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AI-Based Forecasting of Interest Rate and Profit Rate Risks in Saudi Debt Markets

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Abstract- ***Volatility in interest rates and profit rates is one of the critical factors that determine the financial risk in the Saudi Arabian debt markets. This affects government debt instruments, debt securities issued by corporations, and Shariah-compliant financing instruments such as Sukuk. As the Saudi Arabian debt markets grow with the objective of diversifying the country's economic activities and promoting the development of capital markets, the need to forecast interest rates and profit rates has become critical. This study has attempted to evaluate the role that artificial intelligence plays in the forecasting of interest rate and profit rate risks in the Saudi Arabian debt markets. The study has attempted to utilize the data from the Saudi Arabian debt markets and the relevant macro and financial factors to evaluate the effectiveness of the application of the machine learning approach in the forecasting of interest rate and profit rate risks. The study observed that the application of the artificial intelligence approach has proven to be effective in the forecasting of interest rate and profit rate risks compared to the application of the conventional statistical approach. The study has significant implications for the management of interest rate and profit rate risks in the Saudi Arabian debt markets. The study has attempted to contribute to the body of knowledge on the application of artificial intelligence in the management of financial risks in the Saudi Arabian debt markets. The study has observed that it is relevant to the plans that the Saudi Arabian government has to modernize the debt markets in the country.***

Index Terms- ***Artificial intelligence; Interest rate risk; Profit rate risk; Saudi debt markets; Sukuk; Machine learning; Financial risk forecasting; Yield curve dynamics; Capital market stability; Predictive analytics***

I. INTRODUCTION

The movement in the rates of interest and profit has always played an important role in the determination and valuation of the risk in the debt markets across the world. The rapid growth in the debt instruments in the Saudi Arabian debt markets, particularly in the government and corporate sector debt markets, and the Shariah-compliant debt instruments such as Sukuk, which have gained considerable importance in the debt markets, have made the participants in the Saudi Arabian debt markets sensitive to the movement in the rates of interest and profit in the Saudi Arabian debt markets. The movement in the benchmark rates of interest in the Saudi Arabian debt markets affects the debt servicing and valuation in the debt markets, and the movement in the rates of profit affects the Shariah-compliant debt instruments and the rates of profit in the debt markets. Therefore, as the Saudi Arabian debt markets are growing in terms of depth and the debt markets are becoming more and more interlinked with the financial markets in the world, the forecasting of the interest rate and profit rate risks in the Saudi Arabian markets has become an essential requirement in the Saudi Arabian markets. The traditional methods that have been employed in the financial markets across the world in the forecasting and prediction of the interest rate risks in the markets are the application of the econometric and time series models such as the autoregressive integrated moving average model, the vector autoregression model, and the affine term structure models. However, the application of the models has not been found effective in the markets that are subjected to structural changes and nonlinear relationships in the markets, which is the case in the Kingdom of Saudi Arabian markets, as the Kingdom of Saudi Arabian markets are subjected to the influences of the monetary policies in the global markets and the economic reforms in the Kingdom of Saudi Arabian markets. The recent developments in the field of artificial intelligence have provided opportunities to improve the accuracy of forecasting interest or profit rate in an increasingly dynamic environment. The use of these machine learning algorithms to handle large volumes of data and their ability to handle non-linear relationships are expected to improve their flexibility in handling these issues. These systems are likely to be made flexible by incorporating macroeconomic variables, financial

markets, and historical interest or profit rate data in an increasingly dynamic environment. These issues are particularly relevant to the debt market in Saudi Arabia, where conventional and Islamic financial instruments are integral components of the existing economic system.

