
A MERTON JUMP-DIFFUSION AND BIDIRECTIONAL LSTM FRAMEWORK FOR INFLATION FORECASTING UNDER STRUCTURAL BREAKS

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ABSTRACT

Structural breaks, sudden policy-induced discontinuities in macroeconomic processes, represent the most consequential challenge in inflation forecasting for developing economies. In Nigeria, three major shocks between 2020 and 2024, comprising the COVID-19 supply disruption, the abrupt removal of fuel subsidies in June 2023, and the introduction of a floating exchange rate regime, collectively drove headline inflation from 12.13critical limitation: both treat inflation as a continuous, smooth process, rendering them unable to capture the discontinuous jump dynamics that drive inflationary volatility during structural break episodes. This study introduces a hybrid framework integrating a Jump-Diffusion stochastic differential equation with a Bidirectional Long Short-Term Memory (BiLSTM) neural network. The Jump-Diffusion model decomposes Nigeria's monthly Consumer Price Index log-returns into continuous drift, Brownian diffusion, and Poisson jump components, estimated through maximum likelihood. A time-varying Conditional Jump Probability, derived from the model's infinite mixture probability density function through Bayes' theorem, is incorporated as a structured input feature into the BiLSTM network, creating a mathematically principled bridge between stochastic process characterisation and deep temporal learning. Structural breaks are identified endogenously using the multiple breakpoint test. The hybrid framework achieves a Root Mean Square Error of 0.84 and a Mean Absolute Percentage Error of 3.21outperforming ARIMA, standalone LSTM, and standalone Jump-Diffusion by margins of 7341variance estimation. These results demonstrate that hybrid frameworks incorporating jump-driven stochastic structure into deep learning architectures substantially outperform existing methods for inflation forecasting in volatile developing economies, with direct implications for monetary policy and fiscal planning.

Keywords Jump-Diffusion · Bidirectional LSTM · Inflation Forecasting · Structural Breaks · Nigeria · Stochastic Differential Equations

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