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# Bibliometric review of research on economic complexity: current trends, developments, and future research directions

**Behrooz Shahmoradi**[1] · **Nejla Ould Daoud Ellili**[2]

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**Abstract**
The growing literature on the issues of economic complexity makes it challenging to achieve a comprehensive multidimensional picture of the current problem for beneficiaries, policymakers, and future research. Therefore, this study aims to conduct a bibliometric analysis of 272 documents published in the field of economic complexity since 2007 and extracted from the Scopus database. Results are presented through figures, tables, maps of past trends and research directions using keyword analysis, global citation analysis of authors, organizations, countries, journals, articles, references, content analysis, and other bibliometric analysis via VOSviewer, CiteSpace, and WordStat software. A bibliometric review was applied to identify four clusters: Economic Growth, Diversification, Income Inequality, and Ecological Footprint. Finally, the state of the art in economic complexity research is discussed, and directions for future research are provided.

**Keywords** Economic complexity · Systematic literature review · Economic growth · Diversification · Income inequality · And ecological footprint

**JEL Classification** M31 · F37 · G15 · G12

## 1 Introduction

Increasing economic interdependence and the growing complexity of economies and financial systems have led to several challenges to the theories of traditional economists. The financial crisis of recent years and its aftermath in the form of

✉ Behrooz Shahmoradi
shahmoradi@nrisp.ac.ir

[1] STI Financing and Economics, National Research Institute for Science Policy (NRISP), Tehran, Iran

[2] College of Business, Abu Dhabi University, Abu Dhabi, UAE

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economic stagnation and low prosperity highlighted the need for new economic thinking. This new thinking should crystallize how data are obtained and economic theories can be tested.

Like the traditional view of economics, the economic complexity approach concentrates on the interaction between economic outputs and inputs. However, unlike the traditional view, the economic complexity approach uses fine-grained data on many economic sectors that are converted into thousands of outputs (Hidalgo, 2021). Economic complexity analyzes the productive capabilities and knowledge embedded in regions by considering their product space, a term first introduced by Hidalgo et al. (2007) to reflect the dynamics of the production and export structure of a given activity and location. Later, in 2009, Hidalgo and Hausmann (2009) developed metrics of economic complexity using export data to estimate the diversity and complexity of capabilities embedded in a country. Since then, the increasing number of topics addressing economic complexity has made it difficult to achieve a comprehensive multidimensional picture of the current topics for policymakers and future research.

There are several streams of research in the field of economic complexity. The first stream examined improvement in complexity metrics (Ivanova et al., 2017; Sciarra et al., 2020; Servedio et al., 2018; Tacchella et al., 2012). The second stream included the mapping of product networks, such as product space (Cicerone et al., 2020; Ferrarini & Scaramozzino, 2015; Hidalgo et al., 2007), technology (Boschma & Frenken, 2012; Balland et al., 2018), research (Chinazzi et al., 2019; Guevara et al., 2016), or occupations (Muneepeerakul et al., 2013; Dordmond et al., 2020). The third stream addresses the effects of economic complexity like economic growth (Hidalgo & Hausmann, 2009; Chávez et al., 2017; Tacchella et al., 2018; Domini, 2019) inequality (Hartmann et al., 2017), greenhouse gas emissions (Boleti et al., 2021; Neagu & Teodoru, 2019; Romero & Gramkow, 2021), within countries (Sbardella et al., 2017; Morais et al., 2021) and between countries (Hartmann et al., 2017; Lee & Vu, 2020). Finally, the fourth stream addresses factors influencing economic complexity. These factors consist of human capital (Lee & Vu, 2020; Yalta & Yalta, 2021), financial issues (Antonietti & Franco, 2021; Yalta & Yalta, 2021), internet access (Nguyen et al., 2023), geographical approach (Bahar et al., 2022; Vu, 2020), and business environment (Sweet & Maggio, 2015; Lapatinas, 2019).

In this paper, we explore the dynamic field of economic complexity to provide a comprehensive review of its current trends and guide researchers, practitioners, academics, and policymakers on future research in the economic complexity field. Our central inquiry is to examine the development of economic complexity research, seeking to understand the trends, influential authors, and impactful papers contributing to this field. To address this broad question, we proceed to answer the six following questions: What are the current publication trends in economic complexity research, broken down by different research components, i.e., author, affiliation, country, and journal? What are the most frequent keywords in published papers on economic complexity? Who are the main contributors to economic complexity (organizations, authors, and countries)? What are the

most frequently cited papers on economic complexity? What are the most cited reference articles on economic complexity? What are the most cited papers?

Based on the above questions, this study aims to achieve three objectives. Firstly, by illuminating the main contributions to the analysis of economic complexity, this study seeks to fill the gap in the literature by providing a comprehensive overview of the foundation of economic complexity. This is an important step in understanding the development of this field over time and proposing direction for future research. Secondly, identifying the most influential papers, authors, organizations, and countries goes beyond the simple recognition but helps examine the research collaboration networks, knowledge creation, and main drivers in this research field. Lastly, our study provides directions for future research on economic complexity. This is a strategic initiative to highlight the under-explored topics in the economic complexity field and propose new research directions and approaches in response to a more dynamic and complex global environment.

Some scholars attempted to review economic complexity from a different point of view. For example, they reviewed studies on economic complexity, rural diversification, and industrial policy associated with environmental and social sustainability (Ferraz et al., 2021). Later, Hidalgo reviewed economic complexity theory and applications, focusing on two streams of literature: the literature on metrics of economic complexity and the literature on relatedness (Hidalgo, 2022). Finally, Bahrami et al. (2023) followed a multiple-processed approach for a systematic review of 95 papers that uncovered three categories: exploratory studies, measurement techniques, and criticisms. However, despite the recognized social and economic importance of economic complexity, there has been no literature review or systematic literature review of the economic complexity using a comprehensive performance analysis of scientific actors and science mapping, or in other words, a bibliometric analysis of the economic complexity has not been investigated. Therefore, it is for the first time that such a study tries to shed light on this research field. This paper contributes to the current literature by analyzing the most related papers on economic complexity and recognizes documents published in this field. Furthermore, the study's findings classify the literature into four primary clusters: diversification, income inequality, economic growth, and ecological footprint. Ultimately, it opens doors for future research in the area of economic complexity while recognizing the most influential authors, organizations, and countries.

The rest of this study is structured as follows: Sect. 2 presents the methodology and data collection. Section 3 presents the trend in publications, bibliometric, and content analyses results. Section 4 provides recommendations for future research, and Sect. 5 concludes the paper.

## 2 Methodology and data

In this paper, we follow a bibliometric, empirical approach. We obtained the required data from the Scopus database in February 2023 as it has an extensive range of subjects (Md Khudzari et al., 2018), and additionally, it was applied in numerous studies (Nobanee & Ellili, 2023). Then, a systematic literature review (SLR) is

