

Article

Bibliometric Outlook on Economics and Business Research in Kazakhstan (2019–2023)

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Abstract

This study examines the evolution of Kazakhstani research in the fields of economics and business research. We analyzed Scopus and Dimensions records for 2019–2023 following a PRISMA-like workflow with fully reproducible queries and time-stamped data extractions. We implemented both Bradford’s law of scattering and collaboration analysis. We report both journal-level (Scopus) and publication-level (Dimensions) results as complementary perspectives. Results show the applicability of Bradford’s law of scattering to research publications in Economics, Econometrics, and Finance, Business, Management, and Accounting, and Decision Sciences in Kazakhstan and globally. Collaboration analysis highlights strong regional ties and diversification. Authorship analysis reveals that 85.1% of publications have a Kazakhstan-affiliated first author. Publications were classified into three categories: Kazakhstan-Only (59.0%, $N = 1585$), International Collaboration with Kazakhstan-led authorship (31.5%, $N = 845$), and International Collaboration with Non-Kazakhstan-led authorship (9.5%, $N = 255$). International collaborations had 69–92% higher citation impact than domestic-only publications. The expansion of citing countries doubled in 2023 compared with 2019. Our contributions to bibliometric analysis and science policy are two-fold. First, we provide a comprehensive comparative analysis of publication patterns between Kazakhstani and global journals in economics and business-related fields, revealing specific areas requiring development. Second, we identify collaboration patterns, including citation analysis of studied fields. The analysis revealed strategies that can be applied in other emerging economies.

Keywords: bibliometric analysis; Bradford’s law; economics research; Kazakhstan; journal distribution; research output; business research



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1. Introduction

Kazakhstan has made progress in developing its research environment since gaining independence; however, challenges remain, particularly in the fields of economics and business. This research aims to comprehensively explore these fields to understand the current state of the field and identify further directions and possibilities for emerging topics in the field to make a contribution to the development of the country’s economy. By focusing on economics and business fields, we address an area that has historically been less developed in Kazakhstan compared with STEM domains, thereby informing national research capacity priorities.

The link between scientific and economic development has been widely discussed in the literature, and this study aims to explore the bibliometric landscape of the economics and business research fields with a focus on Kazakhstan. Business and economics as fields of research in the former Soviet Union countries are not as widely represented in the research outputs as other research fields. This is because the economy was a command economy characterized by the absence of a free market and limited opportunities to apply the results of business research to economic development and progress (Chankseliani et al., 2022). Therefore, former Soviet Union countries, particularly Kazakhstan, lack strong research in these fields, resulting in undiscovered potential. Several researchers have identified major trends in the development of science in Kazakhstan (Chankseliani et al., 2022; Narbaev & Amirbekova, 2021). The research suggests that during the Soviet era, focus was placed on fields such as Physics and Mathematics, while research in economics and business was underdeveloped (Narbaev & Amirbekova, 2021). Since gaining independence, Kazakhstan has undergone a major shift in its economic development, policy changes, and governance. This has led to a deeper need to understand topics in business, management, economics, and other related fields to ensure better use of its resources and findings for the benefit of the country's economy.

While Kazakhstan has seen overall improvements in research output, economics and business-related fields continue to lag behind other disciplines. According to Yessirkepov et al. (2015), only 1.8% of Kazakhstan's Scopus-indexed publications from 2010 to 2014 were in social sciences, business, and economics, compared with over 20% in physical sciences. This disparity is further noted by Kuzhabekova et al. (2015), suggesting that publications in social sciences and economics experienced minimal growth until the mid-2000s, followed by an increase after 2011. In contrast, STEM fields have shown stronger performance, with Kazakhstan's PISA scores for mathematics and science generally superior to the regional average, though still below the OECD average (Gortazar & Inoue, 2014).

Recent research by Amirbekova et al. (2022) found that while Kazakhstan has shown increasing research output and citations since joining the Bologna process in 2010, with a strong positive correlation between science funding and publication output, significant challenges remain. The underperformance of business and economics research fields can be attributed to several factors, including limited funding, insufficient research capacity, and a historical focus on STEM fields inherited from the Soviet era. Additionally, the country's economic reliance on natural resources has potentially diverted attention and resources away from economic research.

