REVIEW

by Prof. Dr. Radoslav Yoshinov

on a dissertation for obtaining an educational and scientific degree "Doctor"
with author mag. Krassimira Doneva Stoyanova-Chokovaon the topic
"**Models and Methods for Optimizing and Managing Portfolio using Time Series**"
under the scientific guidance of Assoc. Prof. Vassil Guliashki, PhD
in a professional direction
4.6 "Informatics and Computer Science"
scientific specialty: 01.01.12 "Informatics"

1. Actuality of the PhD thesis.

The study of economic systems, such as stock exchanges, banks, insurance and investment companies, is important both for the participants in these systems and for the state from the point of view of the functioning of the financial system. In each of these systems, the person as a decision-maker influences the dynamics of changes in the parameters of the system, but it is for banks, stock exchanges, etc. This influence is a significant, determining reaction of the decision-making system, and, above all , the behavior of themselves is largely determined by the behavior of the participants themselves, by their individual and collective actions. In the classical theory of finance the mathematical model of the representative agent is accepted, being rational and making a decision by maximizing its usefulness, while in all models a strategy for optimal investment is sought, applying the theory of building and managing portfolios.

The design and construction of a portfolio for several periods, as part of the tasks of portfolio management, goes through a number of successive stages. Mathematical modeling in the financial field is one of these stages, which is of great scientific and practical interest in the constitution and management of portfolios. The importance and relevance of the dissertation is immediately apparent, the aim of which is to propose models and methods / algorithms for portfolio optimization using time series in the financial field, to research, develop and build a multicriteria model with a hybrid algorithm for solving portfolio formation tasks for several periods.

2. Degree of knowledge of the state of the problem and general characteristics of the work

In the dissertation an in-depth review analysis of the achievements in the field of mathematical modeling in the financial field and more precisely, development

and construction of multi-criteria models and algorithms for solving portfolio formation tasks for several periods is performed.

Modern tools for portfolio optimization and management are considered, and hybrid algorithms for selection of the assets forming the portfolio are proposed to them.

The bibliography of the dissertation cites 253 literary sources: books, scientific articles and Internet publications. The methods, algorithms and means for solving portfolio formation tasks for several periods are analyzed in detail. Based on the review analysis, the doctoral student formulates the goal and tasks of the dissertation.

General characteristics of the dissertation include - introduction, 3 chapters, conclusion, contributions, list of publications, declaration of originality and bibliography.

Chapter one analyzes the existing mathematical models of the decision maker and presents their advantages and disadvantages. The need for new, intelligent, efficient and at the same time sufficiently accurate methods and techniques, such as evolutionary algorithms, is justified.

Chapter two presents a two-criteria optimization model for forming a portfolio of different assets. A hybrid algorithm for selecting the assets forming the portfolio is applied, based on the combination of the Firefly method and the Pattern search method. A methodology for portfolio formation based on the selected optimization model and hybrid algorithm is presented.

Chapter three describes the results of the tests performed for formulated two models with three and six assets each. It is proved on the basis of the obtained numerical results that the proposed two-criteria model and a new hybrid algorithm are applicable and effective in solving portfolio formation problems for several periods.

CONCLUSION; REFERENCE ON THE CONTRIBUTIONS IN THE DISSERTATION WORK; PUBLICATIONS ON THE DISSERTATION OF WORK; BIBLIOGRAPHY; DECLARATION OF ORIGINALITY; APPENDICES.

The dissertation volume consists of:

Total number of pages - 130; total number of figures 17 and 22 tables; number of applications - 3; number of publications of the author on the topic of the dissertation - 7, number of literary sources - 253.

The above proves that the doctoral student has in-depth knowledge in the subject of the research.

3. Correspondence of the proposed research methodology and the set goals and objectives of the dissertation

The subject of the dissertation is the development of methods and models for improving the efficiency of financial systems.

The object of the research is portfolio optimization and management.

The aim of the dissertation is to propose models and methods / algorithms for portfolio optimization using time series in the financial field. The doctoral student has formulated six tasks, through the solution of which to achieve the set goal, namely:

To review the existing evolutionary single-criteria and multi-criteria algorithms for portfolio optimization; To propose a portfolio optimization model that guarantees certain portfolio properties; To propose an approach / methodology for portfolio optimization using time series; To propose an algorithm for optimization and portfolio management with given criterion, which is sufficiently accurate and fast; To conduct numerical experiments to test the performance of the proposed models and algorithms; To develop a toolkit of MATLAB program modules, allowing the realization of the above tasks.

The development has interesting summaries and guidelines for future development.

