

# Advances in machine learning for the innovation economy: in the shadow of war

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## Abstract

This preface introduces the selected and revised papers presented at the 10th International Conference on Monitoring, Modeling & Management of Emergent Economy (M3E2 2022), held online in Ukraine, on November 17-18, 2022. The conference aimed to bring together researchers, practitioners, and students from various fields to exchange ideas, share experiences, and discuss challenges and opportunities in applying computational intelligence and data science for the innovation economy. The innovation economy is a term that describes the emerging paradigm of economic development that is driven by knowledge, creativity, and innovation. It requires new approaches and methods for solving complex problems, discovering new opportunities, and creating value in various domains of science, business, and society. Computational intelligence and data science are two key disciplines that can provide such approaches and methods by exploiting the power of data, algorithms, models, and systems to enable intelligent decision making, learning, adaptation, optimization, and discovery. The papers in this proceedings cover a wide range of topics related to computational intelligence and data science for the innovation economy. They include theoretical foundations, novel techniques, and innovative applications. The papers were selected and revised based on the feedback from the program committee members and reviewers who ensured their high quality. We would like to thank all the authors who submitted their papers to M3E2 2022. We also appreciate the keynote speakers who shared their insights and visions on the current trends and future directions of computational intelligence and data science for the innovation economy. We acknowledge the support of our sponsors, partners, and organizers who made this conference possible despite the challenging circumstances caused by the ongoing war in Ukraine. Finally, we thank all the participants who attended the conference online and contributed to its success.

## Keywords

computational intelligence, data science, innovation economy, artificial neural networks, machine learning, visualization

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 CEUR Workshop Proceedings (CEUR-WS.org)

## 1. Introduction

The **Monitoring, Modeling & Management of Emergent Economy** (M3E2, <https://m3e2.ccjournals.eu/2022/>) is a peer-reviewed international conference dedicated to scientific achievements in the field of complex systems, the use of information systems and technologies in the economy, interdisciplinary methods, methods of machine learning and fuzzy logic, modeling of socio-economic systems, research global transformations and challenges facing economist scientists. The M3E2 conference is a permanent scientific platform that was launched in 2008 and was formed thanks to the hard work of scientists, practicing researchers, post-graduate students who present the results of their research and have the opportunity to fruitfully discuss them.



Моніторинг,  
Моделювання та  
Менеджмент

Monitoring,  
Modeling and  
Management of  
Emergent  
Economy

Емерджентної  
Економіки



**Figure 1:** Conference poster.

The M3E2 Conference occupies contributions in all aspects of Computational Finance, Economics, Risk Management, Statistical Finance, Trading and Market Microstructure, (Deep) Machine Learning technologies and tools, paradigms and models, relevant to modern financial engineering and technological decisions in the modern age. There is urgent general need for principled changes in postclassic economy elicited by current models, tools, services, networks and IT communication.

M3E2 topics of interest since 2019 [1, 2, 3, 4]:

- Complex cyberphysical systems, synergy, econophysics, economy of agents
- Dynamics of emergent markets in crisis and post-crisis period
- Economic security
- Global challenges for economic theory and practice in Europe

- Information systems and technologies in economics
- Innovation models of economic development
- Machine learning for prediction of emergent economy dynamics
- Management of the state's economic safety and economic safety of economic agents
- Methods and models of artificial intelligence in economic systems
- Modeling of hospitality sphere development
- Models of global transformations
- Monitoring, modeling and forecasting in the banking sector
- Monitoring, modeling, forecasting and preemption of crisis in socio-economic systems
- Optimal management of socio-economic processes
- Risk management models in emergent economy

This volume contains the selected and revised papers presented at the 10th International Conference on Monitoring, Modeling & Management of Emergent Economy (M3E2 2022) held on November 17-18, 2022 in Ukraine.

There were 23 submissions. Each submission was reviewed by at least 3, and on the average 3.2, program committee members. 13 papers were accepted for this volume as regular papers.

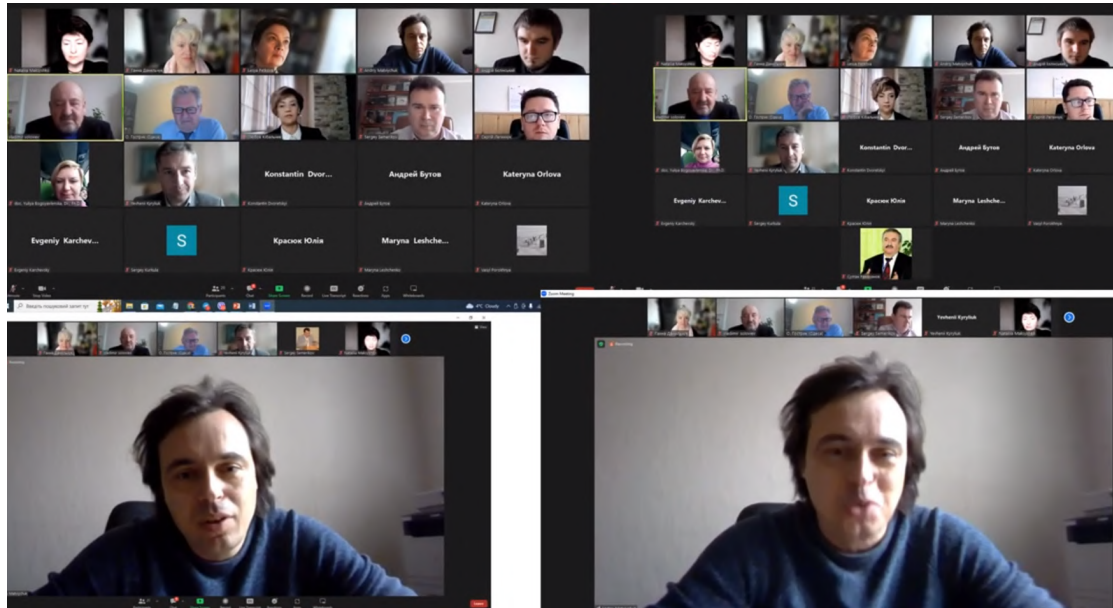
## **2. Program committee**

### **2.1. M3E2 2022 program chairs**

- *Serhiy Semerikov*, Kryvyi Rih State Pedagogical University, Ukraine [5]
- *Vladimir Soloviev*, Kryvyi Rih State Pedagogical University, Ukraine [6]
- *Andriy Matviychuk*, Kyiv National Economic University named after Vadym Hetman, Ukraine [7]
- *Vitaliy Kobets*, Kherson State University, Ukraine [8]
- *Liubov Kibalnyk*, The Bohdan Khmelnytsky National University of Cherkasy, Ukraine [9]
- *Hanna Danylchuk*, The Bohdan Khmelnytsky National University of Cherkasy, Ukraine [10]
- *Arnold Kiv*, Ben-Gurion University of the Negev, Israel [11]