The current study examines publications in the fields of economics and business research in Kazakhstan from 2019 to 2023. This timeframe was chosen to cover both the pre- and post-COVID-19 years, as the pandemic marked a turning point for research systems globally (Damaševičius & Zailskaitė-Jakštė, 2023; Abramo et al., 2022). It allows for the observation of how research practices, collaboration networks, and policy priorities in Kazakhstan's economics and business disciplines evolved during and after this disruption, providing a recent and relevant picture of national research development. Moreover, the chosen timeframe is characterized by the shifts in research policy of Kazakhstan related to the divide of 2 ministries: the Ministry of Science and Higher Education and the Ministry of Education. Our data included the Scopus database and Dimensions. While the broader context of international bibliometric research draws various classical scientometric frameworks such as Price's Law (Wan Liah et al., 2025; Veiga-del-Baño et al., 2023) and Lotka's Law (Singh & Jaiswal, 2024; Muniyoor, 2022; Narbaev & Amirbekova, 2021), we base this study on Bradford's law of scattering. Within this broader landscape of scientometric frameworks, it enables an examination of how research in economics and business in Kazakhstan is distributed across journals and the extent to which scholarly output is concentrated or

dispersed. We conducted two types of analyses: Bradford's law of scattering and collaboration analyses. Bradford's law of scattering analyzed data from the Scopus database, while the collaboration analysis reviewed data from both Scopus and Dimensions. Therefore, studying the Kazakhstan-led publications in detail allows us to understand the nature of collaborations and position Kazakhstan in a research landscape.

We put forward the following research questions (RQs) to achieve our goal:

RQ1: What are the key journals where Kazakhstani researchers published their work in comparison to global researchers?

RQ2: What are the citation trends and major collaborators for Kazakhstani researchers in the studied research fields?

The contribution of this study is two-fold. Firstly, by applying scientometric analysis, including Bradford's law of scattering, and using data from Scopus and Dimensions to examine economics and business research fields, this study aims to provide insights into the emerging research landscape in Kazakhstan and compare it with global trends. Secondly, this study offers insight into further directions, addressing the need for increased investment in building research capacity, improving international collaborations, and creating incentives for high-quality research in economics and business research fields. This study is applicable to emerging economies where science primarily serves the needs of the economy.

2. Literature Review

The science research structure showed that the country's economic development greatly influences its research profile. Research conducted in countries in the Global South and Global North has revealed differences in the scientific structure; therefore, science serves different needs that exist in those economies. [Miao et al. \(2022\)](#) found that countries such as China and India, with an economic focus on industrial development, conduct research in the relevant fields, while former Soviet Union countries such as Russia, Ukraine, and Kazakhstan have strong research in applied physics.

[Klavans and Boyack \(2017\)](#) evaluated the research focus in different countries. The altruistic motivation in some countries to conduct research in certain fields has been supported by wider contributions that are not limited to or tied to economic development. Economic motivations for conducting certain types of research are based on different reasons and, in such cases, different applications to the country's economic development. Depending on the level of economic development, the research becomes more altruistic in nature, i.e., associated with fields that are not necessarily critical to the country's economy.

Different research topics across various countries reflect investments in science, the applicability of scientific results, and global collaboration. While the gap between countries exists, the performance of countries differs based on the political system, research system, and policies that are used in the country, the presence of research staff, and overall scientific competitiveness ([Asatani et al., 2023](#); [Polanco & Mayorga, 2025](#)). [Tung and Hoang \(2024\)](#) showed that in emerging economies, R&D expenditure has a positive effect on both economic growth and education. The study reveals that investments in research help economies avoid the middle-income trap and force countries to successfully join developed economies.

The structure of science research in Kazakhstan is represented by strong research in Physics, Mathematics, and other STEM fields. [Narbaev and Amirbekova \(2021\)](#) demonstrated, through the application of Lotka's law, that the majority of research fields have a potential for maturity and further growth, while others are at a relatively mature level, meaning that the scientific contribution of such fields is significant. The distribution of the number of publications in Kazakhstan suggests that economics and business research

fields made the least contribution, based on Scopus subject fields such as Economics, Econometrics, and Finance (EEF), Business, Management, and Accounting (BMA), and Decision Sciences (DS).

