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UNRAVELLING ECONOMIC COMPLEXITY: A SYSTEMATIC EXPLORATION OF THEMES AND TRENDS THROUGH LITERATURE AND KEYWORD NETWORK ANALYSIS

Sonali Singh[1], Sanjay Kumar Singh[2], Vijay Lakshmi Singh[3] Mariana Petrova[4]

[1), 2] Indian Institute of Management, Lucknow, India
[3)] Jaipuria Institute of Management, Lucknow, India
[4]St. Cyril and St. Methodius University of Veliko Tarnovo, Veliko Tarnovo, Bulgaria

e-mails: [1]phd21004@iiml.ac.in, [2]sanjay@iiml.ac.in, [3]vijaylakshmi.singh@jaipuria.ac.in, [4]m.petrova@ts.uni-vt.bg

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ABSTRACT

***Background**: The Economic Complexity Index (ECI) is a robust and computationally viable measure that captures the diversity and sophistication of an economy's industrial sector, reflecting the knowledge and capabilities embedded in its export basket. The rapid growth in scholarly literature employing economic complexity measures necessitates a systematic review of how ECI has been studied, applied, and understood by economists, policymakers, and researchers. **Objectives:** This study synthesises 215 "Economic Complexity" articles published in Web of Science (WoS) journals from 2006 to 2022. **Methods/Approach:** Using Systematic Literature Network Analysis (SLNA) and Keyword Network Exploration (KNE), the review identifies key trends, critical issues, and emerging topics in the field. SLNA integrates bibliographic networks with systematic literature reviews, while KNE explores thematic interconnections through keyword co-occurrence analysis. Open-source tools such as Sci2, Pajek, Biblioshiny (R-Package), and VOSviewer facilitated network extraction and analysis. **Results:** The findings highlight future research directions, including innovation, regional studies, institutions, human capital formation, ecological footprint, and firm-level economic complexity. **Conclusions:** This research provides essential insights into the development of economic complexity studies and outlines a pathway for future exploration.*

Keywords: Economic Complexity, Systematic Literature Network Analysis, Citation Analysis, Circular Main Path, Keyword Network Analysis.

JEL classification: *C80, L60, F10, F40, Q50, O11*
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INTRODUCTION

Traditionally, macroeconomic indicators measure economic health using the GDP growth rate, unemployment rate, inflation rate, exchange rate stability, and industrial production (McKinnon, 1988). The evaluation of national economic health depends on these essential indicators, yet they present specific drawbacks (Sikdar, 2020). Assessing them is a lengthy process as it is resource-intensive, time-consuming, and costly, especially for individual researchers and smaller institutions (Gao & Zhou, 2018). Traditionally used indicators prove inadequate in measuring how capabilities and economic knowledge interact across

[2] Corresponding author, **Sanjay Kumar Singh** – sanjay@iiml.ac.in

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economies, while both factors remain fundamental for sustained development (Crisp et al., 2023). "Economic complexity" is today an essential breakthrough concept that enhances understanding of economic structure and performance by analysing embedded capabilities in national manufacturing systems (Hartmann et al., 2017).

As described by Hausmann (2013) and supported by Hidalgo et al. (2007), Hidalgo and Hausmann (2009), and Mealy and Teytelboym (2022), a nation's industrial structure and productive capabilities can be examined using the economic complexity framework through exporting basket assessments. The economic growth framework incorporates capabilities when studying national development by combining technological resources with physical assets, legal systems, administrative capabilities, and knowledgeable workforces (Dam & Frenken, 2022). Production of goods and services requires all physical resources, human talents, and regulations, constituting necessary abilities.

The production process requires the active and simultaneous use of complementary capabilities. When economies merge established capabilities with new capabilities, they produce innovative products that lead to economic value creation (Sutton & Trefler, 2016). New capabilities accumulate steadily through development, allowing industries to manufacture progressively complex and varied products. Enhanced product diversity and technical complexity drive manufacturing complexity while increasing the need for implicit technical expertise and scattered information.

Only nations with a broad spectrum of capabilities are equipped to produce highly complex products which go beyond resource abundance or low-cost labour. Advanced expertise, together with significant knowledge-sharing and establishing robust professional and social networks, are requirements for accessing these products (Hidalgo, 2015). A country's productive structure operates as a meaningful indicator both for social assets and the institutional frameworks sustaining its economic infrastructure.

The origins of economic complexity literature can be traced back to the late 1990s, although the first journal article on the subject indexed in the Web of Science (WoS) appeared in 2006. Early efforts to study economic complexity focused on analysing the economy as a complex system shaped by its components and interactions among heterogeneous objects and economic agents (Durlauf, 1998). Viewing economic complexity as a network phenomenon, Sonis and Hewings (1998) introduced a methodology to analyse regional economic sustainability, structural stability, and changes in economic networks, highlighting the interplay between internal and external trade among regions.

The concept of economic complexity was further refined as a driver of economic growth by Hausmann et al. (2005), who emphasised its role as a growth accelerator. Around the same time, Narayan and Smyth (2006) explored socio-economic complexity to examine the relationships between judicial caseload, real income, and urbanisation in Australia. The analysis landscape evolved significantly when Hidalgo et al. (2007) developed the *product space* framework. Under this approach, experts revealed that advanced products cluster toward central locations within product networks, corresponding to highly interconnected areas, whereas simpler products form distant outer network locations. According to their analysis, nations

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achieve growth by systematically upgrading their production and export technologies, leading them to deliver sophisticated products. Nations advance in the product space by acquiring the necessary resources and adaptive technologies while developing suitable institutions and patterning appropriate skills to generate similar products.

Hidalgo and Hausmann (2009) introduced the Economic Complexity Index (ECI) to measure such complexity after building their initial foundation. The economic complexity idea first surfaced during the late 1990s, yet it required nearly ten years to establish its quantitative framework for investigation and measurement. A nation's export basket evaluation through the Economic Complexity Index (ECI) establishes a strong metric to gauge economic development sophistication while providing reliable future economic success predictions (Balland et al., 2022). The economic complexity index demonstrates production sophistication alongside different organisational capabilities through increased numerical value (Boleti et al., 2021). Countries with advanced economic performance display the ability to sell a diverse set of advanced products on international markets. According to research by Hausmann *et al*. (2005), Hidalgo and Hausmann (2009), and Tacchella et al. (2012), increased wealth correlates to more diverse trade portfolios, and wealthier nations demonstrate higher levels of economic complexity.

This study seeks to identify significant areas of economic complexity research and trace their historical development since 2006. The research analyses breakthrough studies alongside emerging trends to present insights about recent developments while highlighting future trends. The researchers analysed 215 WoS-published articles between 2006 and 2022 following the Systematic Literature Network Analysis methodology described by Colicchia and Strozzi in 2012. Systematic Literature Network Analysis combines SLR's bibliometric evaluation with network analysis to detect discipline patterns, developmental pathways, and essential discourse elements (Strozzi et al., 2017).

Combining algorithms and bibliometric networks in structured literature review analysis (SLNA) delivers a more objective systematic review method than traditional descriptive approaches. According to Colicchia et al. (2019), SLNA allows researchers to discover new trends while gaining insight into how knowledge evolves within specific fields. Our research represents the initial use of SLNA in economic complexity.

Research in economic complexity builds upon the existing knowledge base in this emerging yet developing field of study. The research investigation explains significant trends while offering future scholars helpful pathfinding directions. This investigation departs from typical review methods by implementing an advanced analytical system that utilises network-based techniques, according to Newbert (2007) and Sepehrdoust et al. (2019). Economic complexity gains significant research value because of its limited coverage in academic literature through this expansive analytical view.

The remaining paper is structured to begin with an overview of SLNA methodology, followed by its initial segment, the Systematic Literature Review (SLR) phase. This is followed by Network Analysis (NA) and its fundamental sub-elements, which function as the secondary segment of SLNA. The following section

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supplements the SLNA analysis with keyword exploration. Finally, a conclusion with insights and directions for future research is provided.