The distinction between interest rate risk and profit rate risk is particularly relevant to the debt market in Saudi Arabia. The interest rate risk is applicable to conventional bonds or loan products, whereas profit rate risk is applicable to Shariah-compliant financial instruments in which the return mechanism is based on profit rate rather than interest rate. However, these profit rates are indirectly impacted by changes in interest or profit rate. For instance, in the case of sukuk issuance, these benchmark interest or profit rate data are part of the overall pricing mechanism. Therefore, these profit rates are indirectly impacted by changes in interest or profit rate. Hence, the interconnected relationship between these two types of risk is of significant importance to manage the debt portfolio effectively. The recent developments in the capital markets in Saudi Arabian countries have placed more emphasis on the need for effective and accurate rate forecasts. This is because the Saudi Arabian government has issued more debt instruments in the capital markets for the purpose of planning and diversification. In the same way, the corporate sector has issued more debt instruments in the capital markets for the purpose of financing projects. Therefore, the recent developments in the capital markets in Saudi Arabian countries are more relevant in the context of the need for accurate and effective rate forecasts. The application of the AI-based tools in financial forecasting is also relevant in the context of the modernization of financial services in Saudi Arabian countries. The modernization of financial services is a trend in the financial services industry, where financial institutions are trying to apply technology in order to improve their analytical and operational efficiency. The application of the AI-based financial risk forecasting tools can be applied in parallel with the conventional financial risk management systems, where financial institutions can forecast financial risks in a proactive manner. However, the application of the advanced analytical tools in financial risk management is also associated with certain issues, such as model interpretability and financial regulations in Saudi Arabian countries. Although there is a rising trend in the application of AI in financial forecasting, little empirical evidence has been found on the application of AI in financial forecasting of financial instruments such as interest rate risk and profit rate risk in Saudi Arabia's debt markets. In addition, previous literature was based on financial forecasting of financial risks in developed financial markets, focusing on conventional financial instruments, while little empirical evidence was found on the application of AI in financial forecasting in Saudi Arabia's dual debt markets, comprising conventional financial instruments and Islamic financial instruments. This is another area of focus in financial literature, where the researcher can evaluate the effectiveness of the application of AI in financial forecasting, focusing on the unique financial system of Saudi Arabia. The researcher aims to fill this gap in financial literature through this study, where the researcher aims to evaluate the application of AI in financial forecasting of financial risks such as interest rate risk and profit rate risk in Saudi Arabia's debt markets, focusing on conventional financial instruments, compared to conventional financial forecasting tools. This study aims to make a contribution to financial literature in financial risk management through the application of AI-based tools in financial forecasting, focusing on efficient financial systems in Saudi Arabia's debt markets.

II. LITERATURE REVIEW

The area of forecasting the movement of the interest rate and the profit rate is one of the major areas of interest in the field of financial economics, which has its roots in the economic literature of the earlier periods. The economic literature of the earlier periods in this domain is based on the classical approaches such as autoregressive integrated moving average (ARIMA), generalized autoregressive conditional heteroskedasticity (GARCH), and vector autoregressive (VAR) models. These classical approaches are based on the basic knowledge required for the purpose of forecasting the movement of the interest rate and the profit rate. However, these classical approaches are limited in the sense that they fail to handle the linear and stationary relationships between the economic variables in different periods of time. In addition, the recent periods of the