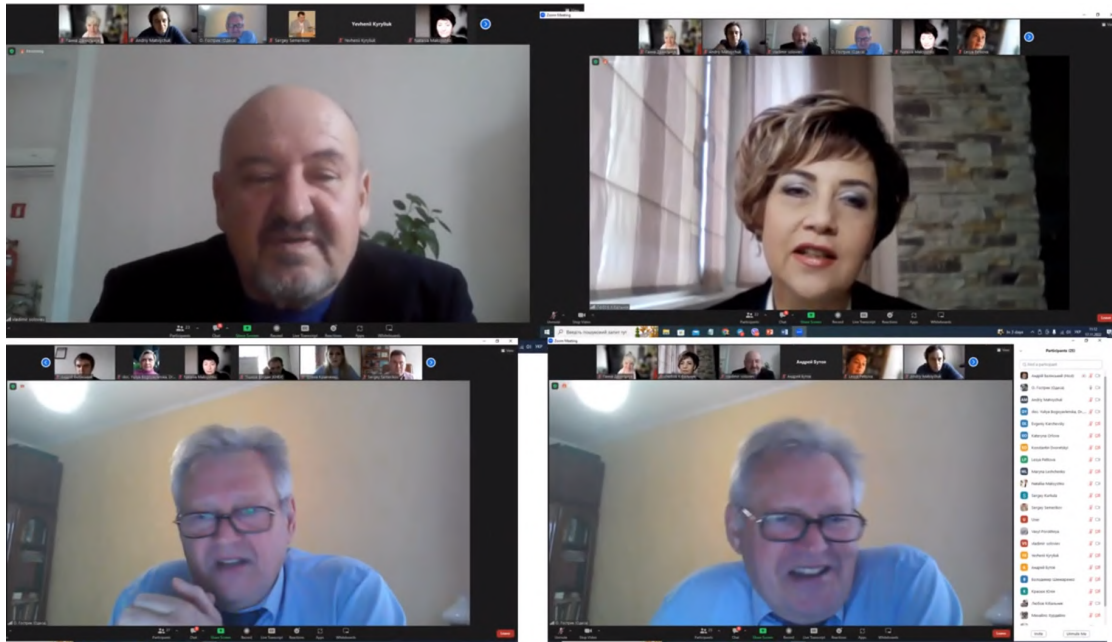
### **2.2. M3E2 2022 program committee members**

- *George Abuselidze*, Batumi Shota Rustaveli State University, Georgia [12]
- *Iluta Arbidane*, Rezekne Academy of Technologies, Latvia [13]
- *Vitalina Babenko*, V. N. Karazin Kharkiv National University, Ukraine [14]
- *Paul Bilokon*, Imperial College London, United Kingdom [15]
- *José Manuel Macedo Botelho*, Universidade de Évora, Portugal [16]
- *Irina Georgescu*, Bucharest University of Economics, Romania [17]
- *Lidiya Guryanova*, Simon Kuznets Kharkiv National University of Economics, Ukraine [18]



**Figure 2:** Conference highlights, part 1.

- *Alexey Hostryk*, Odessa National Economic University, Ukraine [19]
- *Pavlo Hryhoruk*, Khmelnytskyi National University, Ukraine [20]
- *Muhammad Jawad*, Fatima Jinnah Women University, Pakistan [21]
- *Nila Khrushch*, Khmelnytskyi National University, Ukraine [22]
- *Inesa Khvostina*, Ivano-Frankivsk National Technical University of Oil and Gas, Ukraine [23]
- *Oksana Kovtun*, University of Educational Management, Ukraine [24]
- *Serhii Lehenchuk*, Zhytomyr Polytechnic State University, Ukraine [25]
- *Nataliia Maksyshko*, Zaporizhzhia National University, Ukraine [26]
- *Abdukhakim Mamanazarov*, Center of Economic Culture Development, Uzbekistan [27]
- *Ewa Matuska*, Pomeranian University in Slupsk, Poland [28]
- *Inese Mavlutova*, BA School of Business and Finance, Latvia [29]
- *Iveta Mietule*, Rezekne Academy of Technologies, Latvia [30]
- *Dariusz Pawliszczy*, Gromadka Community, Poland [31]
- *Oleg Pursky*, Kyiv National University of Trade and Economics, Ukraine [32]
- *Michael Radin*, Rochester Institute of Technology, United States [33]
- *Sultan Ramazanov*, Kyiv National Economic University named after Vadym Hetman, Ukraine [34]
- *Kateryna Shymanska*, Prague University of Economics and Business, Czechia [35]
- *Victoria Solovieva*, State University of Economics and Technology, Ukraine [36]
- *Galyna Velykoivanenko*, Kyiv National Economic University named after Vadym Hetman, Ukraine [37]



**Figure 3:** Conference highlights, part 2.

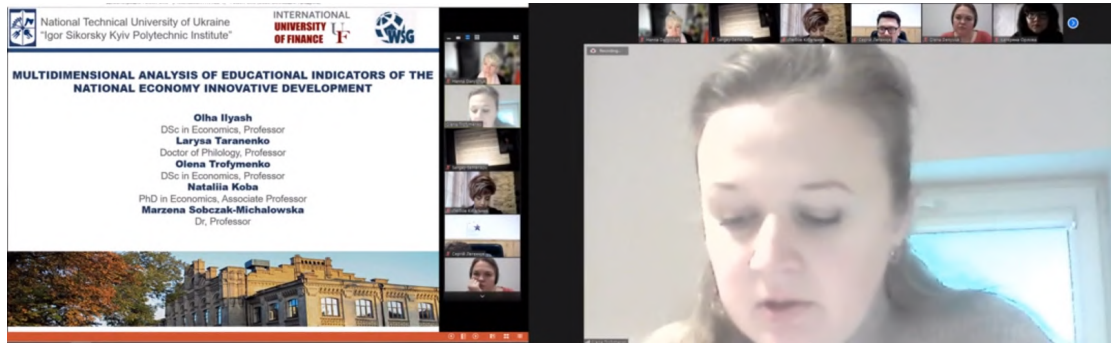
- *Nataliia Zachosova*, The Bohdan Khmelnytsky National University of Cherkasy, Ukraine [38]
- *Pavel Zakharchenko*, Berdyansk State Pedagogical University, Ukraine [39]

### 3. Articles overview

The paper titled “Assessing the educational dimension of national economy innovative development” by Olha Ilyash, Larysa Taranenko, Olena Trofymenko, Nataliia Koba, and Marzena Sobczak-Michalowska [40] examines the educational indicators that reflect the innovative development of the national economy in Ukraine. The study aims to develop a system for evaluating and enhancing the educational component of Ukraine’s innovative development, which can support effective state regulation of educational processes and prevent the risks of reducing the educational security of the national economy.

