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## ASSESSMENT

by Assoc. Prof. Deyan Radev, PhD  
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**Subject:** Doctoral Thesis for the Award of the Doctoral Degree in Professional Field 3.8. Economics (Economics and Industry Management)

**Topic:** „Modeling Economic Uncertainty: Methods, Evaluation, and Applications of Probabilistic Forecasting“

**Author:** Mihail Veselinov Yanchev

**Supervisor:** Prof. Dr. Sc. Anton Gerunov, Department of Economics and Industry Management, Sofia University „St. Kliment Ohridski“

**Basis for the assessment:** Order RD 38-454/19.07.2023 of the Rector of Sofia University „St. Kliment Ohridski,“ Prof. DSc. Anastas Gerdzhikov

### Information about the Author

Mihail Veselinov Yanchev graduated from Second English Language School in 2006 with a focus on English and mathematics. Between 2006 and 2010, he pursued a Bachelor's degree in Economics at Adelphi University in New York. From September 2010 to December 2011, he pursued a Master's degree in Economics with a focus on economic theories, mathematics, statistics, and econometrics at Fordham University. Between 2012 and 2015, he worked as a macroeconomist at the Bulgarian National Bank, after which he held expert and managerial positions in the private sector related to credit risk modeling, quantitative analysis, automation, and other data science applications.

In 2020, he enrolled as a doctoral student in the Department of Industry Economics and Management at the Faculty of Economics and Business Administration at Sofia University. The doctoral student successfully passed all exams within the doctoral program and was prematurely dismissed with the right to defend the dissertation in 2023.

The total amount of points earned from the doctoral program, the assessment of the doctoral candidate's research results, and the publications cover the required number according to the internal regulations of Sofia University and the Faculty of Economics and Business Administration.

### **General Characteristics of the Dissertation and Evaluation of the Obtained Results**

The presented dissertation comprises an introduction, three chapters, a conclusion, and a list of used literature, with a volume of 151 pages. To visualize the content, 33 figures and 18 tables have been used. More than 360 references have been cited, many of which were published in the last ten years.

The introduction discusses the relevance of the topic, the object and subject, the goals and objectives of the research, the research thesis and hypotheses, the methodology, and the limitations of the study. The researched problem is highly relevant both scientifically and in scientific-application terms. The object and subject of the research are clearly and correctly formulated. The chosen research methodology fully corresponds to the set goals and objectives.

The first chapter contains the theoretical framework of the dissertation. The first part of the chapter defines the concepts of risk and uncertainty. The difference between risk and uncertainty is discussed, as well as the historical chronology of the literature on types of uncertainty – from Keynes's uncertainty to Knight's uncertainty. Aleatoric and epistemic uncertainty are defined, and the difference between them is discussed. The part concludes with a definition and classification of uncertainty in the context of economic forecasting. The second part of the first chapter describes the chronology of the development of economic thought related to economic modelling and forecasting the density of the statistical distribution of economic indicators. The author demonstrates an excellent knowledge of various scientific and empirical approaches to the researched issues. The in-depth literature review allows the author to make important conclusions about the essence of statistical models and to propose fields for scientific and practical contributions.

The second chapter introduces probabilistic forecasting based on neural networks. The chapter includes motivation for using neural networks in the context of the researched problem, a description of generating forecasts for the probability distribution based on neural networks, and ways to quantitatively measure epistemic uncertainty using neural networks. An intuitive conceptual framework for distinguishing between aleatoric and epistemic uncertainty is explained, and several measures of the quality of statistical modelling are introduced.

The third chapter presents the results of the empirical application of the neural network models developed by the author. Three cases are examined: 1) Real-time nowcasting of the recession during the COVID-19 pandemic in 2020 for several small open economies; 2) Probabilistic forecasting of natural gas prices passing through the Balkan Gas Hub; 3) Measurement of aleatoric and epistemic uncertainty in forecasting the consumer price index in Bulgaria. Each case includes motivation for the problem under consideration, a description of the data used, presentation of the results of applying the developed neural network model, and a discussion of the results.

The dissertation ends with a conclusion that includes a brief description of the results of the empirical analysis, enumeration of the scientific contributions, an analysis of the originality of the research, as well as the practical limitations of the methodology. The chapter ends with an overview of fields for future scientific research based on the methods developed in the dissertation.

## **Evaluation of the Scientific and Scientific-Applied Contributions**

The dissertation contains substantial contributions to the research field. Based on the obtained results, the author has identified three groups of contributions: 1) Scientific; 2) Scientific-Applied; and 3) Methodological. Among the scientific contributions is the development of a new method for economic forecasting based on neural networks (Deep Quantile-Based Probabilistic Regression, DQPR). The scientific-applied results indicate that the new method performs better than a set of traditional methods used in the literature for forecasting economic processes. Methodological contributions include further development of a version of the new method using Bayesian theory and the development of workflows and metrics for interpreting the results of the new method's applications. I accept all contributions as formulated by the author.

## **Publications Related to the Dissertation**

In connection with the public defense procedure, the doctoral candidate has presented two publications in English, one of which is indexed in Scopus. The publications analyze the issues developed in the dissertation.

## **Assessment of the Abstract**

The abstract for the doctoral dissertation meets the requirements.

## **Notes and Recommendations**

1. The dissertation is written in excellent English.
2. It is efficiently written and very well structured.
3. It shows expertise in writing policy documents.
4. The dissertation work can serve as a basis for the development of educational content that will contribute to the understanding of theoretical and empirical approaches, as well as the current state in the researched field, by students in specialized master's programs in the country.

## **Conclusion**

I positively assess the presented doctoral dissertation. The achieved results and publications demonstrate the author's preparations and skills to conduct independent scientific research of very high quality. The dissertation work complies with the requirements for obtaining an educational and scientific degree of "Doctor" in accordance with the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Regulation for its application, and the Regulation on the conditions and procedures for obtaining scientific degrees and assuming academic positions at Sofia University "St. Kliment Ohridski". **I recommend to the esteemed members of the examination committee to grant the educational and scientific degree of „Doctor“ in the professional field 3.8. Economics**

**(Industrial Economics and Management - Industry) to the doctoral candidate Mikhail Veselinov Yanchev.**

Signature: 

/ Assoc. Prof. Deyan Radev, PhD /

29.09.2023г.