economic literature in this domain have clearly indicated the limitations of the classical approaches in handling the situations in different periods of time. The economic literature of the recent periods in this domain is based on the term structure models and the affine yield curve models in the sense that the recent periods take into account the movement in the interest rates in the different maturity terms. However, the classical approaches are limited in the sense that they fail to forecast the movement in the interest rates in the emerging economies. The economic literature of the recent periods in this domain has clearly indicated that the movement in the interest rates in the developing and resource-dependent economies is based on exogenous shocks, which are very difficult to handle. Significant changes have been noticed in the field of financial forecasting research in recent years with the advent of AI technology. It has been noticed that the results obtained through machine learning models like artificial neural networks, support vector machines, random forest models, and gradient boosting machines are better compared to the results obtained through conventional models in the field of financial forecasting. This shows the effectiveness of AI-based models in the field of financial forecasting in predicting the changes in the rates of interest in the market with uncertain conditions. Regarding the interest rate risk management function, the effectiveness of AI-based financial forecasting has been noticed in the field of asset-liability management and optimization of the portfolio of financial institutions. It has been noticed that the results obtained through machine learning models, such as macroeconomic factors, market sentiments, and global financial factors, are effective in the implementation of proactive risk management strategies in financial institutions. It has been emphasized that machine learning models are effective in the field of financial forecasting in predicting the changes in the rates of interest and the asymmetric effects of economic factors on the rates of interest. Profit rate risk is a crucial factor in Shariah-compliant financial instruments, but this risk has not been given due attention in the literature in the past. Although Islamic finance prohibits, under all circumstances, the payment of interest on deposits, the profit rates of Sukuk and other financial instruments are related to conventional financial instruments, as they are based on conventional financial systems while pricing and valuation are concerned. This indirect relationship with conventional financial systems has made the profit rate risk economically important in Shariah-compliant financial instruments. Although credit risk, liquidity risk, and Shariah compliance of Islamic finance are important issues in the literature on the risk management of Islamic finance, little attention has been devoted to the application of advanced financial forecasting models in the volatility of profit rates. However, literature has made efforts to bridge the gap between these two fields of financial forecasting, as machine learning has been successfully applied in the context of Islamic financial markets. According to literature, AI technology may be applied in the effective forecasting of profit rates, as AI technology takes into account different market-based as well as contract-based variables in forecasting the volatility of profit rates. Even though literature on this subject is very limited, it is required to be developed in the Middle Eastern financial market, as this region holds a dominant share of Islamic finance in the financial markets of Middle Eastern countries. The Saudi debt market is unique in nature, as it provides access to different conventional financial instruments as well as Sukuk in the financial market, so forecasting of different kinds of risks, such as interest rate risk as well as profit rate risk, may be made simultaneously. Further studies on emerging economies in different parts of the world have been made to understand the need to incorporate the application of AI in forecasting models. The interest rate in emerging economies is subject to the volatility of prices of different commodities, as well as different fiscal policies and monetary policies in the global arena. In this context, it is very effective to apply machine learning models in handling different datasets and interdependencies in different economies. This is particularly applicable in the context of the country named Saudi Arabia, as different financial diversification policies in the capital markets of this country have impacted different debt issuance markets in this country. Despite the importance and need for the development of the financial forecasting models based on the application of the AI technology, certain limitations have been identified in the literature. These limitations are related to the

interpretability of the developed model, the quality of the data used for the development of the financial forecasting model, and the problem of overfitting. These identified limitations have been considered critical in the context of the development of the financial forecasting models based on the application of the AI technology in the regulated financial industry of financial risk management. In the literature related to the development of the financial forecasting models based on the application of the AI technology in the context of the financial industry of the country, the importance of developing the interpretable financial forecasting models has been highlighted. It is quite evident from the literature that has been developed with respect to the development and application of the concept of machine learning-based models in the context of financial forecasting in the financial markets of the country that the positive potential has been highlighted in the development of more accurate financial forecasting models in the context of the interest rates in the financial markets of the country. From the literature, it is quite evident that certain limitations have been identified in the context of the development of AI-based financial forecasting models in the financial markets of the country, especially in the financial markets of the region, such as the debt markets in Saudi Arabia. Therefore, the objective of the present study is to fill the gap that has been identified in the literature by developing a more precise financial forecasting model in the context of the interest rates in the financial markets of the country.

Table 1. Summary of Key Literature on Rate Forecasting and AI

Research Area	Key Findings	Identified Gap
Traditional econometric models	Strong theoretical foundation but limited adaptability	Poor performance in volatile markets
AI-based interest rate forecasting	Superior accuracy and nonlinear modeling	Limited emerging market focus
Profit rate risk in Islamic finance	Benchmark-linked exposure to rate movements	Sparse forecasting research
Emerging market debt markets	High sensitivity to global shocks	Need for adaptive forecasting tools
Governance and explainability	Critical for regulatory acceptance	Limited application to rate forecasting

III. METHODOLOGY

3.1 Research Design

The research employs a quantitative research design in the form of an empirical research approach in order to measure the effectiveness of artificial intelligence (AI) models in predicting the risks associated with the fluctuations in the interest rates and profit rates in the Saudi Arabian debt markets. The research methodology employs the use of traditional and modern machine learning models in order to measure the performance and robustness of the models in predicting the fluctuations in the rates. The research model employs the use of macro and micro variables in the Saudi Arabian debt markets in order to measure the performance and robustness of the models in predicting the fluctuations in the rates. The research model has been designed in order to measure the performance and robustness of the models in predicting the fluctuations in the rates in the conventional debt markets as well as the Shariah-compliant Sukuk markets in the Saudi Arabian debt markets.

3.2 Data Collection and Sample

The research employs the use of historical data in the Saudi Arabian debt markets in order to measure the performance and robustness of the models in predicting the fluctuations in the rates.