The study applies a multidimensional analysis of educational indicators, using a system of complex and systemic methods, such as dynamic analysis, system generalization, statistical methods, and taxonomic analysis. The study also compares the educational indicators of Ukraine with those of other countries that have achieved educational and scientific breakthroughs.

The results of the study show that Ukraine has a low level of educational performance and potential for innovative development compared to other countries. The paper proposes some measures to improve the educational component of Ukraine’s innovative development, such as increasing public investment in education, enhancing the quality and relevance of education, fostering international cooperation in education and science, and promoting a



**Figure 4:** Presentation of paper [40].

culture of innovation among students and teachers.

Here are some of the key points of the paper:

- The educational dimension of national economy innovative development is a complex and multifaceted concept that includes a wide range of factors, such as the quality of education, the level of investment in education, the international cooperation in education and science, and the culture of innovation.
- The study found that Ukraine has a low level of educational performance and potential for innovative development compared to other countries.
- The paper proposes some measures to improve the educational component of Ukraine's innovative development, such as increasing public investment in education, enhancing the quality and relevance of education, fostering international cooperation in education and science, and promoting a culture of innovation among students and teachers.

The paper "Fuzzy expert decision support system for foreign direct investment: a swarm metaheuristic approach" by Eugene E. Fedorov, Liubov O. Kibalnyk, Lesya O. Petkova, Maryna M. Leshchenko, and Vladyslav M. Pasenko [41] proposes a fuzzy expert system for foreign direct investment (FDI) decision support. The system is developed using an adaptive gravitational search algorithm (GSA) to determine the optimal parameters of the fuzzy expert system, such as the membership functions for linguistic input and output variables. The system also uses a quality criterion that considers the specificity of the fuzzy expert system and allows assessing the probability of future decisions.

The paper conducts a numerical study to test the performance of the proposed fuzzy expert system and compares it with other existing methods. The results show that the proposed fuzzy expert system has a high accuracy and robustness in FDI decision support. The paper contributes to the literature on fuzzy logic applications in economics and finance and provides a practical tool for investors to make informed decisions on FDI.

Here are some of the key points of the paper:

- The proposed fuzzy expert system is a novel approach for FDI decision support that takes into account the uncertainty and ambiguity of the decision-making process.

## Conclusions

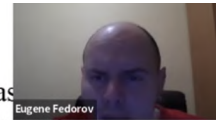
1. Relevant optimization methods and expert systems were investigated as part of the decision-making technology for foreign direct investment. The research results showed that the most effective is the use of fuzzy expert systems, the parameters of which are identified by means of metaheuristic methods today.

2. A fuzzy expert decision support system for foreign direct investment has been developed. The proposed system simplifies the interaction between the operator and the computer system through the use of qualitative indicators, and also allows to identify its parameters using the proposed swarm metaheuristics.

3. A quality criterion is proposed; it considers the specifics of the created fuzzy expert system and allows assessing of the decisions accuracy.

4. A swarm metaheuristic algorithm based on an adaptive gravitational search algorithm has been created; it provides control over the rate of method convergence, as well as providing global search at the initial iterations, and local search at the final iterations due to adaptive control of the particle velocity.

The proposed optimization method based on swarm metaheuristics and a fuzzy expert system make it possible to intellectualize the technology of making decisions on foreign direct investment. Prospects for further research involve testing the proposed method and system on a wider test database set.



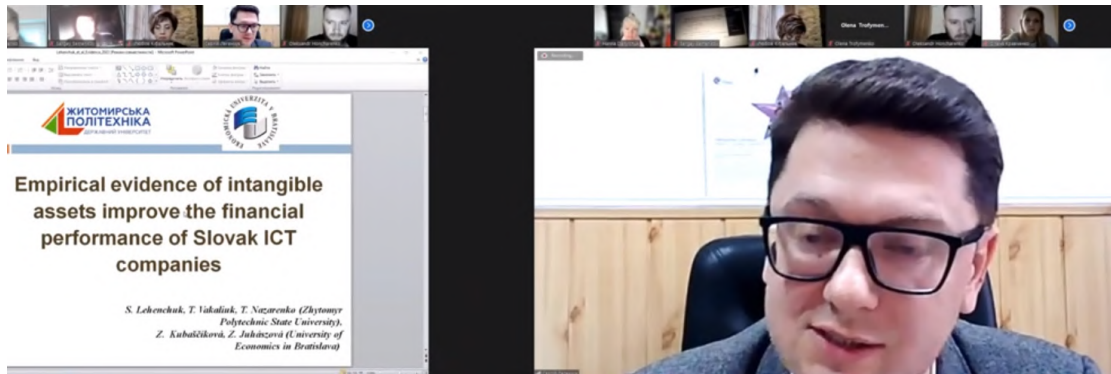
**Figure 5:** Presentation of paper [41].

- The GSA is used to optimize the parameters of the fuzzy expert system, which ensures that the system is able to make accurate and reliable decisions.
- The quality criterion is used to assess the performance of the fuzzy expert system and to compare it with other existing methods.
- The numerical study shows that the proposed fuzzy expert system has a high accuracy and robustness in FDI decision support.

The paper “The impact of intangible assets on the financial performance of Slovak ICT companies: a panel data regression analysis” by Serhii F. Lehenchuk, Tetiana A. Vakaliuk, Tetiana P. Nazarenko, Zuzana Kubaščíková, and Zuzana Juhászová [42] investigates the impact of intangible assets on the financial performance of Slovak ICT companies in the context of the knowledge economy.

