Advanced modeling of inflation dynamics in Sri Lanka: A comparative analysis of Statistical, Machine Learning, Deep Learning, and Hybrid Forecasting approaches

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Inflation is one of the most important factors that impact the economic activities of a country. Inflation forecasting plays a key role in the process of monetary policy formulation at central banks. Previous studies in Sri Lanka have focused mainly on Traditional Time Series (TTS) and Machine Learning (ML) models, while Deep Learning (DL), ensemble, and hybrid approaches with systematic hyperparameter optimization remain largely unexplored. Moreover, prior research has not incorporated recent economic shocks, such as the COVID 19 pandemic and the 2022 economic crisis. This study provides a comprehensive analysis of univariate one-step-ahead inflation forecasting using diverse modeling approaches. TTS models, including Auto Regressive Integrated Moving Average (ARIMA) and Seasonal ARIMA (SARIMA), were benchmarked against ML models [Random Forest, XGBoost, Support Vector Regression (SVR)] and DL models [Feedforward Neural Networks (FNN), Long Short-Term Memory (LSTM), Convolutional Neural Networks (CNN)]. Hybrid approaches were explored, including simple and weighted averaging ensembles, where weights were based on evaluation metrics, and residual-based hybrid models (SVR-CNN, SVR-LSTM, SVR-FNN), where SVR generates initial predictions and DL models capture residual patterns. All models were optimized using the Optuna hyperparameter tuning framework with time series cross validation. Monthly Colombo Consumer Price Index (CCPI) headline inflation data from January 2000 to March 2025 were used. Models were evaluated using RMSE, MSE, MAE, and R^2. Various train-test splits (70:30, 80:20, 90:10) were tested, with 90:10 performing best. While SARIMA captured seasonality effectively, ML and DL models improved forecasting accuracy, and error weighted ensemble models, including the MAE-weighted ensemble, the RMSE weighted ensemble, the MSE-weighted ensemble, and the simple averaging ensemble model, further enhanced forecasting performance. While the MAE weighted ensemble model slightly outperformed the others in numerical error metrics, the Diebold-Mariano test indicated that the proposed simple average ensemble model and error-based weighted average ensemble models provided competitive performance in one-step-ahead inflation forecasting in Sri Lanka.

Keywords: *Inflation forecasting, Machine Learning, Time Series, Hybrid models*