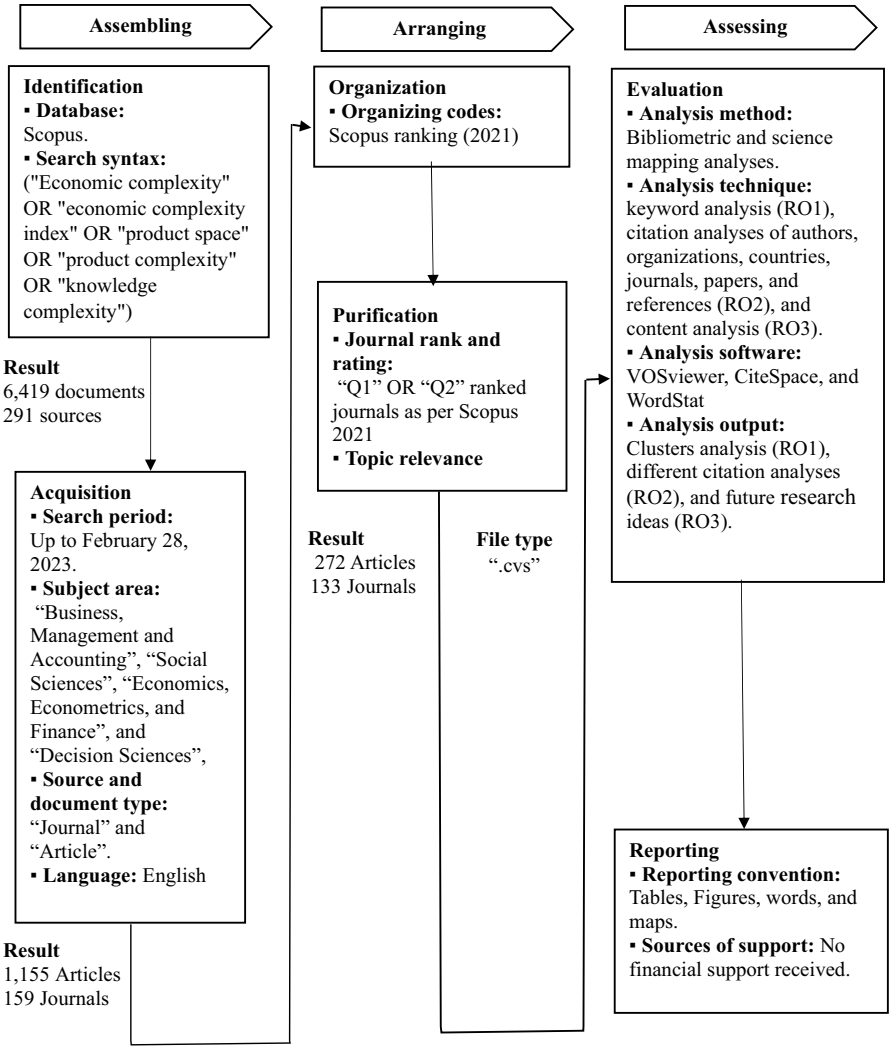



**Fig. 1** The process of review applying SPAR-4-SLR protocol

considered to determine, arrange, and report the papers (Duque-Uribe et al., 2019). The search terms and various steps of data processing are shown in Fig. 1. For the first step of SLR, documents are gathered from the Scopus database using keywords such as "Economic Complexity," "Economic Complexity Index," "Product Space," "Product Complexity," and "Knowledge Complexity." Primarily a total of 1155 articles and 159 journals were identified in subjects like "Economics, Econometrics, Finance", "Social Sciences", "Business, Management and Accounting", and "Decision Sciences".

Following several bibliometric reviews (Ellili, 2023a, 2023b; Khudzari et al., 2018; Nobanee & Ellili, 2023), we searched for published papers from the Scopus

database. We selected this database because it is considered the largest repository of high-quality academic research documents and provides the world's most comprehensive overview of research outputs (Elsevier, 2020). The article's exclusion and inclusion were related to three main criteria. Firstly, it should be published after 2007 and be part of the Scopus Core Collection. Secondly, in at least one of three fields: "title," "abstract," and "author keywords", the article should have one of the "Economic Complexity," "Economic Complexity Index," "Product Space," "Product Complexity," and "Knowledge Complexity" keywords. Thirdly, articles must have been published in "Q1" OR "Q2" ranked journals per Scopus 2021. Then, a screening channel was used to confine the sample to related articles of economic complexity. Next, for the Systematic Literature Reviews (SPAR-4-SLR) protocol first introduced by Paul et al. (2021), every article is inspected and introduced in light of the Scientific Procedures and Rationales. After applying the SPAR-4-SLAR protocol like previous scholars (Das et al., 2022; Ellili, 2023a; Paul et al., 2021), the search was limited to 272 articles. Furthermore, articles published after the final search query date (February 28, 2023) were excluded from this study.

The SPAR-4-SLR protocol consists of three main stages: Assembling, Arranging, and Assessing, with six sub-stages: Identification, Acquisition, Organization, Purification, Evaluation, and Reporting (Lim et al., 2022). They are depicted in Fig. 1. Each stage is described below.

## 3 Results

### 3.1 Publication trend of research on economic complexity

Although the first journal article on economic complexity was published in 2007 (Hidalgo et al., 2007), the annual publication trend in Fig. 2 shows that this field has received more attention only since 2019 (almost doubling compared to 2018). Moreover, the number of articles per year is relatively high after 2019. This indicates the growing recognition of the importance of the concept of economic complexity at different levels. It is noted that in 2022, many articles were published in this area. The rising number of articles confirms that scientists and researchers are progressively keen on this approach. The table shows that most documents (61.62%; 159 out of 258) were published between 2021 and 2022.[1]

### 3.2 Most frequent research topics

To determine the growth and development of research on economic complexity, we performed a co-occurrence analysis of the authors' keywords using VOSviewer. This analysis consists of different steps that are automatically handled by VOSviewer (Donthu et al., 2021). First, VOSviewer identifies keywords, analyses

[1] The 14 papers published in 2023 were not included in Figure as the year is not over yet.

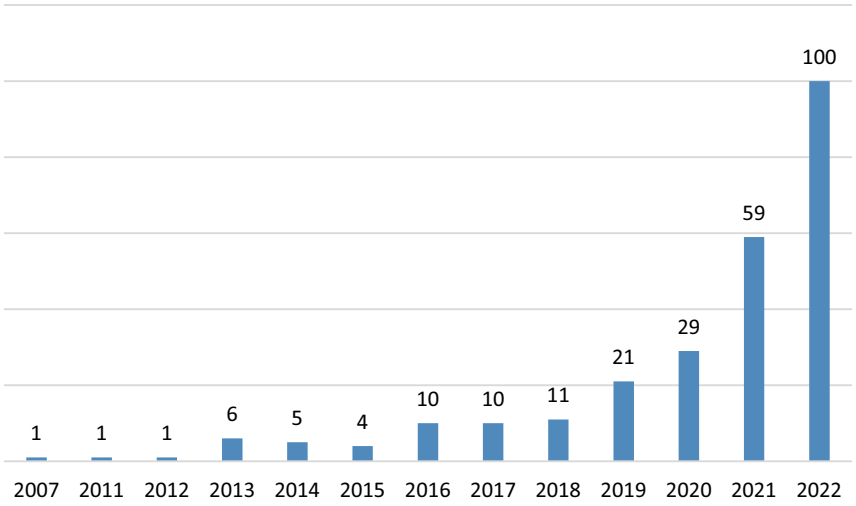



**Fig. 2** Publication trend of papers on economic complexity

their co-occurrence, and calculates the appearance of each pair of keywords in the dataset. Second, it creates a network visualization where each node represents a keyword. Third, VOSviewer identifies colored clusters in the network visualization, indicating a set of keywords frequently used together. Finally, it labels clusters based on the most prominent keyword within each cluster.

To ensure the validity of that, a minimum threshold of two was set for the co-occurrence of a considered keyword, following Khan et al. (2022) and Ellili (2023a). After removing duplicates (e.g., exports and exports) and the keywords included in the query, the results were 33 out of a total of 739 keywords. The result is shown in Fig. 3, which shows four main clusters: Diversification, Income Inequality, Economic Growth, and Ecological Footprint. The frequent use of these keywords in studies shows the need to consider economic complexity in research in response to the prosperity of economies.

