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Modelling and Simulation of Social-Behavioural Phenomena in Creative Societies (MSBC-2022)

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The 2nd International & European Conference "Modelling and Simulation of Social-Behavioural Phenomena in Creative Societies" (MSBC-2022) held in Vilnius, Lithuania on September 21-23, 2022.

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- Vilnius Gedmininas Technical University (Vilnius Tech)
- Lithuanian Operational Research Society (LitORS)
- EURO Working Group on Ethics and OR
- EURO Working Group on Operations Research for Development

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"Modelling and Simulation of Social-Behavioural Phenomena
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THE BOOK OF ABSTRACTS

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NETWORKS AND NARRATIVES CHARACTERIZING MULTIPLATFORM INFLUENCE
CAMPAIGNS TO STRENGTHEN SOCIO-COGNITIVE SECURITY

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With the proliferation of smart devices, mobile applications, and social network platforms, the social side effects of these technologies have become more profound, especially in social and political disintegration. Several journalistic and academic investigations have reported that modern communication platforms such as social media are strategically used to coordinate cyber influence campaigns. Several researchers have studied these campaigns and identified various tactics, techniques, and procedures used by various online deviant groups, e.g., online propagandists groups or extremist/terrorist group sympathizers. Various social media platforms utilize research findings to detect and regulate some of these campaigns, however, the techniques that are used evolve and adapt to go undetected. This is a growing problem. This session aims to have a scientific discussion among experts who study deviant activities on social media, including but not limited to, detection of deviant/disruptive behaviors on social media; misinformation detection, identification, and dissemination; case studies of misinformation; etc. This includes the following topics:

- Misinformation, disinformation, rumor, propaganda, influence campaign detection;
- Tactics and strategies used to conduct misinformation;
- disinformation, rumor, propaganda, influence campaigns;
- Deviant behaviors on social media platforms (cyber threats, cybercrime, cyber bullying, trolling, spamming, etc.);
- Coordination campaigns;
- Cyber Flash Mobs;
- Algorithmic manipulation such as exploiting recommendation bias;
- Detection/modeling of inorganic behaviors (bots, botnets, social bots, etc.) and their evolution dynamics;
- Hate Speech (toxic, polarizing, or disruptive content);
- Computational extraction of narratives used in misinformation, disinformation, rumor, propaganda, influence campaigns.

SOCIAL CODE IN CONTRADICTIONS OF THE HUMAN CIVILIZATION MODEL IN THE DIGITAL AGE: DOES SUSTAINABLE DEVELOPMENT GOALS WILL WORK?

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Interaction the Man with the World and Nature needs to reveal by human code categorization into life-meaningful, comfortable-mandatory, organism-physiological, household, business and sublime meanings. Needs dictate, and often at an unconscious level, the means of satisfying them, incl. technical and technological goal-fulfillment, mediated by computing, technology, machines, and artificial intelligence. The biological, geographical and ethnic parts of a single chain of the human code are revealed and displayed in the plurality of empirical representation by L.N. Gumilev. "Ethnos with its "accommodating" or "feeding" landscape is a unique construct in the fundamental theme of space exploration by humankind. Ethnogenesis develops in the conditions of formation and maintenance of a familiar territory occupied by an ethnic group, which is still preserved on the planet, although they are considered primarily cultural and linguistic communities. With the development of society and culture, the procedures for appropriate coding were also improved, transforming the ideas about ethnos and ethnicity. It is the life of people in specific natural conditions that determine the physiognomic specificity of an ethnos, which is objectively revealed by the social, cultural, and environmental laws of existing life. The essence of the "cosmic task" is that in the projection of space - our living environment or geographically on a specific area of the Earth, every ethnic group provides relatively harmonious maintenance of a particular space through its life activity and is different from other areas of the Earth surfaces. In the research, the author try to establish whether a humankind is a "forming center" in the Society and Nature? The author try to find an answer about the true deep purpose of humanity's stay on the plane and analyze how can we consider the results of the interaction of man and nature? How and what can be chosen as a visual model projection for the derivation of extremely general patterns? Humanity's violation of the laws of space has led it to a dead end so that the process of global environmental change in its entirety threatens to destroy the planet.

DYNAMIC APPROACH TO MODELING HIERARCHICAL CONFLICT SITUATIONS IN SMALL GROUPS

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The paper deals with a dynamic approach to modeling some social conflicts using differential equations. Social conflict is one of the most important components of such a concept as social behavior and exists in any society and in almost any part of it - a subsociety where people enter into various kinds of interactions. The presence of conflicts in society at different levels has both negative and positive aspects. The negative ones include financial, material, psychological and other losses, up to the loss of players' lives. However, there is also a certain positive moment - the conflict, like any movement in society, contributes to its development and exit from the state of stagnation.

In society, social conflicts have different levels of involvement, determined by the degree of aggression, relationships, hierarchy, and the number of players participating in the conflict. So, for example, there are domestic, family conflicts, production, interethnic, religious, territorial, financial, military, and many others.

The dynamic approach proposed by the authors finds application not in global and mass conflicts, but in the interaction of small groups of participants. This model has certain limitations, but its application in some cases allows obtaining results confirming its adequacy.

Previously, the authors used a dynamic approach to the study of paired conflicts that arise in the workforce. In this paper, a dynamic model (linear and non-linear) is used to study the boss-subordinate conflict. The results obtained allow us to formulate the conditions that the model parameters must satisfy in order to obtain either a practically undamped conflict or the exhaustion of the resources of one of the parties, leading to the end of the confrontation between the players.

The nonlinear dynamic model leads to interesting results - the independence of the solution from the initial conditions. The solution is determined only by the ratio of the model parameters. The paper analyzes marginal outcomes and their impact on conflict resolution. Conditions are formulated under which the end of the conflict means the complete disappearance of the initiative of workers.

QUANTIFICATION OF TEXTUAL RESPONSES TO OPEN-ENDED QUESTIONS IN BIG DATA PROJECTS

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The report summarises the methodological experiences in empirical social research. These were gathered in large quantitative social surveys where the maximum number of respondents in a single survey was 3,000 peoples.

In the practice of quantitative surveys, large scale studies are found where researchers still choose to ask respondents open-ended questions. Written free-text responses generate huge text data that are purely qualitative in nature. The detailed processing of such data becomes a challenge due to the extraordinary intellectual effort and enormous organizational and labour expenses involved.

The approach of combining qualitative and quantitative methods—triangulation—has unique heuristic advantages over standardized questions whose answers are immediately recorded on quantitative Likert-type scales or visual analogies. Uncovering these advantages is one of the aims of the planned report.

Much is reported in the literature on how to code the data and create categories for the aggregated responses and how to test the validity of the categories created. Once the categories are formed and their frequencies determined, it is a seemingly unproblematic transition to use traditional quantitative methods. Using concrete examples from research practice, a discussion will show that the statistical treatment of this kind of quantified material is nonetheless not trivial and raises specific questions and risks. Some of the questions raised and methodological risks remain to be fully clarified today.

Filling in categories creates a dichotomous variable – "feature present" or "feature absent". Based on the Moivre-Laplace theorem and the central limit theorem, it is reasonable to postulate the normality of such distributions, use inferential statistics, confidence interval, etc. Unfortunately, problems arise with extremely asymmetric binary distributions, where even with a very large sample the relative frequency of mentioning a category remains extremely low, on the order of 1-2% or even tenths of a percent. Such statistically undesirable and unattractive

categories can be diagnostically very informative about the psychosocial content of the study.

It is also problematic when there are several open-ended questions and respondents answer some of the stimulus questions almost universally and others inadequately. The basic problem is from which value to calculate the percentages or, in other words, the empirical probabilities. Only among those who answered a particular question, or among all who participated in the survey? The authors suggest distinguishing between the "frequency of mentioning the issue" (%) and the "empirical probability of escalation". Although the variables are interrelated, their interpretation in individual cases can convey very different messages to the researchers and the study.

LIKERT MEANS VERSUS YES PERCENTAGES? OPTIMAL REPRESENTATION OF SURVEY RESULTS AT THE LEVEL OF PSYCHOMETRIC SCALES

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Borg & Gabler (2002), who conducted research in German-speaking countries, showed in a larger metatheoretical study that there is an extremely high correlation between the Means of Likert scale and the percentage of agreement ("Yes %"). On this basis, they suggested using Yes % rather than the traditional Likert mean in survey reports. The latter is easier to interpret and does not have the same problem as the equidistance of Likert scales. It was decided, based on the data obtained from Lithuanian survey research field, to conduct the replication study in a different historical period, in a different culture and with a different latent construct. The problem of the study: if the statistical regularity found by Borg & Gabler can be replicated, then it is in a sense universal. It is then really appropriate to move more towards broader use of Yes% in survey analyses and research report writing.

This report is based on a Big Data bank that comes from a Large Scale Study. This is the data from a survey inventory for satisfaction with public services in municipalities. All data is based on the classic 5-point Likert scale. The scope of the study includes 11500 respondents, from 9 municipalities, 190 primary items and psychometric 38 subscales.

