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VOLATILITY MODEL WITH A CLASS OF INVERTED EXPONENTIATED ERROR INNOVATION DISTRIBUTIONS

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ABSTRACT

Error innovation distributions have been found to be very useful in volatility modeling. However, the complexity of data generation processes has led to financial data violation of some significant model assumptions for the error term, such as normality, extreme skewness and kurtosis which has led to different levels of complexity in existing Heteroscedasticity models. To this end, several error innovation distributions have been proposed for estimating volatility modelsby introducing new classes of inverted exponentiated probability distributions. These distributions were validated as proper density functions and some of their properties including moments, moment generating functions, characteristic functions, quantile functions, order statistics, and entropy measures were derived. Monte Carlo simulations were employed to assess the stability of these distributions, using varying parameter values and sample sizes. The performance of the maximum likelihood estimates (MLE) was evaluated through root Mean Square Error (RMSE), and the results demonstrated that the new distributions were stable, with estimates approaching true parameter values as sample sizes increased. The study further converted the distributions to error innovations using Jacobian transformation and therefore applied it to four GARCH-type volatility models: GARCH (1,1), APARCH (1,1), EGARCH (1,1), and TGARCH (1,1). Monte Carlo simulations revealed that the proposed error innovations enhanced the performance of the models and that the EGARCH (1, 1) model consistently yielded the smallest RMSE across all sample sizes. In addition, exponentiated error innovations including the Exponentiated Skewed Student-t, Exponentiated Generalized Skew Student-t, and Exponentiated Kumaraswamy Generalized Skew Student-t distributions were compared to the new distributions using Akaike Information Criteria (AIC) and RMSE, and risk metrics such as Value at Risk (VaR) and Expected Shortfall (ES). The ARCH Effect statistic showed evidence of heteroscedasticity in the returns. The empirical analysis using the models was conducted using daily returns from the Nigerian Stock Exchange All Share Index (ASI). Results indicated that the EGARCH (1,1) model with the inverted exponentiated generalized skew student t (IEGSSt) innovation had the best model fit and forecasting performance, with the lowest AIC value of -92.10193. The results of the Value-at-Risk (VaR) and Expected Shortfall (ES) also revealed that the inverted error innovations yielded the best models with values VaR=-8.302786 and ES=-26.441495 for IESSt innovation showing the least risks associated with the asset investment. This study, therefore, recommends the adoption of this new class of inverted error for parameter estimation in ARCH models and in risk analysis and management.

Keywords Volatility · Inverted Exponentiated · Error Innovation · Distribution

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