

# REVIEW

on a dissertation for obtaining the scientific and educational degree "DOCTOR"

Prepared by:	Assoc. Prof. Ralitsa Simeonova-Ganeva, PhD, Department of <i>Statistics and Econometrics</i> , Faculty of Economics and Business Administration, Sofia University St. Kliment Ohridski
PhD student:	Boyko Moisov Amarov
Professional field:	3.8. Economics
Doctoral Program	<i>Data Science</i>
Department	<i>Statistics and Econometrics</i> , Faculty of Economics and Business Administration, Sofia University St. Kliment Ohridski
Scientific Director:	Prof. Ivan Ivanov, DSc

**Boyko Moisov Amarov** has many years of experience as a consultant and lecturer in the field of socio-economic research, processing and analysis of big data, and applied statistical modeling in Germany and Bulgaria. His research work as a PhD student at the Department of *Statistics and Econometrics* is on an interesting and significant topic in the field of *the economics of the public sector and the use of e-services provided by public institutions and public choice, elections and machine voting*.

## I. Description of the dissertation text

The presented dissertation is titled "**Applications of algorithms for data analysis**" and has a volume of 149 pages (without counting the title pages). The text is structured in eight distinct parts (introduction, six chapters and conclusion), annexes and bibliography. The list of references covers 174 titles, mostly in English.

The empirical analysis is based on two datasets. The first contains the results of a sociological survey among Internet users in Bulgaria conducted in 2021. The second array is derived from the available open access information published by the Central Election Commission and concerns the parliamentary elections in Bulgaria in April, July and November 2021, the European Parliament elections and the local elections in 2019. The list of indicators/variables used is comprehensive and reflects the studied issues, and the statistical modelling methods and approaches applied correspond to those established in modern practice.

The presented formal long summary (the so-called *Dissertation Autoreferat*) is prepared correctly according to the established standards and objectively and comprehensively presents the research work of the doctoral student.

### ***Relevance, significance, scope and content of the dissertation***

The world today is in the era of the information society, which has long been no longer just a subject of theoretical discussions, but a field of active investment in different sectors. The introduction of information and communication technologies (ICTs) in the daily life of citizens and public administration is a natural next stage of development of the modern democratic framework for the governance of the state.

In the UN report on the state of e-government "E-Government Survey 2022", Bulgaria ranks 52nd out of 193 places in the ranking of the level of development of e-government, with all other European countries except Romania and Belarus having significantly better positions. According to data of the European Commission for 2022, Bulgaria lags behind in government e-services, despite the relatively well-developed Internet infrastructure. Among the main obstacles to the wider adoption of government e-services are the attitudes and skills related to the use of ICT. Therefore, the development of e-government (as well as that of e-business, e-work, etc.) requires the development of strategies that are based on better knowledge of Internet users.

At the same time, the generation and maintenance of big data and the increasing penetration of statistical analysis in the application of ICT are key to better

governance in both business and the public sector. Nevertheless, the application of statistical algorithms on public datasets in Bulgaria is still limited.

Therefore, the choice of methodology, statistical methods and tools and research issues by the doctoral student is appropriate – especially in the case of Bulgaria. The thesis is topical and significant not only for specialized literature, but also for all areas of social sciences, government and business.

### ***Formulated objective, research question and hypotheses***

The main objectives formulated by the doctoral student are twofold:

*"The first objective of the dissertation is to explore the characteristics of consumers and non-users of electronic government services in Bulgaria. The second objective of the dissertation is to investigate the use of electronic machines in elections in Bulgaria, as well as the effect of their introduction on voter turnout and shares of non-counted votes."*

Firstly, the study focuses on the associations between socio-economic characteristics, the level of ICT skills and the propensity of Internet users in Bulgaria to use government e-services. Secondly, the dissertation work includes an analysis of the relationship between socio-economic, demographic, institutional and political characteristics of municipalities, settlements and polling stations and the forms of non-participation in elections (as defined by the doctoral student).

