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Artificial Intelligence in Monetary Response: The Role of Investor Sentiment in the Effectiveness of Bank Indonesia's Interventions

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Abstract

Exchange rate stability is a core pillar of macroeconomic resilience, especially for emerging economies like Indonesia. The effectiveness of Bank Indonesia's (BI) monetary interventions in stabilizing the Rupiah depends not only on policy instruments but also on market perceptions and investor sentiment. This study examines the relationship between investor sentiment and the effectiveness of BI's interventions by integrating Natural Language Processing (NLP), event study, and moderated regression analysis. The dataset spans 2023–2025 and includes daily exchange rate data, an investor sentiment index derived from financial forums and business news using VADER and TextBlob algorithms, and BI intervention records. An event study with a ±5 day window evaluates the short-term impact of interventions on exchange rate returns, while moderated regression analyzes the interaction between sentiment and interventions. Results indicate that BI interventions produce short-term exchange rate recovery, with a cumulative average abnormal return (CAAR) of 0.55% on the third day after intervention. Regression findings show that investor sentiment significantly influences Rupiah movements ($p < 0.01$), and the interaction between sentiment and interventions is also significant ($p < 0.05$), indicating greater effectiveness under positive or neutral sentiment. These findings underscore that intervention success is closely tied to market psychology. Therefore, BI should incorporate AI-driven sentiment analysis into policy design to enhance intervention effectiveness and strengthen public communication credibility. This study enriches the literature on behavioral macroeconomics and offers a data-driven framework for adaptive monetary policymaking in the digital economy.

Keywords : *Event Study, Exchange Rate, Investor Sentiment, NLP, Monetary Intervention.*

1. INTRODUCTION

Exchange rate stability is a crucial pillar in maintaining macroeconomic resilience, particularly in developing countries such as Indonesia. Fluctuations in the Rupiah not only affect purchasing power and inflation but also influence investment, trade balance, and public confidence in monetary policy [1], [2]. As the monetary authority, Bank Indonesia (BI) actively implements various interventions, including foreign exchange market operations and adjustments to interest rate instruments, to manage exchange rate volatility [3], [4]. Nevertheless, the effectiveness of these interventions is often influenced by non-fundamental factors such as market expectations and investor sentiment, which have become increasingly dominant in the digital economy era [5], [6].

The advancement of information technology and online media has created an ecosystem in which market perceptions are rapidly shaped through financial forums, business news, social media platforms, and analyst reports [7], [8]. Recent studies indicate that changes in financial asset prices are often more strongly influenced by psychological factors than by traditional economic indicators [9], [10]. In this context, the behavioral finance approach provides a theoretical framework for understanding how the

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collective perceptions of market participants can amplify or diminish the effectiveness of monetary policy [11], [12].

In line with advancements in artificial intelligence (AI), particularly Natural Language Processing (NLP), sentiment analysis can now be conducted quantitatively and in real time using various textual data sources [13], [14]. Algorithms such as VADER and TextBlob enable researchers to assess investor attitudes more objectively, making them valuable supplementary indicators for monetary policy decision-making [15], [16]. Several studies have even found that central bank interventions tend to be more effective under positive or neutral market sentiment, whereas interventions amid prevailing negative sentiment have more limited impacts [17], [18].

These findings underscore that understanding market sentiment has strategic implications for the effectiveness of monetary interventions. By integrating AI-based sentiment analysis into the event study framework and moderated regression models, monetary policy can be designed to be more adaptive to market dynamics [19], [20]. Therefore, there is a need for research that combines the psychological dimensions of the market with data-driven analytical tools to evaluate the effectiveness of Bank Indonesia's monetary interventions.

Based on the aforementioned background, this study specifically aims to provide a deeper understanding of the relationship between investor sentiment and the effectiveness of Bank Indonesia's monetary interventions on Rupiah exchange rate dynamics during the 2023-2025 period [21], [22]. This research not only examines the relationship descriptively but also evaluates its impact through an event study approach to assess exchange rate return changes before and after Bank Indonesia's interventions [23], [24]. Furthermore, this study develops a moderated regression model to identify the role of investor sentiment as a moderating variable that may strengthen or weaken the effect of monetary interventions on exchange rate movements [25], [26]. By integrating these empirical findings, this research is expected to generate data-driven policy recommendations that support the formulation of more adaptive and responsive monetary intervention strategies in line with market dynamics [27], [28]. Through this approach, the study seeks to make a substantive contribution to the development of behavioral macroeconomics literature while offering a practical framework for monetary authorities to enhance the effectiveness of intervention policies in the context of increasingly complex modern financial markets.

