

Exploring Drivers of Natural Gas Price Fluctuations: Application of EEMD for Analysis and LSTM for Forecasting

Authors : Zhaojiali

Abstract : The inherent complexity of the natural gas market presents significant challenges for analyzing and forecasting price fluctuations. We utilize Empirical Mode Decomposition (EEMD) to examine the driving factors of natural gas price fluctuations and further apply a Long Short-Term Memory (LSTM) network to achieve accurate forecasting. First, EEMD decomposes the time series and, based on sample entropy, reconstructs the intrinsic modes into high-frequency, low-frequency, and trend components. By calculating the correlation coefficients and mutual information between these reconstructed components and natural gas prices, we find that high-frequency components exhibit strong correlations solely with their respective gas prices, while low-frequency components show strong correlations not only with their own corresponding prices but also with other gas prices. Additionally, this study explores the relationship between the trend component of natural gas prices and global temperature anomalies, revealing that HH prices exhibit a relatively lagged response to temperature anomalies, indicating a heightened sensitivity to temperature changes. In the forecasting phase, this study compares three distinct algorithms: LSTM Direct Forecasting, EEMD-Entropy Enhanced LSTM (EEELSTM), and Multivariate EEMD-LSTM with Dynamic Reconstruction (MELDR). Among these, MELDR harnesses the combined strengths of EEMD and LSTM to manage long-term dependencies and non-stationary components within natural gas price data. The application of MELDR demonstrates its superiority, particularly in single-step forecasts. By integrating EEMD with LSTM, this study enhances the accuracy of natural gas price predictions. Additionally, through the analysis of the significance and contribution of each IMF component, the study provides a deeper understanding of the factors underlying natural gas price fluctuations, offering more reliable theoretical support for decision-making.

Keywords : ensemble empirical mode decomposition, gas price, forecasting, composition, volatility

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