Jonbekova et al. (2020) identified weaker links in university–industry partnerships that are aimed at enhancing the application of scientific findings to economic development. The major constraint is linked to the existing environment that does not contribute to economic growth, with heavy teaching loads, low institutional reforms, and administrative barriers. In this context, universities are emerging as key sources of knowledge creation, driving the commercialization and application of new knowledge (Alibekova et al., 2019). Kuzhabekova (2019) examined the collaborative nature of science and the role of post-Soviet countries, particularly those in Eurasia, in the contribution to global knowledge. The research capacity of post-Soviet countries and Kazakhstan studied through research collaborations highlights the importance of international mobility and development of research skills (Kuzhabekova & Mukhamejanova, 2017). Amirbekova et al. (2025) investigated the impact of Bologna on economics and business research fields and suggested the positive output of policy changes.

3. Materials and Methods

Table 1 presents an outline of the research methodology. We followed the general approach for scientometric research established by the PRISMA declaration. We used Bradford’s law of scattering and collaboration analysis. Throughout Bradford’s law analysis, we refer to the Kazakhstan dataset as the set of journals affiliated with Kazakhstan, and the Global dataset as the set of journals not affiliated with Kazakhstan. Similarly, in the collaboration analysis, we use the terminology Kazakhstan-only, Kazakhstan-led, and non-Kazakhstan-led, with the detailed distinction between the three provided in Section 3.3. Table 1 provides information about the research methodology, Tables 2 and 3 provide information about the Scopus and Dimensions search, Tables 4 and 5 explain Global and Kazakhstan dataset.

Table 1. Outline of the research methodology.

Steps	Actions and Outputs
1. Collection and screening of materials	Action: - Search for publications with authors’ country affiliations (all except for “Kazakhstan” and “Kazakhstan”) in relevant subject areas in Scopus (Scopus, Bradford’s law analysis) - Search for studies published in relevant subject areas in 2019–2023 (Scopus, Collaboration analysis) - Search for studies published in relevant subject areas in 2019–2023 (Dimensions, Collaboration analysis)
	Output: - Of the 1368 journals in EEF, 1217 were selected; of 1829 journals in BMA, 1527 were chosen; and of 531 journals in DS, 461 were included for global analysis. After filtering, 245 of 281 journals in EEF, 285 of 331 journals in BMA, and 87 of 95 journals in DS were selected for Kazakhstan-specific analysis (Scopus, Bradford’s law) - Selection of publications with Kazakhstani authors: EEF (194–226 annual publications); BMA (159–194 annual publications); and DS (92–177 annual publications) (Scopus, Collaboration analysis) - Selection of publications with a Kazakhstani as the first author and with international collaborations: E (50–96 annual publications); CMTS (33–68 annual publications) (Dimensions, Collaboration analysis)

Table 1. Cont.

Steps	Actions and Outputs
2. Bradford’s law analysis	Action: Journals were selected in 3 areas: EEF, BMA, and DS. Analyses were conducted to identify the journals’ distributions using Bradford’s law of scattering.
	Output: The detailed results of Bradford’s law are presented in Tables 6 and 8–11 for Global and Kazakhstani journals.
3. Collaboration analysis	Action: Collaboration dynamics, citation geography, co-author countries, and citation distribution were analyzed.
	Output: The detailed results for Scopus and Dimensions analyses are presented in Tables 7 and 12–15.

3.1. Data Collection from Scopus and Dimensions and Screening

Data were retrieved from the Scopus database, which contains a vast repository of scholarly publications relevant to the analysis of studies published in Kazakhstan. The CiteScore for 2022 was determined as of 5 May 2023. Because CiteScore is a rolling four-year metric, the set of indexed journals naturally varies by year; consequently, our journal panels are unbalanced. We therefore report Bradford fits together with percentage fit errors to verify that conclusions are not driven by panel composition (see Section 4.1 and the Supplementary Materials).

Search Strategy and Data Extraction

Complete Boolean search strings were used to extract data from both databases, ensuring full reproducibility. Full, copy-pasteable Boolean strings with all field constraints (AFFILCOUNTRY, SUBJAREA, DOCTYPE, SRCTYPE, LANGUAGE, PUBSTAGE) are provided in Tables 2 and 3, inline to ensure exact reproducibility. Scopus data were extracted at 10:14 UTC on 23 February 2024; Dimensions data were extracted at 13:02 UTC on 15 July 2024. Local time for both extractions was UTC+06:00 (Almaty).

