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Exploring Academic Networks in the Fields of Cybernetics and Economics: A Bibliometric Analysis of the Economic Computation and Economic Cybernetics Studies and Research Journal

Abstract. *This study presents a thorough examination of the development of academic publications in the fields of cybernetics and economics, focusing on the ECONOMIC COMPUTATION AND ECONOMIC CYBERNETICS STUDIES AND RESEARCH (ECECSR) journal. The research proposes a bibliometric analysis of the journal's publications conducted in R Studio, using the Bibliometrix platform. The analysis will cover the period from 2007 to 2023. Different analytical techniques like three-field plot, cluster analysis, co-occurrence networks, and thematic evolution are used to investigate patterns and focus areas in published studies. The study shows a consistent focus on themes such as growth in the economy, connection of variables, growth at the community level and creativity, resilience at the local level, policies specific to certain locations, analysis of trends over time, and making predictions, illustrating attempts to comprehend and represent changes in the economy. Moreover, it underscores the need to adapt to changing economic circumstances, such as the COVID-19 outbreak, through a greater emphasis on performance, optimisation, and risk management. This study provides an in-depth look at the development of research in cybernetics and economics, highlighting the impacts and upcoming trends in this area of study.*

Keywords: *bibliometric analysis, place-based policies, local development and innovation, thematic evolution.*

JEL Classification: O10, R10, C00.

1. Introduction

Considering the complex nature of the environment, but also the digital age in which we find ourselves, the complexity generated by its nature highlights new opportunities to investigate new paradigms and research trends by studying the interconnection between cybernetics and economics. It is well known that cybernetics studies complex systems in complex and dynamic economic environments (Nica & Chiriță, 2021). Thus, in the light of this information, the Journal "*Economic Computation and Economic Cybernetics Studies and Research*" (ECECSR) can represent a scientific channel for academic and research activities in the disciplines of economics and cybernetics, facilitating the exchange of new discoveries and advances between experts in these fields. Within this framework, the present research introduces a bibliometric analysis that serves as a comprehensive investigation into the development of publications in this magazine. Its objective is to uncover the intricacies and patterns that influence the scholarly domain of cybernetics and economics.

In this research, we will use complex data analysis tools and bibliometric methodologies with the aim of investigating the progress of researchers from both fields presented previously. The analysis will include the analysis of scientific articles from the period 2007-2023 and will aim to investigate and highlight the objectives, changes and resilience of the academic community in the face of the difficulties generated by the global economic crisis and the COVID-19 epidemic. Also, our study will highlight how the scientific community has adapted to the complex and dynamic problems of the modern world.

Established in 1966, the ECECSR journal aims to publish original, innovative, and high-quality articles in diverse fields such as mathematical modelling of economic phenomena, neural networks, mathematical programming, and artificial intelligence, all of which provide a wide range of mathematical, economic, and computer science methods, models, and tools to capture the dynamics of complex phenomena studied from a cybernetic perspective.

Based on the main purpose of the study to analyse the evolution of publications in the ECECSR journal, we will establish the following three research questions (RQs):

RQ1: Is there a correlation between the development of articles in the ECECSR journal and the changing priorities and trends in academic research in the areas of cybernetics and economics?

RQ2: What are the dominant topics and fundamental ideas in the articles of the ECECSR journal, and how do they reflect the changing priorities and trends in academic research in the fields of cybernetics and economics over time?

RQ3: Do the articles in the ECECSR journal accurately reflect the problems and trends in the field of local development and innovation? Moreover, how do these characteristics evolve over time within the realm of scholarly investigation in the fields of cybernetics and economics?

The organization of our investigation is as follows: Section 2 is dedicated to describing the methods and computer program used for bibliometric analysis. Section 3 is devoted to presenting the outcomes that were achieved. The following part focusses on providing the results and debates pertaining to the three study topics that have been addressed.

2. Literature review

Bibliometric analysis has been chosen as the analysis method for the papers published in the 2007-2023 period by the Economic Computation and Economic Cybernetics Studies and Research journal as it offers the needed tools for exploring the topics and the impactful articles, along with the most prominent authors and their affiliations within the journal under investigation (Block & Fisch, 2020). The bibliometric analysis, unlike the review type analysis, explores the structural aspects of the investigated field, emphasizing its evolution and organization. In contrast, review-type analysis focusses mainly on summarizing the content and significant findings from a particular field of research (Cibu et al., 2023). As a result, over time it has been used in various analyses from different research areas, such as, but not limited to: eco-innovation and sustainable development (Fatma & Haleem, 2023), regional resilience (Miranda Júnior & Hoffmann, 2021), education for sustainability (Gorski et al., 2023), educational artificial intelligence (Moreno-Guerrero et al., 2020), fuzzy logic (Nica et al., 2024).

The primary objective of the study is to examine the papers published by the Economic Computation and Economic Cybernetics Studies and Research. To accomplish this, a dataset has been carefully extracted from Clarivate Analytics' Web of Science Core Collection, which was previously known as the Web of Science (WoS) platform. (WoS, 2023).