Both Table Table 8 The content analysis of articles on economic complexi tyNoTopicKeywordsCoherence (NPMI)FREQCases% Cases1Panel dataData; panel; model; OECD countries; Empirical analyses0.47158522235.95%2Expo rt diversificationExport; product; diversification; country; level; services export diversification; export performance; export product0.41037912219.77%3Income countriesHigh; income; economies; income inequality; income economies; income distribution; developing economies; income levels0.45229011819.12%4Renewable energyEnergy; energy consumption; environmental degradation; energy intensity; population growth0.47726610617.17%5Ecological footprintFootprint; ecological; energy; environmental; emissions, greenhouse gas emissions; environmental sustain ability0.467279497.94%1 and Fig. 3 show that there were four major categories: (1) diversification (red), (2) income inequality (green), (3) economic growth (blue), and (4) ecological footprint (yellow). The cluster of diversification studies has examined the role of economic complexity in industrial diversification based on the capabilities

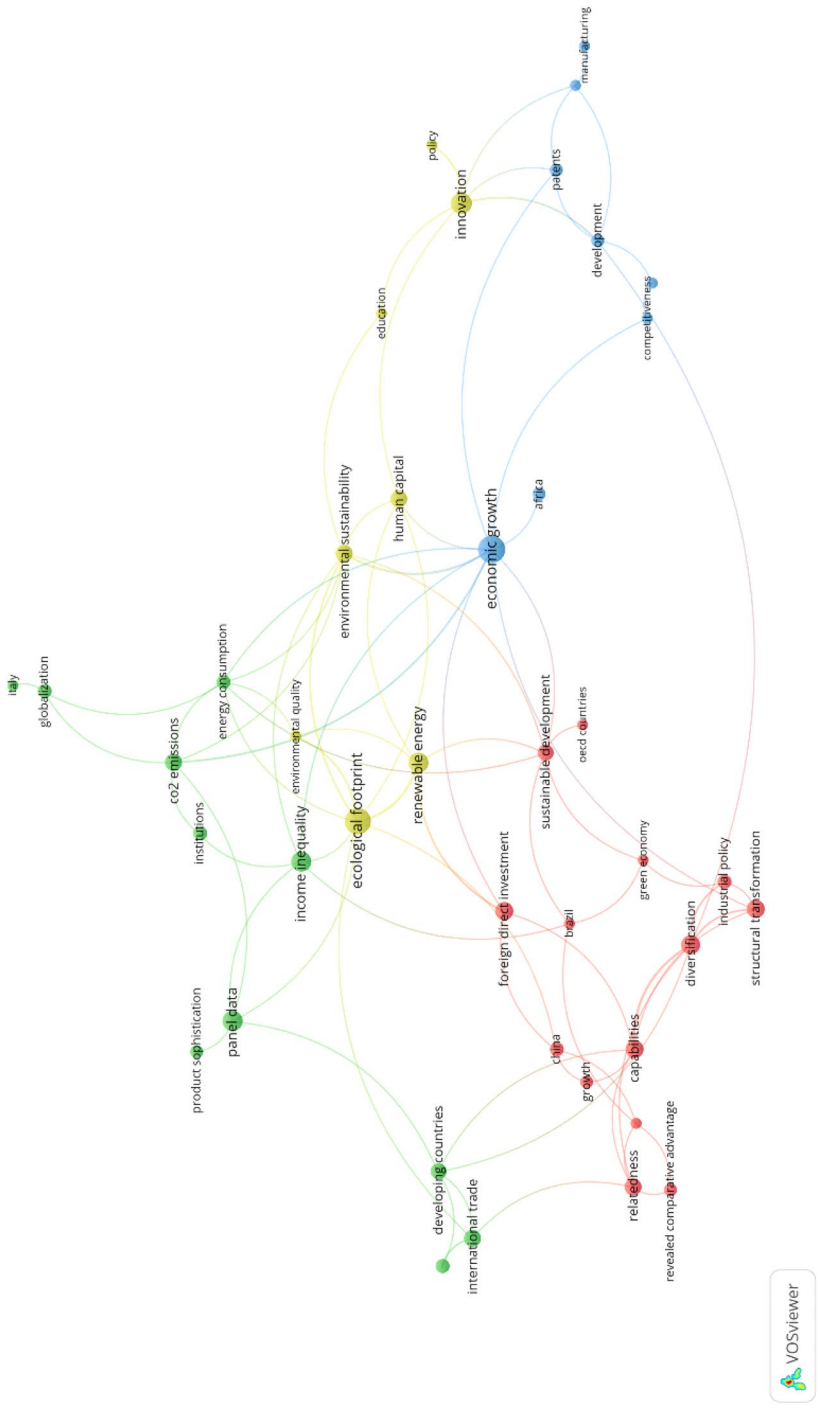



**Fig. 3** Keywords analysis

**Table 1** Clusters and keywords

| Number | Cluster | Keywords |
|---|---|---|
| 1 | Diversification | Capabilities, industrial policy, OECD countries, regional development, structural transformation, green economy, relatedness, China, Brazil |
| 2 | Income inequality | Comparative advantage, developing countries, international trade, product sophistication, panel data, globalization, $CO_2$ emission, energy consumption, Italy |
| 3 | Economic growth | Competitiveness, development, manufacturing, patents, productivity, trade, Africa, |
| 4 | Ecological footprint | Education, environmental quality, environmental sustainability, human capital, innovation, renewable energy, policy |

available in a country. For example, Ferraz et al. (2021) linked diversification, economic complexity, and industrial policy to sustainable development. This cluster also includes studies on regional development (Chávez et al., 2017; Gao & Zhou, 2018; Balland et al., 2018; Cicerone et al., 2020) and industrial policy (Ferraz et al., 2021).

In the income inequality cluster, researchers mainly studied the impact of economic complexity on reducing inequality from various angles (Hartmann et al., 2017; Sbardella et al., 2017; Lee & Wang, 2021a, 2021b) and mitigating greenhouse gas emissions (Boleti et al., 2021; Neagu & Teodoru, 2019; Romero & Gramkow, 2021; Shahzad et al., 2021). In addition, a few studies examined the role of technological innovation (Yu et al., 2022), financial stability (Ashraf, 2022), and globalization (Nan et al., 2022) on $CO_2$ emissions. Moreover, studies in this cluster have considered the importance of the economic complexity approach in introducing advanced products (Tacchella et al., 2013) and gaining comparative advantage in developing countries (Cicerone et al., 2020).

In the economic growth cluster, studies focused on the importance of economic complexity metrics in measuring countries' level of competition (Tacchella et al., 2013), countries' patent productivity (Sweet & Eterovic, 2019), and bilateral trade development (Jun et al., 2020).

Finally, there is the ecological footprint cluster, which is a promising concept in the context of economic complexity. In this cluster, some researchers believe economic complexity could control energy demand and environmental quality (Doğan et al., 2022) or positively impact environmental sustainability (Rafique et al., 2022; Shahzad et al., 2023).

In addition, CiteSpace is applied to evaluate the most frequently considered keywords in the various phases of the advancement trends of the research field of economic complexity. Since our data came from the Scopus database, we converted the CVS file to Web of Science format and uploaded it to CiteSpace. The most frequently cited keywords were determined and organized in CiteSpace from 2007 to 2023 to arrange an overview (Fig. 4). As can be seen, there were no frequent keywords before 2007, but after 2007, the first frequently used keywords were "export" and "economic growth," which were included in the study by Hidalgo et al. (2007), suggesting that the emergence of the economic complexity approach was closely related to the economic growth of countries based on their export data. This study introduced relatedness metrics based on export data that calculate the general affinity between a particular industry and a location (Hidalgo, 2022). In other words, it explains path dependencies and predicts which industries will appear or disappear in a country or location. Since then, the economic complexity approach has been explored for other keywords such as "innovation" (Boschma & Franken, 2012; Ivanova et al., 2017; Sweet & Eterovic, 2019; Cicerone et al., 2020), "income inequality" (Hartmann et al., 2017), and more recently for "ecological footprint" (Rafique et al., 2022; Shahzad et al., 2021) or "renewable energy" (Doğan et al., 2021). The diversity of occurrence of the keyword expresses the evolution of economic complexity in different sectors, from the export sector to the green economy and domestic to international trade. Moreover, since 2020, economic complexity has become more prevalent in newer fields such as sustainable