SYSTEMATIC LITERATURE NETWORK ANALYSIS METHODOLOGY

Colicchia and Strozzi developed the Systematic Literature Network Analysis (SLNA) methodology in 2012, presenting a modern framework for analysing temporal literature. This method combines two established approaches: Systematic Literature Review (SLR) and Network Analysis (NA). SLNA creates an integrated analytical framework from Methodologies SLR and NA, which helps researchers detect influential articles that promote knowledge advancement (Denyer & Tranfield, 2009). The systematic approach of SLNA provides researchers with enhanced domain understanding through its mapping of literature information and its identification of relations and critical contributions between sources. Figure 1 shows the blueprint of the methodology decomposition.

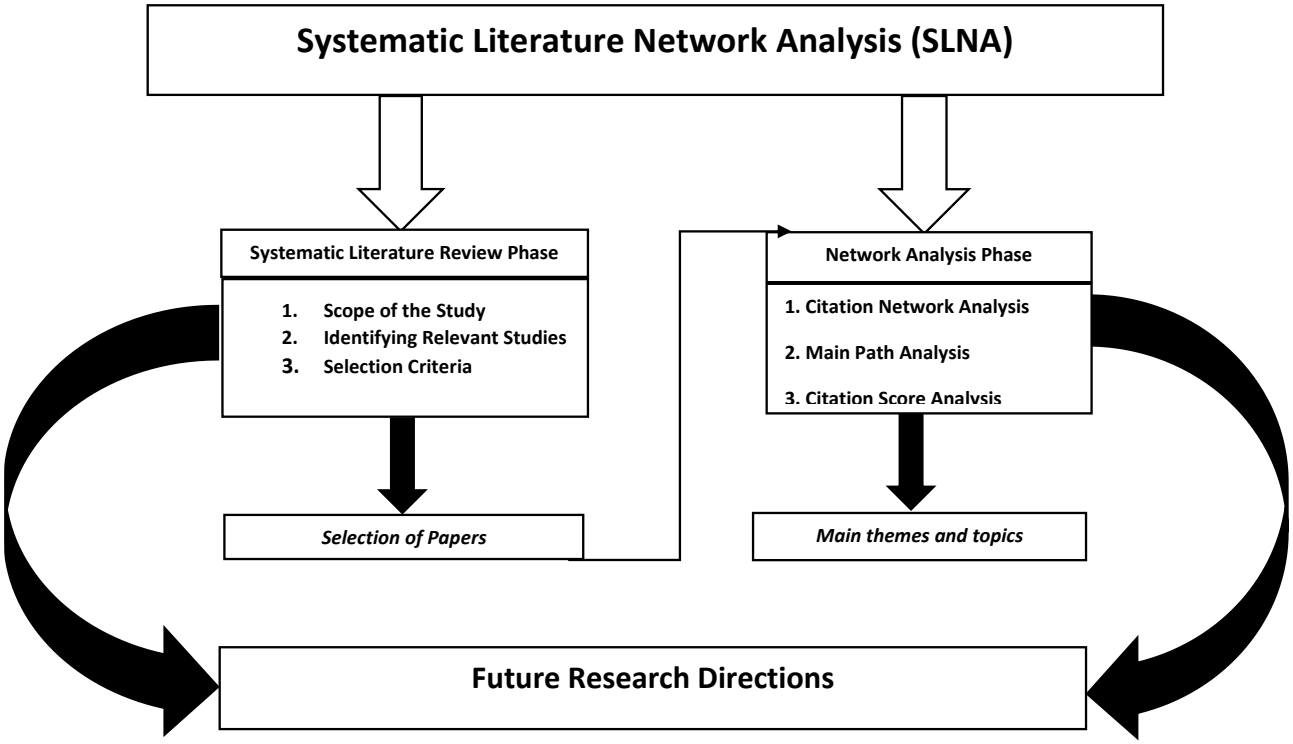

Figure 1. Summary of SLNA Methodology

Source: Figure by authors

SLR is the initial element during Systematic Literature Network Analysis (SLNA). Researchers study relevant works during this phase while evaluating their contribution value and performing data analysis and synthesis. Methodologies based on Systematic Literature Review seek to reduce bias while fully disclosing their methods for achieving essential discoveries.

This phase consists of three key steps:

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1. Scope of the Study: This first step establishes the research direction and depth and breadth of the economic complexity literature.

2. Identification of Studies: Researchers must select appropriate research articles from the selected electronic database.

3. Selection Criteria: Determining inclusion and exclusion parameters determines which studies the researchers will evaluate.

An SLR delivers a detailed examination of research subjects through selective article collection. The synthesising process gathers research findings and spots unriddled areas within the existing literature. This research collected articles from the Web of Science (WoS) database, one of the leading peer-reviewed and citation-based resources.

During the second method phase, researchers retrieved articles from the first phase by employing visual network representations generated by the Sci2 Tool. The modular software Sci2 supports the analysis and visualisation of datasets by offering multiple methods for temporal, geographic and topical network analyses. The program creates Pajek input data files that help researchers develop and display citation network landscapes. The analytics platform Pajek remains a preferred tool for social network analysis (Nooy et al., 2011) and allows researchers to create visual representations of these citation networks. This study uses VOSviewer, Biblioshiny, and other bibliometric tools for keyword network investigations.

Since citation analysis suffers from data boundaries when determining subject areas. The number of initial citations awarded to fresh publications remains generally low as such recent work frequently suffers from insufficient recognition in citation research. Recent important articles often escape detection during citation examinations of scientific literature. Citation analysis requires partnership with alternative research methods like keyword analysis because this combination delivers better insights about subject areas (Strozzi et al., 2017). The study achieves its research goals by applying its stated methodology and analytical instruments to present key established concepts and their historical development and forecast future research directions within economic complexity studies.

SYSTEMATIC LITERATURE REVIEW

The Systematic Literature Review (SLR) process functions as the initial phase in the SLNA methodology, as shown on the left side of Figure 1. Study researchers define their examination boundaries during this phase by choosing appropriate methods for tracking literature studies before selecting their analysis subjects.

Scope of the study

As previously described, this study reviews the existing literature on economic complexity. This theoretical and applied framework integrates concepts from statistical physics and complex systems sciences to evaluate nations' competitiveness and the interrelationships within their various sectors. The research investigates the interplay between economic complexity and domains, including economic growth and

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environmental sustainability, human development and income distribution, gender equality, and regional imbalance.

Identification of studies

Researchers accessed the Web of Science database to retrieve existing studies by utilising specific keywords. Different keywords during this stage produce substantially different results. Because economic complexity represents a new field requiring extensive overview information, the search keywords included both "economic complexity" and "economic complexities." These studies match the analytical purpose of making a complete review of academic literature on economic complexity. The selected keywords enable bibliographic analysis tools to reveal core topics while unveiling essential content-related interactions and ongoing shifts in literary publications.

Selection criteria

The study used various selection criteria to collect appropriate research articles that preserved evaluation transparency. The research considered only peer-reviewed articles published in the Web of Science (WoS)-indexed journals. Researchers limited their study to peer-reviewed publications because these journals provide high-quality studies, according to Snyder (2019), who notes their thorough review process. The analysis included all "Economic Complexity" articles indexed between 2006 and 2022 because the first WoS-indexed journal article appeared in 2006. The search was limited to the "Title" field, as this criterion ensures that the chosen articles are highly relevant to the research field.