Regarding the decision to use the WoS platform instead of other platforms such as Scopus, it is based on two principles. According to previous research, WoS ensures a comprehensive coverage of different research, as highlighted by the studies carried out by Cobo et al. (2015) and Modak et al. (2019). Also, through the selective inclusion of journals, according to the research of Mulet-Forteza et al., 2018, this aspect contributes to increasing its reputation within the scientific community. This idea is also supported by the study by Bakir et al. (2022) in which they supported the use of WoS in bibliometric analysis. Moreover, Moreno-Guerrero et al. (2020), as well as Yu & Muñoz-Justicia (2020) emphasize the use of WoS as a preferred platform for bibliometric studies in various themes, fields and research areas.

Although alternative databases offer options for dataset extraction, our primary preference remains WoS due to the aforementioned reasons. This choice is reinforced by the compatibility of WoS data with the bibliometric analysis tool Biblioshiny (Aria & Cuccurullo, 2017), allowing direct importation of raw data.

In order to access publications that are included in the WoS database under the category of Economic Computation and Economic Cybernetics Studies and Research, the search in the database was conducted using the journal name. This

approach yielded a total of 1139 papers spanning from 2007 (the year of journal indexing in the WoS database) to the present. Since all of the papers are written in English, applying a language filter did not reduce the sample size. Similarly, when restricting the paper type to "articles", the sample size remained unchanged. Consequently, the database of 1139 papers will be analysed alongside the present paper.
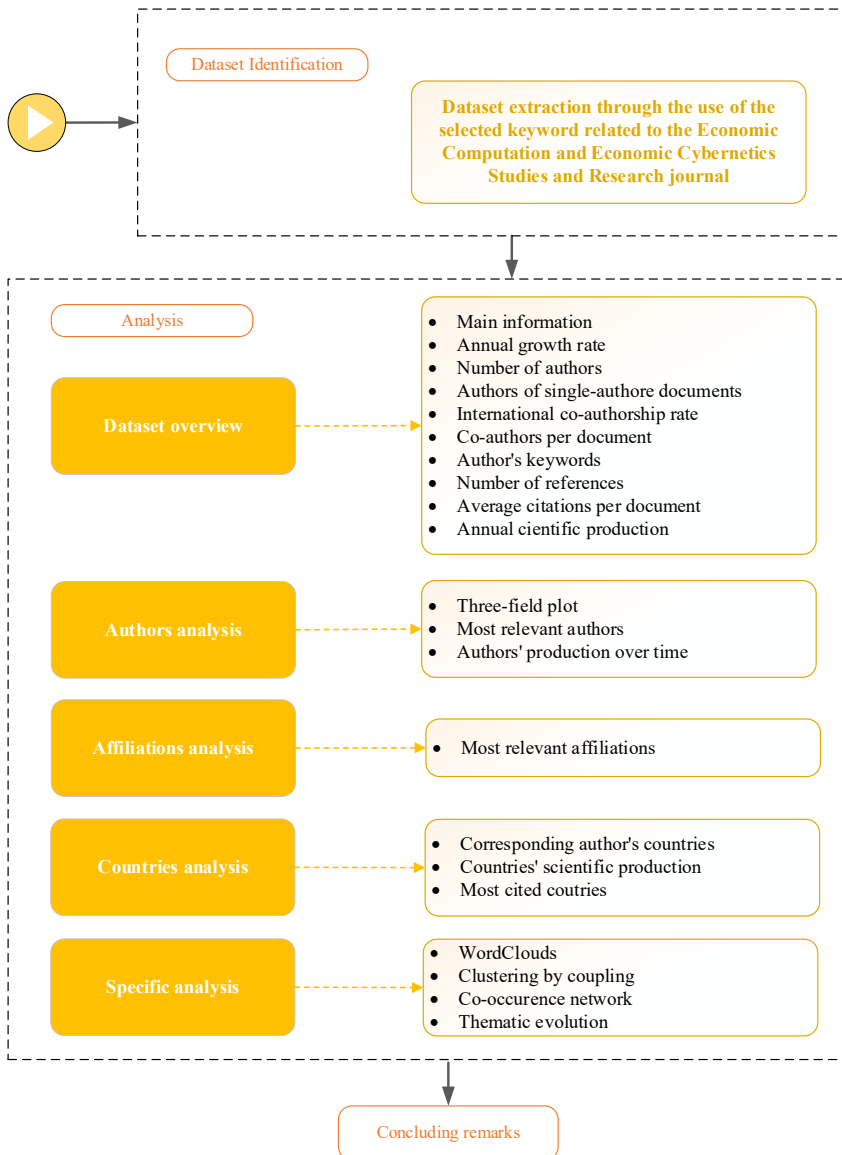
Dataset Identification

Dataset extraction through the use of the selected keyword related to the Economic Computation and Economic Cybernetics Studies and Research journal

Analysis

Dataset overview
- Main information
- Annual growth rate
- Number of authors
- Authors of single-authore documents
- International co-authorship rate
- Co-authors per document
- Author's keywords
- Number of references
- Average citations per document
- Annual cientific production

Authors analysis
- Three-field plot
- Most relevant authors
- Authors' production over time

Affiliations analysis
- Most relevant affiliations

Countries analysis
- Corresponding author's countries
- Countries' scientific production
- Most cited coutries

Specific analysis
- WordClouds
- Clustering by coupling
- Co-occurence network
- Thematic evolution

Concluding remarks

Figure 1. Methodological framework
Source: Authors' own creation.