2. METHOD

2.1. Research Design

This study employs a quantitative approach with an explanatory research design to examine the relationship between investor sentiment, Bank Indonesia's monetary interventions, and Rupiah exchange rate movements. The analysis was conducted in three main stages. First, data collection and processing were carried out using multiple sources including financial forums, online news media, and market analyst reports processed through Natural Language Processing (NLP) methods with algorithms such as VADER, TextBlob, and enhanced large language models (retrieval-augmented LLMs) to construct a real-time and objective investor sentiment index [29], [30]. The second stage involved an event study analysis to measure the impact of monetary interventions on exchange rate returns using a short event window (e.g., –1 to +3 days), consistent with the established literature on event-driven financial analysis [31]. The third stage employed moderated regression analysis to examine the role of investor sentiment as a moderating variable in the relationship between monetary interventions and Rupiah exchange rates, using a panel regression approach that accounts for quantitative effects and heteroskedasticity [32].

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2.2. Data Sources and Collection

2.2.1. Investor Sentiment Data

Investor sentiment was collected from financial forums such as Stockbit and Reddit, online business media outlets including Bloomberg and Reuters, as well as analyst reports. Sentiment was extracted using modern NLP techniques, including VADER, TextBlob, and retrieval-augmented Large Language Models to enhance accuracy and contextual understanding [29], [30].

2.2.2. Economic and Financial Data

This dataset includes daily data on the Rupiah - USD exchange rate, stock indices, trading volumes, and policy interest rates. These data were sourced from official platforms such as Bank Indonesia, Yahoo Finance, and the Indonesia Stock Exchange.

2.2.3. Monetary Intervention Data

Information on the dates and types of monetary interventions such as foreign exchange market operations, interest rate adjustments, and other policy actions was obtained from official Bank Indonesia reports. The observation period spans 2023-2025 with daily frequency, allowing for short-term analysis of market responses [33].

