals of the ARDL models. Under the null hypothesis, residuals are serially correlated, while the alternative hypothesis assumes their independence. The test results indicated no evidence of autocorrelation in the residuals across all three country-specific models. This outcome suggests that the error terms are independently distributed over time, thereby enhancing the reliability of the parameter estimates and the robustness of the ARDL model specification.

Following that, the third diagnostic tool used was the Ramsey Regression Equation Specification Error Test (RESET), which assesses whether the functional form of the model is correctly specified. A model that passes this test implies the absence of omitted variables or incorrect functional forms, ensuring that specification errors do not distort the estimated relationships among variables. All three models successfully passed the RESET test, indicating that the underlying equations are appropriately formulated and free from major structural flaws. This strengthens the overall credibility of the empirical framework used in the study.

Lastly, the Adjusted R-squared (Adj. R^2) metric was employed to evaluate the explanatory power and goodness of fit of each model. The values obtained were 0.753 for China, 0.708 for Japan, and 0.714 for the United States. These figures imply that the chosen independent variables—namely, the real exchange rate, East Java's Gross Regional Domestic Product (GRDP), and the trading partners' Gross Domestic Product (GDP)—collectively account for 75.3%, 70.8%, and 71.4% of the variation in trade balance, respectively. The unexplained portion may be attributed to external shocks, policy interventions, or other structural factors not incorporated into the model. Altogether, the diagnostic outcomes provide strong empirical justification for the validity of the models, affirming that both short-run and long-run estimates are based on a solid econometric foundation. Moreover, these evaluations underscore the necessity of rigorous post-estimation diagnostics in time series analysis to ensure model robustness and to support sound policy implications derived from empirical findings.

Table 6: ARDL Diagnostic Test Result

Trading Partners	ECM_{t-1}	LM	Ramsey RESET	Adj.R^2
China	-2.336** (-7.478)	0.070	0.080	0.753
Japan	-1.981** (-6.740)	0.631	0.027	0.708
United State	-2.421** (-7.001)	0.030	0.01	0.714

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

This study employed the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) tests to assess model stability. The CUSUM test evaluates systematic shifts in regression coefficients and adjustment speed, whereas the CUSUMSQ test detects abrupt structural changes in these parameters. According to Pesaran et al. (2001), both tests are robust tools for examining the stability of ARDL models. Stability is confirmed when the test statistics remain within the 5% critical bounds. As depicted in Figure 4, the CUSUM test for the China model indicates instability by crossing the 5% significance boundary, while the CUSUMSQ test indicates stability. Conversely, both tests confirm stability in the Japan and United States models, as their statistics do not breach the critical threshold.