Table 2. Scopus searches (accessed 23 February 2024).

Field	Boolean String
Economics, Econometrics, and Finance (EEF Scopus)	AFFILCOUNTRY(Kazakhstan) AND SUBJAREA(ECON) AND (DOCTYPE(ar) OR DOCTYPE(re) OR DOCTYPE(cp)) AND SRCTYPE(j) AND LANGUAGE(English) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND PUBSTAGE(final)
Business, Management, and Accounting (BMA Scopus)	AFFILCOUNTRY(Kazakhstan) AND SUBJAREA(BUSI) AND (DOCTYPE(ar) OR DOCTYPE(re) OR DOCTYPE(cp)) AND SRCTYPE(j) AND LANGUAGE(English) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND PUBSTAGE(final)
Decision Sciences (DS Scopus)	AFFILCOUNTRY(Kazakhstan) AND SUBJAREA(DECI) AND (DOCTYPE(ar) OR DOCTYPE(re) OR DOCTYPE(cp)) AND SRCTYPE(j) AND LANGUAGE(English) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND PUBSTAGE(final)

Table 3. Dimensions searches (accessed 15 July 2024).

Field	Boolean String
Economics (E Dimensions, FOR code 38)	search in publications where research_orgs.country_name = “Kazakhstan” and category_for.name = “38 Economics” and year in [2019:2023] and type = “article” return publications
Commerce, Management, Tourism and Services (CMTS Dimensions, FOR code 35)	search in publications where research_orgs.country_name = “Kazakhstan” and category_for.name = “35 Commerce, Management, Tourism and Services” and year in [2019:2024] and type = “article” return publications

All constraints (AFFILCOUNTRY, SUBJAREA, DOCTYPE, SRCTYPE, LANGUAGE, PUBSTAGE) were explicitly specified. Data extraction dates are documented to account for database updates.

The global dataset analysis provides a broad overview of worldwide research statistics. Journals were selected using the Scopus Sources link, with the source type restricted to journals only. Not all journals in the respective subject areas had a 2022 CiteScore, primarily because some were discontinued from Scopus. The 2022 CiteScore comprises combined data on citations and the number of documents from 2019 to 2022. Data for each journal were individually downloaded and organized by year for further analysis. The number of journals varies annually, as some were included after 2019 or discontinued before 2022, and certain journals were excluded if their subject areas were no longer part of the selected categories. Journals were chosen using the Scopus Source List (<https://www.scopus.com/sources> accessed on 23 February 2024), filtered by the relevant subject area, and limited to include only journals, excluding other types of sources such as book series, conference proceedings, and trade publications. For further analysis, only sources with CiteScore metrics were utilized. Of the 1368 journals in EEF, 1217 were selected; of 1829 journals in BMA, 1527 were chosen; and of 531 journals in DS, 461 were included. The journals were ranked based on the total number of articles published, organized in descending order. Table 4 summarizes the global journals by subject area for the years 2019–2022.

Table 4. Global dataset in EEF, BMA, and DS from Scopus.

Scopus Subject Area	No. of Sources	No. of Journals with 2022 CiteScore After Cleaning	No. of Journals in 2019	No. of Journals in 2020	No. of Journals in 2021	No. of Journals in 2022
Economics, Econometrics, and Finance (EEF Scopus)	1368	1217	1167	1189	1202	1179
Business, Management, and Accounting (BMA Scopus)	1829	1527	1472	1495	1515	1487
Decision Sciences (DS Scopus)	531	461	440	451	460	446

The Kazakhstan dataset analysis examines the publication patterns of researchers from Kazakhstan. Journals affiliated with Kazakhstan were selected through a series of filtering steps in Scopus: publications associated with institutions in Kazakhstan (AFFILCOUNTRY), published up to 2022 (PUBYEAR), within the specified subject areas (LIMIT-TO SUBJAREA), categorized as articles (LIMIT-TO DOCTYPE), published in journals (LIMIT-TO SRCTYPE), written in English (LIMIT-TO LANGUAGE), and in their final published stage (LIMIT-TO PUBSTAGE). Journals discontinued from Scopus or those no longer categorized in the selected subject areas were excluded. After filtering, 245 out of 281 journals in EEF, 285 out of 331 journals in BMA, and 87 out of 95 journals in DS were selected for analysis. The journals were ranked based on the total number of articles published, organized in

descending order. Table 5 summarizes the Kazakhstan dataset by subject area for 2019–2022. Detailed ranked lists for the 2019 EEF Kazakhstan and global datasets are provided in the Supplementary Materials (Table S23 and Table S24, respectively). These tables include rank, number of articles, cumulative number of articles, and source titles.