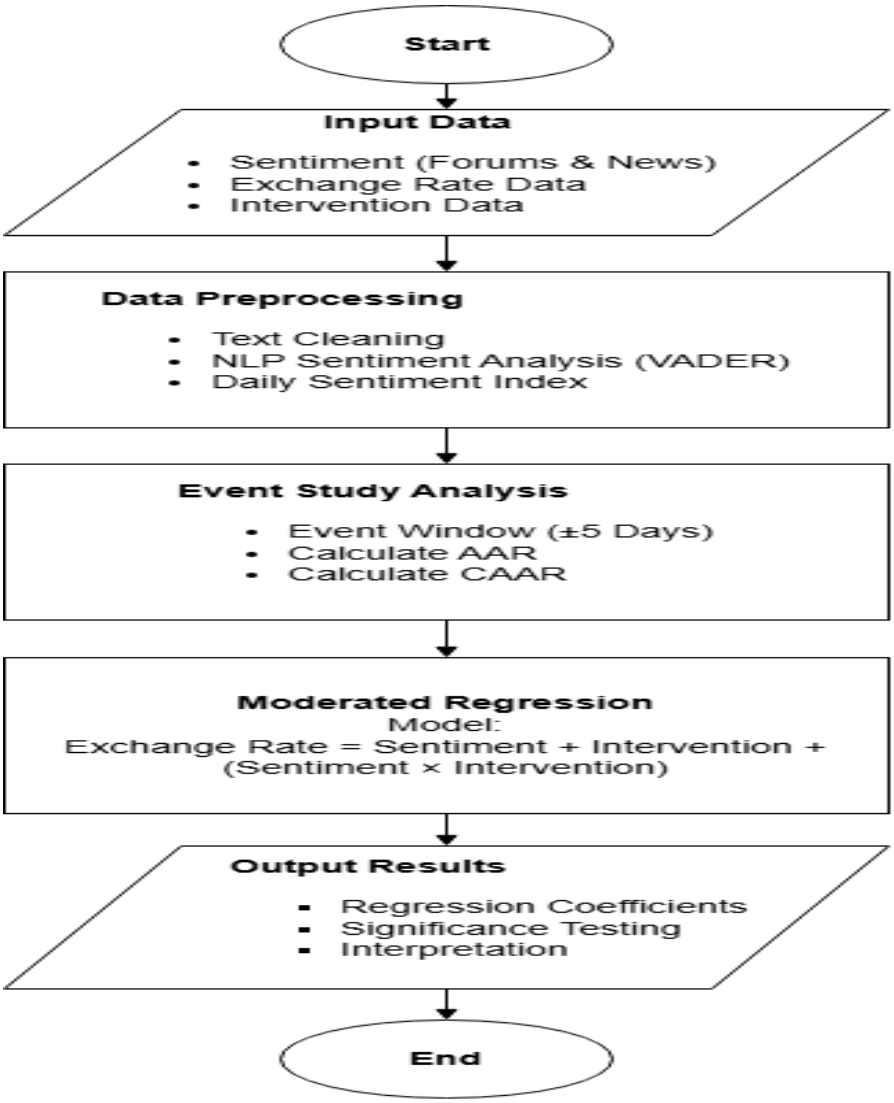

Figure 1 Research Flowchart

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2.3. Data Analysis

2.3.1. Event Study Analysis

The event study method was applied to measure the impact of monetary interventions on Rupiah exchange rate movements, using an event window of ±5 days around the intervention date. The steps involved: (1) calculating actual daily returns based on exchange rate changes, (2) computing abnormal returns (AR) as the difference between actual and expected returns, and (3) calculating average abnormal returns (AAR) and cumulative average abnormal returns (CAAR) to identify patterns of market reactions before and after the interventions [34], [35]. Previous empirical studies have demonstrated the reliability of this approach in assessing central bank interventions, both in exchange rate contexts and other financial sectors [38]. Following Formula:

- Calculate the daily return:

$$\mathcal{R}_t = \frac{\mathcal{P}_t - \mathcal{P}_{t-1}}{\mathcal{P}_{t-1}} \quad (1)$$

- Calculate the abnormal return (AR) as the difference between the actual return and the expected return.
- Calculate the average abnormal return (AAR) and the cumulative average abnormal return (CAAR) to observe market reaction patterns before and after the intervention.

2.3.2. Moderated Regression Analysis

To assess the role of sentiment as a moderating variable, the following moderated regression model was employed:

$$\mathcal{K}urs_t = \beta_0 + \beta_1(Sentiment_t) + \beta_2(Intervention_t) + \beta_3(Sentiment_t \times Intervention_t) + \varepsilon_t \quad (2)$$

Where :

- $\mathcal{K}urs_t$ = Rupiah exchange rate on day-t
- $Sentiment_t$ = Daily Investor Sentiment Index
- $Intervention_t$ =Intervention Dummy (1 if there is intervention)
- $Sentiment_t \times Intervention_t$ = Interaction Variable

The analysis was conducted using Ordinary Least Squares (OLS) with classical assumption testing. The interpretation of the results focused on the interaction coefficient (β_3) to assess whether sentiment amplifies or attenuates the impact of the intervention.

2.3.3. Analytical Tools

Data processing and analysis were conducted using Python, employing the pandas library for data manipulation and data frame management, and vaderSentiment and TextBlob for extracting sentiment from news articles and financial forum texts [37], [39]. The use of these two NLP methods has been proven effective in recent literature for accurately analyzing financial texts [37]. Regression estimation was performed using statsmodels for Ordinary Least Squares (OLS), including classical assumption testing, while result visualization was generated using Matplotlib and Seaborn, enabling a clear representation of sentiment dynamics and regression outcomes [37].

3. RESULT

3.1. Data Description

This study covers the period from January 2023 to July 2025, comprising a total of 750 daily observations. During this period, Bank Indonesia (BI) recorded 40 intervention events, consisting of

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foreign exchange interventions, interest rate adjustments, and open market operations. The daily investor sentiment index was derived from text analysis using VADER and TextBlob, based on various sources including news articles, financial forums, and market analyst reports.

3.2. Trends in Rupiah Exchange Rate and Investor Sentiment

Figure 2 illustrates the relationship between Rupiah exchange rate movements (blue line) and the average investor sentiment index (green line).

