ABSTRACT

Forecasting carbon emission prices is a significant challenge due to the data's highly volatile and non-stationary nature. This study proposes and evaluates a hybrid deep learning model that integrates Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN) with a Long Short-Term Memory (LSTM) network. The methodology compares the performance of an LSTM-Baseline model, a Gated Recurrent Unit (GRU) model, and two hybrid configurations: one with an IMF classification strategy based on Fuzzy Entropy and another (in an ablation study) that models each compo- nent individually. The test results show that the decomposition approach is significantly superior, with the CEEMDAN-LSTM model without IMF classification achieving the highest accuracy. This model yields a MAPE of 0.81% on the test set, a drastic improvement over the 8.62% MAPE from the LSTM-Baseline, and its superiority has been validated as statistically significant by the Diebold-Mariano test. This research showed that while signal decomposition is a powerful preprocessing step, preserving the informational integrity of each individual component is key to achieving maximum forecasting accuracy.

Keywords: *Carbon Emission, CEEMDAN, Hybrid Model, LSTM*