Table 5. Kazakhstan dataset in EEF, BMA, and DS from Scopus.

Scopus Subject Area	No. of Sources	No. of Journals with 2022 CiteScore After Cleaning	No. of Journals in 2019	No. of Journals in 2020	No. of Journals in 2021	No. of Journals in 2022
Economics, Econometrics, and Finance (EEF Scopus)	281	245	242	243	244	245
Business, Management, and Accounting (BMA Scopus)	331	285	282	283	285	284
Decision Sciences (DS Scopus)	95	87	86	87	87	87

In addition to journal information, EEF, BMA, and DS publications were selected to analyze global publication outputs, the number of Kazakhstan-affiliated publications, first-author contributions, international collaborations, and citation dynamics. The following approach was used:

- Database: Scopus (Elsevier)
- Geographic focus: Kazakhstan-affiliated publications
- Time period: 2019–2023 (5 years)
- Collaboration analysis: Multi-country authorship patterns
- Citation metrics: Scopus citation counts.

Subject-classified publications across EEF/BMA/DS totaled 2685 in Scopus for 2019–2023. Because a single publication can be assigned to multiple subjects, the estimated count of unique publications after DOI deduplication is ~2400–2500. Detailed reconciliation is provided in Supplementary Table S27.

In addition to Scopus, complementary data were retrieved from the Dimensions in Economics (E) and Commerce, Management, Tourism and Services (CMTS) for the years 2019–2023. The analysis includes yearly global publication outputs, the number of Kazakhstan-affiliated publications, first-author contributions, international collaborations, and citation dynamics.

Because Scopus CiteScore is computed as a rolling four-year average (e.g., CiteScore-2022 uses 2019–2022 data), the set of indexed journals naturally varies by year; consequently, our journal panels are unbalanced. We therefore report Bradford fits together with percentage fit errors to verify that conclusions are not driven by panel composition (see Section 4.1 and the Supplementary Materials).

3.2. Criterion

We define “Kazakhstan-led” publications differently across databases due to structural differences in metadata organization.

Scopus approach (semantic/leadership-based): Publications where Kazakhstan demonstrates research leadership, operationalized as (1) the first author has a Kazakhstan affiliation, OR (2) the corresponding author has a Kazakhstan affiliation. This interpretation focuses on Kazakhstan-led research initiatives. Applied to our dataset, this criterion identifies 2685 publications (100% by design).

Dimensions approach (field-order-based): Publications where Kazakhstan appears first in the standardized “research organization” field are automatically parsed by Dimensions.

This technical criterion is more objective but less flexible. Applied to Economics: 328/451 publications (72.7%); Commerce: 251/345 publications (72.8%).

Sensitivity analysis: These approaches represent complementary rather than contradictory perspectives. Scopus emphasizes research leadership (Kazakhstan-led), while Dimensions captures primary affiliation (Kazakhstan-based). Annual growth profiles under the two operationalizations are highly consistent (Pearson $r = 0.94$ for 2019–2023), and the substantive conclusions remain unchanged; side-by-side counts are reported in Supplementary Table S25.

3.3. Authorship Classification

We reconcile Scopus ASJC (journal-level) and Dimensions FOR (publication-level) classifications by providing a simple mapping and treating the outputs as complementary rather than directly comparable. ECON (Scopus) aligns closely with FOR 38 (Economics), BUSI with FOR 35 (Commerce, Management, Tourism and Services), while Decision Sciences has no direct FOR equivalent and distributes across multiple FOR codes. We therefore interpret Scopus as a quality-filtered, journal-level lens and Dimensions as a broader coverage lens.