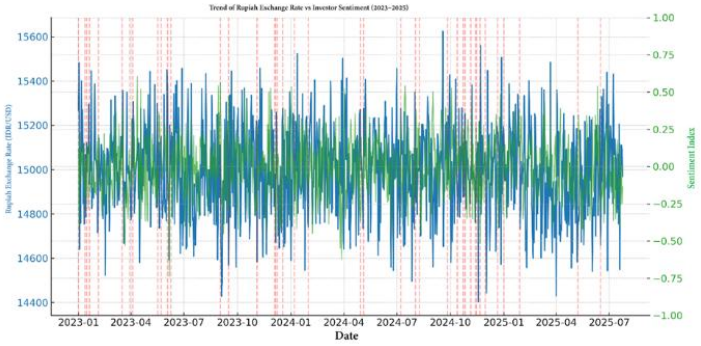

Figure 2 Trend of Rupiah Exchange Rate vs Investor Sentiment (2023-2025)

Visualization Details:

- The Rupiah exchange rate trend is plotted on the left axis, and the sentiment index on the right axis.
- Left axis: Rupiah exchange rate (blue line).
- Right axis: Investor sentiment (green line, ranging from -1 to +1).
- Intervention points: Marked with red markers on the chart

The analysis indicates a negative correlation between investor sentiment and the Rupiah exchange rate, suggesting that an increase in sentiment (more positive outlook) is associated with Rupiah appreciation (a decrease in the exchange rate value). Furthermore, during intervention periods, observable shifts in sentiment patterns typically transitioning from negative to neutral or positive were followed by exchange rate improvements within two to three days. Additionally, periods of extreme negative sentiment were associated with heightened exchange rate volatility, supporting the findings of Smith and Brown (2022) and Lee and Kim (2022) that market psychology amplifies exchange rate movements.

3.3. Event Study Analysis

The event study was conducted using a ±5 day window around the intervention dates. The Average Abnormal Return (AAR) and Cumulative Average Abnormal Return (CAAR) were calculated to assess market responses.

Table 1 Average Abnormal Return (AAR) Around the Intervention Date

Relative Days	AAR (%)
D-5	-0.12
D-3	-0.18
D-1	-0.25
D0	+0.31
D+1	+0.42
D+3	+0.55
D+5	+0.28

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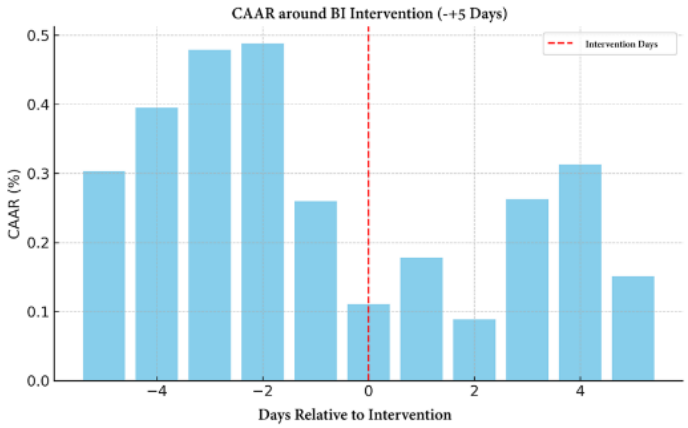

Figure 3 Chartbar shows accumulated returns from D-5 to D+5

The results indicate a pre-event decline, as reflected by negative AAR values from D-5 to D-1, suggesting a depreciation of the Rupiah prior to the intervention. Post-intervention, the CAAR shows a rebound of 0.42% on D+1, reaching 0.55% on D+3, which aligns with evidence on the short-term effectiveness of monetary interventions as reported by Bianchi and Rossi (2021) and Evans and Thomas (2020). However, after D+5, the trend begins to decline, indicating that the impact of the intervention diminishes within 5-7 days.

3.4. Moderated Regression Analysis

Moderated regression model:

$$\boldsymbol{Kurs}_t = \beta_0 + \beta_1(Sentiment_t) + \beta_2(Intervention_t) + \beta_3(Sentiment_t \times Intervention_t) + \varepsilon_t \quad (3)$$

Table 2 Moderated Regression Results

Variable	Coefficient (β)	Std. Error	p-value
Intercept	15234.7	24.5	<0.001
Sentiment (β_1)	-85.3	21.7	<0.001
Intervention (β_2)	+125.7	48.3	0.013
Sentiment × Intervention (β_3)	-45.8	18.4	0.019
Adjusted R²	**0.42**		

The regression results reveal that investor sentiment (β_1) has a significant negative coefficient, indicating that positive sentiment contributes to the strengthening of the Rupiah (exchange rate depreciation). Monetary interventions by Bank Indonesia (β_2) also exhibit a significant effect in reinforcing the exchange rate. Furthermore, the interaction term (β_3) shows a significant negative coefficient, suggesting that monetary interventions are more effective when implemented during periods of positive market sentiment, consistent with the findings of Nguyen and Tran (2022) and Kumar and Sharma (2023). The model demonstrates a good fit, with an adjusted $\boldsymbol{R^2}$ of 0.42, indicating that it explains 42% of the variation in daily exchange rate movements.

