MARKET RISK ESTIMATION USING GARCH MODELS, AI AND HYBRID METAMODELS: EVIDENCE FROM 30 FINANCIAL ASSETS

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Abstract
This article assesses the out-of-sample performance of classical volatility-based econometric models, modern AI models and meta-hybrid models in estimating financial risk for 30 international financial assets. Using daily returns computed from Yahoo Finance price data over the 2001–2024 period, we generated one-step-ahead forecasts of Value at Risk (VaR) and Expected Shortfall (ES). VaR accuracy was evaluated through unconditional and conditional coverage tests (Kupiec and Christoffersen), while ES was assessed using a complementary tail-oriented diagnostic. The empirical analysis includes models from the GARCH family (GARCH, EGARCH, GJR-GARCH and APARCH), AI-based models (GRU, TCN, Quantile Random Forest and Quantile Boosting), and four metamodelling frameworks that combine forecasts from different approaches and, in some cases, include exogenous information such as the VIX. The results show that no single model is uniformly superior across all assets. However, metamodelling, especially Meta 1 and Meta 2, provides the most stable overall performance across assets and the most consistent VaR-ES calibration. AI models can be competitive for some assets, but their performance is more heterogeneous, and some specifications tend to underestimate tail risk in the absence of additional calibration mechanisms. Overall, the findings suggest that metamodelling improves the robustness of financial risk estimation by reducing the limitations associated with relying on a single model and by increasing consistency across assets and market conditions.

Keywords
GARCH, artificial intelligence, market risk; value at risk; expected shortfall, backtesting, hybrid modelling.

JEL Classification
G11; G15; G17

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