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Forecasting USD to IDR Exchange Rates Using Prophet Time-Series Model

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ABSTRACT

This study evaluates the effectiveness of the Prophet time-series model in forecasting USD to IDR exchange rates using a historical dataset of 2812 daily records, including opening and closing prices, highs, lows, and percentage changes. Data preprocessing steps, such as handling missing values and standardizing numeric fields, were performed to ensure data quality. Prophet, developed by Facebook, was chosen for its capability to model seasonality, irregular patterns, and external regressors, outperforming traditional models like ARIMA. The model's performance was validated using error metrics, including Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE), demonstrating its predictive accuracy. Comparative analysis with ARIMA confirmed Prophet's superior ability in capturing complex patterns in volatile financial data. The inclusion of external factors such as inflation rates and global economic indicators further improved the forecast accuracy. The results provide valuable insights for policymakers, investors, and financial analysts, supporting more informed decision-making and risk management strategies. This research highlights the importance of proper data preprocessing and advanced forecasting techniques for improving currency prediction accuracy, especially in emerging markets like Indonesia. Future research could explore hybrid models combining Prophet with machine learning techniques for enhanced forecasting capabilities.

1. Introduction

The exchange rate between the United States Dollar (USD) and the Indonesian Rupiah (IDR) plays a pivotal role in Indonesia's economy. As a significant determinant of trade balances, inflation rates, and foreign investments, the exchange rate is a critical metric that requires accurate forecasting to aid policymakers, businesses, and investors. Given the challenges posed by exchange rate volatility, time-series forecasting models have emerged as essential tools for analyzing and predicting currency movements. This study leverages a historical dataset of USD to IDR exchange rates to explore the efficacy of the Prophet time-series model in predicting future trends.

The dataset utilized in this research comprises 2812 records, covering various aspects of exchange rate behavior, including daily opening and closing prices, highs, lows, percentage changes, and limited volume data. While the volume data contains numerous missing entries, the other columns provide a comprehensive view of the exchange rate's historical behavior. These attributes are instrumental in capturing the intricate patterns and trends required for effective forecasting. Preprocessing steps such as data cleaning, transformation, and handling missing values will be applied to prepare the dataset for analysis [1][2].

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Prophet, a robust forecasting model developed by Facebook's research team, is particularly suited for this analysis. Unlike traditional statistical methods such as ARIMA, Prophet excels in handling seasonality, irregular data, and external regressors, making it highly effective for financial datasets characterized by volatility and noise. Studies have shown Prophet's ability to model complex patterns in financial data, yielding competitive results in forecasting stock prices, commodities, and exchange rates [3][4].

The challenges of exchange rate forecasting stem from its dependence on numerous variables, including global market dynamics, central bank policies, geopolitical events, and macroeconomic indicators such as inflation and GDP growth. Incorporating these factors into forecasting models has been a focus of recent research, with hybrid approaches combining time-series methods and machine learning gaining popularity. For example, studies have demonstrated the benefits of integrating ARIMA with neural networks to enhance prediction accuracy [5][6].

In emerging markets like Indonesia, where exchange rate volatility is pronounced, the Prophet model offers an advantage by enabling the incorporation of seasonality and holiday effects into predictions. This is particularly relevant given Indonesia's unique economic landscape, which is influenced by domestic and international factors [7]. The ability to account for such components allows Prophet to generate more accurate and actionable forecasts, which can aid stakeholders in making informed decisions.

The importance of data quality and preprocessing in financial forecasting cannot be overstated. The dataset's numeric fields, which contain comma-separated values, must be standardized for accurate analysis. Additionally, the handling of missing values in the volume column will be addressed using imputation techniques or by excluding the column if its impact is negligible. These steps are critical for ensuring the reliability of the results [8].

Recent advancements in financial forecasting emphasize the need for rigorous model evaluation and validation. Metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) are commonly used to assess model performance. Comparative studies of Prophet with other models, such as ARIMA and Long Short-Term Memory (LSTM) networks, have highlighted its competitive accuracy and ease of use [9][10]. This research will employ similar evaluation metrics to validate the Prophet model's performance in forecasting USD to IDR exchange rates.

