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Predictive Analysis of the Impact of Exchange Rate Fluctuations on the Financial Performance of Multinational Fintech Companies in Indonesia

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ABSTRACT

Exchange rate fluctuations are one of the primary risks affecting the financial stability of multinational corporations, including those in the digital banking sector in Indonesia. This study aims to analyze the impact of exchange rate fluctuations on corporate financial performance by conducting a case study on Bank BNI Digital. The financial data utilized spans from January 2015 to December 2024 and includes variables such as exchange rate (IDR/USD), revenue, operating expenses, net profit, equity, liabilities, and exchange rate volatility. A machine learning-based predictive approach was employed, specifically using the Random Forest and XGBoost algorithms, to evaluate the relationship between exchange rate fluctuations and the company's financial performance. The results indicate that exchange rate fluctuations exhibit a weak linear relationship with financial performance, particularly company revenue, with a correlation coefficient of 0.01. Nevertheless, simulation of the impact of exchange rate movements on net profit demonstrates that the company is able to maintain financial stability under a scenario of moderate exchange rate changes (±15%). Feature importance analysis from the XGBoost model reveals that revenue and operating expenses are the dominant factors influencing financial performance, while exchange rates have a lesser contribution. Based on these findings, the study recommends the implementation of forward contracts to manage exchange rate risk, natural hedging strategies to balance currency exposure, and optimization of operational efficiency as risk mitigation measures. This research provides strategic insights for Bank BNI Digital and similar institutions in designing resilient risk management strategies to address exchange rate fluctuations in the global market.

KEYWORDS *Exchange Rate Fluctuations, Financial Performance, Bank BNI Digital, Predictive Analysis, Random Forest, XGBoost*

INTRODUCTION

Exchange rate fluctuations have become one of the main challenges faced by multinational companies, particularly in the financial sector such as digital banking. As one of the key instruments influencing economic stability, the *exchange rate* plays a crucial role in determining cash flow and the financial performance of a company (Ashiru et al., 2023; Kasibi et al., 2023; Nguyen et al., 2021; Puspitasari & Sudana, 2023; Santosa, 2019). The uncertainty introduced by *exchange rate volatility* can adversely impact profitability, especially for companies with significant exposure to international transactions (Bambang et al., 2018; Chen et al., 2016; Sufandi & Rahayu, 2019; Zayed et al., 2021). Therefore, a comprehensive understanding of the impact of exchange rate fluctuations on financial performance is essential for developing effective risk mitigation strategies.

Bank BNI Digital, as a leading digital banking institution in Indonesia, is not immune to *exchange rate risk*. In its operations, the bank faces challenges in maintaining financial stability amid domestic currency (*IDR*) volatility against the United States dollar (*USD*). Moreover, with the rapid growth of digital services and cross-border transactions, *exchange rate risk* has become an increasingly strategic concern. For this reason, this study aims to analyze the impact of exchange rate fluctuations on the financial performance of Bank BNI Digital using a predictive, machine learning-based approach.

This study utilizes the Random Forest algorithm and XGBoost, two machine learning methods recognized for their ability to capture non-linear and complex relationships between variables. The data employed includes key performance indicators such as revenue, operating expenses, net profit, equity, liabilities, and *exchange rate volatility*, sourced from Bank BNI Digital's financial statements for the period 2015 to 2024. The primary focus of this research is to evaluate the extent to which exchange rate fluctuations affect key financial performance variables and to formulate relevant risk mitigation strategies.

Several previous studies have demonstrated that *exchange rate volatility* can significantly impact a company's financial stability, especially in the context of multinational operations (Baker et al., 2023; Bekaert & Hodrick, 2019; Berdiyorov et al., 2023; Kotsupatriy et al., 2020; Madura & Fox, 2023; Perera & Peiris, 2021). Other research has also underscored the importance of implementing hedging strategies, such as *forward contracts* and *natural hedging*, in managing *exchange rate risk* (Hull, 2019). In the Indonesian context, similar research remains limited; thus, this study is expected to make a valuable contribution to understanding the dynamics of exchange rate risk in the digital banking sector. By combining predictive analysis and scenario simulation, this research provides strategic recommendations for Bank BNI Digital to address the challenges of exchange rate fluctuations in the future.