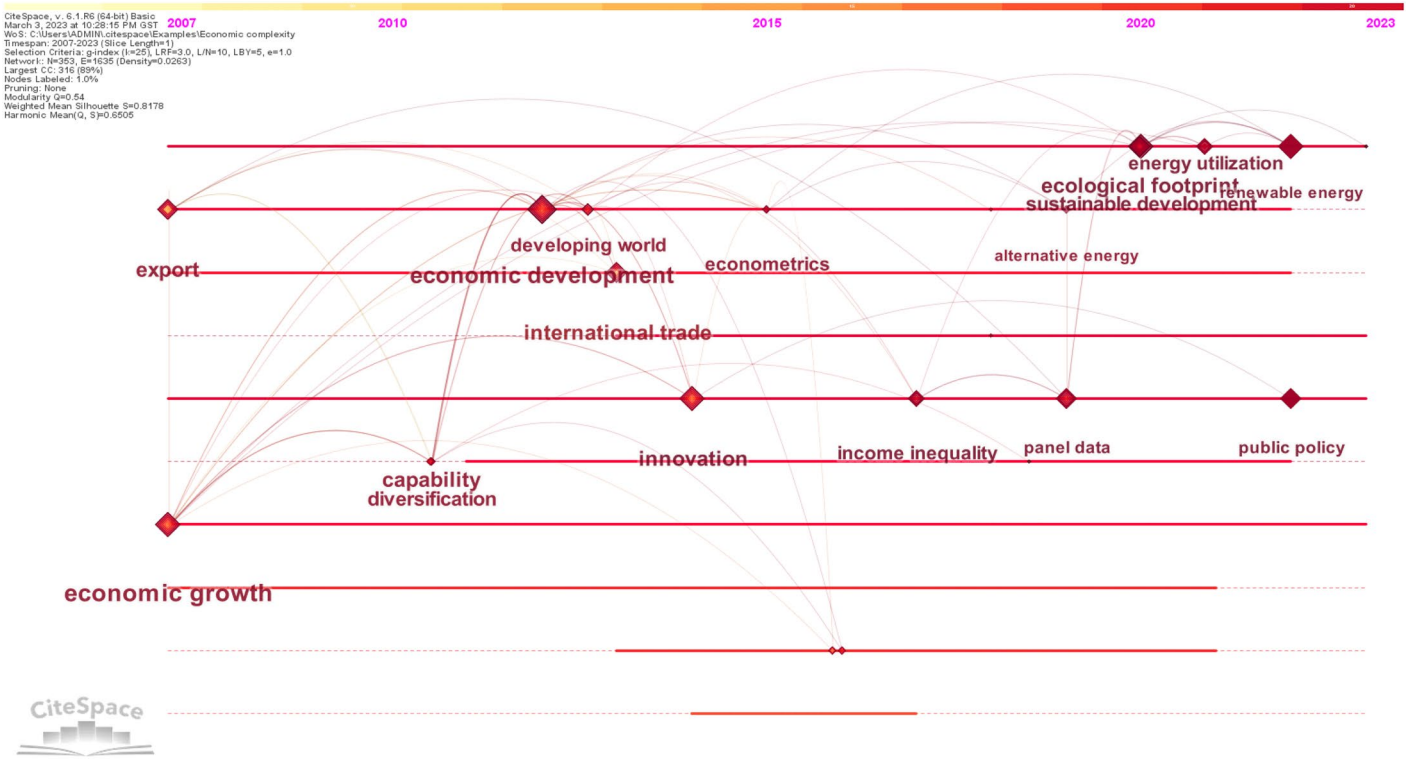



**Fig. 4** Evolution in research on economic complexity over the years

development and energy use or renewable energy. This may because economic complexity explains product complexity, productive knowledge, and structural change, which are the bases for the use of resources (Shahzad et al., 2023).

### 3.3 Authorship analysis

Information on the most frequently cited authors and their respective countries, organizations, and Google Scholar citations is presented in Table 2. In this analysis, we considered, besides the papers' citation, the author's Google Scholar citation to measure further the impact of each author's research. A higher Google Scholar citation indicates that the author's research gained wide recognition among researchers in the same field. A minimum number of two publications per author was used to perform a meaningful analysis. This yielded ten of 602 authors. The highest number of seven papers was published by Nguyen C.P. and Shahzad U., followed by Hidalgo C.A. with six papers, Doğan B., Hartman D., Hausmann R., and Li Y. with five papers, and Balland P.-A., Lapatinas A., and Lee C.-C. with four papers. Moreover, Table 2 indicates that authors affiliated with Vietnamese and Chinese universities published more articles on economic complexity. While authors affiliated with American universities have been more widely recognized by researchers on this topic in terms of citations.

The authorship analysis across the clusters identified in Sect. 3.2. reveals that a few authors focus only on one cluster. For instance, Shahzad U. and Doğan B. focus on "Ecological footprint" (Doğan et al., 2021; Shahzad et al., 2023). Hidalgo C.A, Hausmann R., Li Y., and Balland P.-A. focus on "Diversification" (Hausmann et al., 2021; Hausmann & Hidalgo, 2011; Hidalgo et al., 2007; Ji et al., 2018; Li et al., 2023; Shou et al., 2017; Balland et al., 2019, 2022; Dong et al., 2022). Hartman D. focuses on "Income inequality" (Ferraz et al., 2021; Hartmann et al., 2020, 2021). However, a few other authors conducted research related to more than one cluster. For instance, Nguyen C.P. published papers related to "Economic growth" (Nguyen, 2021, 2022; Nguyen et al., 2021) and "Diversification" (Nguyen & Schinckus, 2022). In addition, Lee C.-C. published papers related to "Ecological footprint" (Lee & Olasehinde-Williams, 2022; Lee et al., 2022; You et al., 2022) and "Income inequality (Lee & Wang, 2021a, 2021b). Lapatinas A. published papers related to "Diversification" (Adam et al., 2023; Lapatinas, 2019), "Ecological footprint" (Lapatinas et al., 2021), and "Income inequality" (Lapatinas & Katsaiti, 2023).

In addition to analyzing citation performance, as shown in Fig. 5 we applied applied science mapping for co-authorship in this study to reveal the main author groups who have contributed to published articles on economic complexity (Ellili, 2023a; Kumar et al., 2023). Since economic complexity is a new topic, the co-authorship network was created for all authors who have authored at least one research in this area. This resulted in three clusters: 1—Hausmann (blue), 2—Hidalgo (green), and 3—Shahzad (red). Hausmann and Hidalgo's clusters mainly focus on topics such as relatedness (Balland et al., 2019), product space (Hidalgo et al., 2007), and measuring economic complexity (Hausmann & Hidalgo, 2011),

**Table 2** Most cited authors analysis

| | Author | Papers | References | Main topic | Papers citation | Organization | Country | Google scholar citations |
|---|---|---|---|---|---|---|---|---|
| 1 | Nguyen C.P | 7 | Nguyen (2021, 2022) and Nguyen et al., (2021) | Economic Growth | 72 | School of Public Finance and Health & Agricultural Policy Research Institute, University of Economics Ho Chi Minh City | Viet Nam | 3063 |
| 2 | Shahzad U | 7 | Doğan et al. (2021), Rafique et al. (2022) and Shahzad et al. (2023) | Ecological footprint | 514 | School of Statistics and Applied Mathematics, Anhui University of Finance and Economics, Bengbu | China | 3893 |
| 3 | Hidalgo C.A | 6 | Hausmann and Hidalgo (2011), Jun et al. (2020) and Pinheiro et al. (2022) | Diversification | 1887 | Center for International Development, Harvard University, Cambridge, MA | USA | 29,304 |
| 4 | Doğan B | 5 | Doğan et al. (2021, 2022) and Ghosh et al. (2022) | Ecological footprint | 217 | Suleyman Demirel University, Isparta | Turkey | 2336 |
| 5 | Hartmann D | 5 | Ferraz et al. (2021) and Hartmann et al. (2020, 2021) | Income inequality | 323 | The MIT Media Lab, Cambridge Fraunhofer Center for International Management and Knowledge Economy IMW, Leipzig | USA, Germany | 1470 |
| 6 | Hausmann R | 5 | Hausmann and Hidalgo (2011), Hausmann et al., (2021) and Hidalgo et al., (2007) | Diversification | 1623 | Harvard Kennedy School, Harvard University, Cambridge, MA | USA | 47,064 |
| 7 | Li Y | 5 | Ji et al., (2018), Li et al. (2023) and Shou et al., (2017) | Diversification | 59 | Peking University, Beijing | China | – |
| 8 | Balland P.-A | 4 | Balland et al., (2019, 2022) and Dong et al., (2022) | Diversification | 285 | Department of Economic Geography, Utrecht University, Utrecht, the | Netherlands | 5710 |