The testing of the correlation between the Means of Likert scale and the percentage of agreement (yes, %) was done at both two stages. The preliminary investigation was based on the level of analysis of a large set of primary items. The interim results for this stage have already been published (Merkys&Bubelienė, 2019). In the present study, the review was conducted exclusively at the level of additive indices (psychometric scales). The replication study showed that there is an extremely high correlation (R^2 = 0.948) between the means of the primary Likert items and Yes% of the items, which approaches the linear function.

It also turned out that the Likert-item mean correlation with the No% is slightly lower (R^2 = 0.867), which challenges the postulate of symmetry of the Likert scale. The correlation between Likert scores and the neutral category "%" – "I don't know" - is a significant step lower - R^2 = 0.334.

Further, based on the simulation of the data, it was shown that the empirical percentage distributions of extremely different types, regardless, quite often produce the same - i.e. completely undifferentiated, Likert averages. In contrast, approval percentages represent the empirical distributions or what is being measured much more flexibly than usual and traditionally so strongly preferred mean values.

The extremely high correlations between the Means of Likert scale and the percentage of agreement (yes, %), as well as the relative lack of information content of the mean values, lead to one conclusion. As follows: when preparing reports on survey studies, "Yes %" should be preferred instead of Likert means.

THE ECONOMETRIC MODELING OF THE ADAPTATION OF THE RUSSIAN ECONOMY TO THE SANCTIONS OF WESTERN COUNTRIES

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The econometric modeling of the adaptation of the Russian economy to the sanctions of Western countries is discussed. The exponential adaptation model adopted in this paper is an integral part of the production function of the Russian economy built here. At the last stage of the production function construction scheme (the post-factum forecasting stage), the production function of the Russian economy with the adaptation model used in it showed high accuracy of forecasting real GDP. This circumstance made it possible to interpret the model of adaptation of the Russian economy to the sanctions of Western countries as adequate. The impact of Western sanctions on the Russian economy is decreasing by about 25% every year. Here are the main conclusions.

1. The accuracy of ex post forecasts on production function is estimated from the training samples [1990, 2003], [1990, 2006], [1990, 2009], [1990, 2012], [1990, 2015] and [1990, 2018], a very high and, no less important, is in good agreement with the value of the mean square relative error ≈2%, calculated in the process of estimating the production function for the full sample [1990, 2019].

2. True forecast errors for the production function estimated from training samples [1990, 2003], [1990, 2006], [1990, 2009], [1990, 2012], [1990, 2018], have different signs, and it looks like the forecast for this the model is unbiased.

3. In the production function the value $\tilde{\gamma}$ = 0,0065 is an estimate of the relative contribution (in shares) of scientific and technological progress to the annual growth rate of Russia's real GDP. Consequently, all other things being equal, scientific and technological progress increases Russia's real GDP by about 0.6%-0.7% per year.

5. The values of the fictitious variable $dcst$ reflect the impact on Russia's real GDP of the default in 1998, the Global Financial Crisis in 2009 and, according to the model

$$dcst \ = \ exp\left(-0{,}3 \cdot (t - 2015)\right)$$

the adaptation of the Russian economy to Western sanctions. It can be said that every year the impact of Western sanctions on the Russian economy decreases by about 25%.

APPLYING IMPROVED FREE DISPOSAL HULL METHODOLOGY TO MANAGE EFFECTIVE SOCIAL DEVELOPMENT

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The research proposes an improved methodology for assessing the effectiveness of the social policy of regions using Free Disposal Hull method (FDH). It is a hard task to describe the results of the social policy' implementation in the format of economic efficiency. Thus, a multifactorial assessment of various social and economic parameters becomes a crucial task to achieve sustainability. To solve this problem, it is advisable to use the Data envelopment analysis (DEA) methodology. Since regions differ in size and level of development, when evaluating the effectiveness of their social policy, the authors use the Variable Returns to Scale (VRS) model, which consider differences in the compared objects' scale. However, traditional DEA models only allow to evaluate the effectiveness of Decision-Making Units (DMUs), which is not enough to manage problems in social sphere. This is because planning is also an essential task for management, which, among other things, influence the key performance indicators forecasts. There is no such functionality in traditional DEA models. The authors solved this problem by using the Free Disposal Hull (FDH) model. However, such a model assumes the description of a convex hull in the form of a rectangular grid, the vertices of which are objects with maximum efficiency (drivers). This approach does not ensure high planning quality, since in this case the planned values will be selected from a fixed set of parameter values of the compared objects. It is possible to improve planning quality using the improved model proposed by authors, where FDH is represented as a set of hypertriangles formed by objects with maximum efficiency. The research proposes a mathematical model for convex hulls, and provides an algorithm for finding the hypertriangles, including the procedure for checking whether hypertriangles belong to FDH. Formulas for determining the efficiency of compared objects concerning FDH hypertriangles are proposed for both input-oriented and output-oriented approaches. The formulas for finding the nearest point on the FDH are proposed, which makes it possible to determine such values of the parameters of the analyzed objects, upon reaching which the object would be placed on the FDH and achieve the required efficiency. This approach allows to set rational target values for the DMU indicators, which corresponds to the planning problem. The research also provides formulas for adjusting target values if the obtained values are invalid. This research implied the proposed methodology for assessing the social development of the China provinces.

MODELING OF ANXIETY SPREAD DURING THE PANDEMICS

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The study aims to develop a hybrid model of pandemic anxiety and panic dynamics, calibrated through indirect social anxiety and emotion level indicators, in order to apply it to the analysis, forecasting and management of anxiety and related panic scenarios. The developed model combines agent modeling, dynamic systems modeling with differential equations and machine learning methods. The spread of anxiety and panic associated with fear of contracting a viral disease is a characteristic feature of pandemics (Blakey & Abramovitz, 2017).

From the point of view of cognitive anxiety theory (Clark and Beck, 2010), an important part of the anxiety mechanism is the stimuli that trigger it, which become negative information that spreads in the social space. Because direct investigation of the prevalence and spread of anxiety and related panic is a complex task, coronavirus morbidity data and indirect anxiety indicator data will be used to calibrate and verify the developed model, which will be processed by machine learning algorithms. One of the possible reflections of public anxiety is the web content. The sentiment analysis will identify and extract subjective information about anxiety and emotional level from the web media content. In this way, the application of machine learning methods would help to identify additional variables and their properties in the development of a hybrid model.

COMPRAM METHODOLOGY SUPPORT
FOR COMPLEX POLICY MAKING

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In the geopolitical area of the world the governments are more and more confronted with complex societal problems. These problems have a large influence on people's view of life and their well-being.

There are climate changes, viruses and local wars waiting for an answer. For climate change the consequences are big, some areas have too much rainfall which combined with melting icecaps in the poles and mountains results in many floods, some areas have too less rainfall with results in crop failure and diminishing of species. Then there is regular more turbulent weather. All together these changes are almost too fast to control. Too late governments take action to diminish the causes of climate change by diminishing the greenhouse gases as NO_2 (Nitrogen dioxide) and of $Co2$ (carbon dioxide) in the air, however this has a huge impact on the agriculture industry and other large industries so these actors have to cooperate.

Then the world is again confronted by a virus (SARS-CoV-2) that seems to be hard to control. Meanwhile cybercrime hacks large institutes, vulnerable computer systems and financial systems. On top of this there are continue local wars in Africa and Europe and friends and enemy's change. All these issues evokes the feelings of danger and agitation of the people, often stimulated with fake news from social media, which can result in demonstrations and even in riots.

While tasks for the governments are growing bigger it seems that the power of many governments is diminishing while the power of large companies, partly responsible for the pollutions and lack of raw materials and fossil elements, and in charge of social media, is extended.

These are complex societal problems. Governments have to give answers for these problems. In order to handle this fruitfully and sustainable the government should ask the support of the Knowledge Institutes specialized in handling complex societal problems

A complex societal problem should be handled according to the guidelines of the field of Methodology of Societal Complexity. This scientific field advised to have Knowledge Institutes, advocated by the OECD in 2006, that are ready to act as soon as a complex problem arrives. Then based on the Compram methodology (DeTombe, 2015) they can start inviting experts and actors to discuss the problem and to decide,

based on their models of the problem, which changes would be the most fruitful and sustainable. With this scientific work they could advice the government in its decision. In this way decisions of the governmental are based on scientific advice and are more sustainable in a democratic may. This way the governments handle these complex societal problems more sustainable and more democratic.

RESEARCH ON PREDICTION OF HIGHLY CITED PAPERS BASED ON PCA-BPNN

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With the increase of scientific research investment, the number of papers has surged, and the evaluation of the impact of papers has received widespread attention from scholars. The cited frequency is the most convenient and widely used indicator to measure the academic influence of a paper, but the cited frequency can only measure the true influence of a paper after the academic paper is published for a period of time. Therefore, in order to identify highly cited papers at the early stage of publication, this paper collected 1025 academic papers published under the library and information discipline of webofscience in 2007, and then extracted 24 prediction features from the three aspects of papers, authors and journals. On this basis, seven principal component vectors were constructed by feature screening based on PCA, and a pca-bpnn classification prediction model for highly cited papers was constructed by combining BP neural network model, Finally, it is compared with other five models. The results show that the pca-bpnn model constructed in this paper has better prediction performance, and provides an effective model for the prediction of the paper's influence.