The methodological framework employed in this paper is the bibliometric approach, which includes several analyses. These analyses encompass a dataset overview, the examination of authors, affiliations, countries, and specific analyses related to the most frequently used words in terms of keywords and authors' keywords. Additionally, the framework explores the association between different groups of keywords, the correlation of key terms, and the evolution of research themes. Figure 1 presents a brief summary of the methodological framework used in this paper.

Furthermore, it is worth noting that Wu et al. (2020) conducted comparable research using bibliometric analysis, but focusing on a distinct time frame. The work provides an analysis of the citation structure, research topics and co-authorship analysis, underscoring the contribution of the Economic Computation and Economic Cybernetics Studies and Research to the economic field within the Romanian landscape and abroad.

3. Results

For the proposed analysis, we used the WoS platform and extracted all publications belonging to the ECESR journal. The most important information is presented in Table 1. The documents have been collected for the period 2007-2023, providing a comprehensive overview of the evolution of research and the areas of interest of the ECESR journal. Following the query in WoS, 1139 articles have been extracted, reflecting a considerable effort in research and publication in the fields of cybernetics and related economics with mathematical modelling, operations research, mathematical programming, artificial intelligence, and others. The annual growth rate of the number of documents is 3.19%, indicating an upward trend in scientific production in these research areas. The significant involvement of the academic community in research and the dissemination of their results is supported by a high number of authors, more than 2000 authors contributing to the works published in the journal. Also, this aspect is supported by the 14.4% percentage of international co-authorship, emphasizing that the ECECSR Journal facilitated collaborations between researchers from various countries and institutions. The total number of 3980 author keywords reflects the thematic diversity of research published in the journal and the variety of academic interests in the fields of cybernetics and economics. The published works are supported by an impressive number of 21896 references, indicating a solid knowledge base and a close connection with other relevant works and theories. With an average of 3.85 citations per document, the ECESR journal appears to be well-received in the scientific community, indicating significant influence and recognition of the published works.

Table 1. Main information extracted from the WoS platform

Description	Results
Timespan	2007:2023
Documents	1139

Description	Results
Annual growth rate	3.19%
Authors	2126
Authors of single-authored documents	115
International co-authorship	14.4%
Co-authors per document	2.94
Author's keywords	3980
References	21896
Average citations per document	3.85

Source: Authors' processing.

Figure 2 illustrates the growth of research and academic activity in the analysed topic throughout the specified time period by displaying the annual publication count of papers. We observe that the number of published articles varies over the years, with minor fluctuations in some periods. Overall, there is a trend of increasing scientific production from the beginning of the analysed period until 2014, after which the number of articles seems to remain relatively constant or experiences slight fluctuations in the following years. The years with the highest values of scientific production are 2022, with 79 articles, and 2021, with 77 articles, while the year with the lowest production is 2008, with 37 articles.
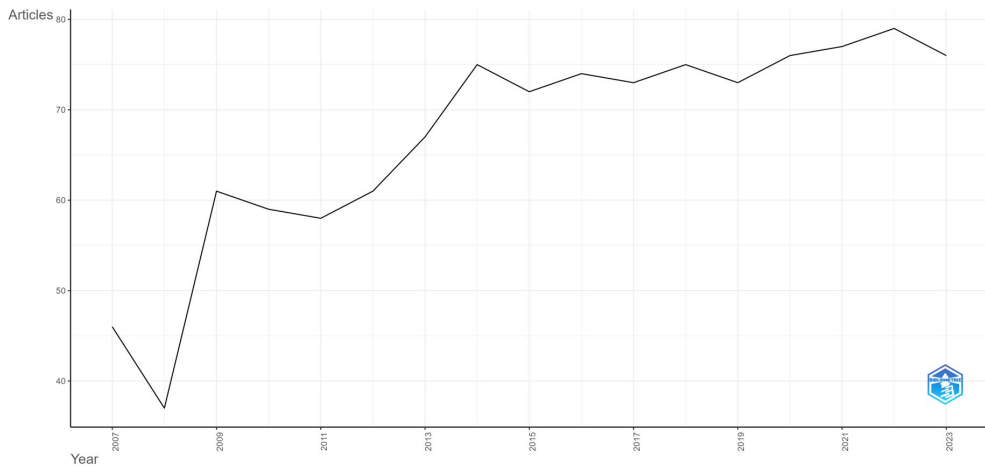
Figure 2. Annual Scientific Production
Source: Authors` own computation.