**Table 2** (continued)

| | Author | Papers | References | Main topic | Papers citation | Organization | Country | Google scholar citations |
|---|---|---|---|---|---|---|---|---|
| 9 | Lapatinas A | 4 | Adam et al. (2023) and Lapatinas (2019) | Diversification | 79 | European Commission, Joint Research Centre (DG-JRC), Via E. Fermi | Italy | 553 |
| 10 | Lee C.-C | 4 | Lee and Olasehinde-Williams (2022), Lee et al., (2022) and You et al., (2022) | Ecological footprint | 61 | School of Economics and Management, Nanchang University, Nanchang | China | 21,975 |

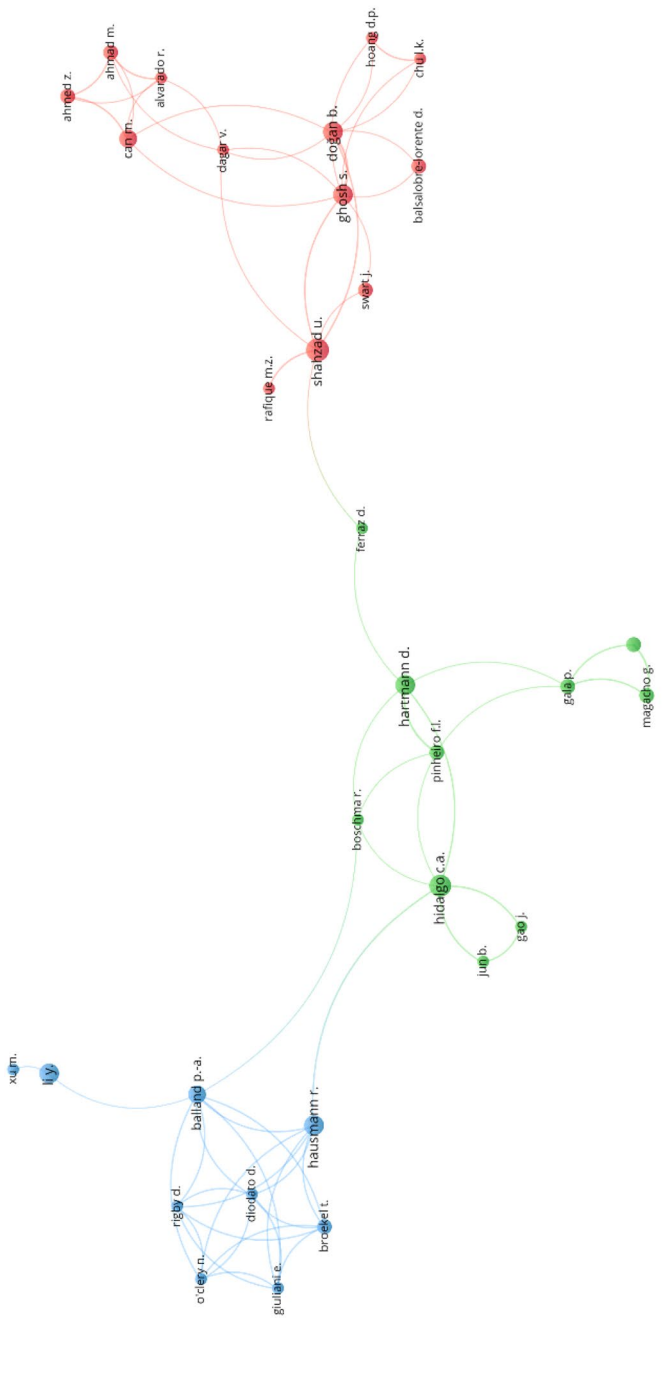



**Fig. 5** Co-authorship network

while Shahzad's cluster emphasizes on the impact of economic complexity on the green economy (Shahzad et al., 2023).

### 3.4 Analysis of organizations

Table 3 shows the 10 most cited organizations. It refers to a threshold of one document with at least 33 citations, resulting in 10 out of 669 organizations, while the maximum number of citations is 495. The table shows that Chinese organizations were leading in this subject, as three of the top ten organizations are based in China. More particularly, the School of Statistics and Applied Mathematics, Anhui University of Finance and Economics, Bengbu in China, is the affiliation of Shahzad U. focusing on "Ecological footprint". The Research Center of Central China for Economic and Social Development, Nanchang University, Nanchang in China, is the affiliation of Lee C.-C. publishing papers related to "Ecological footprint" and "Income inequality". The Faculty of Economics Administrative and Social Sciences, Istanbul Gelisim University, Istanbul in Turkey, is the affiliation of Udemba E.N., Yalçıntaş S., and Bekun F.V. focusing on "Ecological footprint" (Adedoyin et al., 2021; Udemba & Yalçıntaş, 2021). Organizations in Turkey also received a high number of citations. More particularly, Suleyman Demirel University, Isparta, in Turkey is the affiliation of Doğan B., focusing on "Ecological footprint". The Turkish organizations are followed by those in Taiwan. More specifically, the University Hospital, China Medical University, Taichung in Taiwan and the Faculty of Economics and Administrative Sciences, Cag University, Mersin in Turkey are the affiliations of Ozturk I. publishing papers on "Ecological footprint" (Adedoyin et al., 2021; Huang et al., 2022). However, Norway, the Netherlands, and the United Kingdom emerged in this comparatively new research area.

In addition to the organization's analysis, a scientific mapping of co-authorship is also performed to identify the key organizational groups that contributed to the publication on economic complexity. The analysis showed two main groups, as indicated in Fig. 6. One group is led by the School of Statistics and Applied Mathematics at Anhui University of Finance and Economics, Bengbu in China, which has the highest number of publications, citations, and link strength. The other group is led by Suleyman Demirel University in Turkey. The publications of these two groups are associated with the economic complexity approach.

### 3.5 Analysis of the countries

The top ten countries with most frequently cited are listed in Table 4. It represents a minimum of 13 articles and 291 citations per country. That resulted in 10 countries out of 66. Furthermore, the table indicates the distribution of countries' published articles on economic complexity. The United States was the largest contributor with the highest number of citations, followed by China, which contributes the most articles. Although China received the highest number of documents compared to the United States, the number of citations was higher in the United States than in China. These two countries accounted for nearly 32.60% of the total articles and 46.66% of

**Table 3** The main cited organizations

| Rank | Organization | Documents | Citations |
|---|---|---|---|
| 1 | School of Statistics and Applied Mathematics, Anhui University of Finance and Economics, Bengbu, China | 5 | 495 |
| 2 | Suleyman Demirel University, Isparta, Turkey | 4 | 48 |
| 3 | Department of Medical Research, China Medical University Hospital, China Medical University, Taichung, Taiwan | 3 | 159 |
| 4 | Faculty of Economics Administrative and Social Sciences, Istanbul Gelisim University, Istanbul, Turkey | 3 | 114 |
| 5 | University of Stavanger Business School, Norway | 3 | 38 |
| 6 | Amsterdam School of Communication Research (ASCOR), University of Amsterdam, Amsterdam, Netherlands | 2 | 47 |
| 7 | Department of Computing and Informatics, Bournemouth University, Poole, United Kingdom | 2 | 33 |
| 8 | Faculty of Economics and Administrative Sciences, Cag University, Mersin, Turkey | 2 | 151 |
| 9 | Research Center of the Central China for Economic and Social Development, Nanchang University, Nanchang, China | 2 | 59 |
| 10 | School of Management and Economics, Beijing Institute of Technology, Beijing, China | 2 | 89 |