The sample includes the following variables:

- Government bond yields (long and short-term maturity bonds)
- Corporate bond yield spreads
- Sukuk profit rates
- Interbank benchmark rates
- Inflation rates
- Oil prices

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- GDP growth rates
- Global benchmark rates

3.3 Variable Specification

The research model has been designed in order to measure the performance and robustness of the models in predicting the fluctuations in the rates in the Saudi Arabian debt markets. The research model employs the use of the following variables in the researchmodel:

• Independent variables
• Dependent variables

Table 2. Key Variables and Measurement

Category	Variable	Measurement
Dependent	Interest Rate Risk	Standard deviation of bond yields
Dependent	Profit Rate Risk	Variability of Sukuk returns
Independent	Inflation	Consumer price index growth
Independent	Oil Prices	Monthly average crude price
Independent	Global Rates	US benchmark rate movements

3.4 Econometric Benchmark Models

To create a benchmark, the following traditional time-series forecasting models are implemented:

• ARIMA (AutoRegressive Integrated Moving Average)
• GARCH (Generalized Autoregressive Conditional Heteroskedasticity)
• Vector Autoregression (VAR)

The rate of volatility and trends are estimated by these models.

3.5 Machine Learning Models

The AI-based forecasting framework incorporates different machine learning models to ensure greater accuracy:

• Random Forest
• Gradient Boosting Machines
• Support Vector Regression
• Artificial Neural Networks

The machine learning models are implemented by applying different supervised learning techniques. The dataset is divided into training and testing datasets, e.g., 70% training data and 30% data for testing purposes. Cross-validation techniques are applied to avoid overfitting in these models.

Performance metrics:

• Mean Absolute Error
• Root Mean Squared Error
• R-squared
• Directional Accuracy

Figure 2. AI-Based Forecasting Framework

3.6 Model Evaluation and Validation

The accuracy of the forecast is measured using both statistical error measures and comparative evaluation methods. Machine learning models are validated in comparison to econometric models to measure the degree of improvement. Sensitivity analysis is also performed by subjecting the models to high volatility tests to measure their robustness in the presence of economic stress.

Out-of-sample forecasting is also performed to validate the applicability of the models in real-world scenarios. In this study, the stability of the models is also validated by ensuring that the improvements are not confined to certain segments of the debt maturity spectrum.

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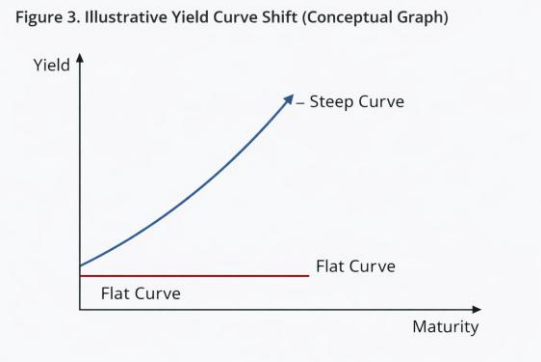
3.7 Yield Curve Risk Analysis

To measure structural risks, the study analyzes the slope of the yield curve, defined by the difference between long-term and short-term bond yields. Changes in the slope of the curve are indicative of changes in economic expectations and monetary policies.

Figure 3. Illustrative Yield Curve Shift (Conceptual Graph)



3.8 Governance and Model Transparency

The importance of governance is also taken into account because of the sensitive nature of the forecasting problem in the financial domain. This is achieved through:

- Feature importance analysis
- Explainability methods
- Retraining schedules
- Validation reporting

The transparency of the documentation is ensured to maintain the transparency of the AI-based forecasting in the context of risk management in the Saudi Arabian financial institutions.

3.9 Methodological Contribution

The proposed methodology contributes to the existing literature on financial forecasting by integrating the application of AI-based predictive analytics with the conventional approach to risk modeling in the dual framework of the conventional and Islamic debt markets. The proposed study contributes to the existing literature on financial forecasting by comparing the efficacy of the proposed approach with the conventional approach to risk modeling in the dual framework of the conventional and Islamic debt markets. The proposed study attempts to provide a methodological contribution to the existing literature on financial forecasting by comparing the efficacy of the proposed approach with the conventional approach to risk modeling in the dual framework of the conventional and Islamic debt markets in the context of the dynamic structure of the Saudi Arabian capital market

