

## Volatility Modelling of Nigerian Bank Stocks: Evidence from Real and Simulated Data using GARCH and Machine Learning

Sandra C. EMENYONU<sup>a</sup>, Bright O. OSU<sup>b</sup>, Promise A. AZOR<sup>c\*</sup>

<sup>a</sup>Department of Statistics, Gregory University Uturu, Nigeria,  
[winchiaka@yahoo.co.uk](mailto:winchiaka@yahoo.co.uk), <https://orcid.org/0009-0006-3223-6896>

<sup>b</sup>Department of Mathematics, Abia State University, Uturu, Nigeria,  
[osu.bright@abiastateuniversity.edu.ng](mailto:osu.bright@abiastateuniversity.edu.ng), <https://orcid.org/0000-0003-2463-430X>

<sup>c</sup>Department of Mathematics and Statistics, Federal University Otuoke, Nigeria,  
[azor.promise@gmail.com](mailto:azor.promise@gmail.com), <https://orcid.org/0009-0001-6028-7803>.

\*Corresponding Author

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### Abstract

This study examines the volatility dynamics of selected Nigerian banking stocks using both real and simulated share price data. Daily closing prices of five major Nigerian banks Access Holdings Plc (ACCESSCORP), Guaranty Trust Holding Company Plc (GTCO), Fidelity Bank Plc (FIDELITYBK), FBN Holdings Plc (FBNH), and United Bank for Africa Plc (UBA) are analyzed over a common sample period from January 1, 2015, to December 17, 2025. Log-returns are computed and volatility is modelled using the GARCH (1,1), EGARCH (1,1), and TGARCH (1,1) models under Normal and Student-t error distributions. To assess the robustness of volatility behaviour, simulated return series are generated from the empirical properties of the real data under a Gaussian assumption and analyzed alongside the observed data. Furthermore, machine learning models including Random Forest regression, Long Short-Term Memory (LSTM) networks, and hybrid GARCH LSTM approaches are employed to enhance volatility forecasting performance. Results indicate that real data exhibits higher volatility persistence and thicker tails than simulated data across most banks. Among the GARCH-family models, EGARCH with Student-t innovations provides superior performance in capturing asymmetric effects and extreme market movements. Machine learning models further improve forecasting accuracy, particularly during periods of financial stress. The findings offer important insights for investors, risk managers, and policymakers in emerging financial markets.

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## Introduction

Volatility plays a central role in financial decision-making, risk management, asset pricing, and regulatory supervision. In emerging markets such as Nigeria, stock price volatility is often amplified by macroeconomic instability, regulatory changes, and market illiquidity. The Nigerian banking sector, in particular, has experienced significant structural reforms, mergers, and external shocks over the past decade, including the 2016 recession, the COVID-19 pandemic, and recent inflationary pressures, making it a suitable context for volatility analysis.

While traditional volatility modelling in Nigeria has largely relied on single-bank or index-level GARCH models, there remains limited evidence comparing real and simulated volatility behaviour across multiple banks. Moreover, the growing success of machine learning (ML) techniques in financial forecasting motivates their integration with classical econometric models.

This study contributes to the literature by:

1. Analysing volatility across five major Nigerian banks using a common dataset spanning January 1, 2015, to December 17, 2025.
2. Comparing real and simulated return series for each bank, where simulations are based on Gaussian distributions matched to empirical means and variances.
3. Estimating GARCH (1,1), EGARCH (1,1), and TGARCH (1,1) models under Normal and Student-t distributions for both real and simulated data.
4. Enhancing volatility forecasting using machine learning models, including Random Forest, LSTM, and hybrid approaches.

Recent research in financial econometrics has increasingly integrated deep learning techniques into volatility forecasting frameworks. Empirical studies demonstrate that recurrent neural networks such as Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRU) are particularly effective in capturing nonlinear dependencies, long-memory effects and regime shifts in financial time series (Fischer & Krauss, 2018; Nelson et al. 2017). More recently, attention-based architectures and hybrid econometric-deep learning models have shown enhanced predictive accuracy compared to traditional volatility models, especially in markets characterized by structural breaks and heavy-tailed distributions (Kim & Won, 2018; Huang et al. 2022).

Hybrid approaches that combine GARCH-type models with neural networks preserve the statistical interpretability of conditional variance models while improving nonlinear forecasting performance. Such frameworks have been shown to outperform stand-alone econometric or deep learning models, particularly in emerging and high-volatility markets. Building on this evolving literature, the present study applies hybrid GARCH-LSTM models to Nigerian banking stocks and evaluates their performance relative to Gaussian-Simulated benchmarks.

## *Data Description*

### *Banks Considered*

The study focuses on the following banks listed on the Nigerian Exchange (NGX):

- Access Holdings Plc (ACCESSCORP)