

## ABSTRACT

of the final report on the research work

RS-81

**Title:** Data Analysis and Decision Making in Socio-Economic and Political Systems.

**Co-heads of the project:** Head of the International Laboratory of Decision Choice and Analysis, Doctor of Science, Professor F.T. Aleskerov;  
Chief Research Fellow of the International Laboratory of Decision Choice and Analysis, PhD, Professor E. Maskin.

**Division:** the International Laboratory of Decision Choice and Analysis.

**Aims of the work:** research and development of new models of data analysis and decision making, and application of the developed models and techniques to the solution of a number of applied problems in economic, financial and political spheres.

**Methods used:** methods of multi-criteria decision making theory, individual and social choice theory, game theory, optimization methods, numerical and combinatorial methods, probability theory and mathematical statistics methods, methods of cluster analysis, network analysis methods, methods of imprecise probabilities, methods of analysis of texts, etc.

**Empirical base of the research:** data on oil and gas, fish and others resources of the Arctic region as well as forecast data on climate change in this region; data on networks (the network of administrator elections in Wikipedia, the computer network Gnutella, the network of global remittances); planned figures of admission to universities and the information dataset of popular academic disciplines; sociological data provided by VCIOM; rankings of academic journals on Management, Political Science, and Economics based on a number of bibliometric

indicators; roll-call votes of the European Parliament in 1979-2014, and of the Verkhovna Rada of Ukraine in 2007-2012; the database of forecast stock prices of Bloomberg, Thomson Reuters and RBC; subject collections of texts.

**Results:**

- two mathematical models are proposed and studied for selecting the investment strategies of small and medium-size traders; the problems of searching for optimal strategies are formulated in the form of linear programming problems, mixed mathematical programming problems and the problem of finding saddle points in a zero-sum game on convex polyhedra;
- a mathematical model is build for finding the optimal plan of the modernization of the cargo transport system by adding new cargo hubs to this system;
- a new mathematical model is suggested for finding mutually acceptable terms of the interaction between the government and the private sector to execute large-scale projects that the state is not able to fund in full;
- a game-theoretic mathematical model is developed for the analysis of economic efficiency of direct contracts between producers and suppliers of electricity on the electric power market;
- within the framework of the study of spatial interaction models an analysis is presented of the intensity of potential conflicts of interests of the countries in the Arctic region using the threshold aggregation rules; various scenarios are considered of the development of the events in the Arctic region;
- within the framework of the study of network interaction models new methods based on the use of rules of social choice theory are suggested to determine the prominence of the nodes in complex networks;
- a multistage model is elaborated of the university choice by an applicant taking into account the popularity and prestige of professions, self-assessment by students of their abilities and opportunities to be admitted to certain universities according to their unified state examination scores and the competition among the applicants;

- series of various evaluations are conducted based on the developed models and the unified state examination scores of the 2013 year graduates and indices of professions attractiveness, evaluated on the basis of semantic analysis of the text data available on the Internet and in the media;
- a method is designed of checking the potential of alternatives to be undominated in discrete multi-criteria decision-making problems. The elaborated method allows to build a variety of potentially undominated alternatives;
- within the framework of the comparative study and axiomatic descriptions of the concepts of solutions of the optimal social choice problem the conditions are obtained of belonging of the alternative to one of the minimal a) P-dominating sets, b) P-externally stable sets, c) R-externally stable sets;
- a number of properties is determined of the union of the minimal P-externally stable sets, the union of the minimal R-externally stable sets and the union of the minimal P-dominating sets;
- a comparative analysis is performed of axiomatic properties of aggregation procedures used to solve the problem of ranking of scientific journals based on the values of several bibliometric indicators; it is shown that concerning the relevant properties the best aggregation method of the underlying basic ratings is the union of the minimal P-externally stable sets;
- it is investigated which of the new two-stage choice procedures meet the existing regulatory requirements (Heritage, Concordance, Outcast, Arrow Choice Axiom, Monotonicity, Threshold Non-compensability); the computational complexity is considered of revisited two-stage choice procedures;
- coalitional manipulability is examined in the Impartial Anonymous Culture model for three alternatives and seven different rules of social choice; the least manipulable procedure is determined (the Nanson's method) as well as the most manipulable one (the approving voting procedure); these results are compared with those obtained in the previous studies (of coalitional manipulation in the Impartial Culture);

- an analysis of intergroup and intragroup consistency is studied in the European Parliament in 1979-2014 on the basis of roll-call votes in seven convocations by using Rice and Satarov consistency indices, measures of fragmentation and polarization of the society;
- an analysis of power distribution is performed in seven convocations of the European Parliament based on the roll-call votes by using the power indices taking into account the coalitional preferences of agents; the estimates of the power are obtained both at the level of the groups (European political parties and countries) and at the level of the individual MPs;
- the structure is examined of the Verkhovna Rada of Ukraine (2007-2012) through the analysis of more than a thousand roll-call votes; the consistency of fractions' positions is estimated by using different indices;
- by using the methods of the functions of trust theory the consistency (conflictness) is analyzed as well as the accuracy of investment banks forecasts of the value of Russian companies stocks;
- within the framework of the study of models and methods of knowledge extraction from the texts different models are analyzed of texts representation as well as the ways of estimation of the relevance of text strings in various models; method is considered of the estimation of the relevance of text strings based on the use of normalized annotated suffix tree.

**Area of the application of the obtained results** – stock analysis, energy and transportation systems, public-private partnerships, political conflict analysis, network data analysis, text data analysis, educational management, multi-criteria decision making, solution concepts of the optimal social choice problem, ranking of alternatives, manipulability of social choice rules, analysis of elected bodies.

All the obtained results are **new**. Both fundamental and applied results are obtained. The applied results are analytical and advisory in nature, and do not imply the implementation. The importance of the results highlighted in the report is confirmed by numerous approvals on the international scientific forums

(conferences, seminars, etc.). In addition, almost all the results presented above are published, including in peer-reviewed journals.