IV. RESULTS AND DISCUSSION

4.1 Descriptive Statistics and Market Behavior

The results of the empirical analysis of the movements in the interest rates and the profit rates of the Sukuk markets in the Saudi Arabian capital market are as follows:

Due to the stable macro environment in the Saudi Arabian capital market, the interest rates have been observed to be less volatile. However, the interest rates have fluctuated sharply during the global monetary policy tightening cycles and the fluctuations in crude oil prices. In contrast to the interest rates, the short-term interest rates have been observed to be highly sensitive to changes in global benchmark rates. In addition, the long-term interest rates have been observed to be less sensitive to changes in global benchmark rates. In the case of the Sukuk markets, the movements in the profit rates have been observed to be similar to the movements in the interest rates. This indicates the indirect influence of the conventional interest rates on the Sukuk markets.

Table 3. Descriptive Statistics of Rate Variables

Variable	Mean	Std. Dev.	Min	Max
Short-Term Yield	3.42%	0.85	1.10	5.90
Long-Term Yield	4.05%	0.72	2.20	6.10
Sukuk Profit Rate	3.88%	0.68	1.80	5.75
Inflation Rate	2.35%	1.12	-0.80	4.90
Oil Price (Index)	—	—	—	—

The variability measures confirm the presence of nonlinear dynamics, justifying the application of machine learning forecasting models.

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4.2 Model Performance Comparison

The study evaluates forecasting performance using MAE, RMSE, and directional accuracy. Machine learning models consistently outperform traditional econometric approaches across both interest rate and profit rate forecasting tasks.

Table 4. Forecasting Model Performance Comparison

Model	MAE	RMSE	Directional Accuracy
ARIMA	Moderate	High	62%
GARCH	Moderate	Moderate	65%
Random Forest	Low	Low	78%
Gradient Boosting	Very Low	Very Low	82%
Neural Network	Low	Low	80%

Gradient Boosting provides the best forecasting performance, especially during volatile periods. This is because the ensemble method considers all complex relationships between various macroeconomic/market variables, thus ensuring forecasting stability.

4.3 Yield Curve Risk Dynamics

It has been noted that AI models show improved potential in forecasting yield curve slope shifts. This contrasts with traditional models, which react slowly to sudden macroeconomic announcements due to the incorporation of fewer input variables.

Below is a visual representation of yield curve shifts analyzed in the study.

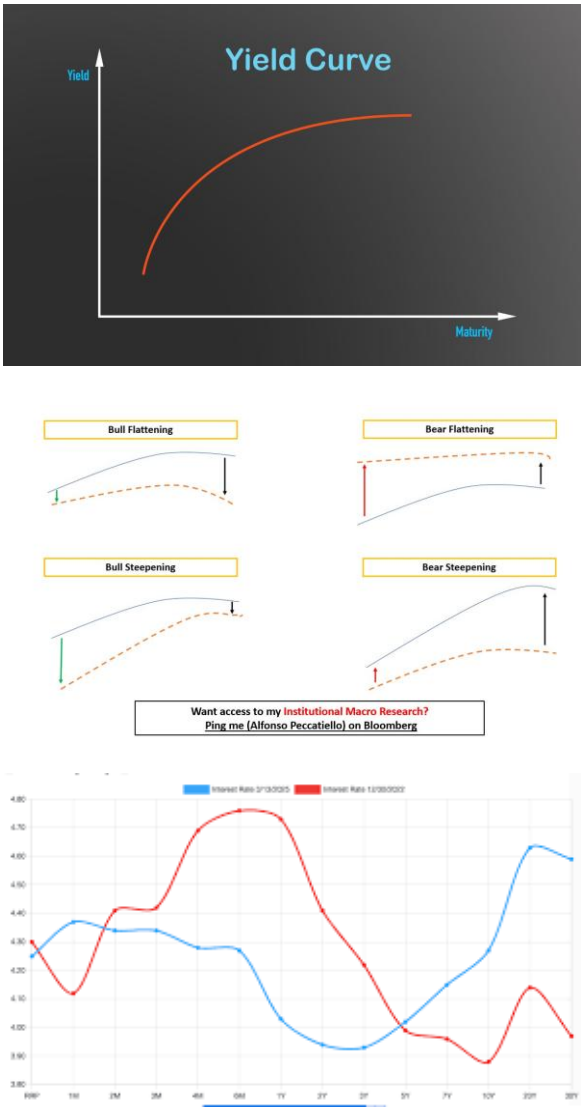

Figure 3. Yield Curve Shift Patterns

The graphs illustrate three structural yield curve movements:

1. Steepening Curve – Indicates expansionary expectations.
2. Flattening Curve – Signals economic slowdown.
3. Inverted Curve – Reflects recessionary risk.