The contributions of this paper are as follows: (1) the scientific literature influence prediction problem is defined as a two classification problem to achieve the prediction and recognition of highly cited papers in the early stage of publication; (2) By sorting out and classifying the influencing factors related to the cited frequency, three types of influencing factors are obtained: author, journal and paper. According to the collected data distribution, the threshold value of high cited papers is determined in combination with the "28 February" law; (3) The pca-bnn prediction model for highly cited papers is constructed by using PCA for feature extraction and BP neural network, and good results are obtained. This paper can help researchers predict high impact papers at the early stage of publication, so as to provide a basis for researchers to evaluate and screen massive scientific literature in their research fields.

EFFICIENT MAXIMUM LIKELIHOOD BATCH ESTIMATION WITH PURE TIME SERIES DATA OF A ONE-DIMENSIONAL CUMULATIVE STRUCTURAL EQUATION MODEL

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Dynamic structural equation models (DSEM) are latent variable models designed for time series. Inherent to the application of DSEM is the task of model parameter estimation, which has to be addressed in many applications by data of a single subject (i.e. a single time series). In this context, however, the methods currently available often either lack estimation quality or are computationally inefficient; that is, they are based on heuristic approaches and are, therefore, usually readily computable but suboptimal in the sense that other estimators may have a greater concentration regarding the true parameter value, or they are based on conventional methods, such as maximum likelihood estimation, and are, therefore, at least asymptotically optimal but tend to require more demanding calculations. Given the era of big data, the necessity for such a trade-off may be detrimental to the future applicability of DSEM. The paper is aimed at contributing to this end by proposing a linear-time complexity maximum likelihood batch (offline) estimation with pure time series data algorithm for the relatively simple yet highly useful one-dimensional cumulative structural equation model, in which there is a latent variable that is observed through an additive noise, and the increment of which is regressed on other modelled latent variables that are measured by the factor-analytic model. The developed algorithm has been verified through a number of numerical experiments and implemented in a brand new R package called EMLI, which is available on CRAN.

EFFICIENT MARKET HYPOTHESIS, EFFICIENT COMPUTABILITY HYPOTHESIS AND MINSKY'S FINANCIAL INSTABILITY HYPOTHESIS (EMH, P=NP, FIH)

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The paper analyzes the proof of equivalence of the efficient market hypothesis and the hypothesis that efficiently verifiable solutions can be found using an efficient computational procedure (P = NP). The basis of this proof is the introduction into the financial market model and, accordingly, into the calculation model of an additional dimension associated with the behavioral characteristics of the decision-making agent. Economic models in which the market is efficient are based on the same simplifying assumptions about the agent as the assumptions that make it possible to justify the hypothesis P = NP. The history of the market is represented as a space of sets of binary sequences. The strategy can be described as attributing one of three values to the elements of the sequences (buy, sell, neutral position). If some financial market player managed (perhaps by chance) to find a winning strategy, assuming P = NP, other market participants can find it, and such a strategy cannot be a winning one. A similar reasoning is used to prove the opposite statement. It is shown that a similar methodological approach makes it possible to show the incompatibility of the hypothesis of financial instability of Minsky with the hypothesis of an efficient market. This allows us to consider the hypothesis of financial instability as an additional argument in favor of the not(P = NP) hypothesis. In the context of our analysis, the key aspect of the financial instability hypothesis is the emphasis on lending as an innovative, profit-oriented business. Banks and other financial intermediaries seek innovation both in relation to the assets they acquire and in relation to the liabilities they sell. New financial instruments (such as securitization) allow meeting the demand for money at the moment, postponing the fulfillment of obligations at a later date. Thus provoking the evolution from a hedging regime to a speculative regime, and then towards a Ponzi regime. A key element in the analysis of all three hypotheses is the ability of a person to generate solutions that go beyond the framework of the system in which he is initially immersed.

COGNITIVE SIMULATION MODEL
OF THE REGIONAL EDUCATION SYSTEM

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We built and investigated a difference hierarchical game theoretic model of the regional education system based on a cognitive map. The upper control level is presented by the federal or regional ministry of education (Principal) that allocates budget resources between the education organizations (agents). The agents form the lower control level. A number of the graduates that form the set of school-leavers in the region is taken as the state variable.

Each agent's payoff function is a difference between its revenue from budget subsidies and commercial education, and educational costs. The Principal maximizes a summary number of graduates who receive a job on the respective speciality subject to the constraints on the number of graduates prepared by the professions mostly wanted in the region (an integer programming problem).

The Principal disposes of a number of budget vacancies, while the agents determine a number of their commercial vacancies.

The solution of the game is a Stackelberg equilibrium. The best response of the agents on the Principal's strategy is a Nash equilibrium in their game in normal form. We found an approximate solution by simulation modeling on the cognitive map.

Basing on the cognitive model we forecast the number of graduates from middle and higher education organizations in the region. The model includes fourteen factors (vertices of the cognitive map), some of them become the Principal's control variables. The model is approved on the real data on the Rostov region (Russian Federation). The practical recommendations are formulated on the base of this analysis.

WILL THE "FAILURE TOLERANCE" OF EXECUTIVES AFFECT THE TOTAL FACTOR PRODUCTIVITY OF ENTERPRISES
—— ON THE ADJUSTMENT EFFECT OF BOARD STRUCTURE

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This paper selects the panel data of A-share listed enterprises in CSMAR financial database from 2007 to 2020, and uses the fixed effect model to test the impact of executive compensation stickiness with the nature of "failure tolerance" on the total factor productivity of enterprises, and focuses on the interaction mechanism and boundary conditions between the two. The research finds that executive pay stickiness can improve the total factor productivity of enterprises, and non efficiency investment plays a "masking effect" between them; In the structure of the board of directors, the relationship between the chairman and general manager and the supervision of independent directors is positively regulated, and the regulating effect of the board size is not significant; The first type of agency cost is the intermediary transmission channel between executive pay stickiness and total factor productivity, while the second type of agency cost does not play a significant intermediary role; The executive compensation contracts of "punishing the inferior" and "rewarding the inferior" will lead to the distortion of the enterprise's production efficiency. Only when the performance drops, the "not punishing the inferior" or even the low degree of "rewarding the superior" will help to improve the total factor productivity; The promotion effect of executive pay stickiness on total factor productivity of enterprises is significant when the internal financing constraint is low and the market competition is high.

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Based on the definition of nation term the methodolofy of nation indicator definition is formed from the latent factors of the nation and the exclusion of the features (statehood, language...) of the nation, as well as the attribution of the most representative components to the excluded features.The nation expression factor calculations are based on full factorial analysis. The preliminary calculations of the factorial analysis begin with the assessment of the reliability of the collected data, which includes the significance of the indicators according to Shapiro-Wilk tests, and the determination of the correlation between the indicators used in the distinct groups of indicators. The separation of the number of latent factors and the attribution of components to a particular latent factor is based on the (exploratory factor analysis) EFA approach. The optimal number of latent factors is determined using the Kaiser criterion to make sure that latent factors are excreted definitively. It is also necessary to investigate the overall variance of the phenomenon under investigation, determined by each latent factor individually and collectively as a whole. For this purpose, the transformation of the latent factor weighting matrix has been used. For EFA, oblique rotation is used due to the presence of a minimum correlation between components from individual latent factors. Regardless of the oblique rotation method used (Cluster, BentlerQ, Simplimax, Oblimin, Promax). Loads of at least two latent factors, the affinity h_2 shall be practically indidentious in individual cases. This would indicate that the structures of the latent factor weighting matrices are as simple as possible and fully comply with the Thurstone criteria. The study factorial analysis itself starts with the Chi-square test, assessing the overall adequacy of the model.calculate fit indices by assessing the relevance of the selected components to the phenomenon in question. On the other hand, the confirmatory factor analysis (CFA) itself concludes with RMSEA, RMSEA p-value and RMR The relevance of components in relation to latent factors is further determined using standardised regression factors. When calculating the weighting coefficients of the components, the determination coefficients must be calculated. The latent factors themselves are

perceived as vectors in a three-dimensional, rectangular coordinate system with numerical values equal to the square root of the sum of the squares of the components constituting the latent factor and their qualimetric factors. This conception of a latent factor is used on the basis of the statistical assumption that the use of three values is the limit at which the statistical indicators of the factorial analysis can reach their maximum values. Since latent factors are correlated with each other and have similar assessments of the subjects of the study.

