STATEMENT

On dissertation work
„ Modeling Economic Uncertainty: Methods, Evaluation, and Applications of Probabilistic Forecasting ”
Submitted by Mihail Veselinov Yanchev
for obtaining a scientific-educational degree "Doctor" in professional field 3.8 Economics
by Jury member Prof. Dr, Georgi Chobanov

1. General presentation of the dissertation work

In this dissertation, a novel artificial neural network architecture is proposed for the purposes of probabilistic forecasting of time series, which is based on the estimation of conditional quantiles and outputs predictive densities. It is inspired by a two-step procedure used in a seminal paper by Adrian et al. (2019), but implements conditional quantile estimation within a neural network architecture, employs simultaneous estimation of quantiles similarly to Rodrigues and Pereira (2020), and outputs predictive densities in a single inference step. The motivation behind this proposition is to address two issues. First, it is practically convenient to have the two steps in the procedure described above contained in a single model. The simultaneous estimation of an arbitrary number of conditional quantiles eliminates the necessity to estimate a separate quantile regression for each quantile level. As discussed below, this addresses the notorious quantile crossing problem. On the other hand, it is convenient to estimate the predictive density in a single inference step instead of two separate steps. Secondly, compared to other probabilistic models which estimate the parameters of a predictive distribution directly, one could argue this approach is more explainable and transparent. Any change in the variance or shape parameters could be related to the observed behavior of the quantiles. Also, any change in the quantiles could be explained by their relationship to the chosen predictors.

The current study demonstrates that a parsimonious model using country-specific sentiment indicators as well as country-specific and global financial variables can successfully nowcast recessions caused by unexpected shocks like the coronavirus pandemic. The comparative performance of the artificial neural network DQPR model proves that it is a useful tool in modeling macroeconomic risks related to the 2020 coronavirus pandemic lockdown in four small open economies in Europe. Its ability to model highly non-linear relationships makes it superior to a set of linear benchmarks in this case.

The current study is focused on day-ahead probabilistic forecasting of the intraday natural gas prices on the Balkan Gas Hub (BGH), with the aim of modeling and predicting risk, and proposes the use of a deep quantile-based probabilistic regression model to achieve this goal. This neural network architecture was previously used for nowcasting the economic crisis caused by the global pandemic lockdown across several countries in Eastern Europe (Yanchev, 2022) and was adapted to the forecasting task at hand. The study uses a historical sample of daily prices starting from the launch of the BGH in 2020 until December 2022. Additional explanatory variables have been used like the TTF 1-month futures, the URALS crude oil spot prices, the European Emissions Allowance (EUA) prices, as well as data on Gazprom import volumes through several pipelines. The proposed model out-of-sample performance is tested against two statistical benchmarks.

2. Contributions

The contributions of the dissertation are:

1. A novel method to improve economic forecasts is proposed, that leverages a neural network architecture for probabilistic time-series forecasting, termed deep quantile-based probabilistic regression (DQPR).
2. The proposed DQPR model outperformed a set of benchmarks when applied to nowcasting the pandemic-related recessions in the four Eastern European countries, which is novel in both scope and results for the economics literature.
3. The proposed DQPR model outperformed both statistical and deep learning benchmarks when applied to forecasting natural gas prices on the Balkan Gas Hub during a period of extreme volatility, which is novel in both scope and results for the economics literature.
4. A Bayesian version of the DQPR model is developed and applied in constructing an inflation fan chart for Bulgaria, as well as quantifying and disentangling aleatoric and epistemic uncertainty.
5. The LIME algorithm for interpretable machine learning is applied to the DQPR model in order to perform sensitivity analysis and gain insights into global and local model explainability.

3. Significance of the contributions for science and practice

The doctorand demonstrates skills for making research, formulating thesis, and proving them using methodologies and achieving significant theoretical results which could be practically applied in Bulgaria.

4. Critical remarks and recommendations.

Some critical remarks and recommendations can be made but they cannot reduce the significance of the results achieved. These remarks have been discussed with Mihail Yanchev.

CONCLUSION

The submitted doctoral dissertation has enough scientific and practical contributions which allow me to propose Mihail Veselinov Yanchev to be awarded with scientific degree Doctor in professional field 3.8 Economics.

Georgi Chobanov

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15.06.2023 Jury member: Prof. Dr, Georgi Chobanov