The paper uses a panel data regression analysis to test the hypothesis that intangible assets have a significant positive effect on four indicators of financial performance: Return on Assets (ROA), Net Profit Margin (NPM), Assets Turnover (AT), and Return on Equity (ROE). The paper analyzes a sample of 180 Slovak ICT companies for the period 2015–2019, using eight independent variables: Research and Development Intensity (R&D), R&D Intensity Squared, Software, Intellectual Property Rights (IPR), Acquired Intangible Assets, Leverage, Size, and Dummy variable for ICT sub-sectors.

The paper applies various tests to select the appropriate estimation method and to check the adequacy of each model. The results partially confirm the hypothesis, as only R&D, R&D Intensity Squared, and Acquired Intangible Assets have a significant positive impact on some



**Figure 6:** Presentation of paper [42].

indicators of financial performance. The paper also finds that the influence of intangible assets varies depending on the type and measure of financial performance.

The paper contributes to the literature on intangible assets and financial performance by providing empirical evidence from Slovak ICT companies. The paper also provides some implications for managers and policymakers to improve their intangible investment policy.

Here are some of the key points of the paper:

- The paper provides empirical evidence that intangible assets have a positive impact on the financial performance of Slovak ICT companies.
- The paper finds that the impact of intangible assets varies depending on the type and measure of financial performance.
- The paper suggests that managers and policymakers should focus on investing in intangible assets that have a proven positive impact on financial performance.

The paper “Maximizing customer satisfaction and business profits through Big Data technology in Society 5.0: a crisis-responsive approach for emerging markets” by Piotr Kulyk, Viktoriia Hurochkina, Bohdan Patsai, Olena Voronkova, and Oksana Hordei [43] explores the use of Big Data technology to maximize customer satisfaction and business profits in emerging markets, especially during crisis periods.

The paper begins by discussing the importance of customer satisfaction in emerging markets, where competition is often fierce and customer expectations are high. The authors argue that Big Data technology can be used to gain a deeper understanding of customer needs and preferences, which can be used to improve products and services, personalize marketing campaigns, and provide better customer service.

The paper then discusses the use of Big Data technology in loyalty programs. The authors argue that traditional discount-based loyalty programs are not effective in emerging markets, where customers are more likely to be attracted to personalized and value-added rewards. Big Data technology can be used to create personalized loyalty programs that are tailored to the specific needs and preferences of each customer.

The paper also discusses the use of Big Data technology in crisis mitigation. The authors argue that Big Data technology can be used to track customer behavior and preferences during



a crisis, which can be used to adjust marketing campaigns and product offerings accordingly. Big Data technology can also be used to identify and target customers who are most likely to be affected by a crisis, and to provide them with the support they need.

The paper concludes by arguing that Big Data technology is a powerful tool that can be used to maximize customer satisfaction and business profits in emerging markets, especially during crisis periods. The paper provides a number of recommendations for businesses that are looking to use Big Data technology to improve their performance in emerging markets.

Here are some of the key points of the paper:

- Big Data technology can be used to gain a deeper understanding of customer needs and preferences.
- Big Data technology can be used to personalize marketing campaigns and customer service.
- Big Data technology can be used to create personalized loyalty programs.
- Big Data technology can be used to track customer behavior and preferences during a crisis.
- Big Data technology can be used to identify and target customers who are most likely to be affected by a crisis.

The paper “A flexible machine learning model for optimizing organizational capital development strategies and resource allocation” by Vasyl Porokhnya, Vladyslav Penev, Roman Ivanov, and Volodymyr Kravchenko [44] proposes a flexible machine learning model for optimizing organizational capital development strategies. The model is based on Q-learning, a reinforcement learning algorithm that can be used to learn optimal policies in a dynamic environment.

The model is designed to be flexible and adaptable to different organizational contexts. It can be used to optimize a variety of organizational capital development strategies, such as training and development, knowledge management, and innovation.

The model is also designed to be data-driven. It uses historical data to learn the relationship between different organizational capital development strategies and their outcomes. This allows the model to make more accurate predictions about the effectiveness of different strategies.

The paper evaluates the performance of the model using a case study of a manufacturing company. The results show that the model was able to identify the most effective organizational capital development strategies for the company. The model also helped the company to improve its resource allocation decisions.

The paper concludes that the proposed model is a valuable tool for optimizing organizational capital development strategies. The model is flexible, adaptable, and data-driven, making it suitable for a wide range of organizations.

Here are some of the key points of the paper:

- The proposed model is a flexible machine learning model that can be used to optimize organizational capital development strategies.
- The model is based on Q-learning, a reinforcement learning algorithm that can be used to learn optimal policies in a dynamic environment.
- The model is designed to be adaptable to different organizational contexts.

## Machine learning alternative development of organizational enterprise capital

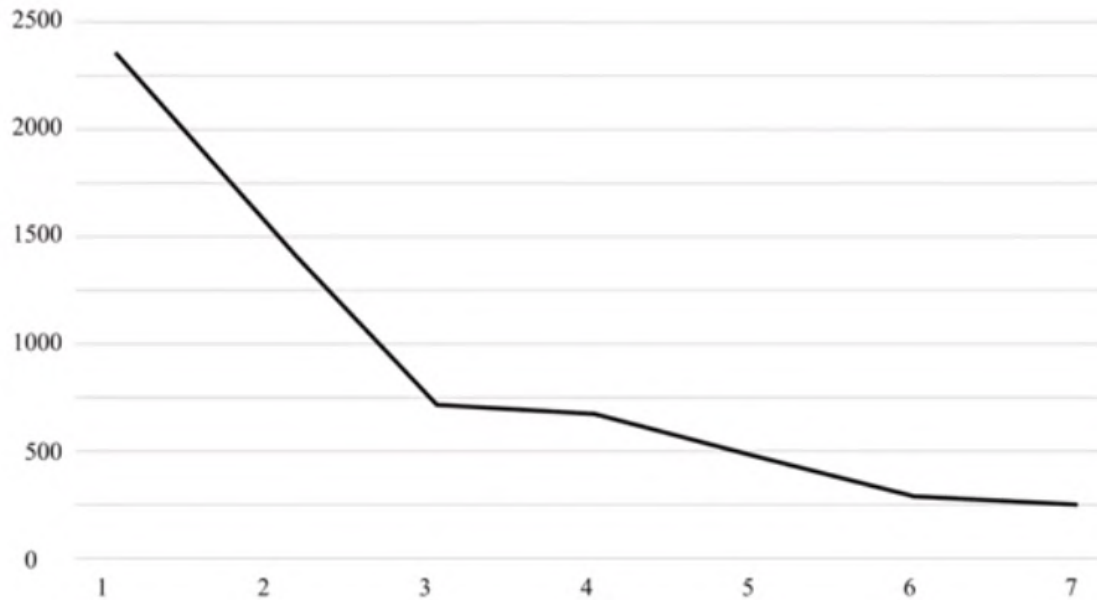


Figure 7: Presentation of paper [44].