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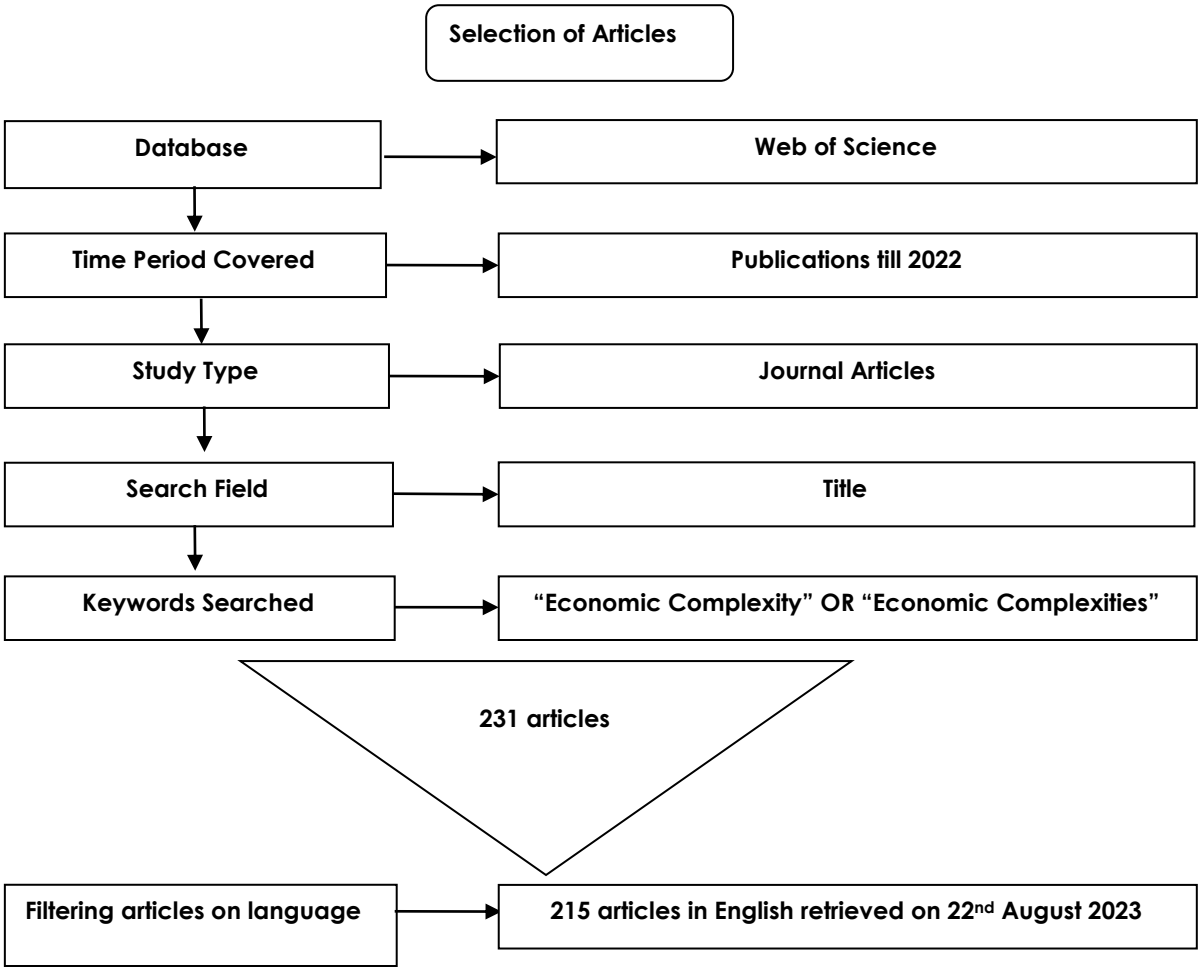

Figure 2. Framework Adopted for Selection of Articles

Source: Figure by authors

The search also filtered out articles that were not written in English.

Since research is inherently interdisciplinary, no field exists in isolation; thus, all subject categories available in the WoS database were considered. These included Economics, Environmental Sciences, Business, Management, Development Studies, Regional Urban Planning, and others. Approximately 30 per cent of the articles were from the Economics category, while 25 per cent were from Environmental Sciences. Ultimately, the search yielded 215 peer-reviewed journal articles published in English between 2006 and 2022. The selection framework is illustrated in Figure 2.

Major Sources of Articles

Figure 3 presents the number of articles published from 2006 to 2022. The figure clearly shows that the number of articles published each year remained in single digits until 2018, with the counts fluctuating around 0 in 2007, 2012, and 2014 and reaching a peak of 8 articles in 2018. Since 2019, however, the number of articles published on the "Economic Complexity" theme has surged exponentially. The number of publications increased from 10 in 2019 to 93 in 2022, reflecting a sharp rise within three years. The number of articles published since 2019 has nearly doubled each year. This trend indicates that economic complexity has gained significant recognition in recent years.

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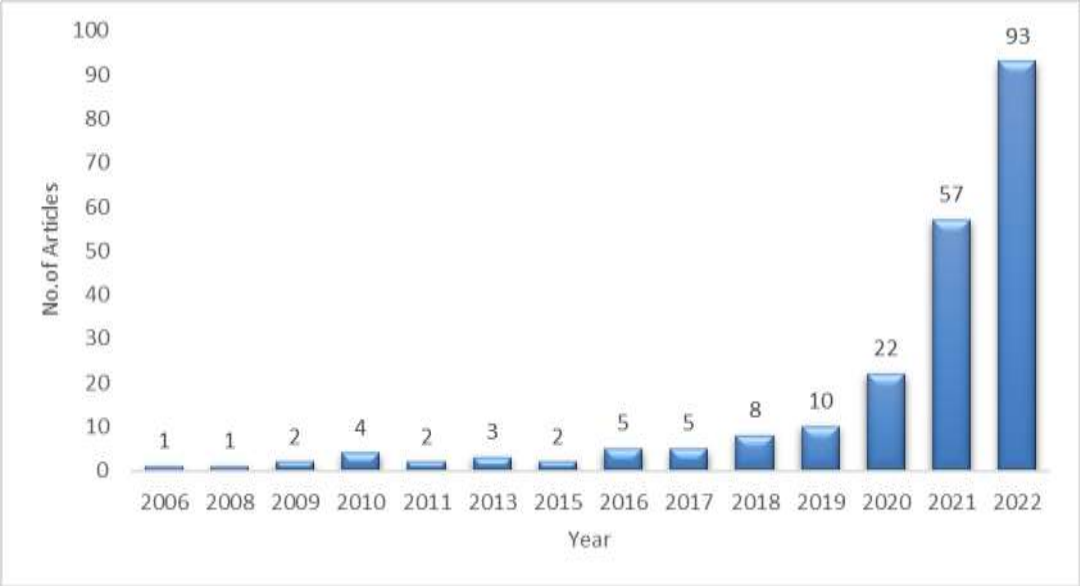

Figure 3. Number of Articles on "Economic Complexity" Published from 2006 to 2022.

Source: Figure by authors

Table 1 lists the top ten journals based on the number of articles published on the "Economic Complexity" theme. Seventy-six articles, accounting for 35% of the retrieved articles, are published in these ten journals. These journals are considered top-quality, as they are classified in the Q1 category (the top quartile) in the Web of Science based on their impact factor. The journal "Environmental Science and Pollution Research" leads with 22 articles, followed by "Sustainability" with 14 articles, "Renewable Energy" with seven articles, and "PLOS One" with six articles. Other journals like "Economic Analysis and Policy", "Journal of Cleaner Production", and "Structural Change and Economic Dynamics" have published five articles each. In contrast, "Frontiers in Environmental Science", "Research Policy", and "Resources Policy" each published four articles. The 215 articles on economic complexity were published across 107 journals. Of these, 67 journals, including the top ten listed in Table 1, are in the Q1 category, followed by 32 journals in Q2, 6 in Q3, and 2 in Q4. Notably, 158 of the 215 articles (approximately 75%) were published in Q1 journals, followed by 46 articles in Q2, 8 in Q3, and just 3 in Q4. This demonstrates that 95% of the articles on economic complexity are published in top-tier journals, namely those in the Q1 and Q2 categories.

Table 2 presents the top ten countries that have contributed the most articles on the "Economic Complexity" theme. The highest number of articles has been published by China (64), followed by Turkey (38), England (28), Italy (26), USA (23), Pakistan (20), Vietnam (18), Spain (15), India (14), and Australia (11). Notably, China, Turkey, England, Italy, and the USA account for 8 out of every 10 articles published. Additionally, China alone contributes to approximately one-third of the total articles.