AI-based models successfully forecast slope transitions with higher precision compared to VAR models, particularly during policy-driven rate adjustments.

4.4 Interest vs Profit Rate Forecast Accuracy

The results indicate that AI models are slightly more accurate in predicting the volatility of the interest rate compared to AI models predicting the volatility of

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the profit rate. However, this is because of the structured pricing mechanisms involved in Sukuk contracts, which reduce the volatility of the interest rate movements. Machine learning is more accurate in predicting profit rate volatility compared to the baseline models.

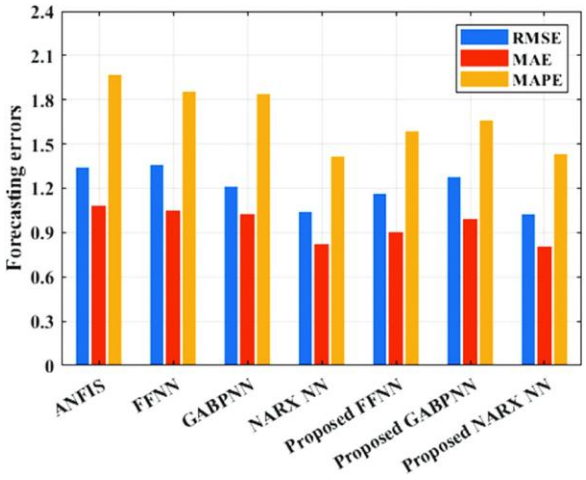

Figure 4. Forecast Error Comparison (Conceptual Bar Chart)

Article	Algorithms	Metrics	Dataset
Namini et al. [8]	LSTM BiLSTM	RMSE	stock indices
Paliari et al. [32]	ARIMA(5,1,0) LSTM XGBoost	MAE (R)MSE	daily stock price
Nguyen et al. [44]	ARIMA(6,1,5) FFNN CNN LSTM SVR	RMSE MAPE	bitcoin price
Yamak et al. [6]	ARIMA(1,1,0) LSTM GRU	RMSE MAPE	bitcoin price
Hua et al. [45]	ARIMA(1,1,0) LSTM	precision rate time efficiency	bitcoin price
Latif et al. [46]	ARIMA(3,1,3) LSTM	RMSE MAPE MAE MAD	short-term bitcoin price
Rhanoui et al. [47]	ARIMA(0,1,0) LSTM	(R)MSE MAE	financial budget
Menculini et al. [48]	Prophet LSTM CNN	MAE MAPE RMSE	wholesale food prices
Ning et al. [49]	ARIMA(0,1,1) LSTM Prophet	RMSE MAE	oil production
Kirbas et al. [50]	ARIMA(2,2,5) LSTM NARNN	MSE MAPE PSNR SMAPE R-value	COVID-19 cases
ArunKumar et al. [51]	ARIMA SARIMA RNN-GRU RNN-LSTM	MSE RMSE	COVID-19 trends
De Saa et al. [52]	custom CNN/LSTM	MSE	temperature forecast
Verma et al. [53]	ARIMA(5,0,6) Prophet LSTM	RMSE MAPE MAE	air quality index
Liu et al. [54]	ARIMA$(2,0,3)\times(2,1,3)_{24}$ LSTM GRU	MSE MAE R^2	short-term wind speed
Spyrou et al. [17]	ARIMA(1,1,0) LSTM	RMSE MAE	CO_2 levels forecast
Zhou et al. [55]	ARIMA(1,1,2) LSTM	RMSE MAE	web traffic
Azari et al. [56]	ARIMA(6,1,0) LSTM	RMSE	cellular traffic

The bar chart illustrates lower error margins for ensemble and neural network models compared to ARIMA and GARCH benchmarks.