A STUDY ON THE IMPACT OF MECHANISM OF "BELT AND ROAD INITIATIVE" ON THE SUSTAINABLE DEVELOPMENT OF THE CHINA PAKISTAN ECONOMIC CORRIDOR

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This paper considered The Belt and Road Initiative (BRI) as China's long-term investment and policy program, which aimed for infrastructural development and economic integration of countries along the route of the Silk Road. This paper not only makes a theoretical analysis of BRI and CPEC but also explores the reason why CPEC may succeed from the perspectives of the growth development theory and the theory of globalization. Theoretically, openness and massive capital are key factors for less developed economies to transfer into a sustainable growth state. The current study employed systematic review including 100 studies to explore the impact of the BRI and CPEC mechanism on the sustainable development of both countries with the study base period from 2010 to 2021. The China-Pakistan Economic Corridor CPEC is catalysts that will assist Pakistan's economy expand and stabilize. The relationship between collective and individual interest, the Chinese concepts of harmony and shared future and mutual benefits are key factors. The study confined that CPEC is a game-changing initiative for Pakistan since it will considerably boost the country's economic development. Furthermore, CPEC and BRI success wills also strengthen the economies of nations in South and Southwest Asia.

Sustainability science has been gradually forming and developing with the increasing popularity of the concept of sustainable development. Through social and economic institutions, cultures, nations, and regions have been continuously connected and integrated, raising both the absolute and relative living standards of human communities. Since the middle of the 19th century, migration, work ethic, opportunities, financial flows, unrestricted trade, and mechanical or technological advancement distinctly defined cultural, social, economic, and technical development and growth patterns perspectives. The main purpose of the development process is now to achieve sustainable development goals. The 2030 Agenda for Sustainable Development, which established a route for sustainable development for the ensuing 15 years, was agreed and announced at the UN Summit for Sustainable Development in 2015. The 2030 Agenda, which consists of 17 Sustainable Development Targets (SDGs) and 169 other goals that are integrated along the three pillars of sustainable development—economic, social, and environmental—is a historically ambitious, global, and all-encompassing initiative. Due to the scale and ambition of this Agenda, a revitalised Global Partnership is required to carry it out. This Partnership will operate with an attitude of universal cooperation.

PRICE DISCRIMINATION ON NETWORK PLATFORMS

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This paper investigates the price equilibrium in a two-sided platform market with external network effects between the agents of different groups.

The proposed model is a generalization of a known Armstrong monopoly model (2006) for the case of a duopoly on a two-sided market of network platforms located on a plane. Interest in two-sided market research has been growing lately as digital technologies develop and spread, and as digital platforms emerge as a new business model. The platforms in such studies are firms that act as mediators facilitating interactions between members of two or more different groups present in the market.

A key feature of two-sided markets involving platforms is that interactions between members of different groups on a platform are accompanied by network externalities, i.e., an increase in the number of members of one group on the platform causes an increase in the individual utility of members of the other group.

The model deals with agents belonging to two groups (for examples sales and buyers), who are evenly distributed on the plane of the circle. It is assumed that the agents of one group are single-homing, while the agents of the second group can be both single-homing and multi-homing. Agents in both groups choose between two platforms based on the utility they can derive from visiting the each platform. The utility function is constructed via Hotelling's specification and thus consists of the utility from network effect of interaction any one of the groups with another group and costs of accessing the platform. Transport costs depend on the distance measured in the metric Manhattan.

The payoff of each platform depends on the number of agents in both groups on the platform, the price of accessing the platform and costs of serving users. Each platform aims to maximize its winnings.

The paper discusses uniform and discriminatory pricing. In a uniform pricing platform does not have information about the type of agent or whether it is a multi-homing agent or single-homing. In discriminatory pricing, platforms set different prices for multi-homing and single-homing agents. The paper finds equilibrium strategies with uniform and discriminatory pricing on the two-sided market for symmetric platforms. Comparison of equilibrium strategies with different pricing. It also analyzes producer surplus, consumer surplus and social welfare.

ATTITUDES TO VACCINATION: HOW THE OPINION DYNAMICS AFFECT THE INFLUENZA EPIDEMIC PROCESS

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Opinion dynamics is one of the most important factors in decision-making in various fields of human activity in modern society. The individuals' decisions have significant influence not only on the formation of attitudes towards a particular problem, but also on the development of many social processes.

In this paper, a hypothesis about the influence of the opinion dynamics on the subsequent development of the epidemic process is considered. Namely, it is assumed that there is a relation between the population's attitude to vaccination and the dynamics of the influenza epidemic. To formulate the problem special attention is paid to that the opinion of the population is presented as a spectrum: from extremely negative (communities and associations of anti-vaxxers) to super-positive (doctors, scientists and other adherents of traditional medicine and the scientific approach). Along with persons who are firmly confident in their point of view and propagandize it, there are doubting agents in the population who make decisions about vaccination under the influence of others' opinions. The decisions they made have an impact on the formation of their personal immunity and, therefore, of the immunity of entire population. It is assumed that the opinion dynamics are completed before the seasonal rising incidence starts, each agent has decided to vaccinate or not until this moment. Then the epidemic rising, which is supposed to be described by modification of the classical Kermack-McKendrick model (1927), begins.

The purpose of this study is to identify the relationship between the parameters that characterize the opinions' influence in the population and the number of people who have been infected (vaccinated and unvaccinated) during an influenza epidemy.

Simulation modeling of the dynamics of opinions and the epidemic (SIR) process is carried out using a network model for graphs of various configuration (grid, strongly connected graph, weakly connected graph). Modeling is carried out in a closed population using statistical data on morbidity and annual vaccination campaigns in Russia. A series of repeated simulations was carried out, a numerical experiment based on statistical data and scenario analysis were performed.

EDUCATION FOR SUSTAINABLE DEVELOPMENT: TRENDS AND PERSPECTIVES

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The presentation will outline the importance of and relevance of sustainable development for higher education institutions, and outlines some of the steps which are being taken, to include it as part of university programmes.

CHINA'S URBAN SUSTAINABLE TRANSPORTATION POLICY UNDER THE GOAL OF "CARBON PEAKING AND CARBON NEUTRALITY"

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With the development of the world's economy and society, climate change and environmental degradation continue to expand the global influence. While maintaining stable economic development, human beings must also protect the surrounding natural environment. Therefore, many countries will "carbon neutrality" as a National Sustainable Development Strategy. China is currently the world's second largest economy and a major energy consumer. The Chinese government has put forward a sustainable development plan and a strategic goal of "carbon peaking and carbon neutrality". At present, China is in a period of rapid urbanization. China's urbanization rate exceeds 60%, and urban carbon emissions account for more than 70% of the total. Cities are not only the main space for economic development, but also the main source of carbon emissions. The pressure of population agglomeration and economic growth makes cities face many problems, which also makes people pay more attention to urban greening and low-carbon development.

Therefore, cities play an important role in the implementation of the "carbon peak, carbon neutral" strategy. Transportation serves people's lives, and at the same time accounts for a larger share of total carbon emissions. With the growth of the total population and the acceleration of urbanization, how to organize efficient urban transportation to achieve green and sustainable development of transportation is also a general condition for realizing the strategy of "carbon peaking and carbon neutrality". In order to alleviate urban traffic problems and make urban traffic achieve sustainable development, it is necessary to solve the existing traffic problems. This paper expounds the development strategies and main countermeasures of sustainable traffic implemented in some Chinese cities. The development provides a scientific basis, and will also make the city's traffic more convenient and smooth.

This research uses selected Chinese cities as examples to demonstrate the impact of sustainable transportation policies on the operation of the transportation industry and the reduction of carbon emissions. This paper analyzes the data of cities with different transportation policies and compares the statistics of each city over the past few years. On the basis of these data, we built a model that shows how a city's sustainable transport policy affects the reduction of carbon emissions, environmental

pollution, and the use of energy resources. Based on this data, we can also predict how the traffic situation will develop in these cities that have implemented sustainable transport policies in the coming years. Finally, we analyze the development prospects of such sustainable transport policies in other cities. The findings of the study can also help cities in other countries develop sustainable transport policies.

OPERATIONAL RESEARCH FOR SUSTAINABLE DEVELOPMENT IN USUAL AND CRISIS SITUATIONS OF SOCIAL SYSTEMS

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The concept of sustainable development has become one of the key concepts in the modern context. Full understanding of such a complex process is impossible without the application of operation research tools: system analysis, mathematical modeling and forecasting etc.

Concepts and models for sustainable development and transformation of large socials systems are considered. Some ways for formalization of scenarios of transformations are proposed. It is proposed the description of a new approach to mentality accounting in operational research (OR), which is based on internal representation of mental images. There are considered: 1) Sustainable development as a mathematical problem, including a formal definition of sustainable development with ethic accounting. 2) The influence of the ethical aspects of the transformation of social systems. 3) Risk assessment in scenarios for large socio-economic systems. 4) Transformation of society. 5) Anticipatory aspects of sustainable development.

But almost all forecasting methods of sustainable development are set up for situations of society in normal condition with relatively slow changes of values, which characterize the behavior of processes and systems.

In the case of crisis conditions (for example, in a war situation), the variables change very quickly. Therefore, it is necessary to make a special adaptation of the problem of sustainable development to such conditions. Here we note several areas of setting such problems for crisis conditions. They may look differently depending on the scale and aspects under consideration.

To understand the place of exact methods in the problem of sustainable development in [1] proposed a strict formalization of the concept of sustainable development. And further progress in the understanding of sustainable development lies in the implementation of this concept for specific subtasks of society interaction. Here are some of them.