The existing body of research has extensively explored the impact of exchange rates on financial performance; however, few studies specifically address the fintech sector in emerging markets like Indonesia. For example, Hull (2019) discusses the effectiveness of derivative instruments in mitigating currency risk, but their applicability to digital banking remains underexamined. This gap is particularly concerning given the rapid growth of fintech in Indonesia, where digital banks like Bank BNI Digital operate in a highly volatile currency environment. The lack of localized studies limits the ability of these firms to adopt tailored risk management strategies.

The urgency of this research arises from the increasing integration of Indonesian fintech companies into the global financial system, exposing them to heightened *exchange rate risks*. The IDR/USD volatility observed in recent years poses a significant threat to revenue and profitability, yet the sector's resilience remains understudied. Without empirical insights, fintech firms may lack the necessary tools to navigate currency fluctuations effectively, potentially undermining their financial stability and growth prospects in the competitive digital banking landscape.

This study introduces novelty by employing machine learning techniques—Random Forest and XGBoost—to analyze the non-linear relationships between exchange rate fluctuations and financial performance. While traditional econometric methods dominate existing research, predictive analytics offers a more dynamic and accurate approach, capable of capturing complex patterns in financial data. By focusing on Bank BNI Digital as a case study, this research provides granular insights into the fintech sector, distinguishing it from broader studies on multinational corporations.

The primary objective of this research is to evaluate the impact of exchange rate fluctuations on the financial performance of multinational fintech companies in Indonesia, utilizing predictive modeling to identify key risk factors. Specifically, it aims to determine the extent to which IDR/USD volatility affects revenue, net profit, and other financial metrics, while also assessing the effectiveness of existing risk mitigation strategies. This analysis bridges the gap between theoretical frameworks and practical applications in the fintech sector.

This study contributes to the academic literature by providing empirical evidence on *exchange rate risk* in the fintech industry, a sector often overlooked in traditional financial research. It also advances methodological innovation by demonstrating the utility of machine learning in financial risk analysis. For practitioners, the findings offer actionable insights, such as prioritizing revenue and cost efficiency over direct currency hedging, as revealed by the feature importance analysis.

The implications of this research are twofold. For policymakers, it underscores the need for regulatory frameworks that support fintech firms in managing currency risks, such as facilitating access to hedging instruments. For corporate leaders, the study highlights the importance of integrating predictive analytics into financial planning to enhance decision-making under uncertainty. By adopting *forward contracts* and *natural hedging*, firms can better safeguard their financial performance against *exchange rate volatility*.

In conclusion, this research addresses a critical gap in the literature by examining the intersection of exchange rate fluctuations and fintech performance in an emerging market context. Through its innovative methodology and practical recommendations, it equips stakeholders with the tools to navigate currency risks effectively, ensuring the sustainable growth of Indonesia's digital banking sector. The findings pave the way for future studies to explore similar dynamics in other high-risk industries or regions.

RESEARCH METHOD

This research employs a quantitative approach grounded in *predictive analysis* using machine learning algorithms to evaluate the impact of *exchange rate fluctuations* on the financial performance of Bank BNI Digital. This approach was selected for its capacity to capture complex, non-linear relationships between variables and deliver accurate predictions, which is critical in financial management contexts. The algorithms implemented—Random Forest and XGBoost—are widely recognized in financial literature as robust methods for processing large and complex financial datasets, particularly for forecasting and risk assessment.

