

ABSTRACT

PANEL DATA FORECASTING OF HARVESTED AREA AND RICE PRODUCTION USING A HYBRID PANEL VECTOR AUTOREGRESSIVE (PVAR)–LONG SHORT-TERM MEMORY (LSTM) MODEL

By

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Rice production is one of the most important indicators of national food security, therefore an accurate forecasting method is required to provide reliable estimates of production development across various regions in Indonesia. This study aims to analyze the relationship between harvested area and rice production as well as to perform prediction and forecasting for 34 provinces in Indonesia. The data used consist of monthly panel time series data for the period 2018–2023, obtained from the *Area Sampling Frame Survey (Kerangka Sampel Area, KSA)* conducted by Statistics Indonesia (BPS). The method applied in this research is the *Panel Vector Autoregression (PVAR)* model with the *Generalized Method of Moments (GMM)* estimation approach. The optimal model is determined based on the *Andrews–Lu Model and Moment Selection Criterion (MMSC)*. In addition, *Impulse Response Function (IRF)* and *Forecast Error Variance Decomposition (FEVD)* analyses are conducted to evaluate shock responses and the contribution of each variable in explaining variations in rice production. Furthermore, the PVAR prediction results are combined with a *Long Short-Term Memory (LSTM)* model as a *hybrid* approach to improve forecasting capability in capturing seasonal patterns and nonlinear fluctuations. The results show that the PVAR model is able to describe the dynamic relationship between harvested area and rice production; however, its predictions tend to be less responsive to sharp production spikes. The *hybrid* PVAR–LSTM approach improves forecasting accuracy compared to the standalone PVAR model, as indicated by lower MAE, RMSE, and MAPE values across most provinces. Therefore, this *hybrid* model can serve as an effective alternative to support rice production planning and food security policy in Indonesia.

Keywords: rice production, harvested area, panel time series, PVAR-GMM, LSTM, *hybrid forecasting model*.

ABSTRAK

FORECASTING DATA PANEL LUAS PANEN DAN PRODUKSI PADI MENGUNAKAN HYBRID PANEL VECTOR AUTOREGRESSIVE (PVAR)-LONG SHORT TERM MEMORY (LSTM)

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Produksi padi merupakan salah satu indikator penting dalam ketahanan pangan nasional, sehingga diperlukan metode peramalan yang mampu memberikan estimasi akurat terhadap perkembangan produksi di berbagai wilayah Indonesia. Penelitian ini bertujuan untuk menganalisis hubungan antara luas panen dan produksi padi serta melakukan prediksi dan peramalan pada 34 provinsi di Indonesia. Data yang digunakan merupakan data panel deret waktu bulanan periode 2018–2023 yang bersumber dari Survei Kerangka Sampel Area (KSA) Badan Pusat Statistik. Metode yang digunakan dalam penelitian ini adalah *Panel Vector Autoregression* (PVAR) dengan pendekatan estimasi *Generalized Method of Moments* (GMM). Model optimal ditentukan berdasarkan kriteria Andrews–Lu *Model and Moment Selection Criterion* (MMSC). Selain itu, dilakukan analisis *Impulse Response Function* (IRF) dan *Forecast Error Variance Decomposition* (FEVD) untuk mengevaluasi respons guncangan serta kontribusi variabel dalam menjelaskan variasi produksi padi. Selanjutnya, hasil prediksi PVAR dikombinasikan dengan model *Long Short-Term Memory* (LSTM) sebagai pendekatan *hybrid* guna meningkatkan kemampuan prediksi pada pola musiman dan fluktuasi nonlinier. Hasil penelitian menunjukkan bahwa model PVAR mampu menggambarkan hubungan dinamis antara luas panen dan produksi padi, namun prediksi cenderung kurang responsif terhadap lonjakan produksi yang tajam. Pendekatan *hybrid* PVAR–LSTM memberikan peningkatan akurasi peramalan dibandingkan PVAR murni, ditunjukkan oleh penurunan nilai MAE, RMSE, dan MAPE pada sebagian besar provinsi. Dengan demikian, model *hybrid* ini dapat menjadi alternatif yang efektif untuk mendukung perencanaan produksi padi dan kebijakan ketahanan pangan di Indonesia.

Kata kunci: produksi padi, luas panen, data panel, PVAR-GMM, LSTM, *hybrid forecasting*.