- The model is data-driven, using historical data to learn the relationship between different organizational capital development strategies and their outcomes.
- The paper evaluates the performance of the model using a case study of a manufacturing company. The results show that the model was able to identify the most effective organizational capital development strategies for the company.
- The paper concludes that the proposed model is a valuable tool for optimizing organizational capital development strategies.

The paper “Recurrence quantification analysis of energy market crises: a nonlinear approach to risk management” by Andrii O. Bielinskyi, Vladimir N. Soloviev, Viktoria V. Solovieva, Serhiy O. Semerikov, and Michael A. Radin [45] uses recurrence quantification analysis (RQA) to analyze and construct indicators of intermittent events in energy indices.

The paper begins by discussing the importance of the energy market and the challenges posed by its unstable price dynamics. The paper then introduces RQA, a nonlinear time series analysis method that can be used to identify and quantify intermittent events.

The paper then applies RQA to daily data of Henry Hub natural gas spot prices, WTI spot prices, and Europe Brent spot prices. The results show that the recurrence measures capture the distinctive features of crashes and can be used for effective risk management strategies.

The paper concludes by discussing the implications of the findings for risk management in

the energy market. The paper argues that RQA can be used to identify the early warning signs of crises and to develop strategies to mitigate their impact.

Here are some of the key points of the paper:

- The paper uses RQA to analyze and construct indicators of intermittent events in energy indices.
- The paper applies RQA to daily data of Henry Hub natural gas spot prices, WTI spot prices, and Europe Brent spot prices.
- The results show that the recurrence measures capture the distinctive features of crashes and can be used for effective risk management strategies.

The paper “High-order network analysis for financial crash identification” by Andrii O. Bielinskyi, Vladimir N. Soloviev, Serhii V. Hushko, Arnold E. Kiv, and Andriy V. Matviychuk [46] proposes to use high-order networks to study the temporal evolution of the Dow Jones Industrial Average (DJIA) index.

November 17-18, 2022, Virtual, Online (postponed due to Russian invasion of Ukraine)

**M<sup>3</sup>E<sup>2</sup> 2022**

10th International Conference on **M**onitoring, **M**odeling & **M**anagement of **E**mergent Economy

**HIGH-ORDER NETWORKS AND STOCK MARKET CRASHES**

**RECURRENCE MEASURES OF COMPLEXITY IN ENERGY MARKET DYNAMICS**

ДЕРЖАВНИЙ УНІВЕРСИТЕТ ЕКОНОМІКИ І ТЕХНОЛОГІЙ

КИЇВСЬКИЙ НАЦІОНАЛЬНИЙ ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ 1906

КИЇВСЬКИЙ ДЕРЖАВНИЙ ПЕДАГОГІЧНИЙ УНІВЕРСИТЕТ 1930

Natalia Maksyshko

**Figure 8:** Presentation of paper [46].

The paper begins by discussing the importance of network analysis for understanding the complexity and dynamics of socio-economic systems. The paper then introduces high-order networks, which are generalized network structures that capture the higher-order dependencies that arise from the interactions of more than two nodes.

The paper then constructs high-order networks from the DJIA time series using the visibility

graph method. The visibility graph method is a method for constructing networks from time series data by connecting points that are visible to each other at a given time.

The paper then measures the topological complexity of the high-order networks using various metrics. The topological complexity of a network is a measure of the richness and interconnectedness of the network.

The paper finds that the complexity of the DJIA high-order networks changes drastically during crisis events. This indicates that high-order network analysis can be used as an indicator of financial crashes.

The paper also shows that high-order network analysis and topology can provide more insights into the nonlinear and nonstationary behavior of the DJIA index than traditional tools of financial time series analysis.

Here are some of the key points of the paper:

- The paper proposes to use high-order networks to study the temporal evolution of the DJIA index.
- The paper constructs high-order networks from the DJIA time series using the visibility graph method.
- The paper measures the topological complexity of the high-order networks using various metrics.
- The paper finds that the complexity of the DJIA high-order networks changes drastically during crisis events.
- The paper shows that high-order network analysis and topology can provide more insights into the nonlinear and nonstationary behavior of the DJIA index than traditional tools of financial time series analysis.

The paper “Multidimensional statistical analysis of investment attractiveness and regional changes in the COVID-19 pandemic” by Pavlo M. Hryhoruk, Nila A. Khrushch, Svitlana S. Grygoruk, and Olena R. Ovchynnikova [47] uses multidimensional statistical analysis techniques to cluster Ukrainian regions based on their levels of investment attractiveness. The paper also examines how the regional investment attractiveness structure has changed during the COVID-19 pandemic.

The paper begins by reviewing the various approaches to assessing investment attractiveness. The authors then use the  $k$ -means method to cluster Ukrainian regions based on their investment attractiveness levels in 2019 and 2020. The  $k$ -means method is a clustering algorithm that groups data points into a predefined number of clusters.

The results of the  $k$ -means clustering show that the investment attractiveness of Ukrainian regions has changed during the COVID-19 pandemic. In 2019, there were four clusters of regions: high-attractiveness regions, medium-high-attractiveness regions, medium-low-attractiveness regions, and low-attractiveness regions. In 2020, the number of clusters increased to five.

The paper then uses principal component analysis (PCA) to rotate the space of selected factors. PCA is a statistical technique that reduces the dimensionality of a dataset while preserving as much information as possible. The quartimax method is a rotation method that maximizes the variance of the rotated components.

The results of the PCA and quartimax rotation show that the regional investment attractiveness structure can be explained by four main factors: economic development, infrastructure,

human capital, and political stability. The authors argue that these factors are important for attracting investment, and that they have become even more important during the COVID-19 pandemic.

The paper concludes by discussing the implications of the findings for potential investors and local self-governing bodies. The authors argue that the findings can help investors to identify key investment areas, and that they can help local self-governing bodies to improve their investment attractiveness.