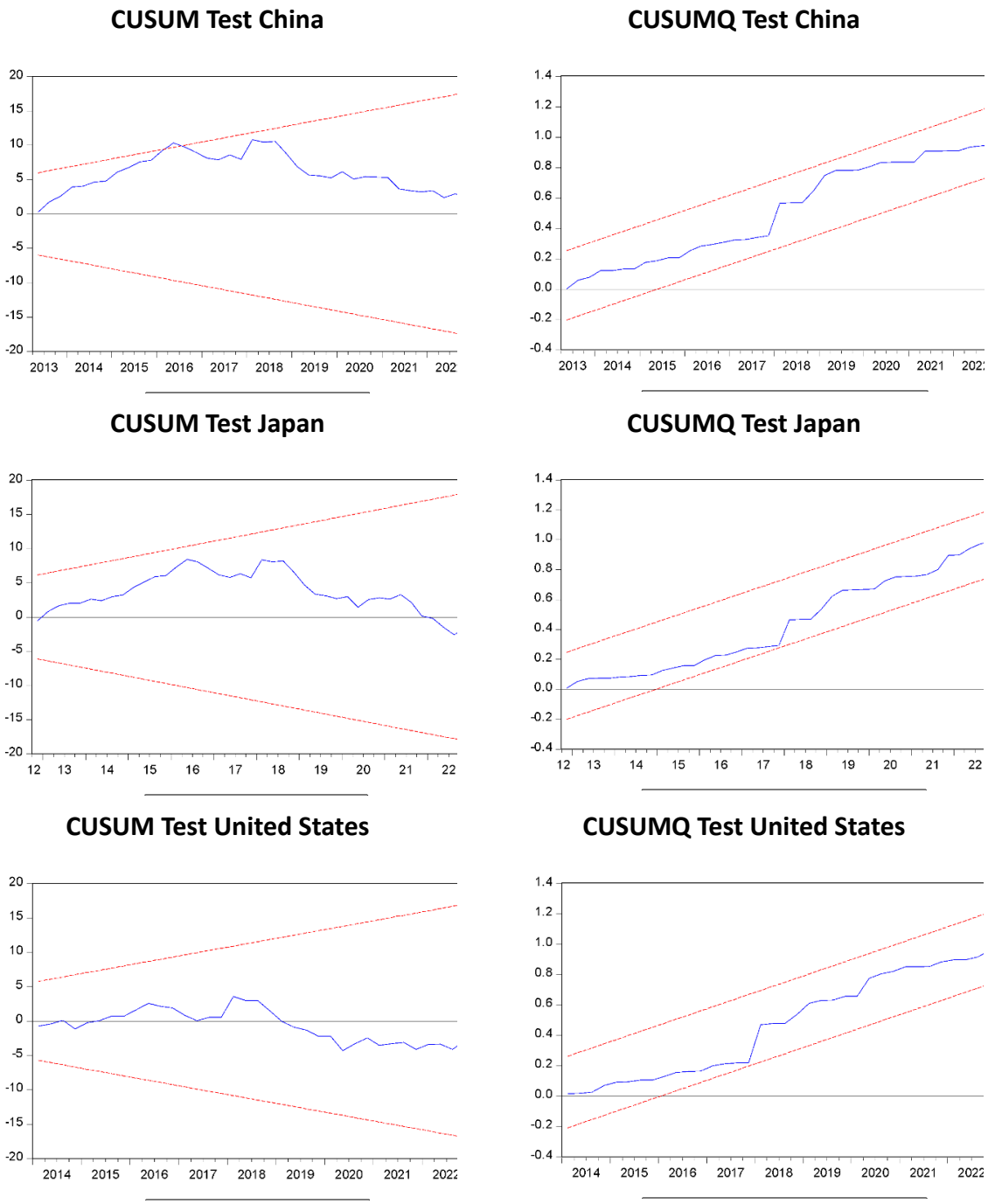

Figure 4: Robustness Test CUSUM and CUSUMQ

Discussion of Result

The empirical findings of this study reveal that, in the short run, fluctuations in the exchange rate do not exert a statistically significant impact on East Java's trade balance under any of the tested models. However, in the long run, the exchange rate exhibits a significant negative effect on the trade balance. This outcome indicates that the J-Curve phenomenon—a theoretical framework widely used in international trade economics—does not appear to be present in the case of East Java. Typically, the J-Curve hypothesis suggests that a currency depreciation initially worsens the trade balance due to higher import prices and rigid export volumes in the short run, followed by a gradual improvement as exports become more competitive and demand adjusts over time. The absence of such a pattern

implies that the expected short-term-to-long-term adjustment path does not apply uniformly across all regional contexts.

The J-Curve concept, first introduced by Magee (1973), has long been used to explain the lagged positive effects of exchange rate devaluation. It portrays the trade balance trajectory as a 'J' shape: a short-term decline followed by a long-term recovery. While this model has been validated in various country-level studies, its applicability at subnational levels, such as provinces, remains relatively underexplored. Therefore, this study contributes to the growing body of literature by testing this phenomenon within a regional context, offering fresh insights for both policymakers and researchers interested in spatial dimensions of exchange rate effects.

Existing literature has predominantly analyzed the exchange rate–trade balance relationship at the national level, assuming a symmetric impact, where currency appreciation and depreciation are expected to yield mirror-image effects of equal magnitude. However, recent studies have shown that these effects may, in fact, be asymmetric, meaning that depreciation and appreciation can affect trade flows differently even if the rate of change is identical. This asymmetry could be influenced by structural factors such as export concentration, trade composition, production capacity, and import dependency, which vary from region to region. These findings emphasize the importance of conducting analyses at more granular levels, as national aggregates may obscure meaningful regional dynamics.

In line with these insights, prior empirical studies have produced mixed results regarding the presence of the J-Curve effect. For instance, Rose and Yellen (1989), using bilateral trade data to address aggregation bias, found no evidence of the J-Curve in the United States' trade with six major trading partners: the United Kingdom, Italy, Japan, Germany, Canada, and France. Similarly, Bahmani-Oskooee and Alse (1994), through an error correction modeling approach applied to 41 countries—including Indonesia—also found no support for the J-Curve in Indonesia's trade dynamics. However, subsequent studies such as Hapsari and Kurnia (2018) did identify long-run J-Curve patterns in Indonesia's bilateral trade with China, Japan, South Korea, and Singapore. These contrasting results highlight the context-dependent nature of exchange rate adjustments and their differential effects depending on trade partner characteristics.

Additional studies reinforce this variation. Bahmani-Oskooee and Goswami (2003) documented J-Curve effects in Japan's bilateral trade with Italy and Germany, while Iqbal et al. (2015) confirmed similar outcomes in Pakistan's trade with the US, China, the U.K., Canada, France, and Saudi Arabia. Nhung et al. (2018) also observed the J-Curve in Vietnam's trade with Japan. Conversely, Panda and Reddy (2016) found no such pattern in the India–China trade relationship. Using a Vector Error Correction Model (VECM), Husman (2005) examined Indonesia's real exchange rate impact on bilateral trade with eight countries and found that the Marshall-Lerner condition—requiring the sum of the absolute values of the export and import elasticities to exceed one—held only for Indonesia's trade with Japan, Germany, and South Korea. Similarly, Adiningsih et al. (2013) validated the J-Curve phenomenon in Indonesia's trade with China and Japan through a comparable econometric approach.