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Table 1. Number of articles on the Theme of "Economic Complexity" Published in Journals (in descending order of number of articles published in top ten journals)

Journal	Article Count	% of Total Articles	Quartile Classification
ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH	22	10.23	Q1
SUSTAINABILITY	14	6.51	Q1
RENEWABLE ENERGY	7	3.26	Q1
PLOS ONE	6	2.79	Q1
ECONOMIC ANALYSIS AND POLICY	5	2.33	Q1
JOURNAL OF CLEANER PRODUCTION	5	2.33	Q1
STRUCTURAL CHANGE AND ECONOMIC DYNAMICS	5	2.33	Q1
FRONTIERS IN ENVIRONMENTAL SCIENCE	4	1.86	Q1
RESEARCH POLICY	4	1.86	Q1
RESOURCES POLICY	4	1.86	Q1

Source: Table by authors

Table 2. Country-wise Article Publication (in descending order of number of articles published by top ten countries)

Country	Article Count	% of Total Articles
CHINA	64	29.77
TURKEY	38	17.67
ENGLAND	28	13.02
ITALY	26	12.09
USA	23	10.70
PAKISTAN	20	9.30
VIETNAM	18	8.37
SPAIN	15	6.98
INDIA	14	6.51
AUSTRALIA	11	5.12

Source: Table by authors

NETWORK ANALYSIS PHASE

Figure 1 demonstrates the second process in SLNA methodology through the Network Analysis Phase (NAP) on its right-hand side. This phase consists of three key components: Citation Network Analysis (CNA), Main Path Analysis (MPA), and Citation Score Analysis (CSA). The results of bibliometric network analysis demonstrate a quantitative approach using objective criteria to generate a clear, comprehensive academic literature overview of economic complexity.

Citation Network Analysis (CNA)

The field of Citation Network Analysis (CNA) has experienced growth throughout diverse research disciplines over recent years. Research outputs have grown to such an extent that literature reviews combined with bibliometric analyses are essential tools for understanding and categorising research findings.

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The analysis enables researchers to evaluate the impact of multiple writers together with their produced work. Through network analysis of citations, researchers gain valuable knowledge about how research domains group themselves. The referential contexts of published works serve as input for CNA through its computer algorithm, which applies network analysis to reference-based projections. The methodology works under a reference-based principle that links academic works to related areas of study. A citation network emerges from cited research connecting to citing works as nodes through citation relationships. The literary research network derived from 215 scholarly documents. The Sci2 tool (Figure 4) is employed for network extraction. In this network, the links are represented by arrows pointing from the cited publications to the citing ones, illustrating the flow of information. The connecting components in the network can vary in size, containing either several nodes or just a few, depending on the citation linkages.

The citation network is typically acyclic, meaning there are no loops within the network, as a new article can only cite older articles. However, in rare cases, a non-acyclic graph may emerge, such as when two articles published in the same issue cite each other. Such non-acyclic networks can be transformed into acyclic ones (Batagelj, 2014). Additionally, a connected component refers to a group of nodes linked through citation connections. Figure 4 illustrates the citation network for the 215 articles, where the nodes (articles) are represented as red circles, and the citation linkages are shown as black lines connecting these circles.

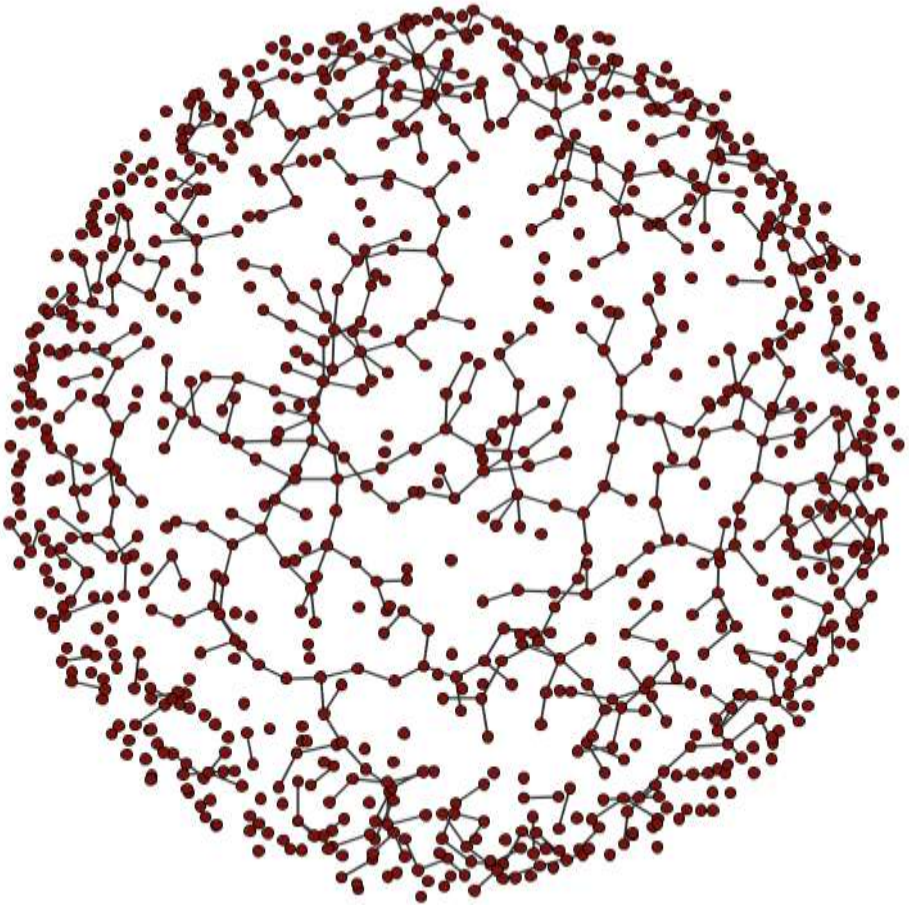

Figure 4. Citation Network Analysis of 215 Articles

*Source***:** Figure by authors using Sci2

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Main Path Analysis (MPA)

The Main Path Analysis stage uses Pajek software and its advanced visualisation tools to create essential routing algorithms (main paths) from the software (Mrvar & Batagelj, 2016). The basic pathway extraction enables the detection of networked components embedded in extensive citation linkages. A main path analysis dynamically visualises connected articles by identifying essential scholarly works across different periods. Within the network's structure, the most influential studies act as the most frequently cited nodes. Analysing these key publications helps us understand the domain's historical development and identify each article's central ideas.

Studying the main path will reveal trends and variations within the "economic complexity" subject area, which may be challenging to discern by simply collecting available articles. The main path is crucial for identifying significant trends that have emerged in the content of the articles (Lucio-Arias & Leydesdorff, 2008). Articles that build upon earlier works while continuing to serve as reference hubs for subsequent publications are highlighted in the main path. The main path analysis consists of two key steps:

1. Calculating the weights of citation traversals: Various methods are used to determine traversal weights; for this study, the search path count method was utilised.
2. Extracting the main path: The main path can be extracted using the traversal weights of articles and citations, which will help identify the primary streams of literature in the field.

Figure 5 illustrates the main path formed by the 215 articles generated using Pajek's citation network with the 'Kamada-Kawai' layout option. In this visualisation, the citations are connected by grey lines, representing the edges leading to the yellow nodes. The main path of the citation network, derived from all 215 articles, highlights the seminal paper in the field: "The Building Blocks of Economic Complexity" by Hidalgo and Hausmann (2009). This paper, which has received the highest number of citations, is the central node in the main path. The 2009 study introduced the "Economic Complexity Index" (ECI), which has been widely used in subsequent research. The main path shown in Figure 5 traces significant articles and the evolution of economic complexity literature over time.

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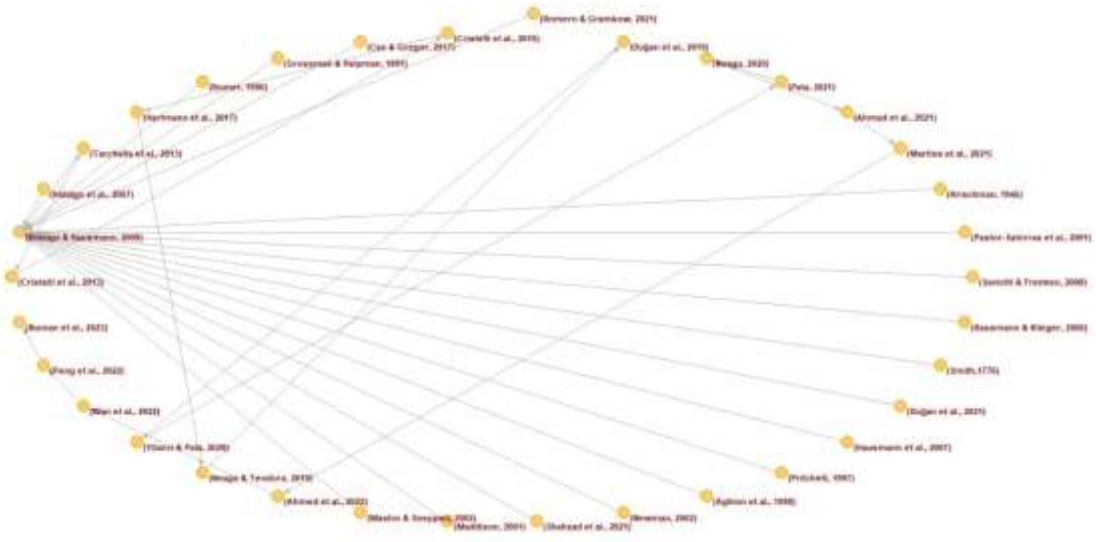