Here are some of the key points of the paper:

- The paper uses multidimensional statistical analysis techniques to cluster Ukrainian regions based on their levels of investment attractiveness.
- The paper examines how the regional investment attractiveness structure has changed during the COVID-19 pandemic.
- The results of the  $k$ -means clustering show that the investment attractiveness of Ukrainian regions has changed during the COVID-19 pandemic.
- The paper uses PCA and quartimax rotation to identify four main factors that explain the regional investment attractiveness structure.
- The authors argue that these factors are important for attracting investment, and that they have become even more important during the COVID-19 pandemic.

The paper “A comparative study of deep learning models for sentiment analysis of social media texts” by Vasily D. Derbentsev, Vitalii S. Bezkorovainyi, Andriy V. Matviychuk, Oksana M. Pomazun, Andrii V. Hrabariev, and Alexey M. Hostryk [48] presents a comparative study of deep learning models for sentiment analysis of social media texts.

The paper begins by discussing the challenges of sentiment analysis for social media texts. Social media texts are often informal, short, and noisy, which makes them difficult to analyze using traditional machine learning methods.

The paper then introduces three deep learning models for sentiment analysis: a convolutional neural network (CNN), a CNN with long short-term memory (LSTM) layers (CNN-LSTM), and a bidirectional LSTM with CNN layers (BiLSTM-CNN). The CNN is a deep learning model that is well-suited for processing natural language text. The LSTM is a deep learning model that is well-suited for processing sequential data.

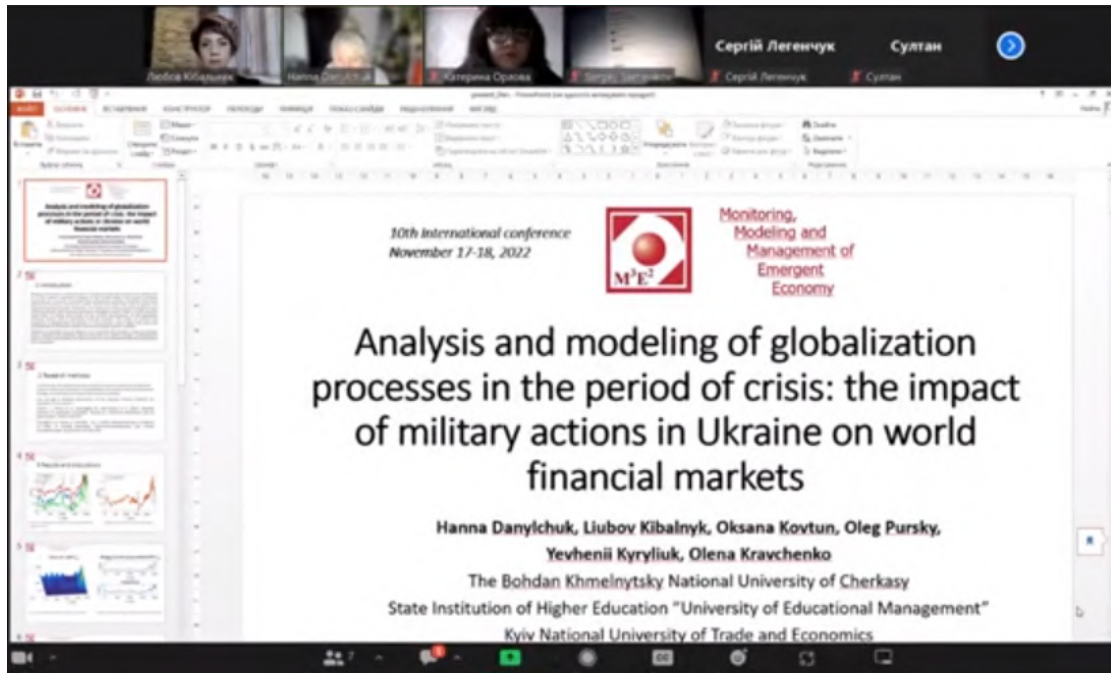
The paper then evaluates the performance of the three models on two datasets: IMDb Movie Reviews and Twitter Sentiment 140. The IMDb Movie Reviews dataset contains 50,000 movie reviews, each of which is labeled as either positive or negative. The Twitter Sentiment 140 dataset contains 1.4 million tweets, each of which is labeled as either positive, negative, or neutral.

The results show that the CNN model achieves the best accuracy of 90.1% on the IMDb dataset, while the BiLSTM-CNN model achieves the best accuracy of 82.1% on the Sentiment 140 dataset. The proposed models are comparable to state-of-the-art models and suitable for practical use in sentiment analysis of social media texts.

Here are some of the key points of the paper:

- The paper presents a comparative study of three deep learning models for sentiment analysis of social media texts.





**Figure 10:** Presentation of paper [49].

for natural gas, oil, gasoline, and currency pairs EUR/USD and GBP/USD. Wavelet entropy is a measure of the complexity and uncertainty of a signal or system. The results show that the war has caused a significant increase in the entropy of these markets, indicating that they have become more complex and uncertain.

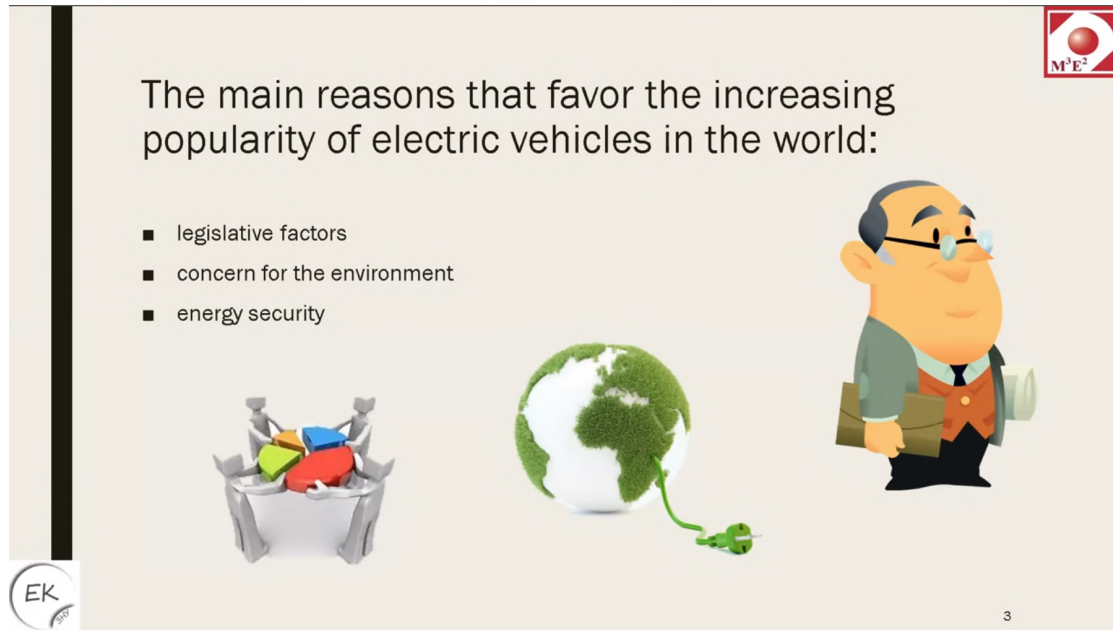
The paper concludes by discussing the implications of the findings for globalization and the world financial markets. The authors argue that the war has had a negative impact on globalization, and that it is likely to lead to a reconfiguration of the world economic space.