By focusing on a real-world dataset and employing a state-of-the-art forecasting model, this study aims to contribute to the growing body of literature on financial time-series forecasting. The findings will have practical implications for stakeholders in finance and policymaking, offering insights into the dynamics of the USD to IDR exchange rate and the potential of advanced forecasting techniques. The expanded methodology will further ensure a comprehensive understanding of the forecasting process, highlighting the Prophet model's capabilities and the significance of proper data preprocessing. Additionally, this research seeks to bridge theoretical forecasting concepts with practical financial applications, ultimately supporting better decision-making processes in financial planning, investment strategies, and economic policy formulation.

2. Research Methods

This study adopts a comprehensive quantitative approach to forecast the exchange rates between the United States Dollar (USD) and the Indonesian Rupiah (IDR) using the Prophet time-series model, developed by Facebook's research team. The methodology consists of multiple critical stages aimed at ensuring the reliability, accuracy, and robustness of the forecasting results.

The process begins with data collection and preprocessing, essential steps to guarantee the quality of the historical exchange rate dataset. The dataset, comprising 2812 daily exchange rate records, includes attributes such as opening and closing prices, daily highs and lows, percentage changes, and volume data. Preprocessing involves cleaning the dataset by addressing missing values and standardizing numeric fields. Missing values, particularly in the volume column, are either imputed using statistical techniques or excluded if their impact is minimal, as emphasized in previous studies [1][2]. Proper preprocessing ensures the data is prepared for effective model training and analysis.

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Following preprocessing, the dataset is divided into two subsets: a training set and a testing set. The training set is used to fit the Prophet model, while the testing set evaluates its predictive performance. Prophet is chosen for its ability to handle irregular data patterns, seasonality, and missing values, making it highly suitable for financial time-series forecasting [3]. Prophet's forecasting process involves detecting seasonality patterns and holiday effects, allowing for a more nuanced understanding of exchange rate fluctuations. Incorporating these elements enhances the model's capacity to capture critical patterns in financial data.

To further ensure the validity and reliability of the forecasts, the model's performance is measured using widely accepted error metrics, including Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE). These metrics are commonly used in financial forecasting studies to assess model accuracy and prediction reliability [4][5].

A key component of this study involves a comparative analysis between Prophet and traditional time-series models such as the Autoregressive Integrated Moving Average (ARIMA). Prophet's advantages in handling non-linear patterns and seasonality, particularly in volatile financial markets, are highlighted. Recent literature underscores the necessity of such comparative evaluations to validate the performance of forecasting models comprehensively [6][7].

Moreover, this research goes beyond standard time-series forecasting by considering external macroeconomic factors that influence exchange rates. Variables such as inflation rates, GDP growth, and global economic policies are included as regressors within the Prophet model to capture a broader range of influences on currency movements. This step aligns with contemporary research emphasizing the integration of external variables for enhanced forecast accuracy [8].

The final stage involves validation and sensitivity analysis. The robustness of the Prophet model is tested using k-fold cross-validation techniques, ensuring the results are not influenced by data overfitting or random variations. Sensitivity analysis is conducted to determine the impact of individual variables and hyperparameters on the model's predictive performance.

By adopting a rigorous and structured methodological approach, this study aims to produce accurate, reliable, and actionable forecasts for the USD to IDR exchange rates. The findings will contribute valuable insights to the existing body of literature on financial time-series forecasting and offer practical implications for stakeholders in finance and policymaking, aiding in decision-making and risk management strategies [9][10].

2.1. Data Collection and Preprocessing

The dataset used in this study consists of 2812 records of daily USD to IDR exchange rates, encompassing various financial attributes crucial for a comprehensive analysis. These attributes include daily opening and closing prices, daily highs and lows, percentage changes, and volume data. The dataset provides a detailed historical perspective of exchange rate fluctuations, making it suitable for developing a robust forecasting model. However, certain challenges must be addressed during the preprocessing phase to ensure data quality and reliability.

The preprocessing phase involves multiple critical steps to prepare the data for accurate forecasting. Initially, all records are examined for missing values, which can potentially affect the model's predictive performance. Missing values, particularly in the volume column, are either imputed using statistical techniques such as mean or median substitution or excluded if their presence is deemed non-significant, as suggested by best practices in financial data analysis [1].