In Figure 3, we constructed a three-dimensional plot with three distinct domains: keywords plus (left), countries (centre), and authors keywords (right). In the left part of the graph, we have keywords such as "impact", "model", "economic

growth", "performance", and "growth", each with a number of outgoing connections to other terms in the graph. This suggests that these keywords are central in the network of concepts analysed and have a significant influence on other concepts. In the centre of the graph, we find countries such as Romania, China, Iran, Turkey, Lithuania, Malaysia, Korea, and Spain. These countries have bidirectional linkages, suggesting that they are subjects of interest in the analysis and actively engage of information and ideas with other concepts and entities. Furthermore, we observe countries like Romania, China, Turkey, and Korea that are connected with keywords such as "impact", "performance", and "growth". This could suggest that these countries are associated with strategies for local development and innovation, and their connections with these keywords may indicate that they are involved in policies and initiatives aimed at improving economic performance and growth in their regions. On the right side of the graph, we find keywords such as "economic growth", "forecasting", "monetary policy", "data envelopment analysis". These keywords have inbound link but no outbound connections. This suggests that these ideas have a less central role in the examined network and have less impact on the interchange of information with other concepts.
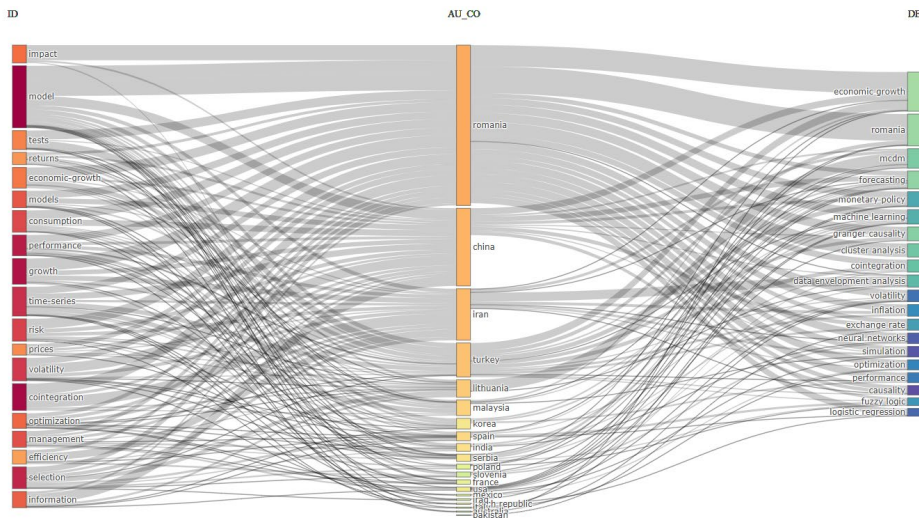

Figure 3. Three-Field Plot representation
Source: Authors' own computation.

Another perspective we analysed was that of the top 10 most relevant authors ranked by the number of publications in the ECECSR journal. In Figure 4, this top can be observed, where, in the first place with 18 publications, we find Zavadskas E.K., followed by Stancu S., Andrei T., and Lungu I. From the perspective of productivity over time of these top 10 most relevant authors, Figure 5 was created. The larger and more intense blue the dot is, the more it indicates that the author has a higher number of published articles and a significant number of citations for that particular year.
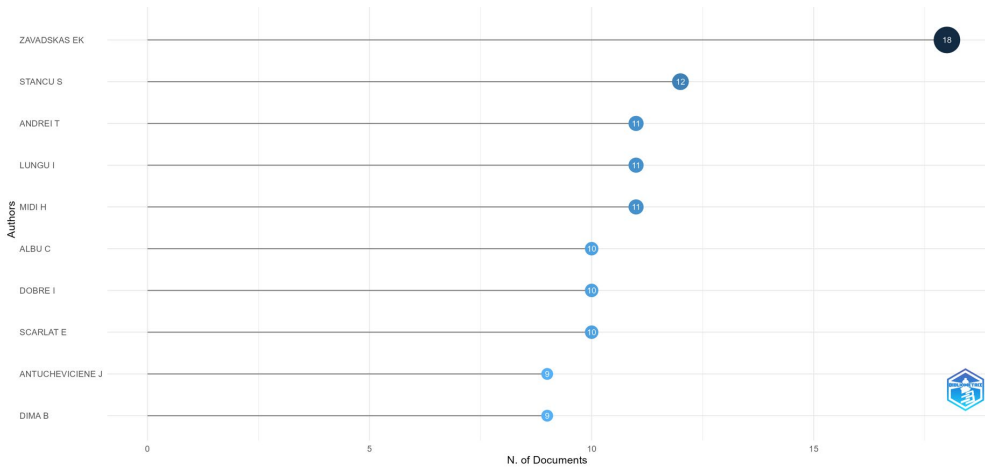
Figure 4. Most Relevant Authors
Source: Authors' own computation.