Here are some of the key points of the paper:

- The paper uses wavelet entropy analysis to study the impact of the war in Ukraine on the markets for natural gas, oil, gasoline, and currency pairs EUR/USD and GBP/USD.
- The results show that the war has caused a significant increase in the entropy of these markets, indicating that they have become more complex and uncertain.
- The authors argue that the war has had a negative impact on globalization, and that it is likely to lead to a reconfiguration of the world economic space.

The paper “Nonlinear dynamics of electric vehicle sales in China: a fractal analysis” by Serhii Kurkula, Nataliia Maksyshko, Dmytro Ocheretin, and Serhii Cheverda [50] applies three methods of nonlinear analysis to investigate the properties of the monthly sales volumes of the leading EV manufacturers in China from January 2016 to June 2022.

The paper begins by discussing the importance of electric vehicles (EVs) and the growth of the EV market in China. EVs are becoming increasingly popular due to their environmental



**Figure 11:** Presentation of paper [50].

benefits and lower running costs. China is the leading market for EVs, accounting for 45% of global sales in 2020.

The paper then discusses the challenges of forecasting EV sales. The EV market is a complex and nonlinear system, making it difficult to predict future sales.

The paper then applies three methods of nonlinear analysis to the monthly sales data: the Hurst normalized range method, phase analysis, and recurrence plots. These methods are used to identify the long-term memory, cyclicity, and determinism of the sales dynamics.

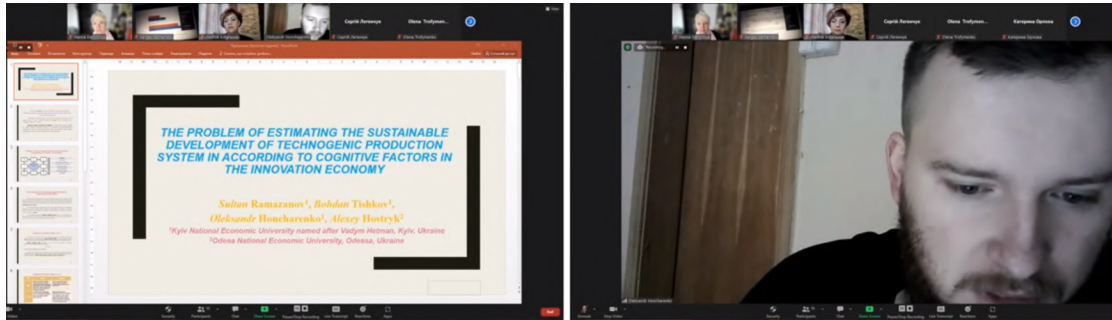
The results show that the sales dynamics exhibit fractal features, trend stability, long-term memory, cyclicity, quasi-cycles, and determinism. These findings can inform the selection of relevant forecasting methods and their parameters for the EV market in China.

Here are some of the key points of the paper:

- The paper applies three methods of nonlinear analysis to the monthly sales data of leading EV manufacturers in China.
- The results show that the sales dynamics exhibit fractal features, trend stability, long-term memory, cyclicity, quasi-cycles, and determinism.
- These findings can inform the selection of relevant forecasting methods and their parameters for the EV market in China.

The paper “A cognitive approach to modeling sustainable development of complex technogenic systems in the innovation economy” by Sultan K. Ramazanov, Bohdan O. Tishkov, Oleksandr H. Honcharenko, and Alexey M. Hostryk [51] proposes a cognitive approach to modeling sustainable development of complex technogenic production systems in the innovation economy.





**Figure 12:** Presentation of paper [51].

The paper begins by discussing the challenges of sustainable development of complex technogenic systems. These systems are characterized by nonlinear dynamics and uncertainty, and they are often affected by human behavior and decision-making.

The paper then proposes a cognitive approach to modeling sustainable development. This approach takes into account the cognitive factors that affect the behavior and decision-making of the system agents. The paper also proposes a model of innovation capital dynamics for the eco-economic and socio-humanitarian system (EESHHS). Innovation capital is broader than intellectual capital by its nature and content, and it is essential for sustainable development.

The paper then derives an extended integral model of nonlinear stochastic dynamics of EESHHS in the innovation space. This model can be used to predict the dynamics of EESHHS and to identify the factors that affect its sustainable development.

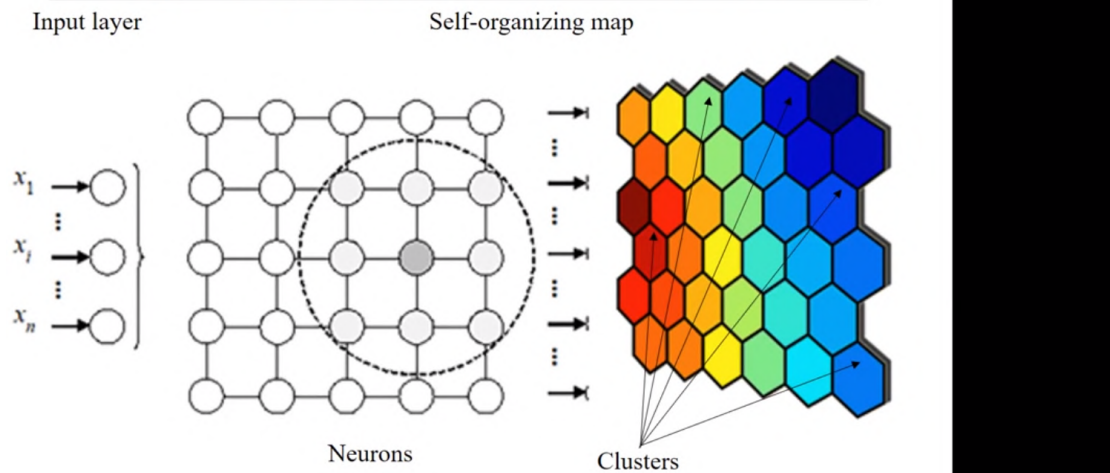
The paper concludes by discussing the implications of the findings for the modeling of sustainable development of complex technogenic systems. The paper argues that the cognitive approach is a promising approach for modeling sustainable development, and that it can be used to improve the accuracy of predictions and to identify the factors that need to be managed to achieve sustainable development.