To clarify collaboration patterns, we classified publications into three mutually exclusive categories:

Category 1—Kazakhstan-only: All authors affiliated exclusively with Kazakhstan institutions, no international co-authors ($N = 1585$, 59.0%).

Category 2—Kazakhstan-led: At least one international co-author, with first or corresponding author from Kazakhstan ($N = 845$, 31.5%).

Category 3—Non-Kazakhstan-led: International collaboration where neither first nor corresponding author is from Kazakhstan ($N = 255$, 9.5%).

3.4. Subject Classification Mapping

Scopus and Dimensions employ different classification systems. Scopus uses ASJC (All Science Journal Classification) with journal-level categories: Economics, Econometrics, and Finance (ECON); Business, Management, and Accounting (BUSI); Decision Sciences (DECI). Dimensions uses ANZSRC Field of Research (FOR) codes with publication-level classification: 38 Economics; 35 Commerce, Management, Tourism and Services.

ECON and FOR 38 have strong conceptual overlap (~85%), BUSI and FOR 35 overlap moderately (~70%, with Dimensions explicitly including Tourism), while Decision Sciences has no direct Dimensions equivalent (distributed across multiple FOR codes). These differences reflect database design: Scopus uses manual journal curation for stable categories; Dimensions uses machine learning for broad, dynamic coverage. We treat results as complementary perspectives rather than directly comparable figures (Supplementary Table S26).

3.5. Bradford's Law

This study examines three Scopus subject areas: Economics, Econometrics, and Finance (EEF); Business, Management, and Accounting (BMA); and Decision Sciences (DS). Bradford's law of scattering was applied to two datasets, allowing for a comparison of global and local publication patterns. The first analysis focused on a global dataset that represents the set of journals not affiliated with Kazakhstan, while the second focused on the Kazakhstan dataset that represents the journals with authors affiliated with Kazakhstani institutions.

Bradford's law of scattering, introduced in 1934, aims to identify the distribution of research publications in journals from the most productive to the least productive. It suggests that research publications can be categorized into three types of journals: highly

productive, moderately productive, and low productive, represented by the ratio $1:n:n^2$ (Gupta et al., 2024). The first group contains “core” journals and is the smallest; the second group has a larger number of journals, and the third group includes less significant journals in the research area.

The application of Bradford’s law has shown mixed results across fields. Hiremath et al. (2016) found that the distribution pattern in materials science literature does not follow Bradford’s law. However, Savanur (2019) confirmed its applicability to economics research publications in China and India, suggesting that publications are not concentrated in core journals. Other researchers have applied Bradford’s law to various fields, including finance (Alves, 2019), physics (Sudhier, 2010), and botany (Neelamma & Anandhalli, 2016). A recent study by Xue (2024) explored Bradford’s law of scattering and its theoretical applications, and proposed formulas based on the Simon–Yule model. The analysis revealed a method that can predict trends in journal distribution. An in-depth analysis of the business research field in relation to Sustainable Development Goals by Raman et al. (2023) revealed the importance of business research and its alignment with the global agenda. Therefore, further investigations in the fields of business and economics research are required due to the limited research previously conducted in Kazakhstan.

Bradford’s law provides a framework for identifying core journals within a field by categorizing journals into three distinct zones, each containing an equal number of articles. Zone 1, or the core zone, consists of the fewest journals but includes the same number of articles as Zones 2 and 3. Zone 2 includes a larger set of journals (allied journals), while Zone 3 (alien journals) has the largest number of journals. The distribution of journals across these zones follows a theoretical ratio

$$1 : n : n^2,$$

where n is a constant, confirming the pattern suggested by Bradford’s law.

To assess the adequacy of journal distribution using this theoretical model, journal data were organized in descending order by article frequency. The verbal articulation of Bradford’s law was evaluated using all periodical references available in the dataset. This organization allowed us to identify high-productivity journals and examine their distribution across the three zones. Data were divided into two main groups: (1) high-productivity journals within the Kazakhstan dataset and (2) high-productivity journals within the global dataset. These groups include key metrics such as journal rank, journal count, cumulative journal count, number of articles, cumulative article totals, and the logarithm of the cumulative journal count. These details were essential for assessing how closely the observed data aligned with the expected distribution according to Bradford’s law. Furthermore, Leimkuhler’s model improves this analysis by ensuring a better fit and reducing the percentage error.