The dataset comprises secondary data from Bank BNI Digital's public financial statements, accessible via the investor section of the BNI website, and *Rupiah* exchange rate data against the *United States Dollar* (*IDR/USD*) sourced from *yahoo finance*. The data spans from January 2015 to December 2024 and includes key financial management variables: *exchange rate* (IDR/USD), *exchange rate changes* (%), *revenue* (IDR), *net profit* (IDR), *operating expenses* (IDR), *equity* (IDR), *liabilities* (IDR), *exchange rate volatility*, and *monthly revenue changes* (%). Data integrity and completeness are ensured through missing value imputation and normalization procedures.

The research process consists of six primary stages. The first stage is Data Preprocessing, where raw data is normalized using *MinMaxScaler* to scale all variables between 0 and 1, facilitating efficient model learning. The dataset is split into training (80%) and test (20%) subsets, enabling objective model evaluation. The second stage is Data Exploration, where preliminary analysis examines data distribution and inter-variable relationships. *Correlation heatmaps* are used to

visualize linear associations, while descriptive statistics outline distribution patterns.

The third stage is Modeling with Random Forest. The Random Forest algorithm constructs a predictive model based on decision trees, averaging results across multiple trees to mitigate overfitting and enhance accuracy. The fourth stage is Modeling with XGBoost, where XGBoost iteratively corrects prediction errors, producing high-accuracy models. *Grid search* is used to optimize model parameters for peak performance.

The fifth stage is Model Evaluation. Model performance is assessed using three core metrics: *Mean Squared Error* (MSE) for average squared prediction error, *Root Mean Squared Error* (RMSE) for error magnitude in original data units, and *R-squared* (R^2) for variance explanation. The last stage is Scenario Simulation, where simulations alter the exchange rate by -5%, 0%, +5%, +10%, and +15% to analyze the sensitivity of *revenue* and *net profit* to exchange rate fluctuations—a standard practice in financial risk management.

All analyses are conducted using Python with libraries such as *Pandas* for data manipulation, *scikit-learn* for preprocessing and Random Forest, *XGBoost* for boosting-based models, *Matplotlib* and *Seaborn* for visualization, and *NumPy* for numerical computations.

Model validity is ensured through k-fold cross-validation (five folds), which divides the dataset into five subsets, rotating each as a test set while training on the remaining data. This technique reduces bias and variance in performance estimates and ensures the model's generalizability beyond a single data split. Model reliability is further tested by comparing predictions on test data against actual values, supporting robust financial decision-making and risk management.

RESULT AND DISCUSSION

Descriptive Analysis

The results of the descriptive analysis of the data show the distribution and trends of key variables such as the exchange rate (IDR/USD), revenue, and net profit of Bank BNI Digital. The following histogram image illustrates the exchange rate distribution (IDR/USD) and the exchange rate change distribution (%).

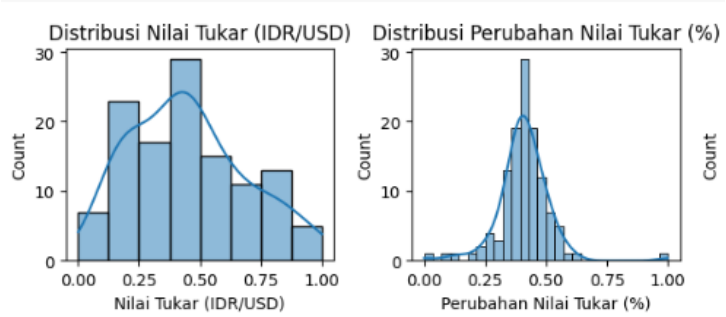

Figure 1. Distribusi Nilai Tukar dan Perubahan Nilai Tukar IDR

From the histogram above, it can be seen that the exchange rate (IDR/USD) has a fairly even distribution with a tendency to be in the middle range (0.3–0.7 after normalization). Exchange rate changes show a distribution pattern close to normal, with the majority of changes being around 0.5 (50% after normalization). This distribution shows a stable level of exchange rate volatility during the observation period.
The following figure shows the trend of exchange rates, income, and equities over time