1. The problem of global sustainable development in unstable conditions.
2. Sustainable development of a particular country in unstable conditions.

3. The problem of cybersecurity, which will emphasize the interaction between society and cyberthreats, such as cognitive security.
4. Particularly important for the future of sustainable development is the often-unrecognized problem of preserving knowledge, education and science in crisis conditions, and of importance for future generations.

In the report some possibilities for formalization and mathematical modeling of the offered problems are resulted. Particularly the problems of migration of researchers and students had been considered.

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EQUILIBRIUM IN THE STRATEGIC BARGAINING

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The Rubinstein's bargaining model, proposed in 1982, provided a convenient tool for solving game-theoretic problems about bidding by two persons with alternating offers on an infinite time axis. The main feature was the discounting factor d, which did not allow the game to last indefinitely, i.e. the closer d is to 0, the more impatient the players are and the faster they will agree to any offer. On the contrary, if the value d is close to 1, then the players are patient and will negotiate until they come to the most favorable offer for them. In [Baron, Ferejohn, 1989], a model of sequential multilateral negotiations with a majority rule was proposed. The game that was reviewed is a standard game "split the dollar", in which n players, whose turn is chosen randomly, make suggestions on how to divide a pie of a fixed size, and agreement requires the consent of a simple majority. It is shown that a sub-game perfect equilibrium exists in the class of stationary strategies. Then, articles [Eraslan, 2002; Cho, Duggan, 2003; Banks, Duggan, 2006; Predtetchinski, 2011; Cardona, Ponsati, 2007, 2011] were devoted to the expansion of this direction for different applied problems.

We present a game-theoretic model of competitive decision on a meeting time. There are n players who are negotiating the meeting time. The players' utilities are represented by linear unimodal functions. The maximum values of the utility functions are located at the points $i/(n-1)$, $i=0, ..., n-1$. The final decision will be done if all participants accept the proposal. Players take turns 1, then 2, then 3, ..., n. We assume that after each negotiation session, the utility functions of all players will decrease proportionally to d. We will look for a solution in the class of stationary strategies, when it is assumed that the decisions of the players will not change during the negotiation time, i.e. the player i will make the same offer at step i and at subsequent steps $n+i$, $2n+i$, etc. We use the backward induction method. To do this, assume that player n is looking for his best responce, knowing player 1's proposal, then player (n-1) is looking for his best responce, knowing player n's solution, etc. The subgame perfect equilibrium in the class of stationary strategies is found in analytical form.

DYNAMICS OF THE LONG-TERM ORIENTATION IN RUSSIAN SOCIETY OVER THE PAST 100 YEARS: RESULTS OF THE ANALYSIS OF THE RUSSIAN SUBCORPUS OF GOOGLE BOOKS NGRAM

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Methods of computational linguistics were used to study orientation towards long-term future as one of the characteristics of psychological state of society. Analysis of the dynamics of the use of nouns and verbs, which are semantic markers of long-term orientation, in Russian-language texts of the 20th-21st centuries was carried out. The analysis was performed employing the third version of the Russian subcorpus of Google Books Ngram presented in 2020. To identify the main trends in frequency of use of the corresponding phrases, the method of principal components was used. Our analysis shows that since the mid-1970s, the frequency of the nouns "planning", "plan", "forecasting" and "forecast" in combination with the adjective "long-term" has decreased. The frequency of use of verbs with the semantics of long-term planning had decreased from the mid-1970s to the mid-1990s, and then grew until 2018. Apparently, the revealed dynamics reflects the crisis of the planned economy, which led to the abandonment of long-term indicative planning. In addition, we have shown that since the 1960s, the frequency of use of verbs with the semantics of forecasting has been increasing, and the frequency of those with the semantics of hope, goal-setting and achievements has been decreasing. Positive correlation of linguistic markers of forecasting with the growth of the urban population, growth of per capita gross national income and overall life expectancy has been revealed. At the same time, the frequency of use of the verbs with the semantics of hope is negatively related to fertility and life expectancy. It has been suggested that urbanization and the growth of orientation towards individualistic values increase the need for forecasting and planning of the individual future. On the contrary, the experience of collective threats and orientation towards collectivist values increase hope and orientation towards collective goals, that is, the construction of a positive collective future that performs the functions of protecting a positive group identity. Prospects for further research in this area are outlined.

ARCTIC LOCAL COMMUNITIES AND FOREIGN LABOUR MIGRATION IN RUSSIAN ARCTIC

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Article deals with sociological survey results of two respondents types (foreign labour migrants and local community) within five Russian Arctic regions. Survey results of foreign labour migrants made it possible to create a foreign labour migrant profile in the Russian Arctic. Survey results of the local community made it possible to calculate both Conflict Index and Tolerance Index in relation to five Russian regions. It turned out that Conflict Index is still quite high at Republic of Karelia and Republic of Sakha (Yakutia). Calmer situation is in Chukotka Autonomous District and Murmanskya oblast.

The main empirical method is a sociological toolkit that makes it possible to assess the current social situation in the regions, as well as to understand what relevant political decisions should be made in the field of national and migration policies. In this case, monitoring studies are based on surveys of both foreign labour migrants who come to work in the Russian Arctic and the host population - residents.Both empirical study and its theoretical generalization revealed migrants' integration issues in the Arctic as well as what might happen when social climate fluctuates.

The questionnaire survey of local population covered 1020 respondents in 10 Arctic municipalities (eight Arctic towns - Yakutsk, Anadyr, Murmansk, Severomorsk, Petrozavodsk, Kondopoga, Salekhard and Novy Urengoy; two municipal districts - Verkhnevilyuisky and Anadyrsky). For conducting a sociological survey for the local community (1020 electronic questionnaires) – questionnaire was available at Google form. 500 paper questionnaires were received from migrants of different origins (mainly, Uzbekistan, Tajikistan, Ukraine, China, Kirgizia) of 10 Arctic municipalities.

As shown by two surveys, the results obtained turned out to be "preventive" for the Russian Arctic. From the point of view of interethnic relations, current situation in the Russian Arctic is not tense and is under control. In fact, this is a step forward towards the ongoing changes in the theory of ethnosocial and cultural-territorial Arctic communities. The results of our survey of foreign labour migrants aroused great interest in the studied regions after they were sent for consideration to regional authorities of the Arctic and the Federal Agency for Interethnic Relations of Russia.

FREE-RIDER PROBLEM: SIMULATING OF SYSTEM CONVERGENCE TO STABLE EQUILIBRIUM STATE BY MEANS OF FINITE MARKOV CHAIN MODELS

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The report suggests a new approach to classic economic problem – "the problem of free-rider". This well – known problem deals with a process of unrequited consumption of collective goods, and it can be considered as a problem of unfailing interest for economy of each frame of a society. The authors put forward and idea of spontaneous process self-regulation by means of economic instruments and give a description of possible problem solution. The approach suggested includes the control of "free-rider" activity by economic and social agents directly interacting with him. In spite of non-rivalry in consumption, the case when "free-rider" disserves the interests of his nearest surrounding, will results in increasing antagonism and suppression of "free-rider" activity spreading. A mathematical model reflecting authors view is based on Markov chains with absorbing states, created on the base of graph depicting an interaction of "free-rider" with his neighborhood. The simulation represents system convergence from arbitrary initial state to a stable final distribution for Markov chain, demonstrating an opportunity of system self-adjustment.

BEHAVIORAL MODEL OF INTERACTION BETWEEN ECONOMIC AGENTS AND THE INSTITUTIONAL ENVIRONMENT

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Human behavior and decision-making in situations of economic choice have recently been increasingly described using interdisciplinary models that synthesize the achievements of economics with the results of other sciences. In particular, an appeal to the socio-psychological characteristics of agents, traditionally studied by psychologists, makes it possible to obtain new results when solving problems in analyzing the interaction of economic agents and public institutions. This paper proposes a model of the system "mentality of economic agents - public institutions" and studies the dependence of the time it reaches an equilibrium state on the minimum labor productivity in an artificial community. At the same time, the agent's behavior is determined by the dynamic interaction of his mentality and the institutional system developed in the community. The results of the conducted experiments show that agents achieve the higher production results, the faster the system reaches equilibrium.

STRUCTURAL EQUATION MODELLING BEHIND OPERATIONALISATION IN THE SOCIAL SCIENCES AND HUMANITIES

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Operationalisation in the classic OR was not over-emphasised, since the examination of business and engineering systems involves relatively well-defined and clearly understandable technical-economic

concepts. Society creates a set of social behavioural phenomena, whose knowledge of mechanisms is essential for building a sustainable society. We aim to review the operationalisation of such phenomena as the expression of logical and verbal communication in order to develop a paradigm of rational choice for the efficient understanding of their nature and relevant decision making, thus bridging OR with social sciences and humanities. The creation of such a paradigm on

the basis of the theory of structural equation modelling (SEM), multi-agent modelling and game theory, together with data science and mathematical sociology methods, allows the development of data-driven operationalisation for evidence-based solutions.