Further empirical refinement was introduced by Bahmani-Oskooee and Harvey (2017), who tested the J-Curve hypothesis in Indonesia's trade with 12 major partners using both Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL (NARDL) models. Their findings revealed that while the linear ARDL model identified J-Curve dynamics in trade with the US, the Philippines, the UK, and Singapore, the NARDL approach—accounting for asymmetrical

responses—detected J-Curve effects in Indonesia's trade with Australia, England, Japan, South Korea, and Singapore. These results underscore the critical role of model selection and methodological precision in evaluating exchange rate–trade balance relationships.

Beyond the J-Curve framework, Bahmani-Oskooee and Harvey also analyzed the impact of exchange rate volatility—another crucial dimension often neglected in standard J-Curve studies. Their analysis, which combined both linear and nonlinear methods, found that short-run fluctuations in the real exchange rate tended to support the trade balance. However, in the long run, linear models pointed toward a negative correlation, while nonlinear models revealed pronounced asymmetries, indicating that trade balances do not respond uniformly to currency appreciation and depreciation. These insights underscore the need to incorporate nonlinear and asymmetric modeling in contemporary trade research, enabling a more accurate capture of the complex nature of economic adjustments over time. Taken together, the findings of the present study and those of related works suggest that the effect of exchange rate movements on trade performance—particularly at the provincial level—should not be generalized. Instead, it demands a nuanced and context-aware analytical framework that reflects regional trade structures, production systems, and exposure to global value chains. As global trade becomes increasingly decentralized and interconnected, provincial-level analyses such as this become vital in informing local economic strategies and policy decisions.

Conclusion

This study explores the influence of exchange rate fluctuations on the trade balance of East Java Province in relation to its three primary trading partners: China, Japan, and the United States. The analysis is conducted across both short-term and long-term perspectives and also examines whether the J-Curve phenomenon is evident within these bilateral trade relationships. Employing the Autoregressive Distributed Lag (ARDL) model and quarterly time-series data from Q1 2010 to Q1 2023, the results reveal that in the short run, exchange rate movements do not significantly affect East Java's trade balance across any of the estimated models. However, in the long run, the exchange rate demonstrates a statistically significant negative impact, implying that sustained depreciation of the Rupiah may actually deteriorate the province's trade performance over time.

In addition to the exchange rate, this study incorporates other macroeconomic variables—namely the Gross Regional Domestic Product (GRDP) of East Java and the Gross Domestic Product (GDP) of its trading partners. These variables yield diverse impacts across different temporal scopes. In the short run, East Java's GRDP exerts a negative influence on the trade balance within the China model, suggesting that rising domestic output may be accompanied by increased import demand. Conversely, the GDPs of China and the United States positively influence the province's trade balance, potentially reflecting growing demand for East Java's exports in those markets. In the long term, East Java's GRDP contributes positively to its trade balance in the US model, while Japan's GDP also shows a significant positive association with East Java's trade performance.

The absence of the J-Curve effect in all three bilateral relationships suggests that the typical adjustment path associated with currency depreciation does not materialize in this case. The J-Curve, as posited by Magee (1973), outlines a scenario in which a country's trade balance initially worsens following a depreciation before improving over time as trade volumes adjust to new relative prices. For such a pattern to occur, the price elasticity of both exports and imports must be sufficiently high. The findings in this study indicate that East

Java's trade sectors are largely price inelastic, meaning that exchange rate changes have limited influence on trade volumes. This implies that traditional monetary policy tools such as depreciation may be ineffective for boosting regional export competitiveness, particularly in cases where the province's exports are dominated by low-elasticity commodities or sectors with rigid supply structures.

This phenomenon may be explained by the structural characteristics of East Java's economy. The province's export profile is often centered around limited product categories, many of which fall within low-technology or resource-based manufacturing, where global demand is less sensitive to price changes. Additionally, import dependence for raw materials and intermediate goods may dampen the benefits of depreciation, as input costs rise in tandem with the weakening rupiah. These conditions limit exporters' capacity to scale up production and respond to price-driven competitive advantages.

Given these constraints, policymakers should look beyond exchange rate policy as a primary tool for trade development. Instead, efforts should be redirected toward enhancing the quality, value, and diversification of export products. Strategic initiatives such as improving technical skills through exporter training programs, fostering university–industry linkages, and integrating digital and green technologies into the production process can boost long-term competitiveness. In particular, aligning export strategies with global market trends, such as sustainable sourcing and innovation-based differentiation, can help East Java tap into higher-value global value chains. Moreover, fostering regional trade resilience requires not only supply-side improvements but also demand-side alignment. This includes developing better market intelligence systems, promoting branding for regional products, and improving logistics infrastructure to reduce transaction costs. Integrating these structural policies can help East Java achieve a more stable and growth-oriented trade trajectory, regardless of exchange rate dynamics.

In conclusion, while exchange rate fluctuations are a relevant macroeconomic variable, their isolated effect on trade balance—particularly in East Java—appears limited in both scope and magnitude. The findings reinforce the importance of holistic trade policy frameworks that incorporate both macroeconomic instruments and structural transformation strategies to create sustainable export growth.

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