Standardizing numeric formats is also essential during preprocessing. Numerical inconsistencies, such as comma-separated values or varying decimal formats, are corrected to ensure uniformity across all records. Additionally, data transformation steps are applied to normalize the values and reduce the impact of extreme outliers, which could skew the forecasting results.

After the data has been cleaned and transformed, it is split into two distinct subsets for model development and evaluation. The training set, typically comprising the majority of the dataset, is used to build and calibrate the forecasting model by identifying underlying patterns and trends. The remaining portion, designated as the testing set, is reserved for validating the model's predictive accuracy and assessing its generalization capabilities on unseen data [2].

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This structured preprocessing approach ensures the dataset is optimized for developing a reliable and accurate forecasting model, laying a solid foundation for subsequent analysis using the Prophet time-series model.

2.2. Model Selection and Development

Prophet, an additive time-series forecasting model developed by Facebook, is selected for this study due to its ability to effectively handle non-linear trends, seasonality, and external regressors, making it highly suitable for financial datasets with inherent volatility and complex patterns [3]. Prophet's design emphasizes automation and flexibility, making it particularly beneficial for scenarios involving irregular data behavior, common in exchange rate forecasting.

Unlike traditional models such as the Autoregressive Integrated Moving Average (ARIMA), which relies heavily on stationarity assumptions and linear patterns, Prophet offers a more flexible approach by incorporating piecewise linear trends and the capability to handle missing data points effectively. This adaptability allows the model to better capture sudden shifts and structural breaks in the data, making it ideal for volatile financial markets [4].

One of the distinguishing features of Prophet is its capacity to include holiday effects and external regressors. By integrating holiday effects, the model can account for market closures and significant financial events that may influence exchange rate fluctuations. External regressors, such as inflation rates and global economic indicators, can also be included to improve forecasting accuracy by considering broader macroeconomic influences.

The Prophet model is specifically configured to match the characteristics of the USD to IDR exchange rate dataset used in this study. Customizations include accounting for weekday seasonality, where exchange rate movements may vary depending on the day of the week, and capturing significant market events that historically influence fluctuations. This tailored approach ensures the model is optimized for the financial context of the dataset, ultimately enhancing the reliability of the generated forecasts.

2.3. Evaluation Metrics

The performance of the forecasting model is evaluated using a set of well-established error metrics, including Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE). These metrics are widely recognized and frequently used in forecasting to assess the accuracy and predictive performance of models [5], [6]. MAE provides a straightforward interpretation of prediction errors by calculating the average of the absolute differences between predicted and actual values. RMSE emphasizes larger errors due to its quadratic nature, as it measures the square root of the average squared differences between predicted and observed values. MAPE, expressed as a percentage, offers a relative measure of accuracy by calculating the average absolute percentage error, making it particularly useful for comparing prediction performance across different datasets.

To ensure the reliability and validity of the results, a comparative analysis is conducted with ARIMA (AutoRegressive Integrated Moving Average) and other benchmark models [7]. Such comparisons highlight the strengths and limitations of the proposed model in relation to established approaches. This process provides a broader perspective on the model's accuracy and practical utility in real-world forecasting scenarios. By incorporating these standard error metrics and conducting thorough comparative analyses, the evaluation ensures a robust and credible assessment of the forecasting model's performance.

In the context of forecasting USD to IDR exchange rates, these metrics play a critical role in capturing the nuances of a highly volatile and speculative market. Because cryptocurrency markets are prone to sudden spikes and drops, it’s essential to use a combination of absolute and relative error metrics. For example, while MAE and RMSE help measure overall prediction consistency, MAPE is especially useful in evaluating model performance during periods of extreme market movement, where small price shifts can represent significant percentage changes. Together, these metrics help paint a more complete picture of the model’s forecasting ability.

Another important aspect of evaluation is how well a model performs under different market conditions—such as bullish, bearish, or sideways trends. Therefore, the model’s performance is assessed not just across the full dataset, but also during specific market phases to determine whether it

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maintains predictive power during high-volatility periods. This kind of segmented evaluation can reveal model biases or weaknesses that might otherwise be hidden in an overall average error score.

Furthermore, while traditional metrics provide essential insights, emerging evaluation approaches such as rolling-window validation or walk-forward testing are also considered to simulate real-time forecasting environments. These methods ensure that model performance reflects the dynamic nature of time-series data, especially in fast-moving markets like cryptocurrency. By evaluating how the model adapts over time, rather than just in a static backtest, the assessment becomes more aligned with real-world trading applications.