Figure 5 shows that in 2015, author Zavadskas E.K. had the highest number of publications with 3 papers. However, in terms of citations obtained, the most significant year was 2016, with 43 citations.
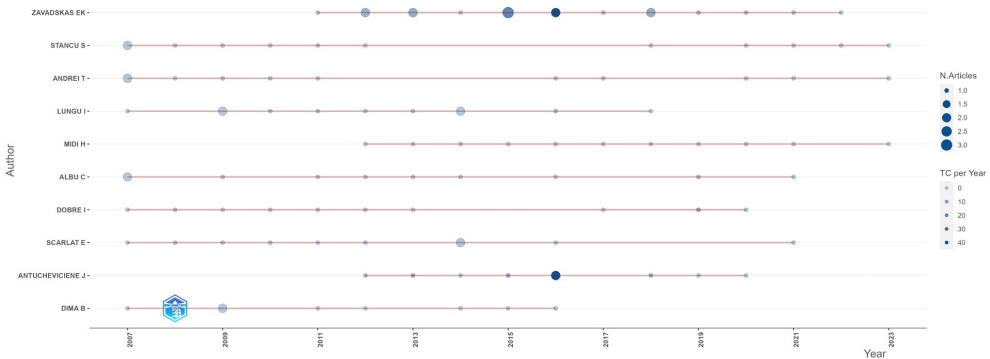

Figure 5. Authors' Production over Time
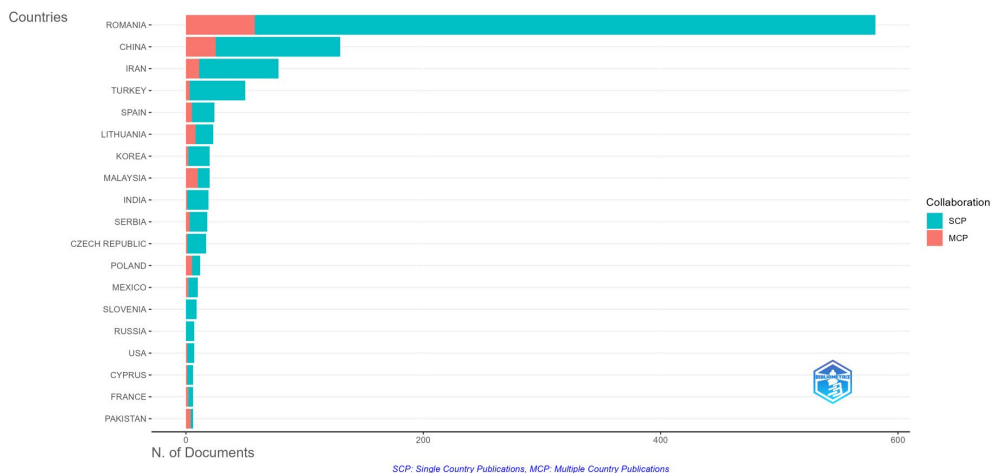*Source*: Authors' own computation.

Table 2 presents the affiliations considered most relevant in the context of the number of articles published in the journal analysed. Certainly, the *Bucharest University of Economic Studies* dominates in this regard, with a significant number of 583 articles. This may reflect the commitment and consistent contribution of this institution to the field of economic research. On the other hand, other affiliations in the list, such as the *Islamic Azad University* and the *West University of Timisoara*, also present a considerable number of articles but to a lesser extent compared to the Bucharest University of Economic Studies. These figures highlight the diversity and contribution of multiple institutions to the field of economic research, providing an insight into their academic commitment and impact on the field.

Table 2. Most Relevant Affiliations

Affiliations	Articles
Bucharest University of Economic Studies	583
Islamic Azad University	67
West University of Timisoara	45
University of Bucharest	41
Romania Academy of Sciences	34
Vilnius Gediminas Technical University	30
National University of Science and Technology Politehnica Bucharest	21
University Putra Malaysia	19
Alexandru Ioan Cuza University	14
Lucian Blaga University of Sibiu	14

Source: Authors' processing.

Figure 6 presents an analysis of scientific production in the field of research focusing on the metrics associated with corresponding author's countries.

Figure 6. Corresponding Author's Countries
Source: Authors' own computation.

As expected, Romania has a significant production of publications, being present in both single-affiliation and multiple-affiliation publications. Similarly, China and Iran also show a considerable presence in publications, both as single affiliations and in collaboration with other countries. Turkey and Spain, while present in fewer publications, maintain a relatively high proportion of publications in which they are affiliated with other countries. Therefore, there is a significant variation in the frequency of appearance of different countries in the analysed

publications, reflecting the level of commitment and contribution of each country to economic research. Furthermore, we conducted an analysis of scientific production at the global level. Figure 7 depicts this analysis, where we observe that Romania has the highest publication frequency, followed by China, Iran, Turkey, Lithuania, Malaysia, and Spain.
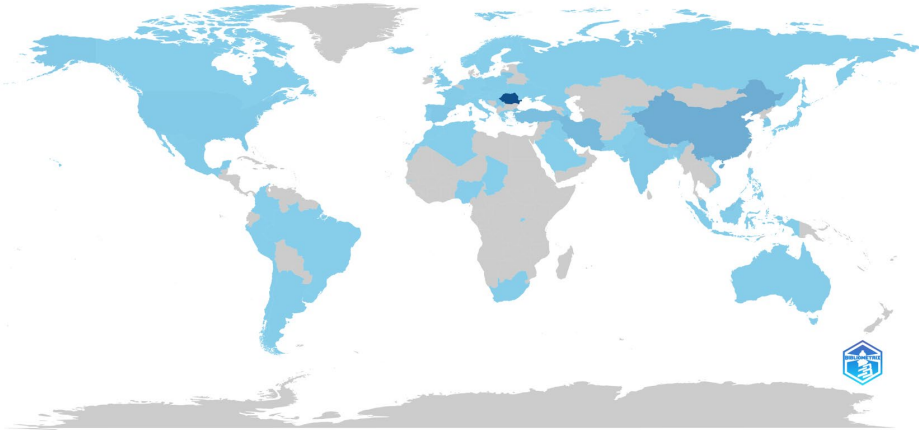

Figure 7. Countries' Scientific Production
Source: Authors' own computation.