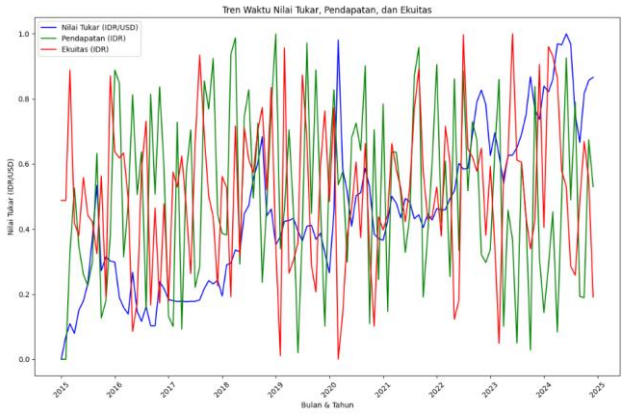

Figure 2. Tren Waktu Nilai Tukar, Pendapatan, dan Ekuitas

The exchange rate trend shows moderate fluctuations during the observation period. Exchange rates are likely to increase in recent years, especially in 2023 and 2024. Revenue and equity also show a volatile but relatively stable pattern, with an increasing trend in recent years. The relationship between exchange rates, income, and equity seems indirect, as there is no clear synchronization pattern between the three.

Analysis of the Correlation between Exchange Rate and Income

The correlation between the exchange rate (IDR/USD) and revenue (IDR) was analyzed to evaluate the linear relationship between the two variables. The correlation results are shown in the following image

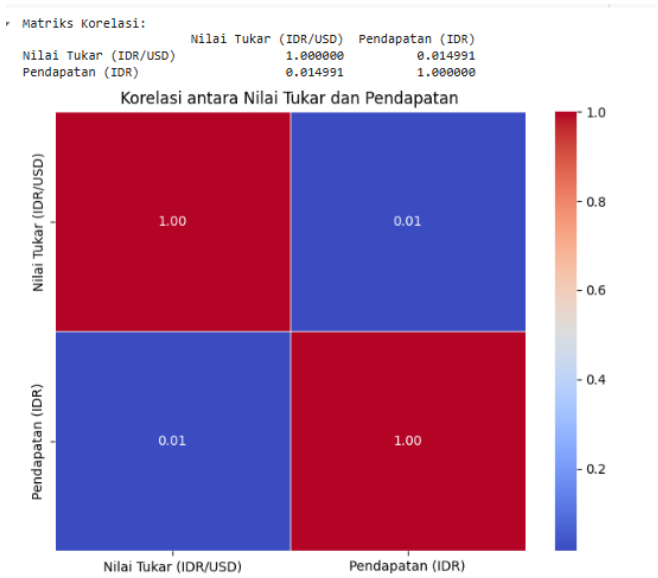

Figure 3. Matriks Korelasi antara Nilai Tukar dan Pendapatan

From the correlation matrix above, it can be seen that the correlation coefficient between the exchange rate and income is only 0.01, indicating a very weak linear relationship. This indicates that changes in the exchange rate do not have a significant impact directly on a company's revenue. This relationship is more likely to be influenced by other variables, such as operating costs or revenue efficiency, rather than by the exchange rate itself.

Analysis of the Correlation between Exchange Rate and Income

Two machine learning algorithms, namely **Random Forest** and **XGBoost**, are used to build predictive models. The results of the performance evaluation of the two models are shown in the following table:

Table 1. Performance Results of Random Forest & XGBoost Models

No	Metrics	Random Forest	XGBoost
0	MSE	0.011239	0.008981
1	RMSE	0.106013	0.094767
2	R^2	0.752832	0.802488

XGBoost performs better than Random Forest, with a lower MSE value (0.0090) and a higher R^2 (0.8025). This shows that XGBoost is better able to explain data variance and provide more accurate predictions. Therefore, the next analysis uses the XGBoost model.