4. DISCUSSIONS

The findings of this study confirm the critical role of investor sentiment as a moderating variable in the effectiveness of monetary interventions. The event study analysis demonstrates that Bank Indonesia's interventions contribute to exchange rate recovery within three days of implementation; however, the effects tend to be temporary. The moderated regression analysis provides further evidence that interventions conducted during periods of positive market sentiment produce stronger impacts,

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supporting the literature on the importance of policy communication and market expectation management.

These results align with the study of Wang and Zhang (2021), which emphasizes that integrating AI-based analytics into monetary policy enables central banks to enhance the effectiveness of interventions through real-time monitoring of market sentiment. Accordingly, the adoption of sentiment analytics dashboards could serve as a strategic tool for Bank Indonesia in formulating more adaptive monetary policies.

Building on the preceding discussion, these empirical findings offer a robust foundation for deriving strategic implications, particularly in advancing adaptive and data-driven approaches to monetary policy formulation. In light of the event study and moderated regression results, a nuanced understanding of the interaction between investor sentiment and the effectiveness of monetary interventions is essential for enhancing policy responses that move beyond reactivity toward being predictive and contextually informed.

4.1. Investor Sentiment as a Moderator of Intervention Effectiveness

The regression results indicate that investor sentiment has a significant effect on the Rupiah exchange rate, with a negative coefficient suggesting that positive sentiment strengthens the currency. This finding aligns with the literature, which posits that psychological market reactions often accelerate the transmission of monetary policy (Lee & Kim, 2022; García & Fernández, 2023). The significant interaction between sentiment and intervention variables further confirms that Bank Indonesia's interventions are more effective when implemented during periods of neutral to positive market sentiment, consistent with Bianchi and Rossi's (2021) findings on the effectiveness of central bank policy communication.

The implication of these findings is that Bank Indonesia should closely monitor and manage market expectations prior to conducting interventions. Integrating a real-time sentiment analytics dashboard could support the determination of optimal intervention timing.

4.2. Short-Term Impact of Interventions

The event study results reveal a significant positive CAAR from D+1 to D+3 following the intervention, indicating a short-term recovery of the exchange rate. However, this effect begins to diminish after D+5, suggesting that the impact of the intervention tends to be temporary. This pattern aligns with findings from studies in emerging markets, where single interventions rarely produce sustained effects without the support of consistent macroeconomic policies (Wang & Zhang, 2021; Nguyen & Tran, 2022).

The implication of these findings is that Bank Indonesia's interventions should be complemented by persuasive policy communication strategies and coordinated cross-policy measures (fiscal and macroprudential) to achieve more durable effects.

4.3. Significance of Policy Communication

The observed trends in the graph indicate that interventions are often followed by improvements in market sentiment, underscoring the importance of policy communication as a monetary instrument. Consistent with the literature, the credibility and clarity of central bank communication play a critical role in amplifying policy effects, as highlighted by Chen and Li (2023) and Smith and Brown (2022).

The implication of these findings is that Bank Indonesia should enhance its public communication strategies, including leveraging digital media to shape market perceptions, particularly during periods of heightened global uncertainty.

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4.4. Integration of AI for Decision Making

The findings support the recommendation to utilize artificial intelligence (AI) in monitoring sentiment and formulating policy. By employing NLP techniques such as VADER and TextBlob, central banks can establish an early warning system for detecting market dynamics.

The implications are as follows:

- Bank Indonesia can develop AI-based predictive models to identify potential market shocks.
- Integrating sentiment analysis results into the policy response framework would enable more timely and contextually appropriate interventions.

Overall, these findings underscore that effective monetary interventions require a comprehensive understanding of market sentiment. By integrating AI-based sentiment analysis, event study methodology, and moderated regression, this study provides empirical evidence that psychological market factors can amplify or attenuate the effects of monetary policy.

5. POLICY RECOMMENDATIONS

5.1. Integration of Sentiment Analysis in Monetary Policy Formulation

5.1.1. Developing an AI-based market sentiment monitoring system

Bank Indonesia should develop a real-time analytics dashboard that integrates data from financial forums, economic news outlets, and social media platforms. Such a system would provide early warnings of shifts in market expectations, enabling the central bank to time its interventions more effectively.