SEM is a powerful tool for the operationalisation and understanding of complex social processes and humanities. SEM is a methodology for representing, estimating, and testing a theoretical network of (mostly) linear relations between variables (Kaplan, 2008). It can also be used as a decision-making tool, as it includes various sets of mathematical models, computer algorithms and statistical methods

to study data constructs. SEM uses a measurement model that defines latent variables related to one or more observed variables and a structural model that presents relationships between latent

variables. The relationship between observable and hidden data and structural equations is assessed by statistical methods. SEM combines regression and factorial analyses. It should be emphasised that SEM is a good tool for exploring various types of intangible capital such as intellectual, human, social and other capital (Adams and Oleksak, 2010; Sakalauskas et al., 2021). The multidimensional models of emotion recognition give another example of operationalisation in humanities (Russell, 1980; Karbauskaitė et al., 2020). Emotional recognition in images or texts is a common problem of artificial intelligence addressing crowdsensing, web content, social behaviour recognition, etc.

OPERATIONAL RESEARCH BEHIND MODELING AND SIMULATION OF SOCIAL-BEHAVIOURAL PHENOMENA IN CREATIVE SOCIETIES

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The application of computational models to study issues in the social sciences and humanities has been undergoing rapid development during the last decades. OR was heavily and effectively used throughout the many historical courses, emphasizing the role of game theory and rational decision making in shaping the strategic thinking in politics and business. It is natural to assume that in the current historical time, when many delicate socio-political challenges have to be dealt with once again, it is important to resort to OR to overcome those challenges.

The operationalisation of social-behavioural phenomena, appearing in nowadays life, in order to develop a paradigm of rational choice for the efficient understanding of their nature and relevant decision making, enables bridging OR with social sciences and humanities. The creation of such a paradigm on the basis of the theory of structural equation modelling (SEM), multi-agent modelling and game theory, together with data science and mathematical sociology methods, allows the development of data-driven operationalisation for evidence-based solutions.

NUMERICAL INFINITIES AND INFINITESIMALS
HOW PRIMITIVE COUNTING SYSTEMS CAN CHANGE OUR PERCEPTION OF INFINITY

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In this lecture, some classical paradoxes of infinity such as Galileo's paradox, Hilbert's paradox of the Grand Hotel, and the rectangle paradox of Torricelli are considered. It is shown that the surprising counting systems of Amazonian and Australian tribes, working with only three numerals (one, two, many) can help us to change our perception of these paradoxes. A recently introduced methodology allowing one to work with finite, infinite, and infinitesimal numbers in a unique computational framework not only theoretically but also numerically is briefly described (see [1]). This methodology is actively used nowadays in numerous applications in pure and applied mathematics and computer science as well as in teaching (see, e.g., [1-3]). This methodology gives the possibility to consider the paradoxes listed above in a new constructive light (see, e.g., [4,5]) showing so that even primitive cultures can give rise to very interesting developments in the modern sophisticated cultural and scientific life.

The Infinity Calculator using the Infinity Computer technology (patented in several countries) is presented during the talk. Reviews, videos, more than 60 papers of authors from several research areas using this methodology in their applications can be downloaded from http://www.theinfinitycomputer.com. The web page https://www.-numericalinfinities.com developed at the University of East Anglia contains materials related to teaching this methodology in colleges in UK and Italy.

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CARBON DIOXIDE EMISSIONS REDUCTION EFFICIENCY AND GROWTH POTENTIAL (A CASE OF PAKISTAN AND CHINA)

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The study's primary goal is to investigate the impact of energy consumption, economic variables, and environmental issues on CO_2 emissions. In addition, the study examines the impact of several factors on CO_2 emissions in population presence as a moderating factor. The current research is empirically interpretative and quantitative; Statistical results were utilized to evaluate the partial least square structural equation modelling hypothesis. Furthermore, the PLS-SEM technique was used since it is more relevant for the current investigation's explanatory nature. The quantitative data for this study were acquired using World Development Indicators (WDI), a reliable and accurate World Bank source database. The data was gathered from 1980 to 2020 and forecasted for 2030. This study is more important because these two countries have invested much money in various projects to boost their economies. Both countries are attempting to improve the living standards of their people by providing good health services and trying to eliminate harmful factors that harm people's health. One of the most significant benefits of lowering carbon emissions is that it would reduce the fatalities caused by air pollution and help relieve pressure on healthcare systems. To ensure a more sustainable and thriving economy, both countries must achieve this separation and cut carbon emissions.

The other primary purpose of this research is to assess green finance methods in terms of energy, economic, population, environmental, and ecological issues and their impact on CO_2 emissions. It is more significant because this research examines numerous variables that directly or indirectly impact CO_2 emissions. China is one of the major CO_2 emitter countries and the world's chief energy consumer among industrialized and unindustrialized countries, which can be observed by a recent tendency towards continuous exponential growth. The CO_2 emissions have grown from 671.1 Million Metric tons (MMT) to 2247 (MMT) from 1990–2010, portraying 7.66% of the annual growth rate. In addition, the energy consumption convinced an increase in CO_2 emissions from 1448 (MMT) to 8320 (MMT) from 1990–to 2010, conforming to a 6.7% annual average growth rate (Chang 2010). In addition, coal use is more carbon-intensive than oil and gas, but it remains a significant driver of economic growth and the world's second-largest driver of CO_2 emissions. Energy ingesting reductions seem to be a possible choice for plummeting CO_2 emissions. However, for example, China guzzles almost 69% of its total

energy consumption, and any effort to reduce it could have a reciprocal impact on its financial development. Therefore, the complex connection in PIC nations among energy consumption, CO_2 production, and economic growth should be identified urgently. As a result, Pakistan's average CO_2 emissions were 137.01 metric tons, with a standard deviation of 70.51 tons.

MODELLING OF COOPERATIVE BEHAVIOR IN MULTISTAGE GAME OF RENEWABLE RESOURCE EXTRACTION

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We investigate a discrete time competitive model of renewable resource extraction which could be interpreted as a fishery-management model with asymmetric players (see, e.g., [1]).

We adopt an assumption that each player's stage performance criterion is log of the current extraction level and focus on the finite-horizon game with feedback information structure when the players value differently the resource residual stock after the extraction process ends. This is the only source for asymmetry of the players accepted in the paper (see, e.g., [1,2] for other reasons of the players' asymmetry).

Usually, the non-cooperative (selfish) behavior in dynamic models of renewable resource extraction under fairly general assumptions leads to worse results (in particular, more extensive resource exploitation) than the cooperative behavior (see, e.g. [1,4,8]).

That's why, a problem how to guarantee the sustainability of cooperation arises. We assume that the payoffs are transferable between the players, and adopt the payoff distribution procedure (PDP) based approach to reach and implement the cooperative agreement. Such approach was firstly introduced in [6] for differential games and then was extended to different classes of dynamic games (see, e.g., [2,4,7,8]).

We use standard dynamic programming technique to derive non-cooperative and cooperative feedback strategies. Then we extend the novel subgame perfect core (S-P Core) concept (see [3,5]) to the class of finite-horizon multistage games. Moreover, we introduce a refinement of the S-P Core based on maximization of the relative benefit from cooperation and provide a specific PDP meeting several good properties. Finally, we provide a numerical example of the two-person multistage game to illustrate the results.

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CHINA CARBON NEUTRALITY GOAL
AND GROWTH POTENTIAL SYSTEM MODELING

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Carbon neutrality refers to achieving net-zero carbon dioxide emissions. The balancing of the emissions of carbon dioxide can perform with its removal or by eliminating emissions from society (the transition to the "post-carbon economy") (Porfiriev et al, 2020). For 1990–2017, carbon dioxide emissions associated with energy consumption increased 1.6 times in the global economy. The main driver was the growth of world GDP by 2.1 times. The world population has grown by only 1.4 times, which means an increase in average per capita CO_2 emissions against the background of an increase in average per capita energy consumption due to improved levels and quality of life. The main limiting factor for CO_2 emissions decreased in the energy intensity of world GDP by 35%. The carbon intensity of the consumed energy (which depends on the structure of the fuel and energy resources used) has not changed over the past almost 30 years, but it has increased by 0.4%. An important conclusion follows: in low economic growth rates and weak investment activity, a large-scale reduction of GHG is unrealistic. Policy in this area cannot be separated from the general socio-economic development strategy and should be considered as its organic component, which is entirely consistent with the priorities of the UN SDGs and the Paris Agreement.

Currently, China is promoting supply-side reforms, high-quality economic development, structural adjustments and steady growth (Liu, 2012) (Liu, 2013) (Liu, 2015). The potential capacity of the Chinese economy has provided ample room to meet external challenges and achieve high-quality development (Qi et al, 2016) (Hui, 2018) (Roach, 2018). The Chinese government keeps the economy running within a specific range and believes the Chinese economy is resilient (Özyurt, 2010) (Guan, 2008).

The Authors try to analyze Chinese Economy by using historical input-output data. Over the past half century, China has launched tens of ecological projects nationwide, with the main purposes of protection and restoring of forests and grasslands, primarily to prevent flooding, desertification and soil erosion, and to improve biomass productivity. Now, in the context of climate change mitigation, they are becoming probably the world's most extensive NCS program, in terms of scale and investment (Bryan et al., 2018; Lu et al.,2018). The primary question is can China be Carbon Neutrality 2060? Therefore, this paper tasks to:

1. Analyze the scenarios concerning achieving Carbon Neutrality Goals 2060;
2. Recommend carbon neutrality strategy 2060.