Also, in Figure 8, we illustrated the top 10 most cited countries. Romania has the highest number of citations, totalling 1531, followed by Lithuania with 927 citations and China with 475. Additionally, this ranking includes countries such as Spain with 106 citations, Serbia with 104, and India with 81.
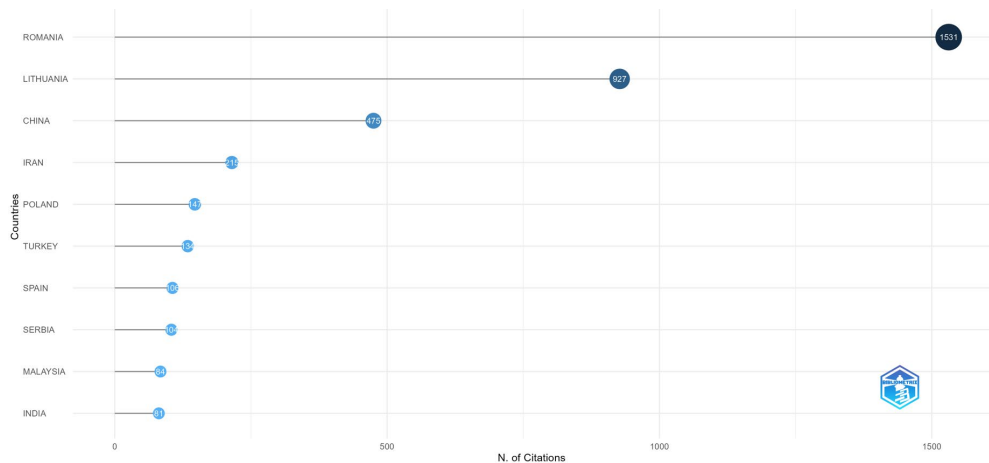

Figure 8. Most Cited Countries
Source: Authors' own computation.

Figure 9 presents important insights into the prevalent themes and key concepts in our research. Thus, we observe that the keyword "*model*" appears most frequently in the publications in the ECECSR journal, suggesting a focus on developing theoretical frameworks or empirical models for cybernetic and economic analysis. Additionally, from an economic perspective, this concept could be relevant for developing an integrated model of local development. The keyword "*cointegration*" suggests a focus on analysing long-term relationships between economic variables, which could be relevant for understanding the dynamics of regional economies. The subsequent term which frequently appears in the studied journal papers is "growth". This may indicate a substantial interest in economic growth, which aligns with the increasingly relevant goals related to economic development and resilience.

Figure 9. WordCloud by Keywords Plus
Source: Authors' own computation.

Analysing the frequency of author keywords in Figure 10, we notice that some of the most widespread concepts are "*economic growth*", "*Romania*", and "*forecasting*".
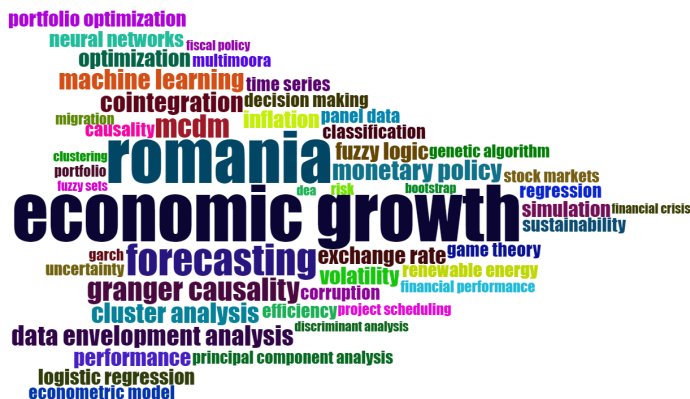

Figure 10. WordCloud by Author's Keywords
Source: Authors' own computation.

This suggests that the research focusses on analysing and understanding economic growth in the context of Romania, with an emphasis on the ability to forecast future developments. Additionally, we observe the presence of specific technical terms and methodologies such as "*Granger causality*", "*cluster analysis*", "*cointegration*", "data envelopment analysis", "machine learning", and "monetary policy", indicating a rigorous and diverse analytical approach in economic research. These concepts could be used to explore and evaluate factors influencing economic growth, including monetary policy, trading behaviour, and the effects of various variables on economic performance.