Figure 5. Main Path of 215 Articles

Source: Figure by authors using Pajek

Citation Score Analysis (CSA)

The Citation Score Analysis (CSA) consists of two components: the Global Citation Score (GCS) and the Local Citation Score (LCS). The GCS represents the total number of citations a manuscript has received, regardless of whether the citing articles are part of the study's sample. Articles with high GCS are considered fundamental contributions to the field, as they are frequently cited by a wide range of research (Knoke and Yang, 2008). In contrast, the LCS reflects the number of citations an article has explicitly received within the citation network of this study. The LCS indicates how often other articles in the study sample have cited an article. It is possible for an article to have a high LCS but relatively fewer citations in the broader academic community, as it may be highly influential within a specific research sample. In this study, LCS is derived from a sample of 215 journal articles, while GCS is sourced from all journal articles listed in the Web of Science database.

Table 3 shows the topmost cited articles based on their Local Citation Score (LCS), listed in descending order. Notably, the top three most cited articles also hold the highest Global Citation Scores (GCS) in the same order. The article with the highest citation score is Hidalgo and Hausmann's (2009) influential study, "The Building Blocks of Economic Complexity". It is followed by Can and Gozgor's (2017) article, "The Impact of Economic Complexity on Carbon Emissions: Evidence from France", and Hartmann et al.'s (2017) article, "Linking Economic Complexity, Institutions, and Income Inequality".

In 2009, "The Building Blocks of Economic Complexity" established itself as the foundational work of economic complexity research. This groundbreaking article shows how the Economic Complexity Index (ECI) was created by understanding trade information as dual-network data that maps countries to exported products. The research shows that economic complexity measurement requires network structure analysis for

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nation-states to determine their economic complexity levels. The study indicates that economic nations move toward income streams linked to their product system complexity levels. Efforts to develop sustainable growth and prosperity require focusing on enabling conditions that help complexity emerge.

The second most influential article is "The Impact of Economic Complexity on Carbon Emissions: Evidence from France" by Leitao et al., 2021. This analysis shows how French CO2 emissions respond to rising economic complexity by demonstrating that complex economies experience lasting reductions in CO2 emissions. The analysed data produces important insights regarding environmental policies and emission reduction initiatives nationwide.

A research paper titled "Linking Economic Complexity, Institutions, and Income Inequality" positioned itself as the third top article in the field in 2017. The research shows that countries exporting sophisticated goods demonstrate better income equality measurements than nations exporting essential products. Through multivariate regression analysis, the authors establish that economic complexity is a significant negative predictor of income inequality. The research highlights that economic complexity embodies crucial information about how an economy generates and distributes income. Moreover, the findings suggest that the productive structure of a nation imposes constraints on its level of income disparity, offering valuable insights into the relationship between economic development and social equity.

Table 3. Articles with their Citation Scores

Rank	Article	Year	LCS	GCS	LCS to GCS ratio (%)
1	(Hidalgo and Hausmann, 2009)	2009	158	1114	14.18
2	(Can and Gozgor, 2017)	2017	75	207	36.23
3	(Hartmann et al., 2017)	2017	68	262	25.95
4	(Neagu and Teodoru, 2019)	2019	61	166	36.74
5	(Doğan et al., 2019)	2019	55	124	44.35
6	(Doğan et al., 2021)	2021	45	219	20.54
7	(Romero and Gramkow, 2021)	2021	43	86	50.00
8	(Shahzad et al., 2021)	2021	43	191	22.51
9	(Pata, 2021)	2021	42	253	16.60
10	(Boleti et al., 2021)	2021	38	78	48.71

Source: Built by the Authors using Bibliometrix

KEWORDS ANALYSIS

A scholarly article's core foundation consists of keywords, which enable articles to share similar themes and exchange keywords, thus developing co-keyword and keyword co-occurrence networks (Donthu et al., 2021). Research using keywords reveals intricate relationship patterns that exist between different academic materials (Wang & Chai, 2018). The systematic literature review (SLR) process identified sample articles, and this section presents the keyword network analysis. A keyword network analysis reveals the dominant

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keywords alongside newly popular choices, which point toward upcoming research terms that researchers will use in future studies (Choi et al., 2011).

Co-Occurrence of Keywords

Co-occurrence analysis functions on the principle that keywords reflect content value and help establish topic relationships within text documents (Ding et al., 2001; Strozzi et al., 2017). The 215 methodology-choice articles make up the keyword pool selected during SLR. Through its minimal complexity algorithm, VOSviewer analyses co-word networks while reducing function through item similarity measures (Van Eck and Waltman, 2010).

Second, the VOSviewer software is employed to generate and analyse a co-word network by minimising a function based on a similarity measure ($\boldsymbol{AS_{ij}}$) between items (Van Eck & Waltman, 2010). The formula for the similarity measure is presented in Equation 1.

$$\boldsymbol{AS_{ij}} = \frac{c_{ij}}{c_i c_j} \quad \textbf{(1)}$$

The recurrence of the terms *i* and *j* within the same document is measured by c_{ij}, while c_i and c_j represent the anticipated counts of co-occurrences of *i* and *j*, respectively, under the assumption that these terms are statistically independent (Di Cosmo *et al.*, 2021).

Figure 6 presents the co-occurrence network analysis of the 215 articles, focusing on the keywords. Using the VOSviewer algorithm, four significant clusters were identified from 869 keywords. The analysis required a minimum occurrence threshold of 5, producing 79 qualifying keywords. Panels generated from low co-occurrence thresholds feature unneeded words, and those generated from high thresholds will eliminate newly trending keywords without enough shared patterns.

The size of each circle in the figure corresponds to the frequency of a keyword (or group of keywords) appearing across the sample articles; larger circles indicate higher occurrences (Van Eck & Waltman, 2010). The analysis reveals that "Economic Complexity" is the most significant keyword in the network, as indicated by its prominent circle size. Additionally, the strength of each link's weight highlights the relationship between keywords; thicker lines represent stronger associations between terms (Van Eck & Waltman, 2010). Additionally, the strength of each link's weight highlights the relationship between keywords; thicker lines represent stronger associations between terms (Van Eck & Waltman, 2010).

Additionally, Table 4 lists the top 10 keywords based on their frequency of occurrence and link strength within the network. As highlighted in Figure 6, "Economic Complexity" emerges as the central keyword in the co-occurrence network, with the highest link strength. This underscores its pivotal role in the analysed body of literature.

The second most prominent keyword is "Growth," followed by "CO2 Emissions," "Renewable Energy," "Ecological Footprint," "Impact," "Financial Development," "Energy Consumption," "Consumption," and "Urbanisation." These keywords reflect the interconnected themes and evolving research priorities within economic complexity.