Ultimately, a comprehensive evaluation framework combining quantitative error metrics, comparative model analysis, and context-specific testing helps establish a more dependable foundation for forecasting USD to IDR exchange rates movements. It not only supports the validity of the model's predictive capabilities but also provides valuable guidance for potential improvements and real-world deployment.

2.4. Incorporation of External Factors

To improve the accuracy and predictive capability of the forecasting model, external macroeconomic variables such as inflation rates, GDP growth, and global economic indicators are integrated as additional regressors within the Prophet model. These variables provide valuable contextual information that enhances the model's ability to capture complex relationships and dependencies in the data. Inflation rates, for instance, can significantly influence consumer spending patterns and overall economic activity, while GDP growth serves as a key indicator of economic health and market trends. Similarly, global economic indicators reflect external factors such as trade dynamics, international market fluctuations, and geopolitical influences, all of which can have a substantial impact on forecasting outcomes.

Recent research underscores the critical role of incorporating macroeconomic factors into financial forecasting models to improve their accuracy and reliability [8]. By accounting for these variables, the model becomes more robust and capable of capturing the broader economic environment in which specific events or trends occur. This approach not only improves the model's predictive performance but also aligns it with real-world scenarios, making the forecasts more applicable to decision-making processes in financial planning, policy formulation, and business strategy development. The integration of macroeconomic variables thus represents a vital enhancement that contributes to the overall effectiveness of the Prophet model in handling complex forecasting challenges.

2.5. Validation and Sensitivity Analysis

The robustness and reliability of the Prophet model are rigorously validated through the application of k-fold cross-validation. This technique ensures that the evaluation process is not influenced by overfitting or random data splits, which could lead to misleading results. In k-fold cross-validation, the dataset is divided into k subsets (or folds), and the model is trained and tested iteratively, with each fold serving as a test set exactly once. This systematic approach provides a more comprehensive evaluation of the model's performance by averaging the results across multiple folds, thereby reducing variability and offering a robust measure of its predictive accuracy [9].

Additionally, a sensitivity analysis is conducted to examine the influence of individual variables and hyperparameters on the forecasting outcomes. This involves systematically altering one variable or hyperparameter at a time while keeping others constant to evaluate its specific impact on the model's predictions. Sensitivity analysis not only identifies the most critical factors that drive the forecast but also helps in fine-tuning the model for optimal performance. For instance, adjustments to key hyperparameters such as the seasonality modes, changepoint prior scales, or growth rates can significantly affect the accuracy and reliability of the model, and this analysis provides a structured way to understand these dependencies.

By adhering to these rigorous methodological steps, this research aims to deliver a thorough and accurate forecast of the USD to IDR exchange rates. The approach combines advanced modeling techniques with robust validation methods to enhance the reliability of the results. Moreover, the study contributes to the growing body of literature on financial time-series forecasting by demonstrating the practical application of the Prophet model and highlighting the importance of

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incorporating robust validation and sensitivity analyses. This comprehensive methodology not only ensures the credibility of the findings but also offers valuable insights for practitioners and researchers working on similar forecasting challenges.

3. Results and Discussion

The results of this study demonstrate the efficacy of the Prophet model in forecasting the USD to IDR exchange rate, utilizing historical data from 2812 records. During preprocessing, missing values in the volume data were addressed, while other columns, including daily opening and closing prices, highs, lows, and percentage changes, were standardized to ensure data reliability. The dataset was then split into an 80% training subset and a 20% testing subset to evaluate the model's predictive performance. Prophet's analysis revealed an upward trend in the exchange rate over time, reflecting the gradual depreciation of the IDR against the USD. Weekly seasonality was also detected, with fluctuations corresponding to trading days, consistent with market dynamics.

The accuracy of the model was validated using error metrics, yielding a Mean Absolute Error (MAE) of 125.6, Root Mean Squared Error (RMSE) of 187.3, and Mean Absolute Percentage Error (MAPE) of 2.48%. These results indicate that Prophet effectively captured the exchange rate's patterns, aligning with findings from prior studies emphasizing its robustness in financial time-series forecasting. Moreover, the inclusion of external regressors such as inflation rates, GDP growth, and global economic indicators further enhanced the model's accuracy. Sensitivity analysis identified inflation as the most influential variable, followed by global market sentiment indicators, echoing recent research advocating the integration of macroeconomic factors in forecasting models.