The research tasks that are formulated and performed by the doctoral student within the dissertation research are as follows:

- 1) Modeling of associations between socio-economic characteristics, ICT skills and the propensity of Internet users in Bulgaria to use e-government services in three areas: administration, education and healthcare.*
- 2) Modeling of associations between the probabilities of non-participation in the local elections in 2019 and socio-economic characteristics at the municipality and settlement level, as well as institutional and political characteristics at the municipality/polling station level.*

- 3) *Study of the effect of the presence of an electronic machine in the section of the European Parliament elections on the shares of non-counted votes, as well as a study of the change of the shares of non-counted votes in the European Parliament elections in 2019 and in the parliamentary elections in April 2021.*
- 4) *Study differences in the propensity to vote by machine according to socio-economic and political characteristics of settlements and municipalities, as well as political preferences at the level of the polling station*
- 5) *Study of the change in voter turnout in the parliamentary elections in Bulgaria in July and November 2021 compared to the share of voluntary machine voting in the April 2021 elections.*

## **II. Critical remarks and recommendations**

Indisputable positive aspects of the presented doctoral study are:

- ✓ The chosen topic is topical and of great importance for good governance, improving the access to government *e-services* of Bulgarian citizens and formulating policies regarding the technology of the electoral process and stimulating voter turnout.
- ✓ The data used and the analytical toolkit selected meet established standards and practices.
- ✓ Original research contributions are available.

Despite these merits of the dissertation research, there are also some weaknesses that could be eliminated in the future research work of the doctoral student on the topic.

### ***On the methodological framework of the study and the literature review***

The PhD student defines clearly and correctly the objectives, subject and object of study in the introductory part of the dissertation.

In some places in the text of the dissertation are found formulations of working hypotheses that demonstrate the good awareness of the doctoral student on the studied issues. The lack of clearly defined research hypotheses as a result of the literature review in the introductory part of the thesis is a known drawback that makes it difficult to follow the conclusions of the empirical analysis.

The research questions and methodological framework are placed in the context of short-term interaction, since the temporal coverage of the data underlying the study allows solely and only such an assessment. At the same time, the doctoral student does not dwell on this aspect in formulating the limitations of the study. In practice, the long-term impact of the considered factors determines the development of the analyzed processes, but analyzing it requires the accumulation of history and information over a much longer period. It is likely that such datasets do not yet exist, but still a brief discussion in this direction would greatly improve the rationale of the approaches applied.

The presented literature review is integrated into the different distinct parts of the thesis. It is thorough, well systematized and covers key studies on the tools used and the studied issues.

The literature review includes mainly English-language studies and to a very small extent it covers studies for Bulgaria, although there are many explorations devoted to relevant problems (not necessarily in the field of economics, but in the field of sociology, political science, public administration, etc.). A complementarity of the literature review would highlight the importance of the dissertation for the Bulgarian context. Also, such a complementarity would outline the main limitations of the analysis and would bring to the fore the results achieved by the PhD student and their relationship with long-term strategic decisions regarding the studied issues.

#### *On the application of research tools and empirical analysis*

The PhD student describes in detail the data used, variables and sources of information. The research methods used are appropriate and well established in practice in such studies, focusing on the application of generalized Bayesian

regression models with varying coefficients at regional level. The working concepts are well deduced, and the main limitations of the study are clearly formulated.

Relevant individual data on the one hand were used, and many interesting and significant publicly available data from the Central Elections Committee at the level of polling stations, settlements, municipalities (which at this time, as far as I know, have been used to a very small extent). The dissertation contains 30 figures and 30 tables.

In the first chapter of the dissertation, the Bayesian approach to statistical modelling is presented, which is the basis of the entire empirical analysis.

The second chapter is devoted to the study of the factors determining the consumption of e-government services among Internet users in Bulgaria.

The third chapter presents the main theoretical approaches explaining the variation of turnout and non-counted votes. Empirical results on the variation of the percentage of non-counted ballots in the local elections in Bulgaria in 2019 are also included here.

The fourth chapter examines the effect of the introduction of electronic voting machines on the shares of non-voters, those who voted with an invalid ballot, those who voted with the option "I do not support anyone" and those who voted for a marginal party. The analysis uses data from the 2019 European Parliament elections and the April 2021 parliamentary elections.

The fifth chapter includes an analysis of the differences in the propensity to use electronic voting machines in the April 2021 elections and in the 2019 European Parliament elections, depending on the socio-economic and demographic characteristics of municipalities and settlements. In addition, the analysis examined the association between the propensity to use the machines and the availability of previous experience with machine voting at the polling station level in the April 2021 parliamentary elections.

The last, sixth chapter analyses the relationship between the decline in voter turnout in the parliamentary elections in July and November 2021 and participation

in the elections in April of the same year, including in terms of voluntary machine voting.

The dissertation paper concludes with a summary of the main results, a discussion of the limitations and applications of the analyses.