Exchange Rate Scenario Simulation

The simulation was conducted to evaluate the impact of exchange rate changes on the company's revenue and net profit. Five exchange rate change scenarios (-5%, 0%, +5%, +10%, and +15%) were analyzed. The simulation results are shown on the following graph:

Figure 4. Simulation of Exchange Rate Scenarios on Income

From the chart, it can be seen that revenue increased moderately at exchange rate changes of up to +10%. In the +15% scenario, revenue has decreased slightly. This shows that the impact of the exchange rate on income is non-linear.

Net profit shows a similar pattern to revenue, where an increase in the exchange rate of up to +10% leads to an increase in net profit. However, in the +15% scenario, net profit starts to decline slightly, indicating that the impact of the exchange rate on financial performance is not significant in extreme conditions.

Feature Importance Analysis

The results of feature importance analysis using XGBoost show that revenue and operating expenses are the two variables that most affect financial performance. Exchange rates contribute much smaller to the model.

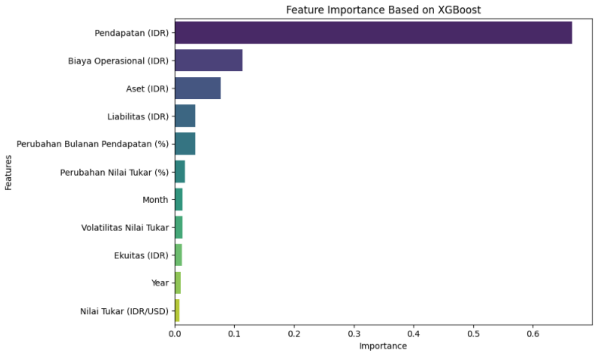

Figure 5. Feature Importance Analysis Results

Analyze Revenue Trends Over Time With Exchange Rate Fluctuations

The following figure shows the revenue trend (IDR) over time, which reflects how exchange rate fluctuations affected Bank BNI Digital's revenue during the observation period.

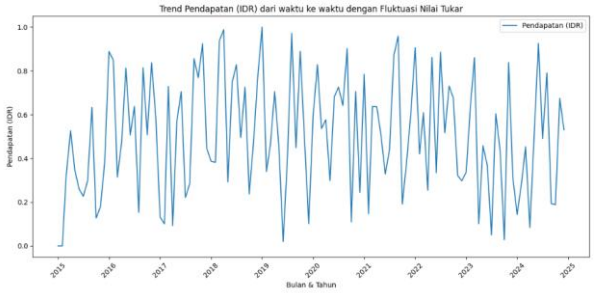

Figure 7. Income trends over time with exchange rate fluctuations

Chart analysis shows that revenue has a significant pattern of fluctuations over time, reflecting the sensitivity of the company to market dynamics. However, the overall trend shows that earnings have remained stable despite exchange rate volatility. This indicates that Bank BNI Digital has an adequate risk management mechanism to mitigate the impact of exchange rate changes on revenue.

In the period 2023 to 2024, revenue showed a slight decline despite the increase in exchange rates. This indicates that in addition to the exchange rate, there are other factors that may have more influence on revenue, such as the level of market demand or the operational efficiency of the company.

Comparison of Revenue and Exchange Rate Predictions

The prediction results using the XGBoost model for 2025 show a relatively stable trend in the IDR/USD exchange rate with little fluctuation in the middle of the year. Predictions suggest that the exchange rate will peak in the 5th and 6th months, then experience a gradual decline until the end of the year. The company's revenue, based on this model, remained stable throughout the year with a slight increase from month to month. Quantitatively, the IDR/USD exchange rate is estimated to range from 0.8424 to 0.9647 (in normalized form), while the company's revenue is predicted to be in the range of 0.48 to 0.50 (normalized). This stability reflects the ability of the XGBoost model to capture dominant historical patterns, providing smoother and more linear predictions.