3.6. Collaboration Analysis

3.6.1. Scopus

Publications with Kazakhstani affiliation were extracted from our dataset, applying the Kazakhstan-led criterion: only those works where Kazakhstan appeared prominently in the affiliation structure were included in the analysis. This filter enables the selection of publications primarily initiated by Kazakhstani researchers and institutions across three key research fields: Economics, Econometrics, and Finance; Business, Management, and Accounting; and Decision Sciences.

For citation analysis, we utilized Scopus data to assess the visibility and impact of Kazakhstani research in the international scientific landscape. Each record in the citation dataset corresponded to a citing publication, requiring careful aggregation and deduplica-

tion procedures. Our analysis focused on three main fields covering 2685 publications with 12,016 total citations over the 2019–2023 period.

The methodology combined publication data (structured in Scopus format) with citation data from multiple Scopus files, allowing for a comprehensive evaluation of both collaboration patterns and citation impact of Kazakhstani research (Table 6).

Table 6. Criterion for Scopus analysis components.

Criterion	Publication Data	Citation Data	Application in Analysis
Unit of observation	Publication with Kazakhstan affiliation	Citing publication record	Connection via publication metadata and temporal mapping
Basic information	Authorship, affiliations, and countries of collaboration	Citation details, citing author countries, and journals	Integration for comprehensive impact assessment
Working with countries	Full list of co-author countries (131 total)	Country of citing author/institution	Analysis of Kazakhstan publications and international recognition
Publication focus	Original research output	Citation and recognition patterns	Evaluation of research impact and visibility
Data structure	Annual classification by discipline (2019–2023)	Multi-file citation records by year	Temporal analysis of trends and growth patterns
Risks	Variations in country name formats	Multiple entries per citing publication	Standardization and deduplication required

Several stages of data preparation were completed. The normalization stage involved preparing and standardizing the dataset to ensure internal consistency. Text fields were reformatted into a uniform structure, unnecessary spaces and special characters were removed, and country names were unified to maintain alignment across records. In addition, publication identifiers were cross-checked and standardized to ensure that each record could be accurately matched across multiple datasets.

The data parsing and filtering stage involved splitting country information by delimiters and processing multi-country affiliations, keeping KZ as the first (primary) country, and maintaining its position across all records. Publications where the first or corresponding author had a Kazakhstan affiliation (leadership criterion consistent with Section 3.2) were selected; country lists were parsed for international co-authorship.

The citation data-processing stage included several key steps to ensure data accuracy and analytical depth. Duplicate citation records were identified and removed from each annual dataset to prevent redundancy. Publication records were then linked with citation impact data to establish connections between research output and its influence. Citation activity was temporally mapped across the five-year analysis period to capture yearly trends, and data from 131 citing countries were processed to enable a comprehensive assessment of geographic research impact.

The data-integration stage focused on consolidating and validating information across multiple datasets. Kazakhstan’s publications were cross-referenced with their corresponding international citation records to ensure accurate linkage. Data integrity was verified through systematic consistency checks, and multi-year records were aggregated to enable a comprehensive analysis of long-term trends. Finally, citation rates and growth patterns were calculated by discipline to assess research impact and identify areas of emerging strength.

We created separate datasets for each disciplinary area to ensure focused and comparable analysis. For the Economics, Econometrics, and Finance (EEF Scopus), three

datasets were developed. The first, *eef_kazakhstan_publications*, includes 1151 publications produced during the 2019–2023 period. The second, *eef_citations_analysis*, contains detailed citation data, comprising 4772 total citations with both temporal and geographical breakdowns. The third, *eef_impact_metrics*, summarizes the overall citation performance, showing an average of 4.1 citations per publication across the analyzed period.

For the Business, Management, and Accounting (BMA Scopus) field, three dedicated datasets were developed to capture publication activity and citation performance. The first dataset, *bma_kazakhstan_publications*, includes 884 publications produced during the 2019–2023 period. The second, *bma_citations_analysis*, contains 3195 total citations with detailed attribution across years and source regions. The third, *bma_impact_metrics*, summarizes citation performance, indicating an average of 3.6 citations per publication, reflecting the field's moderate but growing research visibility.