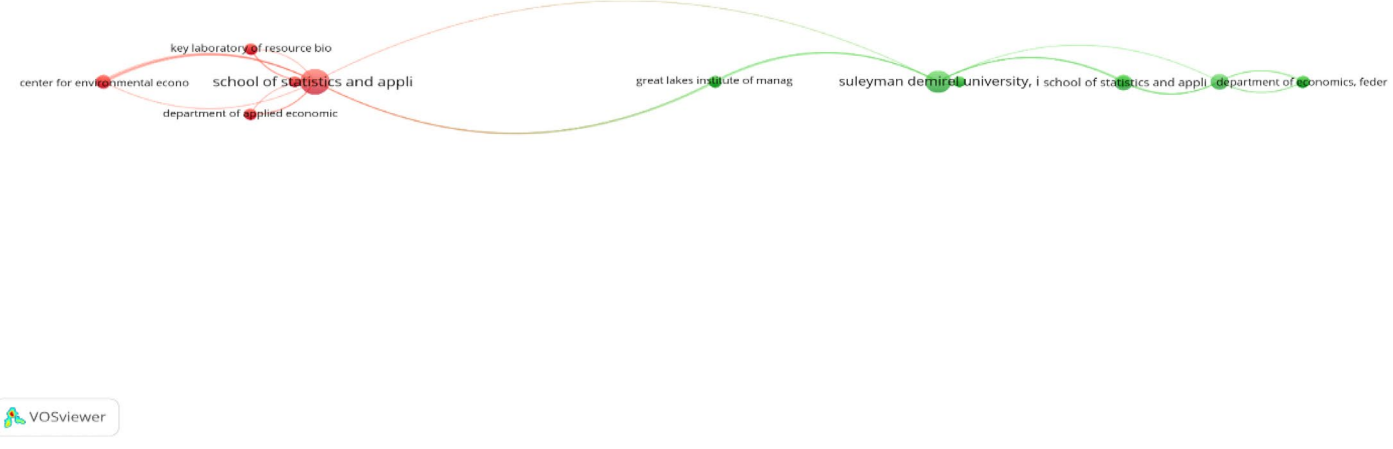



**Fig. 6** Organizations network of co-authorship

**Table 4** Main cited countries

| Rank | Country | Publications | Citations |
|---|---|---|---|
| 1 | China | 54 | 1086 |
| 2 | United States | 35 | 2386 |
| 3 | Italy | 35 | 675 |
| 4 | United Kingdom | 33 | 635 |
| 5 | France | 26 | 590 |
| 6 | Turkey | 24 | 632 |
| 7 | Vietnam | 19 | 309 |
| 8 | Netherland | 18 | 499 |
| 9 | Pakistan | 16 | 291 |
| 10 | Brazil | 13 | 338 |

the total citations. The concentration of publications in this area shows that it was mainly carried out between two countries worldwide.

In addition, the countries analysis across the clusters identified in Sect. 3.2. reveals that the publications of each country are related to different clusters. For instance, in China, the publications are related to "Ecological footprint" (such as Numan et al., 2022; Shahzad et al., 2023), "Income inequality" (such as Lee & Wang, 2021a, 2021b; Li et al., 2023), "Economic growth" (such as Tabash et al., 2022; Zhu & Li, 2017), and "Diversification" (such as Gao et al., 2021; Shou et al., 2017). Similarly, in the United States, the publications are related to different clusters including "Ecological footprint" (such as Can & Ahmed, 2023; Doğan et al., 2021), "Income inequality" (such asGhosh et al., 2023; Morais et al., 2021), "Economic growth" (such asKoch, 2021; Mewes & Broekel, 2022), and "Diversification" (such as Balland et al., 2019; Ben Saad et al., 2023).

Additionally, a co-authored country analysis was applied to identify the main country groups that have contributed to the publication on economic complexity. This analysis provides information on potential international collaborations to researchers interested in this topic. The network of co-author countries consists of those countries with a minimum of two publications since this area of research is still in its beginning period. This step resulted in 37 out of 66 countries. The analysis identified four main clusters, which are shown in Fig. 7. The first one (red) includes 13 countries which was led by China and obtained the highest number of publications and citations. Moreover, China has the most international research cooperation with other countries, such as South Korea, the United Kingdom, France, and the United Arab Emirates. The key theme of this cluster is sustainability performance. The second group (green) includes nine countries, headed by Turkey, that have joint research on the relationship between economic complexity and human capital. Turkey has collaborated with Canada, India, Brazil, Germany, and Portugal. The third cluster (blue) included eight countries, headed by Vietnam. This cluster indicates that most of Vietnam's research cooperation is mainly with Asian countries such as Pakistan. Finally, the fourth cluster (yellow) consisted of seven countries headed by the Netherlands. This cluster indicates that most

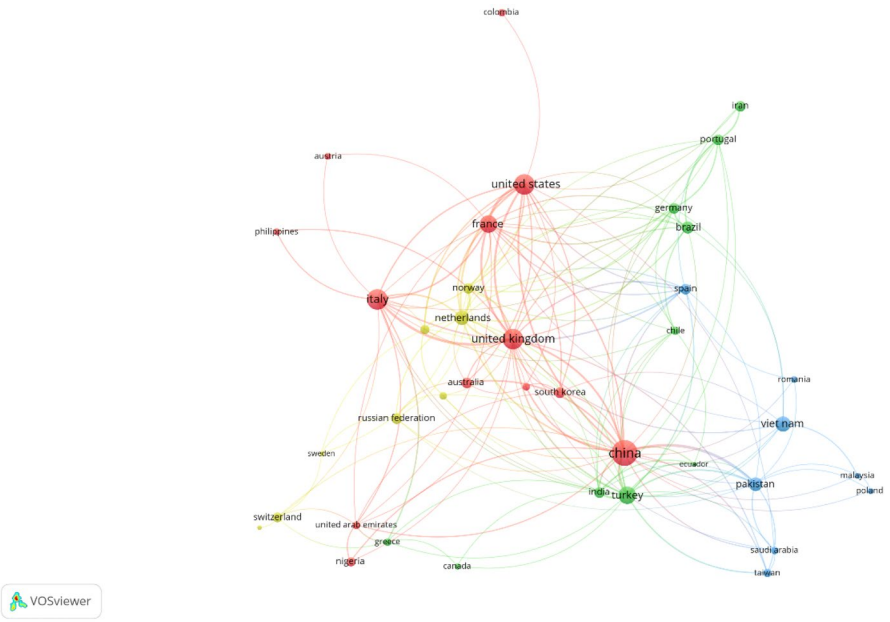



**Fig. 7** Co-authorship countries network

of the research cooperation by the Netherlands is mainly with European countries like Norway, Sweden, Switzerland, and the Russian Federation.

### 3.6 Most cited papers

Table 5 provides a list of the ten most frequently cited papers. It is based on a threshold of at least 100 citations per article. This analysis resulted in 10 out of 272 articles. Table 5 shows that the two most cited articles are "The product space conditions the development of nations" (Hidalgo et al., (2007)) and "The network structure of economic output" (Hausmann and Hidalgo, (2011)). Both studies are considered the main source for the economic complexity approach. The first focuses on the relatedness network between products, or the "product space," while the second focuses on the structure of production contained in the network that links countries to the commodities they produce. These two papers together account for 53.15% of all mentions. These two works were followed by the paper "Linking economic complexity, institutions, and income inequality," in which Hartmann et al. (2017) suggest that economic complexity is a negative and significant predictor of income inequality.

