ABSTRACT

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The main goal of this thesis was to investigate how deep neural network models perform in financial time series forecasting. In particular, it focuses on combining deep learning and econometric methodologies. In this regard, the theoretical foundations of ARMA-GARCH econometric models, deep recurrent LSTM networks and convolutional networks were discussed in detail.

The thesis proposes innovative solutions in the form of ARMA-GARCH-LSTM hybrid volatility point forecast models, as well as models that enable forecasting the parameters of the probability distribution of future asset returns, using deep learning networks.

The empirical research presented in the dissertation was carried out on three levels. First, neural network models using MLP, LSTM and CNN network architectures were examined in the context of point forecasting of returns. The results obtained by these models were assessed with the use of point forecast assessment measures (such as MSE, MAE, MADL) and by examining the effectiveness of investment strategies, built on the basis of these forecasts. The second group of models was used to obtain point volatility forecasts. In this regard, the ARMA-GARCH class models (using the GARCH, EGARCH, GJR-GARCH and APARCH specifications with given types of conditional distribution in the form of a normal distribution, student's t-distribution and student's t-distribution) as well as proposed ARMA-GARCH-LSTM hybrid models were tested. These models were assessed with the most frequently used measures (MSE, IEA, HMSE) and in the context of financial risk estimation, by using measures of Value-at-Risk and Expected Shortfall. As the third group of models, the proposed deep network probabilistic forecasting models were examined. Results obtained by these models were evaluated using the criteria for assessing the accuracy of probabilistic forecasts (LPS, CRPS, PIT) as well as in the context of financial risk estimation. The model specifications from each of these groups were then subjected to a detailed comparative analysis. The benefits and limitations related to the use of deep learning methods in forecasting of financial time series as well as directions of further research development in this area were also indicated.