Here are some of the key points of the paper:

- The paper proposes a cognitive approach to modeling sustainable development of complex technogenic systems.
- This approach takes into account the cognitive factors that affect the behavior and decision-making of the system agents.
- The paper also proposes a model of innovation capital dynamics for the EESHHS.
- The paper derives an extended integral model of nonlinear stochastic dynamics of EESHHS in the innovation space.
- The paper argues that the cognitive approach is a promising approach for modeling sustainable development, and that it can be used to improve the accuracy of predictions and to identify the factors that need to be managed to achieve sustainable development.

The paper “University competitiveness in the knowledge economy: a Kohonen map approach” by Dmytro H. Lukianenko, Andriy V. Matviychuk, Liubov I. Lukianenko, and Iryna V. Dvornyk [52] studies the factors of university competitiveness in the knowledge economy.

## Visual representation of a self-organizing map with clusters definition



**Figure 13:** Presentation of paper [52].

The paper begins by discussing the importance of universities in the knowledge economy. Universities play a key role in the generation and dissemination of innovations, and they are also becoming the drivers of digital transformation in science, business, countries, and society as a whole.

The paper then proposes a clustering approach to group countries based on their university competitiveness. The clustering approach is based on the Kohonen map, which is a neural network that can be used to cluster data points into groups. The paper uses the normalized parameters of university competitiveness to cluster countries into four groups: high-performing, medium-performing, low-performing, and very low-performing.

The paper then assesses the level of significance of the normalized parameters. The results show that the most significant parameters are research productivity, internationalization, and the number of publications in high-impact journals.

The paper then proposes an organizational design for a competitive model of the university. The proposed organizational design is based on the principles of open science, education, and innovation. The paper argues that this organizational design can help universities to improve their competitiveness and become drivers of innovation and transformation.

The paper concludes by discussing the key factors of the university's success in the system of open science, education, and innovation. These factors include:

- A strong focus on research and innovation
- A commitment to open science
- A global outlook

- A focus on entrepreneurship and the transfer of knowledge to society

The findings of this study contribute to the understanding of the factors that drive university competitiveness in the knowledge economy. The proposed organizational design and key factors of success can be used by universities to improve their competitiveness and become drivers of innovation and transformation.

Here are some of the key points of the paper:

- The paper studies the factors of university competitiveness in the knowledge economy using a clustering approach.
- The paper proposes an organizational design for a competitive model of the university based on the principles of open science, education, and innovation.
- The paper discusses the key factors of the university's success in the system of open science, education, and innovation.

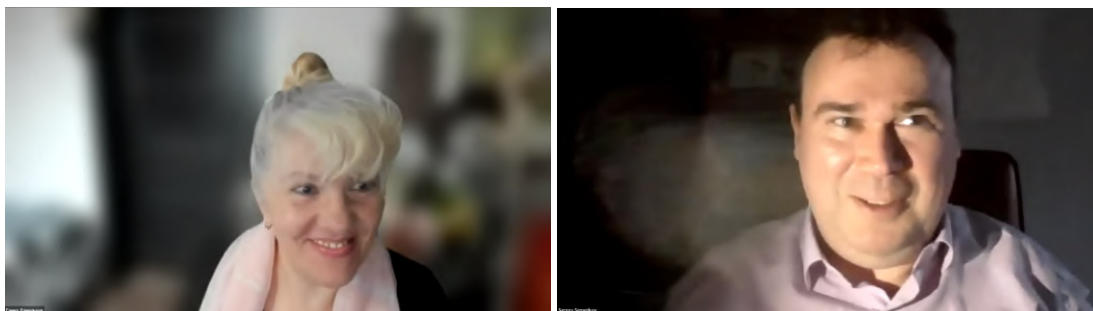
## 4. Conclusion

The vision of the M3E2 2022 is to provide a premier interdisciplinary platform for researchers, practitioners, and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of emergent economy.

The conference has successfully performed as a forum for transferring and discussing research results among researchers, students, government, private sector, or industries. Participants and presenters from several countries have attended the conference online to share their significant contributions in research related to Monitoring, Modeling, and Management of Emergent Economy.

We are thankful to all the authors who submitted papers and the delegates for their participation and their interest in M3E2 as a platform to share their ideas and innovations. We are also thankful to all the program committee members for providing continuous guidance and efforts taken by peer reviewers who contributed to improve the quality of papers. The constructive critical comments, improvements, and corrections provided to the authors are gratefully appreciated for their contribution to the success of the conference. Moreover, we would like to thank the developers and other professional staff of the *Not So Easy Science Education* platform (<https://notso.easyscience.education>) and the Academy of Cognitive and Natural Sciences (<https://acnsci.org>), who made it possible for us to use the resources of this excellent and comprehensive conference management system, from the call of papers and inviting reviewers, to handling paper submissions, communicating with the authors, etc.

The war in Ukraine has had a devastating impact on the country and its people. The scientific community in Ukraine has also been affected, with many researchers forced to flee their homes and laboratories. The M3E2 2022 conference was held in the shadow of this war, but it was also a testament to the resilience of the Ukrainian scientific community. The conference provided a platform for Ukrainian researchers to share their work and to connect with colleagues from around the world. We hope that the conference will help to rebuild the scientific community in Ukraine and to contribute to the country's recovery.



**Figure 14:** Hanna B. Danylchuk and Serhiy O. Semerikov, volume editors.

We also hope that the conference will contribute to the understanding of the war in Ukraine and its impact on the global economy. The papers in the proceedings address a variety of topics related to the war, including its impact on innovation, investment, and trade. We believe that these papers will be valuable resources for researchers, policymakers, and the general public.

Finally, we would like to express our solidarity with the people of Ukraine. We hope for a swift and peaceful resolution to the war.

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