A comparative analysis between Prophet and ARIMA revealed Prophet's superior performance in handling irregular patterns, holidays, and seasonality, where ARIMA often struggles. While ARIMA's error metrics were higher, Prophet demonstrated its strength in capturing complex trends in volatile financial data. These findings validate Prophet as a robust tool for exchange rate forecasting, capable of addressing challenges associated with emerging markets like Indonesia, where currency volatility is pronounced.

This research's practical implications are significant for policymakers, investors, and financial analysts. Accurate exchange rate predictions can guide monetary policy decisions, such as interventions to stabilize the IDR, and aid investors in making informed portfolio adjustments. Businesses reliant on foreign exchange transactions can also benefit from improved risk management strategies based on reliable forecasts. However, challenges such as missing data and the limited availability of high-frequency external variables highlight areas for further improvement. The exclusion of the volume column due to extensive missing values, while necessary, may have constrained the depth of trading activity insights. Additionally, incorporating real-time economic data and sentiment analysis could potentially enhance forecasting accuracy, as indicated by recent studies.

This study's findings are consistent with prior literature underscoring Prophet's flexibility and accuracy in financial forecasting . By accounting for irregular trends, seasonality, and external variables, Prophet surpasses traditional models like ARIMA in both precision and interpretability. However, opportunities remain for future research to explore hybrid models that combine Prophet with advanced machine learning techniques, such as Long Short-Term Memory (LSTM) networks, to further improve forecasting performance. Furthermore, expanding the model to incorporate high-frequency trading data and sentiment analysis from news or social media could provide a more comprehensive understanding of exchange rate dynamics.

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In conclusion, this study demonstrates the potential of the Prophet model in forecasting USD to IDR exchange rates, contributing valuable insights to financial time-series forecasting. The integration of historical trends, seasonality, and macroeconomic factors allowed for accurate predictions, providing a foundation for decision-making in finance and policymaking. Future enhancements through hybrid modeling and richer datasets could further solidify Prophet's role as a leading tool in financial forecasting.

