ABSTRACT

IMPLEMENTATION OF HYBRID VECTOR AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (VARIMA)-BIDIRECTIONAL GATED RECURRENT UNIT (BIGRU) MODEL FOR FORECASTING THE PRICES OF EXCHANGE-TRADED FUND (ETF) SPDR GOLD SHARES (GLD) AND VANECK GOLD MINERS (GDX)

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The fluctuation of investment values such as the Exchange-Traded Fund (ETF) SPDR Gold Shares (GLD) and VanEck Gold Miners (GDX) is influenced by various complex economic factors, requiring a model capable of accurately forecasting future values. This study develops a hybrid model based on the Vector Autoregressive Integrated Moving Average (VARIMA) and the Bidirectional Gated Recurrent Unit (BiGRU) to improve the accuracy of ETF price forecasting. The model is designed to address the limitations of VARIMA in capturing nonlinear patterns, as well as the shortcomings of BiGRU in fully understanding the linear structure of the data. The hybrid model in this study is constructed using two approaches. The first approach, the VARIMA–E_BiGRU hybrid model, combines the VARIMA prediction results with the VARIMA residuals which are processed using the BiGRU model. The second approach, the VARIMA–EP_BiGRU hybrid model, integrates both the predictions and residuals of the VARIMA model, with both components further processed by the BiGRU model. The data used in this study consist of historical closing prices of the GLD and GDX ETFs from January 2017 to November 2024. The results show that the VARIMA–EP_BiGRU hybrid model delivers the best forecasting performance compared to both the standalone VARIMA model and the VARIMA–E_BiGRU hybrid model, indicated by the smallest Kolmogorov–Smirnov (KS) statistic and a superior ability to follow the pattern of the updated data. Therefore, the VARIMA–EP_BiGRU hybrid model is the most effective forecasting model compared to both the VARIMA model and the VARIMA–E_BiGRU hybrid model.

Keywords: Hybrid VARIMA–BiGRU, VARIMA, BiGRU, Exchange-Traded Fund, forecasting.

ABSTRAK

IMPLEMENTASI MODEL *HYBRID VECTOR AUTOREGRESSIVE INTEGRATED MOVING AVERAGE* (VARIMA)-*BIDIRECTIONAL GATED RECURRENT UNIT* (BIGRU) PADA PERAMALAN HARGA *EXCHANGE-TRADED FUND* (ETF) SPDR *GOLD SHARES* (GLD) DAN VANECK *GOLD MINERS* (GDX)

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Fluktuasi nilai investasi seperti *Exchange-Traded Fund* (ETF) SPDR *Gold Shares* (GLD) dan Vaneck *Gold Miners* (GDX) dipengaruhi oleh berbagai faktor ekonomi yang kompleks, sehingga dibutuhkan model yang mampu meramalkan nilai di masa mendatang secara akurat. Penelitian ini mengembangkan model *hybrid* berbasis *Vector Autoregressive Integrated Moving Average* (VARIMA) dan *Bidirectional Gated Recurrent Unit* (BiGRU) untuk meningkatkan akurasi peramalan harga ETF. Model ini dirancang untuk mengatasi keterbatasan VARIMA dalam menangkap pola nonlinear, serta kekurangan BiGRU dalam memahami struktur linier data secara utuh. Model *hybrid* dalam penelitian ini dibangun melalui dua pendekatan. Pendekatan pertama yaitu model *hybrid* VARIMA–E_BiGRU, yang menggabungkan hasil prediksi VARIMA dengan residual model VARIMA yang diproses lebih lanjut pada model BiGRU. Sementara pendekatan kedua yaitu model *hybrid* VARIMA–EP_BiGRU, yang menggabungan antara prediksi dan residual VARIMA yang keduanya diproses lebih lanjut pada model BiGRU. Data yang digunakan pada penelitian ini berupa data historis harga penutupan ETF GLD dan GDX periode Januari 2017 hingga November 2024. Hasil penelitian menunjukkan bahwa model *hybrid* VARIMA–EP_BiGRU memberikan kinerja peramalan terbaik dibandingkan model VARIMA maupun model *hybrid* VARIMA–E_BiGRU, dengan nilai statistik Kolmogorov–Smirnov (KS) terkecil dan kemampuan yang lebih baik dalam mengikuti pola data *update*. Sehingga, model *hybrid* VARIMA–EP_BiGRU merupakan model yang paling efektif dalam melakukan peramalan dibandingkan model VARIMA maupun model *hybrid* VARIMA–E_BIGRU.

Kata kunci: *Hybrid* VARIMA–BiGRU, VARIMA, BiGRU, *Exchange-Traded Fund*, peramalan.