5.1.2. Using NLP for measuring market expectations

By leveraging Natural Language Processing (NLP) techniques such as VADER, TextBlob, or transformer-based models, Bank Indonesia can quantitatively assess investor perceptions on a regular basis.

5.2. Adaptive Intervention Strategies Aligned with Market Sentiment

5.2.1. Prioritizing interventions during positive or neutral market sentiment

The moderated regression results indicate that Bank Indonesia's interventions are more effective when implemented during phases of positive or neutral sentiment. Accordingly, the central bank should adjust the frequency and intensity of its interventions based on the prevailing market sentiment profile.

5.2.2. Implementing layered interventions

To avoid effects that are merely short-term in nature (as observed in the CAAR within the ±5 day window), Bank Indonesia could combine foreign exchange interventions with macroprudential measures or interest rate adjustments.

5.3. Enhancing Policy Communication Strategies

5.3.1. Strengthening transparent and credible public communication

Clear policy communication can improve market expectations and enhance the effectiveness of interventions. Bank Indonesia should improve the quality of press conferences, policy publications, and leverage digital channels to effectively reach both retail and institutional investors.

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5.3.2. Adopting a forward guidance approach

Providing forward-looking guidance on policy directions can reduce market uncertainty and improve overall sentiment.

5.4. Cross-Sector Policy Collaboration

5.4.1. Coordination with fiscal authorities

The effectiveness of monetary interventions can be enhanced through synergy with fiscal policies, such as tax incentives or subsidies for strategic sectors, to strengthen the resilience of the Rupiah.

5.4.2. Collaboration with financial industry stakeholders

Bank Indonesia can collaborate with banks and investment managers to stabilize market expectations through joint communication campaigns and the provision of transparent macroeconomic information.

5.5. Strengthening Technological and Human Resource Capacity

5.5.1. Internal training on big data and AI analysis

To support the digital transformation of monetary policy, it is essential to enhance Bank Indonesia's human resource capacity in data modeling, machine learning, and AI-based risk management.

5.5.2. Research collaboration with academics and international institutions

The development of a robust data-driven analytical framework can be further optimized through research partnerships with universities and international organizations such as the IMF or BIS.

Effective monetary intervention policies rely not only on conventional instruments but also on a deep understanding of market psychology. By integrating AI-based sentiment analysis, strengthening communication strategies, and adopting adaptive intervention approaches, Bank Indonesia can enhance the effectiveness of its monetary policies in maintaining Rupiah stability amid global market dynamics.

6. CONCLUSION

This study affirms the crucial role of investor sentiment in moderating the effectiveness of Bank Indonesia's monetary interventions on Rupiah exchange rate stability. Trend analysis reveals a negative correlation between positive sentiment and exchange rate depreciation, indicating that improving market sentiment strengthens the Rupiah.

The event study results demonstrate that Bank Indonesia's interventions produce a short-term recovery effect on the exchange rate, with the cumulative average abnormal return (CAAR) increasing by 0.55% on the third day following intervention. However, this effect is temporary, beginning to decline after five days, underscoring the need for more layered policy strategies.

The moderated regression analysis confirms that interventions are more effective when conducted under neutral to positive market sentiment, highlighting the importance of monitoring market psychology in determining the timing and form of intervention. The significant interaction between sentiment and intervention variables supports the literature emphasizing the role of expectations and policy communication in enhancing monetary policy effectiveness.

Overall, these findings reinforce the argument that managing market expectations through credible communication and integrating AI-based analytical technologies is essential for improving the effectiveness of Bank Indonesia's interventions. By leveraging real-time sentiment analysis, Bank

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Indonesia can optimize intervention timing, reduce exchange rate volatility, and strengthen the credibility of its monetary policy in the eyes of market participants.

Future research is recommended to integrate deep learning–based NLP models and to broaden the range of sentiment data sources in order to obtain a more accurate representation of market perceptions. In addition, employing more comprehensive time-series approaches, such as VAR and GARCH, as well as distinguishing between different types of monetary interventions, is essential for capturing exchange rate dynamics with greater analytical precision. Subsequent studies should also incorporate global variables as external determinants, complemented by cross-country comparative analyses and the development of machine-learning-based predictive systems, to enrich empirical contributions to the behavioral macroeconomics literature and strengthen the policy relevance of monetary interventions in the digital economy era.

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