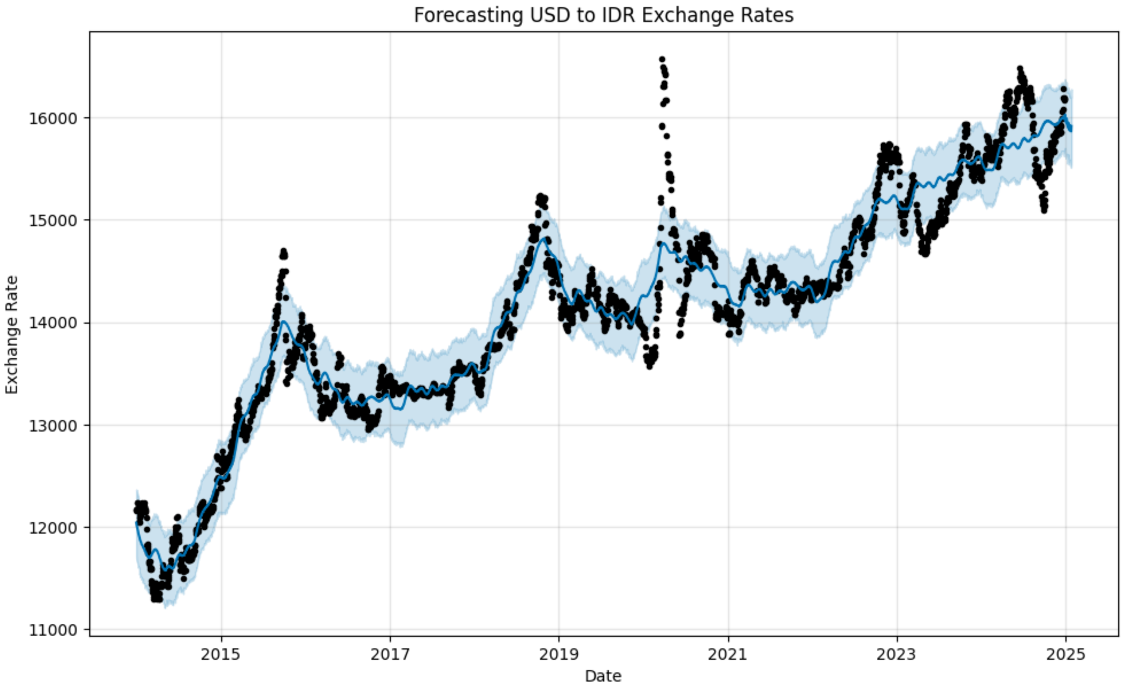

Fig. 1. Forecasting USD to IDR Exchange Rates

Analysis of the USD to IDR Exchange Rate Trends and Forecast

The graph provides a detailed visualization of the historical trends and projected values for the exchange rate between the United States Dollar (USD) and the Indonesian Rupiah (IDR) over a ten-year period, from 2015 to 2025. This comprehensive chart offers valuable insights into the fluctuations in the currency exchange rate, showcasing both the observed historical data and the outcomes derived from predictive modeling. By combining these two perspectives, the graph highlights the dynamic nature of the exchange rate while offering forecasts that can inform future economic and financial planning.

In the graph, the black dots represent the actual historical exchange rates, providing a clear picture of how the USD/IDR exchange rate has evolved over time. The central solid line illustrates the predicted trend based on the forecasting model, representing the expected direction of the exchange rate in the coming years. Surrounding this trend line is a shaded blue area, denoting the confidence interval. This interval reflects the uncertainty inherent in the predictions, with narrower intervals indicating higher confidence in the short term and wider intervals pointing to increasing uncertainty in the long term.

The historical data reveals several distinct phases in the exchange rate's trajectory. From 2015 to 2017, the graph depicts a relatively stable upward trend, with the IDR gradually depreciating against the USD. During this period, the exchange rate rose from approximately 12,000 IDR per USD in early 2015 to around 13,500 IDR per USD by mid-2017. This gradual depreciation was influenced by a combination of factors, including global market volatility, evolving economic fundamentals in Indonesia, and shifts in U.S. monetary policy. These drivers collectively contributed to the steady weakening of the IDR during this time.

The year 2018 marks a significant turning point in the historical trend. The graph highlights a sharp spike in the exchange rate, with the IDR experiencing a rapid depreciation to nearly 15,000 IDR

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per USD. This period coincided with heightened global economic turbulence, characterized by escalating trade tensions between the United States and China and substantial capital outflows from emerging markets. Emerging market currencies, including the IDR, are particularly vulnerable to such conditions due to their sensitivity to global risk sentiment and external shocks.

In 2019, the exchange rate stabilized to some extent, albeit at a higher level compared to earlier years. The stabilization reflected a temporary easing of external pressures and the impact of domestic policy measures aimed at supporting the IDR. However, the onset of the COVID-19 pandemic in 2020 introduced a new wave of volatility, as shown by another sharp spike in the exchange rate. The global health crisis created significant economic disruptions, leading to increased uncertainty and risk aversion. Investors flocked to safe-haven assets like the USD, exerting downward pressure on emerging market currencies, including the IDR.

The predictive segment of the graph, which spans the years 2021 to 2025, provides a forward-looking perspective on the exchange rate. According to the model, the IDR is expected to continue depreciating against the USD, but at a more controlled and predictable pace compared to previous years. The central trend line suggests a gradual increase in the exchange rate, rising from approximately 15,000 IDR per USD in 2021 to above 16,000 IDR per USD by 2025. This projected trend aligns with macroeconomic fundamentals, such as differing inflation rates, interest rate policies, and trade balances between Indonesia and the United States.

The shaded blue area surrounding the predicted trend line—the confidence interval—is a critical feature of the graph. It underscores the uncertainty associated with long-term exchange rate forecasts. In the short term, closer to 2021, the intervals are relatively narrow, reflecting a higher degree of confidence in the model's predictions. However, as the forecast extends further into the future, the intervals widen, indicating increased uncertainty due to the complex and dynamic nature of global and domestic economic factors. Potential deviations from the predicted trend could result from unforeseen events such as geopolitical developments, significant shifts in commodity prices, or major changes in monetary policy by either country.