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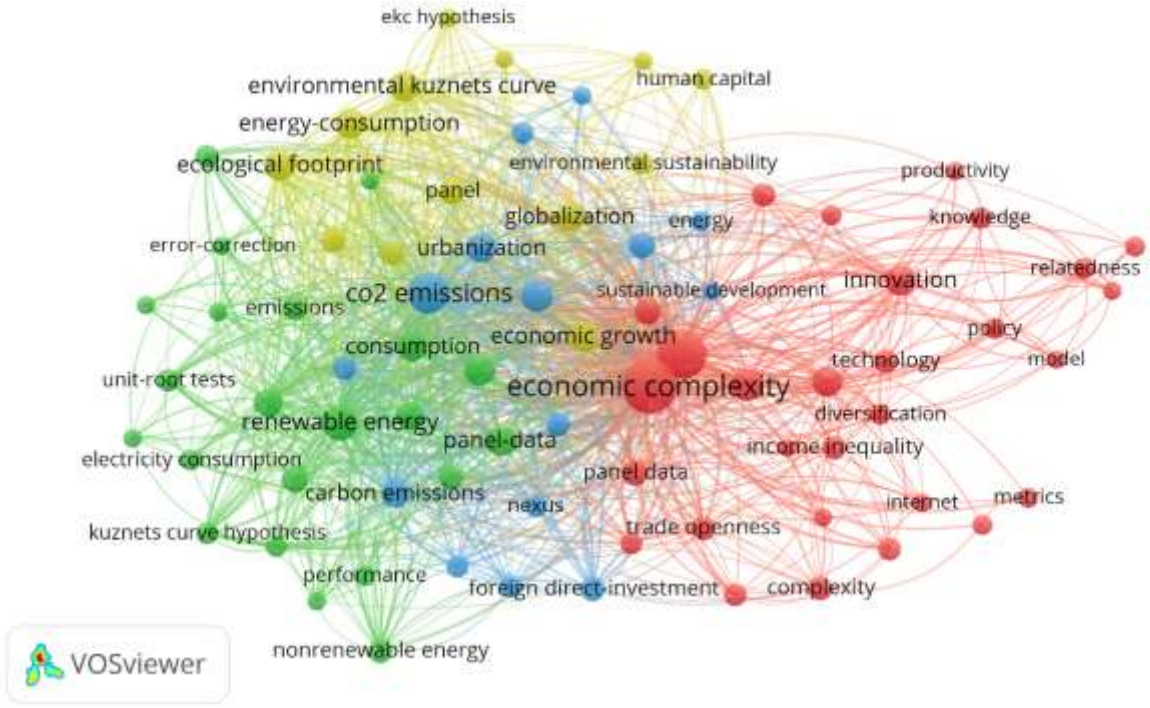

Figure 6. Co-occurrence Network of Keywords

Source: Figure by authors using VOSviewer

Table 4. Keywords and Occurrences with Link Strength

Rank	Keyword	Occurrences	Total link strength
1	Economic complexity	150	842
2	Growth	105	693
3	CO2 emissions	60	486
4	Renewable energy	40	338
5	Ecological footprint	26	222
6	Impact	27	222
7	Financial development	24	210
8	Energy consumption	23	195
9	Consumption	22	181
10	Urbanization	21	179

Source: Table by authors using VOSviewer

Keywords can also be grouped into four clusters: red, green, blue, and yellow. Table 5 presents the classification of keywords across these clusters.

1. Red Cluster (Largest, 29 Items): The red cluster primarily revolves around economic complexity and its principal measure - the Economic Complexity Index (ECI). Unlike traditional growth measures emphasising production factors, ECI quantifies an economy's productive capabilities as a measure of economic growth. It predicts economic growth and explores aspects like income inequality and

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institutional quality. Additionally, it encompasses innovation and export diversification. This cluster includes keywords such as complexity, diversification, economic development, economic growth, income inequality, innovation, technology, institutional quality, international trade, trade openness, productivity, regions, and panel data.

2. Green Cluster (Methodology and Environmental Concerns): The green cluster focuses on methodologies commonly used in the sample articles, including keywords like causality, co-integration, CS-ARDL, error correction, quantile regression, and unit-root tests. It also incorporates environmental and energy-related themes, such as climate change, electricity consumption, energy consumption, environmental quality, non-renewable energy, and emissions.
3. Blue Cluster (Sustainable Development and Regional Focus): The blue cluster emphasises sustainable development, particularly foreign direct investments (FDI) and their implications. It also includes studies focused on specific regions, such as OECD countries and China, as these keywords surpass the threshold of five occurrences. Key terms in this cluster include carbon emissions, environmental degradation, energy, renewable energy consumption, and urbanisation.
4. Yellow Cluster (Environmental Kuznets Curve and Globalization): The yellow cluster highlights research related to the Environmental Kuznets Curve (EKC) and environmental sustainability in the context of globalization. Additionally, it addresses themes like human capital formation, energy consumption, and ecological footprint.

Table 5. Clusters of Occurrence of Keywords Network

Cluster (items)	Keywords
Cluster 1 (29 items) Red Cluster	complexity, countries, diversification, economic complexity, economic complexity index, economic development, export diversification, geography, growth, income inequality, innovation, institutional quality, institutions, international trade, internet, knowledge, metrics, model, panel data, policy, productivity, quality, regions, relatedness, research and development, systems, technology, trade, trade openness.
Cluster 2 (22 items) Green Cluster	causality, climate change, co-integration, consumption, cs-ardl, electricity consumption, emissions, energy consumption, environmental quality, error-correction, financial development, growth nexus, hypothesis, income, kuznets curve hypothesis, nonrenewable energy, panel data, performance, quantile regression, renewable energy, tests, unit-root tests.
Cluster 3 (15 items) Blue Cluster	carbon emissions, China, co2 emissions, determinants, empirical evidence, energy, environmental degradation, foreign direct investment, impact, nexus, oecd countries, regression, renewable energy consumption, sustainable development, urbanization.

Cluster 4 (13 items) Yellow Cluster	carbon dioxide emissions, ecological footprint, economic growth, ekc hypothesis, energy consumption, environmental kuznets curve, environmental sustainability, globalization, growth evidence, human capital, index, kuznets curve, panel.

Source: Table by authors using VOSviewer

Conceptual Structure Map

A conceptual structure map visually represents a specific study area's scholarly landscape (Rejeb et al., 2022). Figure 7 illustrates the conceptual organisation of keywords analysed in this study. The map creates a simple two-dimensional (or three-dimensional) graph that reflects the similarity between keywords by condensing large datasets with multiple variables into a low-dimensional space. Multiple correspondence analysis (MCA) of the dataset's keywords was employed to generate this map.

Keywords positioned closer to the centre of the map are those that have recently garnered significant attention (Rejeb et al., 2023). The results are interpreted based on the relative placements of the words: the closer the words are depicted on the map, the more similar their distribution.

The most significant theme, represented by the red cluster, highlights the strongest connections. It encompasses terms and ideas related to economic complexity, including *growth*, *globalization*, *foreign direct investment*, *renewable energy*, *export diversification*, *financial development*, *trade*, *urbanisation*, *emission*, and *innovation*. Studies in this cluster predominantly rely on panel datasets and focus on country-level analyses.

The second most significant theme, represented by the blue cluster, revolves around energy and environmental aspects, such as *energy consumption*, *carbon dioxide emissions*, and *ecological footprint*.

The red and blue clusters, depicted in Figure 7, are presented within a two-dimensional space (Dim 1 and Dim 2). These dimensions can be roughly interpreted as principal components (PCs). Dim 1 corresponds to the first principal component, which accounts for the most significant portion of the total variance, explaining 49.25%. Dim 2 represents the second principal component, explaining 10.32% of the total variance. Together, these two dimensions explain nearly 60% of the total variability in the dataset.

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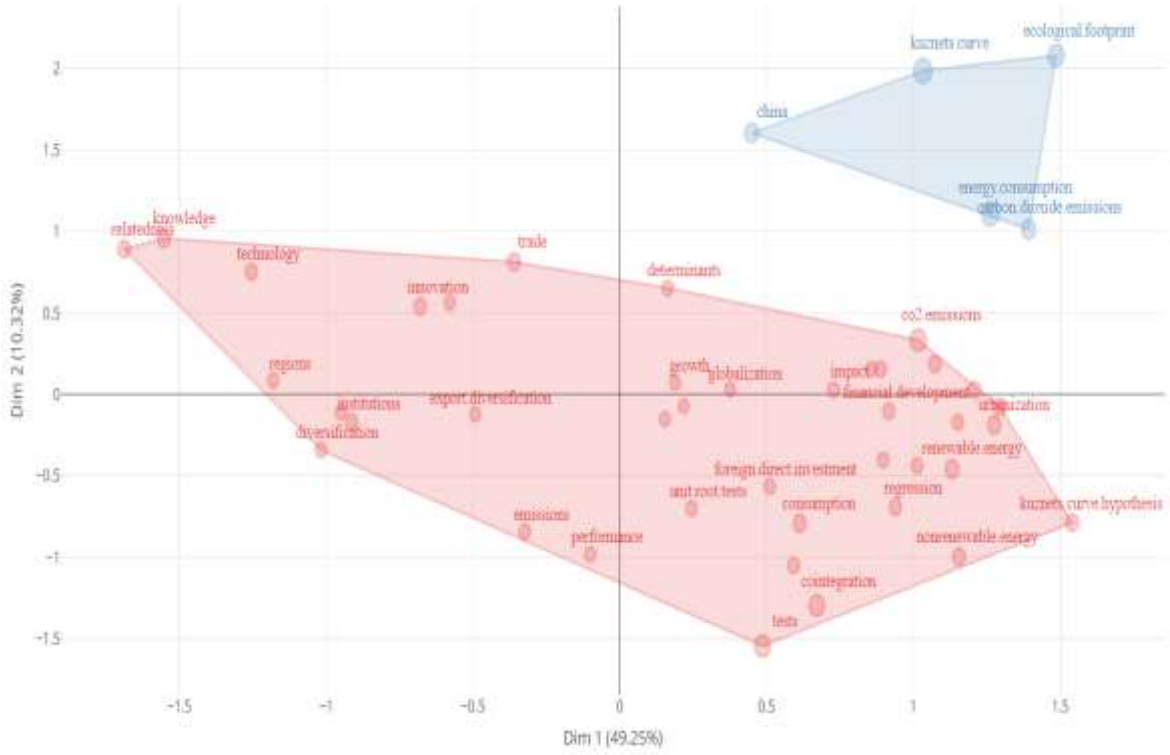