Subsequently, we performed a clustering analysis by coupling to determine the correlation between different groups of phrases in our study. Thus, in Figure 11, we observe that 7 clusters have formed placed in the four quadrants based on impact and centrality.
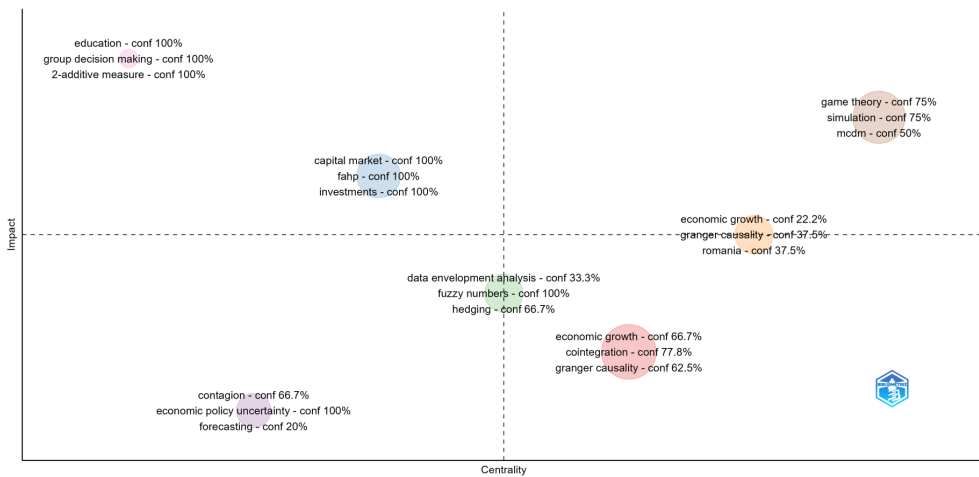

Figure 11. Clustering by coupling
Source: Authors' own computation.

The first cluster (pink) presents concepts such as "*education*", "*group decision making*", and "*2-additive measure*". These concepts suggest a concern for decision-making processes and information management in an educational context and for the development of public policy. The second cluster (blue) features keywords "*capital market*", "*fahp*", and "*investments*", indicating a focus on the capital market and financial decision-making processes. Therefore, this cluster illustrates that publications in the ECECSR journal emphasise aspects related to investments and evaluating the performance of the financial market. The next cluster (purple) contains terms such as "*contagion*", "*economic policy uncertainty*", and "*forecasting*". This cluster suggests an investigation into the impact of economic policies and uncertainty on the financial market and the economy in general. Additionally, the analysis of future forecasts and potential economic contagion effects appears to be an important aspect for authors publishing in the ECECSR journal. Another cluster (green) includes keywords "*data envelopment analysis*", "*fuzzy numbers*", and "*hedging*". These concepts suggest a concern for risk

management and evaluating efficiency in the context of market fluctuations and uncertainty. The concepts "*economic growth*", "*cointegration*", and "*granger causality*" form another cluster (red), suggesting an investigation into the relationships and dynamics of economic growth using advanced analysis and modelling. Additionally, a similar cluster contains, alongside "*economic growth*" and "*cointegration*", the keyword "*Romania*", indicating a specific focus on the economic regional development of Romania and the factors influencing economic growth in the country. The last formed cluster (brown) consists of keywords "*game theory*", "*simulation*", and "*mcdm*", indicating a concern for modelling and simulating economic processes, as well as for using multi-criteria decision-making techniques in a complex economic environment.

In figure 12 we made the co-occurrence network that illustrates the connection and importance of the significant keywords in our study. The algorithm uses the Walktrap method, generating six clusters. In the first cluster (red) it can be seen that the importance of modelling and selecting appropriate information to manage risk and obtain optimal results in various economic contexts, with a special emphasis on optimisation processes and efficient management, is highlighted. Regarding Cluster 2 (blue), it can be seen that it groups keywords that underline the interest of researchers in the analysis of volatility and the models used in order to understand and anticipate fluctuations in the performance and behaviour of financial markets. Cluster 3 (green) indicates interest in analysing economic growth and long-term relationships between economic variables, also highlighting concern for the impact and behaviour of the economy over time. Cluster 4 (purple) can indicate concern for predicting future trends and financial events, as well as identifying and evaluating the risk of bankruptcy. An important emphasis is also placed on decision-making processes, as can be seen in Cluster 5 (orange). The classification in this cluster emphasizes the attention of specialists on how aggregation operators are used to combine information and streamline the decision-making process. Also, Cluster 6 (brown) indicates a special attention on how to evaluate the efficiency and compare the performance of economic entities using data envelopment analysis.
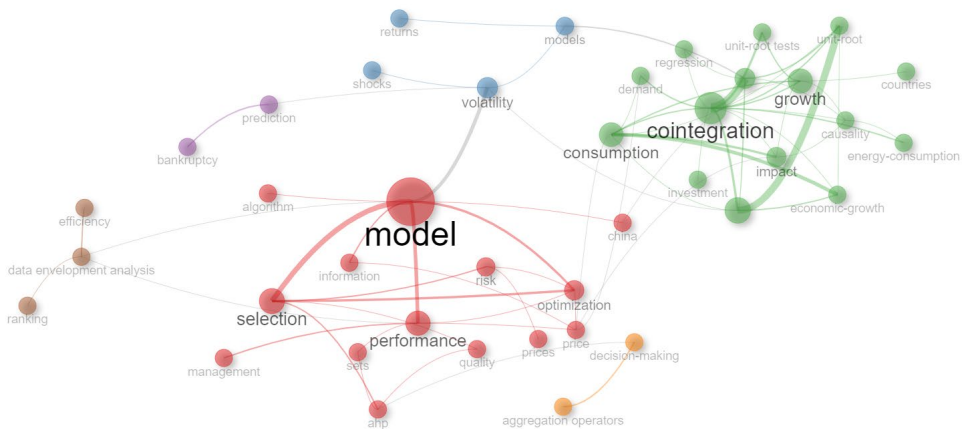

Figure 12. Co-occurrence Network
Source: Authors' own computation.