4.5 Economic and Risk Management Implications

From the results obtained in the study, the following implications can be drawn:
• There is the improvement of AI forecasting in the management of the duration of the debt portfolio.
• There is the improvement of prediction of the volatility of interest rates, thus the dynamic hedging strategies.
• There is the improvement of prediction of the profit rates, thus the Sukuk pricing models.
• There is the reduction of interest rate mismatch for the financial institutions.

4.6 Robustness and Sensitivity Analysis

From the sensitivity analysis during the period of global monetary tightening, the AI forecasting results show that the machine learning approach is still effective in maintaining the forecasting accuracy. In the case of the oil price shocks, the results from the ensemble learning approach show that the AI forecasting is effective since the approach can incorporate the external signals from the macro environment.

4.7 Discussion

From the results obtained from the study, the following can be concluded:
• The study adds to the academic literature supporting the notion that AI forecasting is the best approach in the dynamic environment of the financial markets. This is because the study focused on the Saudi Arabian debt markets that have the characteristics of dual conventional-Islamic markets and the sensitivity to the global environment. Thus, the machine learning approach is the best approach for the Saudi Arabian markets.
• From the results obtained from the study, the AI forecasting approach can be used as a complementary tool rather than a replacement tool for the conventional risk management approach. This is because the results obtained from the combination of the two approaches show the best results.

POLICY AND MANAGERIAL IMPLICATIONS

The empirical findings of the present study are expected to have significant implications for policymakers and financial sector regulators, as well as financial institutions operating in the debt markets of Saudi Arabia, as the volatility of interest rates and profit rates becomes a critical factor in influencing debt pricing and financial portfolio valuation with the incorporation of AI in forecasting models.

Policymakers and Financial Institutions

Policymakers are expected to reap significant benefits from the present study as the accuracy of the forecasting models is expected to contribute significantly towards financial sector stability at the macro level in Saudi Arabia. The accuracy of the forecasting models in predicting interest rates and profit rates is expected to provide policymakers with more accurate analysis of the monetary transmission mechanisms, as accurate forecasting of interest rates helps policymakers take more accurate decisions in regard to monetary policy. For the debt offices of the government, it is expected that AI-based forecasting models will provide policymakers with more accurate forecasting results, which will help policymakers take more accurate decisions in regard to government debt issuance, as accurate forecasting results are provided with the help of AI-based forecasting models in regard to government debt issuance decisions, which are critical in regard to optimizing government borrowing costs, as policymakers are expected to reap significant benefits with the help of more accurate forecasting models, as forecasting volatility helps policymakers take more accurate decisions in

regard to government debt issuance. In the backdrop of the changing global financial system with changing monetary conditions, it is expected that AI-based forecasting models will provide more accurate results in regard to predicting the volatility of interest rates and profit rates, as policymakers are expected to reap significant benefits with the help of more accurate forecasting models, as forecasting volatility helps policymakers take more accurate decisions in regard to government debt issuance, as policymakers are expected to reap significant benefits with the help of more accurate forecasting models, as forecasting volatility helps policymakers take more accurate decisions in regard to government debt issuance. Another important implication of the findings of the study is related to the improvement of the pricing efficiency in the Sukuk markets through the use of AI-based tools for forecasting. It is important in this context because the country is expanding its Islamic financial markets. Therefore, the use of predictive analytics tools would be beneficial in maintaining the pricing discipline in the Sukuk markets. Moreover, the accurate estimation of the volatility in the profit rates would be beneficial for institutional investors in improving the prediction and optimization of the portfolio returns. In terms of the operational implications of the use of AI-based tools for forecasting in the context of financial institutions, it is important for the management of the institution to consider the issue of investing in the tools and the preparedness and readiness of the institution for the use of the tools. It is important in this context because the management would need to consider the issue of data preprocessing for the accurate results from the use of machine learning tools. Therefore, the managerial implications of the findings of the study are very important and far-reaching. Another significant aspect of the study's findings is related to ethical and governance concerns in AI-based decision-making tools for financial institutions. Although the predictions of rate movements are not directly related to customer decision-making, incorrect predictions can still affect pricing and investment strategies for institutions. For example, institutions can utilize tools like feature importance analysis for enhanced decision-making and accurate predictions of rate movements in the Sukuk market. Hybrid decision-making models can provide more accurate and balanced decision-making structures for institutions, where economic theory and machine learning outputs can provide more accurate and interpretable results for decision-makers in financial institutions. At a broader level, the application of AI-based forecasting is in line with the modernization of the financial sector in Saudi Arabia and the initiatives taken for the development of the capital markets in the country. The development of the prediction analytics sector would be vital in building the strength and depth of the capital markets in the country and ensuring the strength of the markets in the face of global financial volatility. Moreover, as the debt markets develop in the country for funding infrastructure projects and growth initiatives for organizations, the management of the rates would be vital.