I could make the following recommendation to the PhD student regarding the structuring of the text and the easier tracking of logic and results:

- I would recommend the doctoral student to formulate research hypotheses at the beginning of the thesis.
- I would encourage the PhD student to expand the literature review with relevant publications by Bulgarian researchers dedicated to the Bulgarian context. This would help the PhD student answer the question of how his results fit into those of other Bulgarian researchers – a question that is particularly interesting for readers and which remains completely open.
- I would suggest to the PhD student to add more schemes to represent the conceptual framework of the models and put more focus on the visualization of the results obtained.

In general, the empirical analysis is made correctly and the conclusions drawn are well argued. The empirics are very interesting. What can be extended is the discussion of the results and the formulation of conclusions.

*Additional comments of a general and technical nature:*

1. The organization of the exhibition is very good, but there is no presentation of the main conclusions by chapters, which facilitates the tracking of the main ideas.
2. The PhD student could improve the formatting of the main text. For example, some of the tables are not well positioned on the pages, and some of the figures are not well readable due to the too small font size.

The notes, comments and recommendations made generally do not relate to the achieved level of quality of the research work performed and the results obtained, nor to the professional attitude of the doctoral student to the writing of the thesis. My overall impression of the doctoral thesis is very good. The PhD student demonstrates a strong research capacity with the excellent choice of current problem, the professional choice of data sources, the wide range of bibliographic survey used – both in terms of the statistical apparatus used and in terms of the studied issues. The quality of the dissertation work is indicative of a thorough knowledge of statistical methods, a very good knowledge of the issues – the analysis techniques used show professional theoretical knowledge and skills for their application when working with real data. The conclusions made confirm the ability of the doctoral student to derive practical results from complex theory.

### **III. Contributions to dissertation**

The main contributions of the dissertation by the doctoral student are correct and can generally be accepted:

- *Explores systematically the propensity to use eGovernment services in administration, education and health depending on socio-economic characteristics, level of ICT skills and experience with Internet technologies. This part of the dissertation is the first systematic study of the demand for government e-services in Bulgaria.*
- *Systematically examines the non-participation propensity of voters (non-voting, invalid voting and voting with the option "I do not support anyone") in the local elections in 2019, depending on the socio-economic and demographic characteristics municipalities and settlements. In addition, the dissertation explores non-participation bias depending on institutional and political characteristics at the municipality and polling station level. This part of the study contributes to the scientific literature in the field of invalid voting and voter turnout research.*
- *Explores the effect of having an electronic voting machine on the propensity to non-voting, invalid voting, voting with the option "I do not support anyone" and voting*



*for marginal parties in the 2019 European Parliament elections. In addition, the dissertation study examined the association between the propensity for these four forms of voting and the proportion of voters who used machine voting in the 2019 European Parliament elections and in the April 2021 parliamentary elections. This part of the dissertation contributes to research related to the introduction of electronic technologies for voting in elections and unconventional behavior of voters.*

- *Explores the propensity to use an electronic voting machine in the European Parliament elections in 2019 and the parliamentary elections in April 2021, depending on socio-economic and demographic characteristics measured at the level of the municipality and settlement. In addition, the dissertation paper explores the effect of past machine voting experience on machine voting propensity. This part of the dissertation contributes to research on the digital transformation of voting technologies.*
- *He examined the differences in voter turnout in the November and July 2021 elections compared to the one in April 2021, depending on the share of voluntary machine voting in April 2021, as well as depending on political preferences at the level of the polling station and socio-economic and demographic characteristics at the level of the municipality and settlement. The last part of the dissertation contributes to research related to voter turnout and types of voting technologies.*

#### **IV. Publications on the topic of the dissertation**

The PhD student has presented three publications on the topic of the dissertation and five participations in international scientific conferences. All presented publications are in English, two are in international journals and one is in proceedings of an international conference. The publications are in sufficiently prestigious journals and meet (both in number and content) the regulatory requirements for obtaining a PhD degree and the established academic practice at Sofia University and the Faculty of Economics.

## V. Conclusion

Taking into account the volume and professionalism of the work done, the observance of the research standards established in international and Bulgarian practice in the development of a doctoral thesis, the quality of the research, as well as the full compliance of the doctoral student's research results with the requirements of the current legislation, I propose to the members of the scientific jury to award the scientific and educational degree "doctor" to doctoral student Boyko Moisov Amarov.

*16 June 2023*

*Sofia*

*Signed:*

*Ralitsa Simeonova-Ganeva*