On the other hand, the Random Forest model also provides similar predictions to XGBoost, although there are some differences in fluctuation patterns. Random Forest predicts the IDR/USD exchange rate to peak in the 5th month, but the downward trend after the peak is slightly sharper compared to XGBoost's prediction in the last quarter. The company's revenue prediction by Random Forest also shows stability with values ranging from 0.48 to 0.50 (normalized), similar to the prediction from XGBoost. Nonetheless, there was little variation in the early months that showed Random Forest's sensitivity to more complex historical data patterns.

Comparisons between these two models show that XGBoost tends to provide smoother and more linear results, reflecting the model's ability to capture more dominant long-term patterns. On the other hand, Random Forest produces predictions with greater variation, especially in the first and fourth quarters of 2025. These differences reflect the characteristics of each model; XGBoost is more effective at capturing historical data trends that are linear in nature, while Random Forest is more sensitive to outliers or small variations in data.

The results of this prediction have important implications for multinational fintech companies in managing exchange rate risk and formulating revenue strategies. The exchange rate stability predicted by XGBoost suggests that the company could take advantage of a flexible hedging strategy in the middle of the year, when the exchange rate is expected to peak. The use of derivative instruments such as forward contracts or options can help companies protect their exchange rates against fluctuations. In addition, the stability of revenue predictions provides an opportunity for companies to focus on diversifying revenue sources and product innovation to maintain sustainable growth. With these predicted results, the company can plan market expansion and strategic investments to ensure revenue stability.

However, it is important to note that these predictions are based on available historical data patterns, so they do not take into account external factors such as global economic policies or unforeseen events that could affect future exchange rates and earnings. In addition, since the predicted value has been normalized to a range of 0 to 1, the practical interpretation requires de-normalization to return the value to its original unit. Nevertheless, the predictions from the XGBoost and Random Forest models provide valuable insights into future exchange rate trends and company revenues, which can be an important guide for strategic decision-making.

Discussion

Based on the results of the analysis, several important points were found that can be used as a basis to understand the impact of exchange rate fluctuations on Bank BNI Digital's financial performance:

1) Fluctuations in Trends: Earnings show sharp fluctuations in a given period, which are most likely due to seasonal factors, market volatility, or changing monetary policies. Nonetheless, the chart shows that the company is able to maintain stability in the long term.

2) Weak Correlation with Exchange Rate: Analysis of the correlation between exchange rate and income shows a very weak relationship (correlation coefficient of 0.01). This confirms that other factors such as operational costs and management

efficiency may have a more significant impact on a company's financial performance.

3) External and Internal Factors: While exchange rates have a limited impact on revenue, companies still need to consider other external factors such as inflation rates, global market conditions, and local regulations. On the other hand, strong internal management, such as operational cost efficiency, plays a crucial role in maintaining financial stability.

4) Simulation and Prediction: The simulation results show that exchange rate changes have a small but insignificant impact on revenue and net profit. This shows that the company has managed to mitigate most of the negative impacts of exchange rate volatility through an effective financial strategy.

This discussion underscores the importance of risk mitigation strategies, both through hedging and internal optimization, to maintain financial performance stability amid market volatility.

CONCLUSION

This study finds that exchange rate fluctuations have a limited direct impact on the financial performance of multinational fintech companies in Indonesia, with revenue and operating expenses emerging as the primary determinants of net income stability. While these companies have shown strong resilience to exchange rate volatility, the adoption of risk mitigation strategies—such as *forward contracts*, *natural hedging*, and currency diversification—remains advisable to minimize future exposure. *Forward contracts* are particularly effective in locking in exchange rates for future transactions, thereby reducing uncertainty and helping companies better manage cash flow and protect profit margins, though they also come with limitations such as the inability to benefit from favorable rate movements and potential administrative costs. Combining forward contracts with natural hedging can further enhance risk management. To strengthen overall financial performance, companies should continue to focus on operational cost efficiency and revenue optimization. For future research, it is recommended to explore the effectiveness of other derivative instruments, such as options or swaps, and to examine the impact of exchange rate risk management strategies across different segments of the fintech sector and in various macroeconomic conditions.

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