### 3.7 Most co-cited reference papers

This part lists the 20 most cited references in articles on economic complexity published in Scopus journals. This analysis relates to a threshold of at least 17

**Table 5** Top cited documents

| Rank | Document | Citations | Title |
|---|---|---|---|
| 1 | Hidalgo et al. (2007) | 1302 | The product space conditions the development of nations |
| 2 | Hausmann and Hidalgo (2011) | 299 | The network structure of economic output |
| 3 | Hartmann et al. (2017) | 261 | Linking Economic Complexity, Institutions, and Income Inequality |
| 4 | Balland et al. (2019) | 260 | Smart specialization policy in the European Union: relatedness, knowledge complexity and regional diversification |
| 5 | Doğan et al. (2021) | 175 | The mitigating effects of economic complexity and renewable energy on carbon emissions in developed countries |
| 6 | Felipe et al. (2012) | 163 | Product complexity and economic development |
| 7 | Shahzad et al. (2021) | 160 | Investigating the nexus between economic complexity, energy consumption and ecological footprint for the United States: New insights from quantile methods |
| 8 | Neagu and Teodoru (2019) | 150 | The relationship between economic complexity, energy consumption structure and greenhouse gas emission: Heterogeneous panel evidence from the EU countries |
| 9 | Sweet and Eterovic Maggio (2015) | 140 | Do stronger intellectual property rights increase innovation? |
| 10 | Tacchella et al. (2013) | 102 | Economic complexity: Conceptual grounding of a new metrics for global competitiveness |

**Table 6** Main co-cited reference articles

| Rank | Cited reference | Citations |
|---|---|---|
| 1 | Hidalgo, C.A., & Hausmann, R. (2009). The building blocks of economic complexity. *Proceedings of the National Academy of Sciences, 106* (26), 10570–10575 | 106 |
| 2 | Hidalgo, C.A., Klinger, B., Barabasi, A.L., & Hausmann, R. (2007). The product space conditions the development of nations. *Science, 317* (5837), 482–487 | 72 |
| 3 | Hausmann, R., Hwang, J., & Rodrik, D. (2007). What you export matters. *Journal of Economic Growth, 12* (1), 1–25 | 58 |
| 4 | Hartmann, D., Guevara, M.R., Jara-Figueroa, C., Aristaran, M., & Hidalgo, C.A. (2017). Linking economic complexity, institutions, and income inequality. *World Development, 93*, 75–93 | 46 |
| 5 | Hausmann, R., & Hidalgo, C.A. (2011). The network structure of economic output. Journal of Economic Growth, 16 (4), pp. 309–342 | 42 |
| 6 | Can, M., Gozgor, G. (2017). The impact of economic complexity on carbon emissions: evidence from France. *Environmental Science and Pollution Research, 24*(19), 16364–16370 | 31 |
| 7 | Felipe, J., Kumar, U., Abdon, A., & Bacate, M. (2012). Product complexity and economic development. *Structural Change and Economic Dynamics, 23*(1), 36–68 | 29 |
| 8 | Blundell, R., Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87* (1), 115–143 | 28 |
| 9 | Romero, J.P., & Gramkow, C. (2021). Economic complexity and greenhouse gas emissions. *World Development, 139*, 105317 | 20 |
| 10 | Cristelli, M., Gabrielli, A., Tacchella, A., Caldarelli, G., & Pietronero, L. (2013). Measuring the intangibles: a metrics for the economic complexity of countries and products. *PloS one 8*(8), e70726 | 17 |

citations, yielding 10 references for a total of 15,191. Table 6 shows all the most cited articles and shows that the highest number of citations is 106, although this research topic is quite new and is the first published one in this area, dates back to 2007. Two of the co-cited references correspond to the green economy, one to income distribution, and the rest to the formation of product spaces and the measurement or application of economic complexity in economic development.

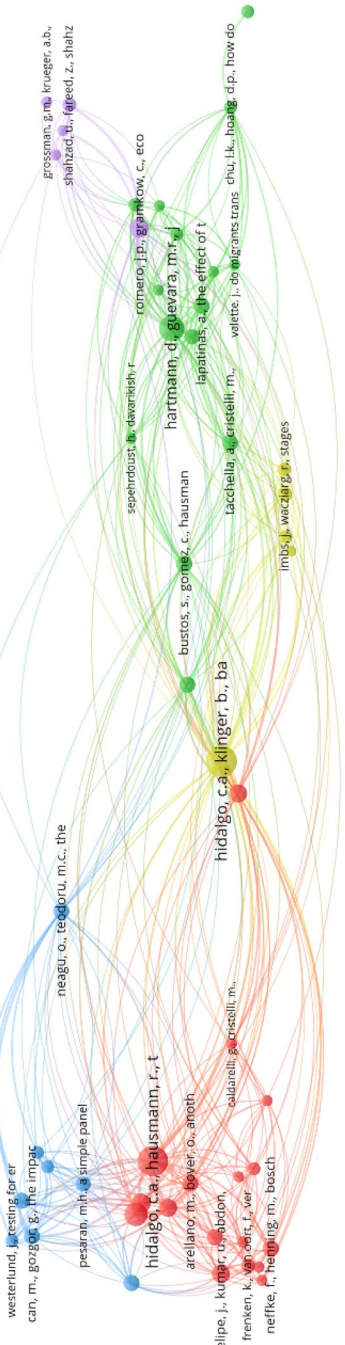
In addition, an analysis of the network of co-cited references was conducted to identify the clusters in the references. The network included the references with the highest number of citations, 17. The results are shown in Fig. 8 and reveal five main clusters of references. The first cluster (red) consists of 17 references related exclusively to economic complexity, including economic growth and development, network and structural change, and metrics of economic complexity. The second cluster (green) consists of 15 references related to research methods and, particularly, the application of economic complexity to other research areas such as income inequality. The third cluster (blue) consists of eight references related to emissions, green economy, or ecological footprint. The fourth cluster (yellow) belongs to references related to product space and includes 5 references. This cluster is associated to the focus topic of Hidalgo et al. (2007). Finally, the fifth cluster (purple), led by Romero and Gramkow (2021), consists of five references focused on the link between economic complexity and greenhouse gas emissions.

### 3.8 Most cited sources

This part provides a citation analysis of the five most cited sources. This corresponded to a minimum of eight publications by the source. Table 7 shows indicates the sources with their related quartiles and Source Normalized Impact per Paper (SNIP) factors. The table shows that all journals are in Scopus Q1 and have SNIP factors greater than 1.31. The most productive journal was *Sustainability,* which published the highest number of papers (21). The *Journal of Cleaner Production* had only eight papers but had the highest number of citations (404). Table 7 also shows that *Research Policy, Structural Change and Economic Dynamics,* and *Resources Policy* are emerging in the publication of papers on economic complexity.

### 3.9 Content analysis

Additionally, quantitative content analysis is performed by applying WordStat, a software that analyzes textual information. The content analysis consists of several steps. WordStat automatically processes all these steps. First, WordStat identifies the most frequent words and sentences within the abstracts of the papers included in the dataset. Second, it identifies the relationships between the most co-occurring words and sentences. Finally, it categorizes these words and sentences into topics. These topics may include the most frequent themes in a particular field, as well as empirical methodologies (panel data, questionnaires, regressions, case study) and types of samples included in the different studies (emerging economies, developed




VOSviewer

**Fig. 8** The network of most co-cited references

**Table 7** Most cited journals

| Rank | Source | Documents | Citations | Quartile (SNIP) | Publisher |
|---|---|---|---|---|---|
| 1 | Sustainability (Switzerland) | 21 | 278 | Q1 (1.31) | Multidisciplinary Digital Publishing Institute (MDPI) |
| 2 | Research Policy | 13 | 286 | Q1 (3.623) | Elsevier |
| 3 | Structural Change and Economic Dynamics | 12 | 378 | Q1 (1.724) | Elsevier |
| 4 | Journal of Cleaner Production | 8 | 404 | Q1 (2.444) | Elsevier |
| 5 | Resources Policy | 8 | 93 | Q1 (1.996) | Elsevier |

markets, banking industry, family businesses) (Ellili, 2023a, 2023b). The analysis distinguished the five most common themes in articles on economic complexity: Panel Data, Export Diversification, Income Countries, Renewable Energy, and Ecological Footprint. Table 8 shows the results of the study.

The first topic is related to the most used empirical methodology panel data. It accounts for the largest share of economic complexity research and consists of studies that empirically analyze the effects of economic complexity in the context of emissions using econometric models (You et al., 2022; Lee & Olasehinde, 2022). The second theme is export diversification, which accounts for 19.77% of all themes. Studies on this theme have examined the role of economic complexity in export diversification strategies and sustainable development (Ferraz et al., 2021) to distinguish between related and unrelated diversification (Balland et al., 2019; Pinheiro et al., 2022). The third theme belongs to income countries and has a share of 19.12% in the total number of themes. It consists of studies examining the role of economic complexity on the extent of income inequality (Lee & Vu, 2020; Hartmann et al., 2020; Ghosh et al., 2023) or income inequality between countries (Hausmann et al., 2021). The next topic is renewable energy, which accounts for 17.17% of all topics. It includes studies on economic complexity and its effect on controlling energy demand and environmental quality (Doğan et al., 2021, 2022; Shahzad et al., 2023). The last topic is ecological footprint, which has obtained 7.94% of the total topics. The studies on this topic are related to the role of economic complexity in diminishing greenhouse (Neagu & Teodoru, 2019; Romero & Gramkow, 2021) or emissions (You et al., 2022).