Figure 7. Conceptual Structure Map

Source: Figure by authors using Bibliometrix

Trending Topics

Figure 8 provides insights into the keywords and the analysis of trending topics in the economic complexity literature over recent years.

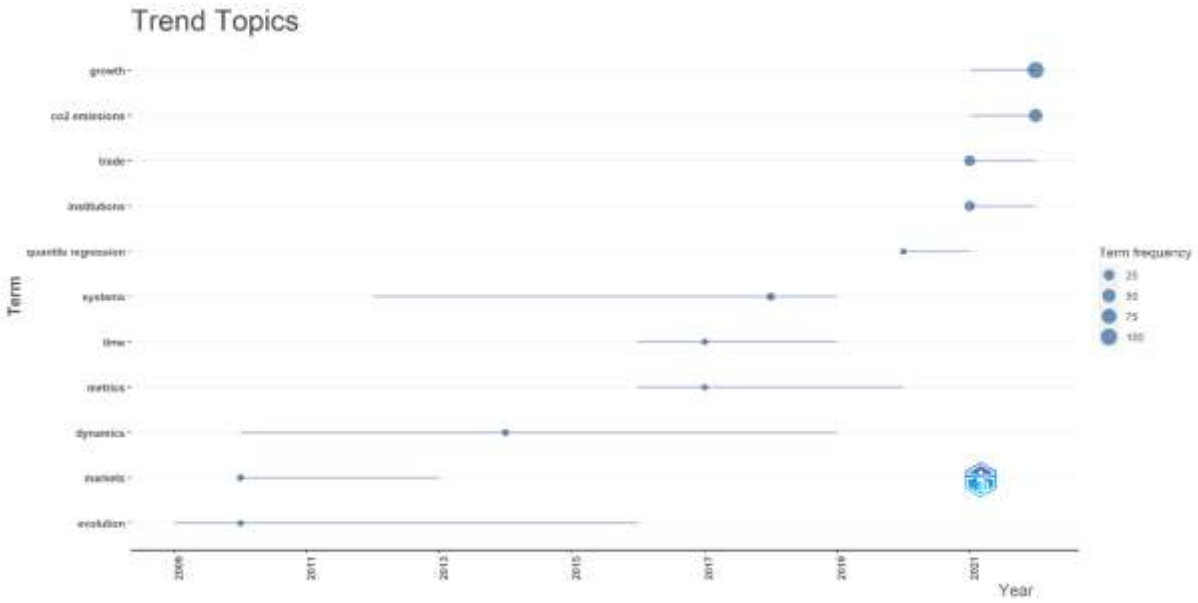

Figure 8. Topics in Trend for Economic Complexity

Source: Figure by authors using Bibliometrix

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The analysis uses the following settings: This analysis utilises a keyword frequency threshold of 5 words alongside a yearly word count limitation of 3. Growth and carbon dioxide emissions proved to be dominant keywords in 2022, establishing themselves as the primary discussion points, while trade and institutions maintained their dominance in 2021. Recent research shows an increasing trend towards environmentally sustainable growth which combines environmental quality concerns with economic growth objectives.

Thematic Map

A thematic map is a valuable tool for understanding a specific field's present and future trends as it visualises the relationships and dynamics between various themes and concepts and further shows the structure and development of a subject (Mostafa, 2020). A thematic map helps inform researchers and stakeholders about the opportunities for establishing new research topics within a discipline (Aria & Cuccurullo, 2017). In thematic analysis, keyword clusters and their connections derive different themes presenting specific traits, density, and centrality of topics (Aria & Cuccurullo, 2017). The vertical axis (Y-axis) represents density, which assesses the cluster network's internal strength, indicating a theme's evolution and the horizontal axis (X-axis) shows centrality, providing insights into the importance of a specific theme (Di Cosmo et al., 2021).

A thematic map depicting keyword use in economic complexity sample articles can be seen in Figure 9. Eight bubbles appear in four quadrants (Q1 to Q4), and four bubbles stand out because their keywords frequently appear together. The quadrants are categorised as follows: Aria & Cuccurullo (2017) partition the data into four quadrants where Q1 contains "Motor Themes", Q2 holds "Niche Themes", while Q3 displays "Emerging or Declining Themes", and Q4 features "Basic Themes."

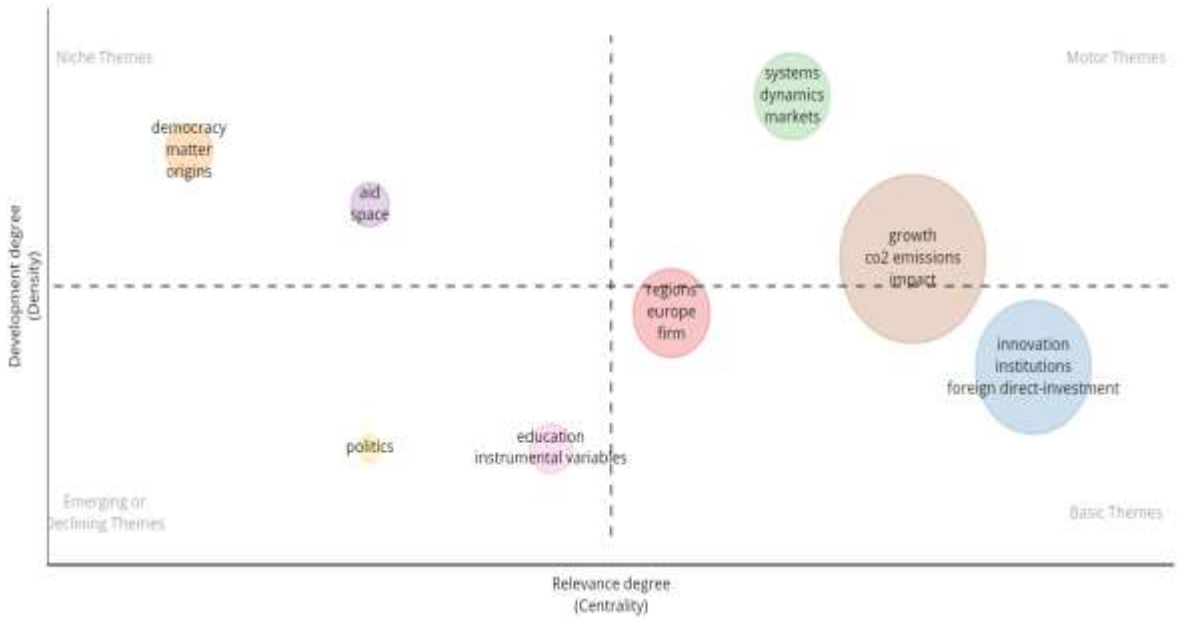

Figure 9. Thematic Map for Economic Complexity

Source: Figure by authors using Bibliometrix

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Figure 9 highlights the keywords “growth,” “CO2 emissions,” and “impact.” They are positioned approximately at the intersection of Q1 (Motor Themes) and Q4 (Basic Themes), forming the largest bubble of keyword co-occurrences, which means that economic complexity needs to be studied in the context of environmentally sustainable growth. Scholars agree in their recent studies that pursuing population growth isolated from environmental assessment does not provide adequate insights into development (Dahmani, 2023; Hopwood et al., 2005).