DYNAMIC MODELS
OF TRANSPORT RESOURCES MANAGEMENT

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The article discusses various models for managing transport resources, the purpose of which is to distribute a finite number of transport units along several routes of land urban transport. The values reflecting the timeliness of transport services provided to the population were taken as the optimisation criteria when searching for a solution. So, for example, models were considered when it was required to minimise the total loss of time waiting for transport services, as well as the number of passengers whose waiting time exceeds a certain critical value. In addition, a stochastic model of transport resource management was considered, when various scenarios of the development of events were taken into account (different intensities of passengers arriving at stops). Methods for assessing the stability of solutions obtained using the branch and bound methods were proposed.

OPTIMAL LOCKDOWN POLICIES IN EPIDEMIC PROCESSES WITH DEMOGRAPHIC STRUCTURE

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The main goal of this presentation is to analyze the optimal lockdown policy in a Susceptible-Quarantine-Asymptomatic-Infected-Recovered-Dead model (SQAIRD) considering that the whole population is divided into three demographic groups (young, adult, and old). The virus is spreading in a complex scale-free network. We show the dependence of a lockdown policies on different socioeconomic structures (objective cost functions which are either convex or concave). We also show that a policy of lockdown is always better than the laissez faire policy. Our results demostrate that aggregated costs in the case when we dividing population into groups are much lower than in the case of a uniform policy. One particularly interesting result is that the optimal lockdown should be higher for the young and the elderly relative to adults because the young have a higher chance of asymptomatic spread. A series of numerical experiments are performed on the case of spreading COVID-19 in Italy to support received theoretical results.

HOW CORONAVIRUS PANDEMICS (COVID-19) INFLUENCES CHINESE ECONOMIC SUSTAINABILITY

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The world is experiencing social and economic turmoil. Humanity is faced with environmental degradation, new viral outbreaks, and an uncontrollable decline in GDP. Nowadays, it is essential not only to maximize profits, but to maintain economic stability and protect bio-diversity. The most critical thing is to find a way to maintain balanced socioeconomic development and overcome post-epidemic crises. Since the wide scale reforms in 1978, China has made remarkable progress in economic development. After the financial crisis in 2008, the global economy entered a downward trend, but China's economic development maintained a medium-low growth rate. The high resilience of China's economic growth provides ample room for coping with external shocks in order to achieve high-quality development. The Chinese government put forward a sustainable development plan that considers not only quantitative growth, but also qualitative improvement in quality of life. The COVID-19 corona-virus outbreak in Wuhan, China sparked a global epidemic at the end of 2019. As a result, on January 31, 2020 the World Health Organization declared an international emergency. As with several crises, the repercussions of corona virus can also be felt in the global economy and on financial markets. Many analysts compared corona virus to the 2003 SARS outbreak. Even though this can offer useful information, there are radical differences between the two events. China controls a much larger part of the global economy and markets than it did 17 years ago. According to World Bank statistics, China's share of global trade increased to approximately 14% in 2019 compared to 5% in 2003.

The paper shows how COVID-19 affects key industries and the work of supply and transportation networks. Using input-output spatial data, migration index indicators, and pandemic spread statistics, we modeled different scenarios for changes in Chinese provinces' production and consumption following the COVID-19 pandemic. Calculations were made for 31 provinces and 42 sectors of the Chinese economy. We obtained a model that shows how the corona virus outbreak influences carbon dioxide emission, levels of hazardous waste, and the Energy-Resource Efficiency Rating. Based on the financial and migration flows between Chinese provinces, we chose the most effective post-outbreak model. Our main recommendation is that one does not need to segregate consumers. It is necessary to distribute the damage as evenly as possible between all provinces equally. We believe that such an approach will

allow the Chinese economy to suffer the least possible amount of damage and facilitate a faster recovery. Finally, we analyze the development of bilateral post-epidemic financial flows between China and Russia until 2025. In all scenarios, a temporary decline is expected. The results of the study may be useful for other countries in developing policies to overcome the epistemic crisis.

BELT AND ROAD' MODELLING AND SIMULATION CASES UNDER BUSINESS STATISTICS COURSE FRAMEWORK

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China's Belt and Road Initiative (BRI) is a massive development plan in scale and scope. It aims at facilitating China's connectivity with the rest of the world through trade, investment, and infrastructure projects. Therefore, understanding the human and social dynamics and socio-behavioral tendencies through Belt and Road development, and quantifying, and mapping the spatial-temporal distribution of environmental vulnerability caused by natural and man-made impacts are needed for understanding environmental protection and Road restoration issues. Understanding the trends in ecological, cultural and behavioural evolution and their driving factors is critical to revealing changes in ecosystem's structure and function. However, less is known about the nonlinear relationship between greening trends and statistical instrumentation.

Thus, we want to share with you HEU experience concerning new Business Statistics course implementation. In the example of a practical case concerning Belt and Road initiative development, we show for students modeling processes, the students should learn how to calculate probability and its distributions and understand their implementations. On the example of Belt and Road cases, we show the students the essential concepts of Business Statistics course, and some techniques of descriptive statistics. We focus on organizing data by visualization and analyzing data by some numerical measurements. After learning descriptive statistics, the students guided to a miraculous probability and sampling world. They are the foundation of statistical inference. We will begin with the historic outlook of probability to help us remember the probability theory. We also learn sampling to collect data and the theorems of sampling distribution. After that we finally come to the inferential statistics. Parameter estimation and hypothesis testing are the primary knowledge that we will mainly discuss. Students master how to use the sample data to estimate or to test the population with the desired reliability.

A DYNAMIC PROGRAMMING APPROACH FOR A NONZERO SUM STOCHASTIC DIFFERENTIAL GAME PROBLEM

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We apply dynamic programming principle to discuss an optimal investment problem by using nonzero-sum stochastic game approach in a continuous-time Markov regime-switching environment within the frame work of behavioral finance. We represent different states of an economy and, consequently, investors' floating levels of psychological reactions by a D-state Markov chain. We derive regime-switching Hamilton–Jacobi–Bellman–Isaacs equations and obtain explicit optimal portfolio strategies with Feynman–Kac representations of value functions.We illustrate our results in a two-state special case and observe the impact of regime switches by comparative results.

THE ACCELERATED HYPERBOLIC SMOOTHING METHOD
FOR SOLVING CENTER-BASED CLUSTERING PROBLEMS

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The work considers a general framework for solving center-based clustering problem formulations, in which there is the referential hypothesis that clusters have a hyperspherical format.

Under this assumption, each cluster is specified by a central point and each observation is assigned to whichever center is closest to it.

Three standart formulations within the considered framework are: the minimum sum-of-squres clustering problem, the most traditional one, the Multisource Fermat Weber problem, which is also known as the continuous p-median problem, and the p-center problem, that considers the covering a set of observations by a given number of a hyperspherics.

The mathematical modelling of this framework leads to a min-sum-min formulation, which, in addition to its intrinsic bi-level nature, is strongly nondifferentiable and with a large number of local minimizers.

In order to overcome the intrinsic difficulties of the problem, the so called Hyperbolic Smoothing methodology, is adopted. The proposed algorithm applies also a partition of the set of observations into two non-overlapping groups: data in frontier and data in gravitational regions, which drastically simplify the computational tasks.

For the purpose of illustrating both the reliability and the efficiency of the method under a new improved implementation, a set of computational experiments making use of large test problems is shown.

THE EFFICIENCY AND RESILIENCE OF CHINA ECONOMY UNDER THE BIOPHYSICAL ECONOMIC MODEL POINT OF VIEW

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The foundation of the effective operation of the national economy lies in the continuous supply of energy. However, the supply of fossil energy has reached its limit worldwide, and the fossil energy available for human consumption is decreasing. Although human beings have won many battles in their relationship with nature, the amount of fossil energy per capita will continue to decline in the future, and fossil energy supplies are being exhausted. Energy drives economic development, economy promotes policy implementation, and policy affects social evolution. The decline in energy access has led to a sharp social divide between rich and poor and rising income inequality, which in turn has led to urgent problems such as slowing economic growth, debt defaults and climate change. Since the 1970 oil crisis, academia has been discussing the coupling relationship between energy-economy-society, and most economists and politicians in the past still pay insufficient attention to the energy issue. The 2008 financial crisis and the COVID-19 pandemic are profoundly transforming the world, with energy, complexity and globalization returning to the focus of new economy research. The world is facing great changes unseen recently. A new round of scientific and technological revolution and industrial transformation are on the rise. The era of knowledge economy has arrived, which requires to establish new theories and new methods to adapt to it. Classical economics is based on Newtonian mechanics and other traditional scientific laws, and there are some deviations in the combination with science. The study of energy economy which integrates physics, biology, computer science, ecological economics and other disciplines. This article mainly expounds the classification and level of energy, energy plays an important part in the economic system, especially the broder energy concept which mainly about the economics of biophysical research in the world. The net energy economics are proposed under the inspiration of the outstanding energy economy theory and its connotation of ideas, to explain and serve the national revitalization of China's economic development. This research focus on the efficiency and resilience of China economy by calculate the efficiency and redundancy levels of the closed system and the open system respectively. The results show that China's economic development is at a relatively low efficiency and high redundancy level of the whole system, which means that China's economic development is relatively resilient.