Our analysis identified four main clusters in Sect. 3.2 (Diversification, Income Inequality, Economic Growth, Ecological Footprint) and five major themes from the content analysis in Sect. 3.9 (Panel Data, Export Diversification, Income Countries, Renewable Energy, Ecological Footprint). The comparison between these clusters and themes reveals insightful links between them.

For instance, "Export Diversification" in the content analysis is aligned with the "Diversification" cluster, indicating a better understanding of how countries diversify in products, markets, and technologies, contributing to economic complexity. Similarly, the "Income Countries" theme is related to the "Income

**Table 8** The content analysis of articles on economic complexity

| No | Topic | Keywords | Coherence (NPMI) | FREQ | Cases | % Cases |
|---|---|---|---|---|---|---|
| 1 | Panel data | Data; panel; model; OECD countries; Empirical analyses | 0.471 | 585 | 222 | 35.95% |
| 2 | Export diversification | Export; product; diversification; country; level; services export diversification; export performance; export product | 0.410 | 379 | 122 | 19.77% |
| 3 | Income countries | High; income; economies; income inequality; income economies; income distribution; developing economies; income levels | 0.452 | 290 | 118 | 19.12% |
| 4 | Renewable energy | Energy; energy consumption; environmental degradation; energy intensity; population growth | 0.477 | 266 | 106 | 17.17% |
| 5 | Ecological footprint | Footprint; ecological; energy; environmental; emissions, greenhouse gas emissions; environmental sustainability | 0.467 | 279 | 49 | 7.94% |

Inequality" cluster, suggesting that income inequality across countries contributes to economic complexity. "Panel Data" in many studies illustrates how econometric analysis contributes to understanding long-term trends and patterns in economic growth and inequality. Furthermore, the theme of "Ecological Footprint" is prevalent across both the clusters and content analysis, highlighting its growing importance in the analysis of economic complexity. Based on the convergence of these topics, an integrated approach to analyzing economic complexity can be developed, including aspects such as diversification strategies and sustainability challenges. This comprehensive approach is important for policymakers and researchers interested in determining the factors of economic complexity.

In terms of studies,

## 4 Recommendation for future research

This section provides recommendations for future research on economic complexity. We recommend to future researchers to conduct studies on the following ideas:

(a) *Network analysis:* Although the economic complexity approach started with the concept of network analysis, it is still becoming more critical in its studies. Future research should apply this method to better understand the economic structure and complexity by examining the possible connections between various products and industries by including service sector such as healthcare and technology. It will also inform policymakers about the optimal industrial strategy (Jun et al., 2020) to improve the resilience of economic systems.

(b) *Combination policy:* Economic complexity has an important implication for policymakers since it will suggest a successful identification of products and industries of a country. The industrial policy cannot use worldwide national and regional databases, like economic complexity and relatedness research (Ferraz et al., 2021). Expanding such a database should also focus on a new combination of industrial, innovative, and social policies by considering the possible interactive learning between different parts of society and sciences (economics, sociology, political, and environmental), applying empirical tests, and formulating region-specific approaches (Balland et al., 2019; Ferraz, et al., 2021).

(c) *Machine learning and big data:* Due to the increasing number of datasets available for economic complexity studies and technological advancements, the use of big data and machine learning techniques are becoming more important. Future studies should use these techniques to help researchers identify additional possible connections between different industries and products (Tacchella et al., 2018).

(d) *Innovation and entrepreneurship:* Economic complexity acts as a motivator for innovation across different sectors, particularly in manufacturing. It serves as a channel of expertise and knowledge, crucial for the manufacturing sector, as it contributes to innovation and entrepreneurship. Thus, examining the elements of innovation and entrepreneurship in future studies is essential to evaluate

their influence on global economic growth (Adam et al., 2023). Furthermore, it's important to identify and implement more effective strategies to stimulate economic development (Doğan et al., 2022).

(e) *Sustainability:* The field of sustainability is becoming more important in economic complexity studies (Ferraz et al., 2021; Rafique et al., 2022; Shahzad et al., 2023). However, other than $CO_2$ emissions, there is no studies analyzing ecological footprints and pollutants (Ferraz et al., 2021). Therefore, future research should consider the impact of economic complexity on alternative fields, such as social and environmental sustainability, which are important for policy implications while studying economic complexity.

## 5 Conclusion

This study applies a bibliometric analysis to provide a complete encapsulation of economic complexity fields. A primary difficulty encountered in this analysis is the abundance of documents about economic complexity, though it has been a long-standing topic, indicating a promising prospect of further research on this method in the digital age. We attempted to achieve three research objectives by applying a variety of analyses, considering global citation analysis of authors, organizations, countries, journals, articles, references, content analysis, and other bibliometric analyses. The sample data from 2007 to 2023 shows that some prominent scholars have contributed to research in this field. Indeed, research in economic complexity, though still rooted in research on diversification, economic growth, inequality, and recent emissions, has grown to consider a variety of topics; therefore, in the future, researchers are encouraging further examination of these fields to advance these fields.

According to the study, economic complexity publications have gained momentum since 2007, and there has been a remarkable increase in research published on adopting economic complexity. From 11 articles in 2018 to 100 in 2022, the number of publications increased significantly. The main reason behind this was, from one side, the increasing economic interconnections and the growing complexity of economies and financial systems, which led to the formation of several challenges in the theories of traditional economists. From the other side, the financial crisis of recent years and its aftermath of economic stagnation and insignificant prosperity all indicated the need for new economic thinking such as economic complexity.

Results indicate that Hidalgo et al. (2007) and Hausmann and Hidalgo (2011) were the most influential publications among all the economic complexity adoption studies. Both studies are considered the main source of the economic complexity approach. The first focuses on the network of relatedness between products, or 'product space', while the second study looks at the output structure regarding the network that links countries to the export products. By looking at the top contributors in this area, the study found that the US had the largest number of citations and China had the largest number of papers. Although China obtained the highest number of documents compared to the US, the citation number of the US is

higher than China's. Further, based on the total citations received, Anhui University of Finance and Economics in China, and China Medical University in Taiwan were the most influential institutions in the field. Finally, based on the findings of this research, there are five directions for future research: network analysis, machine learning and big data, international trade and global value chain, innovation and entrepreneurship, and sustainability.

This study has several implications. The policy implication is that the findings of this study, particularly in Sect. 3.2, reveal the impact of economic complexity in reducing income inequality, suggesting that policies that foster economic complexity could effectively address income disparities. In addition, the results indicate that higher economic complexity is associated with a lower ecological footprint, emphasizing the need for policies that encourage sustainable economic practices. These results provide insight into the dynamics of economic complexity and assist policymakers in designing more effective economic plans by considering economic growth, diversification, income inequality, and ecological footprint. In addition, the findings of this study help policymakers identify industries with high potential economic complexity growth to boost diversification and sustainable development. The educational implication is that this study highlights, in Sect. 3.2, the impact of technological innovation on economic complexity, underscoring the importance of educational policies that focus on enhancing skills in creativity, technology, and innovation. This result explains the need for educational and skills development programs, especially in innovation and technology, to adopt economic complexity better, ensure economic growth and sustainable development, and reduce income inequality. The strategic implication is that this study provides valuable insights for businesses, especially those operating in complex economic markets. Our study findings, more particularly in Sects. 3.2. and 3.9, reveal that economic complexity is characterized by diversification and sustainable development. The businesses should consider in their strategies the investment in research and development, innovation and technology, and the identification of new growth and diversification opportunities to gain a competitive advantage.

Although this review provides valuable information on the economic complexity, it has a few limitations. The study only includes articles from the Scopus database and does not consider other relevant documents published in other databases like the Web of Sciences. In addition, the data in this study included only papers published in English. Therefore, it is recommended that future researchers extend the bibliometric review by including publications in non-English languages.

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