The chosen methods correspond to the main goal and tasks set for solving by the doctoral student.

4. **Characteristics of the nature and assessment of the authenticity of the material on which the contributions of the dissertation are built**

   The models that are created and used correspond to the target task. For some, empirical numerical results have been obtained, and for others, solutions have been presented and guidelines for future research have been provided.

   I have not noticed any errors in either the concrete or the conceptual models. I also find that the proposed strategies are well-founded.

5. **Contributions to the dissertation**

In the dissertation the doctoral student claims for the following five contributions: (the reviewer categorizes them as scientific-applied and applied)

1. A model for portfolio optimization for several periods has been formulated, which is a modification of the Mean Variation (MV) model of Harry Markovic.

2. A generalized methodology for portfolio formation is proposed.

3. A hybrid evolutionary algorithm based on the Young method and the Pattern search method of Hooke and Jeeves was formulated. The advantage of the proposed algorithm is the accuracy in the calculation of the optimal solution and the relatively short time for solving the optimization problems. The polynomial computational complexity of the Hybrid Evolution Algorithm allows it to be used successfully to solve large-scale optimization problems.

4. Based on the proposed optimization model, the corresponding tasks are formulated, which are solved by the proposed Hybrid Algorithm and by the

standard fmincon solver by Matlab (Interior point). The obtained results confirm the operability of the Hybrid Algorithm.

5. Software modules have been developed, implementing the proposed Hybrid algorithm for solving the task of portfolio optimization while minimizing the risk, with an expected degree of diversity and a given degree of return.

The reviewer accepts the scientific and applied contributions (1,2,3) of the doctoral student.

The reviewer does not accept contribution 4. - so verbalized.

The reviewer accepts contribution 4, as - The operability of the Hybrid algorithm is confirmed, based on empirical solutions of the set tasks.

The reviewer accepts all applied contributions (5) of the doctoral student.

The reviewer accepts the contributions described in this way, recommending that the doctoral student learn to present his / her achievements more accurately.

6. Degree of PhD student's personal participation in the contributions

The personal participation of the doctoral student is judged by the publication activity of the doctoral student reflected in the materials published on the dissertation. The doctoral student convincingly presents the achieved results, with very good and thorough argumentation, as well as uses professional graphic design of the materials.

The nature of the research presupposes very good and wide preparation in the field of optimization and portfolio management.

I believe that the doctoral student has succeeded, without questioning his personal participation in the development of the dissertation material.

7. Evaluation of the publications on the dissertation

Sevan publications have been made on the topic of the dissertation - one independently and six in co-authorship with the supervisor. All seven articles are in English. They have been published at international indexed scientific conferences and journals. One of them is part of a collective monograph. An article published in an international journal has an impact factor.

The publications reflect the more significant results achieved in the dissertation. They have been reported at sufficiently reputable scientific forums, which I consider to be an approbation in the scientific circles.

8. Conformity of the abstract with the requirements for its preparation and adequacy of reflection of the main positions and contributions of the dissertation

The presented project for an abstract is in accordance with the rules for preparation of the abstracts for the dissertations, indicated on the website of IICT-BAS. Reflects the results achieved as well as the contributions of the author. It is

graphically very well designed and includes the necessary information describing in summary the dissertation.

9. Opinions, recommendations and remarks

In the dissertation work a very complex, dynamically developing and perspective area is developed. This implies sufficient in-depth knowledge, the ability to interpret and formulate strategies for effective development of the field. The content and graphics of the material are very well developed. The doctoral student's publications are in renowned international scientific forums.

I recommend more accurate verbalization by the doctoral student of his achievements - to learn more clearly and accurately to present their contributions.

10.CONCLUSION

The content and contributions of the dissertation of Mag. Krassimira Doneva Stoyanova-Chokova fully meets the requirements of the Law on the Development of the Academic Staff of the Republic of Bulgaria, the Regulations for its implementation and the Regulations on the terms and conditions for obtaining scientific degrees in IICT. Significant research work has been carried out in terms of volume and content. There are a sufficient number of scientific and applied contributions. A sufficient number of publications on the dissertation published at prestigious scientific forums are presented. The educational doctoral minimum set in the individual plan is covered. The personal participation of the doctoral student in the development and the received contributions is indisputable. This gives me reason to strongly recommend to the Honorable Scientific Jury to award a Mag. Krassimira Doneva Stoyanova-Chokova educational and scientific degree "Doctor" in Professional direction "Informatics and Computer Science" in scientific specialty: 01.01.12 "Informatics"

Reviewer:

/ Prof. Dr. Radoslav Yoshinov /

Sofia, 17.06. 2020