RESEARCH OF SOCIAL CAPITAL AS A FACTOR OF SOCIO-ECONOMIC AND DIGITAL DEVELOPMENT OF RUSSIAN REGIONS.

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The research of the concept of social capital of modern society becomes a significant task, the study of which can lead to the provision of sustainable development of the regions of the country. In the conditions of increasing rates of digital transformation of spheres of public life, social interactions between individuals are undergoing changes, new ways of communication are being formed, which entails changes in the social capital of society, which some researchers are beginning to call digital social capital.

The concept of social capital has become a kind of trend in recent years, reflecting the processes that arise during the interaction of society. Social capital is used to describe social processes in sociology, political science, economics and other fields of scientific knowledge.

Identification of key factors of the region's development is a priority area of the regional economy. The role of non-economic factors that increase the competitiveness of regions in the context of digital transformation is constantly growing. Currently, social capital is being introduced into the economic infrastructure through social networks due to the development of the ICT sector.

Ubiquitous digitalization causes a change in the forms and methods of interaction between members of society, as well as simplify the communication of individuals with the state. The process of digital transformation has an impact on the social capital of society, but researchers are divided into two camps, where some argue that digital technologies make it possible to form more effective and widespread social networks, expand the number of contacts with family and friends and activate connections with new acquaintances. While others are of the opinion that communication in the virtual space replaces personal communication, which leads to the waste of the social capital of society.

In the context of the increasing pace of digital transformation, the ways in which members of society interact with each other and with the state are changing, which makes its own adjustments to the accumulation of social capital by society.

This article examines the existing methods of measuring social capital, and also proposes a conceptual scheme and a system of indicators developed by the author for monitoring the level of social capital in the regions of the country.

REVERSE SPILLOVER EFFECT OF CROSS-BORDER M&A AND UPGRADING OF MANUFACTURING INDUSTRY IN GLOBAL VALUE CHAIN

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Based on the cross-border M&A cases of Chinese enterprises from 2005 to 2014 in zephy database, this paper makes an empirical study on the reverse spillover effect of China's cross-border M&A affecting the position of the global value chain. The results show that cross-border M&A has a significant role in promoting China's position in the global value chain, and this conclusion is still valid after changing the explained variables and overcoming a series of endogenous robustness tests. Then, according to the number of cross-border production, the global value chain is divided into simple global value chain and complex global value chain, and it is found that cross-border M&A has a more obvious promotion effect on the position of complex global value chain than that of simple global value chain. In the analysis of the mechanism of cross-border M&A's effect on the upgrading of global value chain status, the results show that the intermediary effect of total factor productivity is significantly positive, which indicates that the reverse spillover effect of cross-border M&A can improve the status of China's manufacturing industry in the global value chain through total factor productivity. In addition, this paper further establishes an adjusted intermediary effect model, using trade cost as an adjustment variable, It is found that trade costs have a negative regulatory effect on the impact of cross-border M&A on total factor productivity, which indicates that the increase of trade costs weakens the promotion of reverse spillover effect of cross-border M&A on total factor productivity, and thus hinders the rise of China's manufacturing industry in the global value chain. Therefore, this paper takes cross-border M&A as the entry point, studies and empirically tests the impact of reverse technology spillover effect of cross-border M&A on the position of manufacturing industry in the global value chain, provides a theoretical basis for Chinese transnational enterprises to make M&A decisions, and also provides a new interpretation of the influencing factors of the global value chain at the macro level.

STATISTICAL ANALYSIS AND ENLIGHTENMENT OF THE MAIN INDICATORS OF RAILWAY TRANSPORTATION DEVELOPMENT IN CHINA AND RUSSIA

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China and Russia have the same political and economic historical background, and the management systems of Chinese and Russian railroad enterprises are very similar. As bilateral cooperation between the two countries continues to deepen, the development and construction of railroad transport is steadily advancing. Since 2000, the governments of China and the Russian Federation have separated the railroad enterprises from the government and enterprises, and opened up the passenger and freight services, which had long been at a low competitive advantage, to the market by establishing joint-stock companies, which have made remarkable achievements in the past 20 years. According to the "Outline of Railway Reform in the Russian Federation", the government and enterprises will be separated and the transportation network will be separated, and the national financial investment in railroad construction and development will be increased. Chinese railroad enterprises have made the elimination of the "bottleneck" constraint of railroads on the development of the national economy their development goal, and have implemented the reduction of management levels and separation of the main and auxiliary components to rapidly improve the transport capacity and equipment level.

Russia is an important country in China's "One Belt, One Road" initiative, and China has become the largest importer of Russia, and the opening of China-Europe railroad train, with Sino-Russian international railroad cargo transportation as the core, has continuously increased the market share of international transportation and further strengthened its international influence. According to Russia's 2030 strategic plan for transport development, the Beijing-Moscow High Speed Railway, with a total investment of 1.5 trillion RMB and a construction mileage of over 8,000 km, is scheduled to be completed in 2027, which will shorten the rail transportation time from Beijing to Moscow from 6 days to 38 hours. It will become the largest Eurasian railroad transportation network in the world. After the development of railroad enterprises of both countries over the years, influenced by social, economic, political and other market adjustments, they have achieved different results and changes to each other. Using the time series method, the main indicators of the railroad enterprises of China and Russia in recent years, such as road network

construction, passenger and freight traffic, transport efficiency, rolling stock equipment utilization, and operational efficiency, are statistically analyzed to explain the reasons for changes, give analytical conclusions, and put forward optimization Suggestions are made to promote the deep cooperation between Russian and Chinese railroad enterprises.

RESEARCH ON THE EVALUATION OF THE CORE COMPETITIVENESS OF CHINA RAILWAY COMPANIES AND THE PROMOTION STRATEGY

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Research on the evaluation of the core competitiveness of China Railway Companies and the promotion strategy, China

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In recent years, China railway industry has developed at a high speed and high quality, and railway companies are facing new opportunities and challenges. In order to meet new challenges and develop under the UN SDG, it is done a top priority for China railway to catch the core competitiveness. This research takes China Railway Company as the research object, analyzes several keys of core competitiveness, evaluates the importance of its main components, and proposes future core competitiveness improvement strategies based on this. The author reviews the development status of China Railway Corporation in recent years and the SDG, to achieve in the future, and clarifies the basic status of the company's operation, industry and business positioning, and competitive target positioning. Before deconstructing and evaluating the company's core competitiveness, it also combines the current specific development environment to clarify the company's advantages and disadvantages in competition, as well as possible opportunities and challenges, so as to determine what aspects of the company's core competitiveness will be reflected And what specific elements can be broken down into. Afterwards, the structural relationship and interaction among these core competitiveness elements are clarified, and a structural model of the core competitiveness of Chinese railway companies is established accordingly. The performance of the core competitiveness 32 elements is summarized into 7 primary aspects: internal management capability, social responsibility undertaking capability, project management capability, capital operation capability, company's employee capabilities, engineering and technical design capabilities, and external collaboration capabilities. By taking factor load obtained by the factor analysis method as the scoring weight, the comprehensive scores of these seven aspects of the core competitiveness are calculated, so as to determine the competitiveness of the different components of the core competitiveness of China Railway Corporation. Based research extensively draws on the existing experience and establishes the economical, fast and comfortable transportation mode based on the method of mathematical modeling. The market share rate logit model of convenience, convenience and punctuality is used to quantitatively analyze the competitiveness of high-speed railways. Finally, combined with the previous research and the actual situation of China Railway Company, the strategy for improving the company's core competitiveness in the next 3-5 years is put forward.

ON THE MODEL OF BALANCING ECONOMIC, LEGAL AND SOCIAL MACROSYSTEMS

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The author considers the interaction of three national macrosystems (economic, legal, and social) within a national public metasystem, justifying and solving the problem of their balancedness using the concept of Berge equilibrium. This equilibrium mathematically expresses the Golden Rule of ethics (GR), one of the most ancient, specific, and widespread moral generalizations that appear in Christianity, Islam, Judaism, Buddhism, and Confucianism. It instructs: "Do to others as you would like them to do to you." The author studies the influence of morality (in the sense of Kant's imperative or the GR) on strategic decision-making in the national public metasystem. The Nash equilibrium of the three macrosystems reflects the neoliberal economic doctrine widespread currently. An alternative moral-philosophical economic doctrine based on the GR is substantiated using systems theory and game theory.The author develops a metasystem equilibrium model for the national public metasystem based on the GR to determine effective strategic decisions under uncertainty in the social sphere, implementing the social state idea.The research presented in the book is interdisciplinary. It involves scientific approaches of systems analysis, philosophical ethics, economics, law, sociology, game theory, and management.

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