To analyze changes in the evolution of interests and focuses in the research published in the ECECSR journal, the thematic evolution graph in Figure 13 was created.
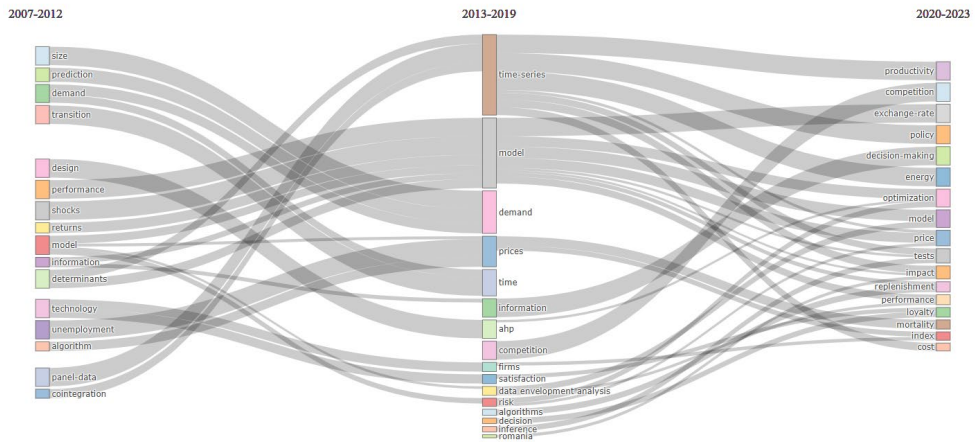

Figure 13. Thematic Evolution
Source: Authors' own computation.

The research was divided into three distinct time periods. The period spanning from 2007 to 2012 is associated to the worldwide economic crisis that occurred between 2007 and 2009. The period from 2013 to 2019 is characterised by the consequences on the worldwide economic downturn and the context of the COVID-19 pandemic. The last period describes the contemporary circumstances. During the first period examined, there is a notable focus on concepts such as "*cointegration*", "*model*", "*time-series*", and "*forecasting*" is observed. These keywords indicate efforts to understand and model economic dynamics and predict future developments, in an effort to manage the uncertainty and volatility caused by the crisis. In the second period analysed, there is a diversification of key terms, reflecting efforts to rebuild and adapt to new economic realities post-crisis and in the context of the COVID-19 pandemic. Increased attention is noted for terms such as "*performance*", "*optimisation*", "*prediction*", and "*risk*", reflecting concerns for efficiency, adaptability, and risk management in an unstable economic environment. In the current period, there is an emphasis on terms such as "*policy*", "*exchange-rate*", and "*competition*", reflecting the new challenges and changes in the current economic context, such as pandemic management, adaptation to changes in trade, and economic policies. There is also a continuation of previous concerns, such as "*model*" and "*performance*", indicating the persistence of certain aspects of economic research over time.

4. Conclusions

Our research in this study focused on exploring trends, priorities and changes in academic research, contextualising its evolution considering the events and

challenges of the analysed periods. Next, we will highlight the impact of these findings on the understanding of the evolution of research in the fields of cybernetics and economics, and we will discuss their implications for the future directions of academic research in this field.

Our analysis has revealed a significant number of articles published in the ECECSR Journal, reflecting an increase in interest in research and publication in the fields of cybernetics and economics, especially regarding mathematical modelling, operational analysis, mathematical programming, and artificial intelligence (RQ1). The results obtained regarding the scientific production, characterised by an annual growth rate of 3.19%, indicate an upward trend and a concern in these fields of research. This aspect is also supported by the significant involvement of the academic community, supported by a high number of authors and the increase in international collaborations. Furthermore, our results have highlighted that some of the most frequent keywords in the publications from the ECECSR Journal are "*model*", "*cointegration*", and "*growth*". These findings suggest a significant interest in developing theoretical frameworks or empirical models for cybernetic and economic analysis, analysing long-term relationships between economic variables, and exploring the factors influencing economic growth (RQ2). The thematic evolution analysis of the publications in the ECECSR Journal indicates a shift in research concerns, reflecting adaptation to new economic realities and concerns for efficiency and adaptability. Regarding the last three years analysed (RQ3), the analysis of the thematic evolution of the ECECRS Journal publications indicates a high emphasis on key concepts such as "economic policies", "economic growth" and "machine learning". This highlights the challenges and changes in the current economic context, such as managing the pandemic and adapting to changes in economic policies and international trade, as well as the increased interest in local development and innovation.

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