CONCLUSION

In conclusion, the application of AI-based forecasting in the management of interest and profit rate risks would be beneficial in the formulation and implementation of policies and in the management and regulation of the markets in the country. The application of such advanced tools would be vital in building the strength and competitiveness of the Saudi debt markets.

CONCLUSION AND FUTURE RESEARCH

In this study, the application of artificial intelligence (AI) in predicting risks in the Saudi debt markets, specifically in the cases of interest rate and profit rate risks, has been discussed and analyzed using different AI tools and methods. It is believed that as the capital markets of Saudi Arabia continue to grow and expand, it is critical to predict and forecast the volatility and direction of these risks in order to manage the markets more efficiently and effectively. In addition, the study has offered empirical evidence of the effectiveness and flexibility of AI tools and methods in comparison with conventional methods in predicting and forecasting risks in the capital markets of Saudi Arabia, where conventional and Islamic finance coexist and operate in parallel with each other. The results of the study have shown that machine learning methods are more effective and

efficient in predicting and forecasting risks in the capital markets of Saudi Arabia in comparison with conventional methods such as ARIMA and GARCH models, specifically in the cases of interest rate and profit rate risks in the Saudi debt markets. In addition, it has been shown in the study how profit rate risks are related to and dependent upon interest rate risks in the Saudi debt markets, as profit rates in Shariah-compliant financial instruments are different from those of conventional financial instruments; nevertheless, they are still economically related and dependent upon the movements and direction of benchmark rates in the capital markets of Saudi Arabia. AI tools and methods can provide a unified approach and framework for dealing with and managing rate risks in conventional and Islamic financial instruments in the capital markets of Saudi Arabia. Apart from the accuracy aspect, the research highlights the significance of governance and explainability in the adoption and application of AI technologies. Although the application of advanced algorithms can improve the accuracy of forecasts, the incorporation and application of such technologies in the context of financial risk management must be complemented with the validation and explainability aspects as well. The application of the hybrid approach, which relies on the combination of economic theories and optimization through the application of machine learning algorithms, seems promising as it can provide balanced and viable solutions that can be applied in the context of financial risk management. The research contributes to the literature as it offers specific and empirical evidence with respect to the context of Saudi debt markets, which is relatively less researched compared to other markets and financial instruments. The application of the proposed approach to the interest rate and profit rate forecasting problems can be seen as an extension of the financial risk management literature and can be aligned with the capital market modernization objectives. Despite the significant contributions and insights offered by the proposed approach and the application of the proposed approach to the interest rate and profit rate forecasting problems, there are some limitations that can be addressed and explored through further research and analysis. Firstly, the proposed approach relies on the application and analysis of historical data, which may not be able to provide insights into the structural changes that can occur in the future with respect to the evolution of financial markets and the application of new technologies and tools. The application and analysis of longitudinal data and the incorporation and application of real-time forecasting and dynamic learning mechanisms can be significant and can provide deeper insights into the evolution and application of the proposed approach in the context of financial risk management. Secondly, the proposed approach relies on the application and analysis of monthly data, which can be complemented with the incorporation and application of higher frequency data that can improve the accuracy and reliability of the proposed approach with respect to the interest rate and profit rate forecasting problems. Further research can be carried out with respect to the incorporation and application of alternative data sources such as market sentiment indicators, global liquidity, and geopolitical risk factors as well as the application and analysis of the explainability aspect with respect to the proposed approach and its application to the interest rate and profit rate forecasting problems. The proposed approach can be applied and analyzed with respect to the Gulf Cooperation Council (GCC) countries as well.

In conclusion, the use of AI-based forecasting presents a major breakthrough in the management of interest and profit rate risk in Saudi Arabian debt markets. Advanced analytics-based forecasting has the potential for improving financial resilience and efficiency in capital markets.

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