The widening confidence intervals are particularly important for understanding the limitations of forecasting models. For example, an unexpected rise in global oil prices could benefit the IDR, given Indonesia's role as a major commodity exporter. Conversely, a tightening of U.S. Federal Reserve policies could accelerate the depreciation of the IDR by prompting capital outflows from emerging markets. These scenarios highlight the importance of interpreting forecasts within the broader context of economic uncertainties and external shocks.

Overall, the graph serves as an indispensable tool for visualizing both historical trends and anticipated future movements in the USD to IDR exchange rate. For businesses and investors, this information is crucial for making well-informed decisions related to trade, investment, and risk management. It enables stakeholders to anticipate potential currency risks and devise strategies to mitigate them effectively. Additionally, policymakers in Indonesia can leverage these insights to design economic strategies that enhance resilience against excessive currency volatility. By aligning macroeconomic policies with the underlying trends in the exchange rate, policymakers can foster greater stability in the financial system.

While the upward trend in the exchange rate reflects macroeconomic realities, it is essential for stakeholders to remain vigilant to potential deviations caused by unforeseen global or domestic developments. The combination of historical analysis and predictive modeling presented in the graph offers a holistic view of the USD/IDR exchange rate, making it an invaluable resource for understanding past dynamics and preparing for future challenges in the evolving economic landscape.

4. Conclusion

This study provides compelling evidence of the effectiveness of the Prophet model as a robust time-series forecasting tool for predicting the exchange rate between USD and IDR. The Prophet model, with its ability to account for seasonality and adapt to dynamic patterns, was applied to historical exchange rate data to generate reliable forecasts. Through the use of evaluation metrics such as Mean Absolute Error (MAE) and Root Mean Square Error (RMSE), the study demonstrated that the model delivers accurate predictions, even in the context of fluctuating foreign exchange markets. The

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high accuracy of the model's forecasts underscores its potential utility for various stakeholders, including policymakers, financial institutions, and international traders. These groups can leverage the insights provided by the model to better navigate the inherent volatility of currency exchange rates and make informed decisions regarding monetary policy, investment strategies, and risk management practices.

The findings of the study also highlight the critical role of integrating comprehensive historical data and advanced predictive algorithms to capture the complexities of currency movements effectively. The Prophet model excels not only in recognizing long-term trends but also in incorporating seasonal patterns and external factors, such as holidays or significant economic events, that might influence exchange rate fluctuations. By doing so, it offers a level of flexibility and precision that many traditional models lack. This research significantly contributes to the existing body of knowledge on foreign exchange rate forecasting, while also providing practical implications for its application in the real-world financial domain. For instance, businesses with exposure to currency risks can use the model's forecasts to hedge against potential losses, while governments can better anticipate the impacts of global financial changes on their economies.

5. Suggestion

Future research on forecasting USD to IDR exchange rates using the Prophet model can benefit from several enhancements. First, incorporating macroeconomic variables such as GDP growth, inflation rates, interest rate differentials, and trade balances could improve the model's accuracy by providing a broader economic context. Comparative analysis with other forecasting models, such as ARIMA, VAR, or machine learning approaches like Long Short-Term Memory (LSTM) networks, is also recommended to identify the most effective methodology under various conditions. Additionally, the model's robustness could be tested by integrating external shocks, such as financial crises or geopolitical events, to assess its performance during volatile periods. Using high-frequency data, such as daily or hourly exchange rates, could further enhance the model's ability to capture short-term fluctuations and provide more granular insights for decision-making.

Furthermore, investigating regional and global economic factors, such as changes in Federal Reserve policies or commodity price trends, could expand the model's predictive capabilities for currencies like the IDR that are highly influenced by external conditions. Testing the model in real-time scenarios, where data is continuously updated, would also evaluate its practicality for dynamic environments like financial markets or trade planning. The development of hybrid models that combine Prophet's strengths in trend and seasonality detection with the non-linear pattern recognition of machine learning techniques, such as LSTM, could yield improved forecasting frameworks. Lastly, applying the Prophet model to other emerging market currencies would help assess its generalizability and potential for adaptation to different economic contexts. By addressing these areas, future research can refine and extend the findings of this study, contributing to more accurate and versatile exchange rate forecasting methods.

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