The concepts "innovation", "institution", and "foreign direct investment" emerge as essential fundamental themes throughout Q4. The core concepts of “regions”, “Europe”, and “firm” coexist within this quadrant. Research on economic complexity benefits tremendously from these critical themes, which display high importance but low diversity within the academic discourse. Q2 niche themes present high-density levels while maintaining low centrality, demonstrating their limited connection to broader intellectual dialogues. This category includes the keywords “aid,” “space,” “democracy,” “matter”, and "origins".

The themes of politics and education fall into the Q3 category of Emerging or Declining Themes. The niche group of keywords demonstrates both minimal importance and infrequent use, implying their marginal status in today's academic dialogue (Wilczewski & Alon, 2023). The bibliometric analysis provides information about the current state of emergence or decline for these respective themes. The study showed 22 instances of the keyword “education” in 215 selected articles published from 2017 through 2022. The frequency rise of "education" indicates its emergence as a significant subject in economic complexity research literature. The keyword “politics” barely appeared twice in 215 study articles from 2020 and 2022. Now, it emerges more frequently while showing better development than the keyword "education" despite its relatively lower occurrence. Future investigations into economic complexity should use these results to guide their analysis of “politics” and “education.”

CONCLUSIONS AND FUTURE RESEARCH

This study establishes structured connections among published academic research on economic complexity. The analysis reviews relevant research history within the field and identifies future directions while creating frameworks for future scholarship. We used Sci2 along with Pajek and Biblioshiny, and VOSviewer as open-source analysis tools to process data we obtained from the Web of Science database. Analysis through these tools helped to create, visualise, and analyse citation and keyword networks (Moral-Muñoz et al., 2020) based on articles retrieved using the keywords “Economic Complexity” OR “Economic Complexities,” following a recently developed methodology: Systematic Literature Network Analysis (SLNA) and Keyword Network Analysis (KNA). Via our study, we offer an extensive economic complexity literature review and novel perspectives on its evolution and current research interests.

The research developed both SLNA and KNA, which added complexity to economic analysis and presented features with multi-domain flexibility as key outputs of this study. The study separates citation

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networks into components for researchers to gain full comprehension of the subject matter. It enriches the body of knowledge on economic complexity by uncovering fundamental issues, novel patterns, and evolutionary trajectories and aids researchers in advancing the field.

The findings reveal that most existing research focuses on cross-country analyses, leaving ample scope for regional studies within countries. While prior studies have primarily assessed economic competitiveness on a global scale, it is vital to explore regional economic complexity within nations to address economic peculiarities and disparities effectively (Gao & Zhou, 2018). Understanding the disparities is important for learning the nuances of regional economies.

Economic complexity literature features minimal research into innovation in the context of information and communication technologies, as shown in Figure 10. Research directed at firm-level applications of economic complexity theory exhibits strong potential for meaningful findings. Similarly, education, a critical factor in human capital formation, holds significant promise for future studies. The research potential for political structures and institutional frameworks rises significantly as an essential new theme for analysis. A deep analysis of economic complexity elements with these variables represents an exceptional opportunity to gain valuable knowledge. Future investigations should focus on understanding the economic complexity dynamics that influence ecological footprints (e.g. Agarwal, 2008; Kumar, 2003).

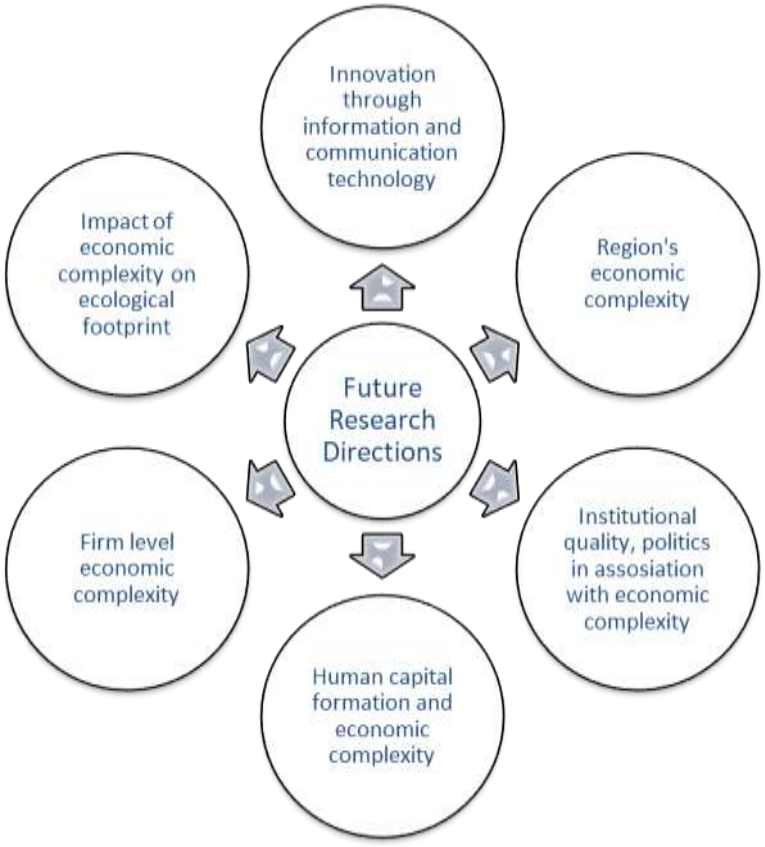

Figure 10. Future Research Directions

Source: Figure by authors.

The research lays the groundwork to analyse economic complexity using more profound analytical methods (e.g. Jha et al., 2022; Zhang et al., 2024). An essential limitation of this research emerges from the extensive Web of Science database since the process of sample retrieval potentially omitted substantial research works within the economic complexity field. The study proves that systematic literature and keyword network analysis effectively serve for complete research theme evaluation despite their recognised weakness.

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Author Contributions:

Conceptualization, S.S (Sonali Singh, S.S.) and S.K.S.; methodology, S.S. and S.K.S.; software, S.S.; validation, S.K.S. and V.L.S.; formal analysis, S.S.; data curation, S.S. and S.K.S.; supervision, S.K.S.; visualization, S.S., V.L.S. and M.P.; writing - original draft preparation, S.S. and S.K.S.; writing - review and editing, V.L.S. and M.P.; All authors have read and agreed to the published version of the manuscript.

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About the authors

Sonali SINGH,

Doctoral candidate in Economics at the Indian Institute of Management, Lucknow. Her research centres on economic complexity, environmental economics, and sustainable development. She is a recipient of the UGC-JRF grant.

Research interests: multidisciplinary research, economic development, environmental sustainability.

ORICD ID: 0000-0001-6290-7941

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Sanjay Kumar SINGH

Dr., Professor in the Business Environment Area at the Indian Institute of Management Lucknow. Dr. Singh is recipient of the NASI-Scopus Young Scientist Award in the area of social sciences for the year 2014, as well as the Manas Chatterji Award for Excellence in Research in Regional Science for the year 2006.

Research interests: applied economics, technology and innovation, industrial economics, infrastructure**,** transportation

ORICD ID: 0000-0003-0169-1141

Vijay Lakshmi SINGH

Dr., Associate Professor at the Jaipuria Institute of Management Lucknow. She earned her doctoral degree from the Indian Institute of Management Ahmedabad. Dr Singh has qualified the Government of India - University Grants Commission's National Eligibility Test for Lecturer and Research Fellowship. Her research has been awarded by the Academy of Management.

Research interests: industrial organization, public policy, development sector research, human-computer behaviour, productivity

ORICD ID: 0000-0001-5361-4741

Mariana PETROVA

Professor, D.Sc. in Physics and Mathematics, assoc.prof. St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria; Professor (Management), University of Telecommunications & Post, Sofia; Researcher (R4), Director International Science and Research Center, Tsenov Academy of Economics, Svishtov, Bulgaria.

Research interests: management of IT processes, project and services, business administration, intelligent systems and modeling technologies, information systems and innovations, sustainable development.

ORICD ID: 0000-0003-1531-4312