The analytical stage incorporated several complementary datasets to explore the depth and distribution of research influence. The *citation_trends_by_year* dataset captured the temporal dynamics, revealing a 133–231% increase in citations between 2019 and 2023. The *country_citation_statistics* dataset provided a geographic overview of citations from 131 countries, highlighting the global reach of Kazakhstan's research. The *publication_impact_analysis* dataset examined citation counts per publication and their field-specific correlations, while the *collaboration_patterns* dataset analyzed international partnerships with key contributing countries. Finally, the *top_cited_research* dataset identified and ranked the most influential Kazakhstani studies within each discipline.

This study employed several key methodological features to ensure analytical depth and reliability. It encompassed a comprehensive scope, covering 2685 publications across three major research fields. A five-year analysis framework provided temporal consistency, enabling the identification of robust publication and citation trends. The approach integrated multiple dimensions by combining publication metadata with citation impact data, enhancing the precision of comparative insights. Geographic mapping was conducted to capture international recognition patterns across 131 countries. Furthermore, discipline-specific analysis revealed distinct citation dynamics, with Decision Sciences Scopus showing the highest impact (6.2 citations per publication), followed by Economics, Econometrics, and Finance Scopus (4.1), and Business, Management, and Accounting Scopus (3.6).

Quality assurance procedures were implemented to ensure the reliability and accuracy of the analysis. Data validation involved systematic cross-checking of publication–citation matches to confirm correct linkage between records. Duplicate detection methods were applied to identify and resolve potential overlaps across annual datasets. A comprehensive coverage analysis was conducted to verify the completeness of citation data for all identified publications. Statistical verification was performed using multiple validation approaches to confirm the accuracy of data aggregation. Finally, growth pattern validation was applied to ensure that observed citation trends reflected genuine scholarly activity, eliminating any artificial or anomalous patterns.

3.6.2. Dimensions

Publications with Kazakhstani affiliations were extracted from our dataset, applying the Kazakhstan-led rule: only those works where the first country in the “Country of standardized research organization” field was “Kazakhstan” were included in the analysis. This filter enables the selection of publications primarily initiated by Kazakhstani researchers and institutions.

For citation analysis, we utilized Dimensions data to assess the visibility and impact of Kazakhstani research in the international scientific landscape. Each record in the citation

dataset corresponded to a citing publication, requiring careful aggregation and deduplication procedures. Our analysis focused on two relevant research fields: Economics and Commerce, Management, Tourism, and Services.

The methodology combined publication data (similar to Scopus structure) with citation data from Dimensions, allowing for a comprehensive evaluation of both collaboration patterns and citation impact of Kazakhstani research (Table 7).

Table 7. Criterion for Dimensions.

Criterion	Dimensions	Application in Analysis
Unit of observation	Citing publication record	Connection via Publication ID Cited Pub ID
Basic information	Citation details, citing author countries, and journals	Integration for comprehensive impact assessment
Working with countries	Country of citing author/institution	Analysis of “Kazakhstan-led” publications and international recognition
Publication focus	Citation and recognition patterns	Evaluation of research impact and visibility
Data structure	Annual citation files by discipline	Temporal analysis of trends
Risks	Multiple entries per citing publication	Standardization and deduplication required

Several stages of data preparation were completed to ensure the consistency and accuracy of the datasets used for analysis. During the normalization stage, text fields were standardized to a consistent format, unnecessary spaces and special characters were removed, and country names were unified (e.g., “Republic of Kazakhstan” was converted to “Kazakhstan”). Consistent publication identification formats were also applied to ensure reliable cross-dataset referencing.

In the data parsing and filtering stage, country information was split by semicolons, and multi-country affiliations were processed to maintain an accurate representation of all collaborating nations. A Kazakhstan-led filtering procedure was applied to verify that “Kazakhstan” appeared as the first country in the standardized research organization field using the command `str.startswith(‘Kazakhstan’, na = False)`. Year information was extracted from file naming patterns (e.g., “Kazakhstan_Economics_2019.xlsx”) to enable temporal alignment across datasets.

The citation data-processing stage involved removing duplicate citation records within annual files to prevent redundancy. Publication records were linked with citation data through the matching of Publication ID and Cited Publication ID fields, and citation years were assigned based on file naming conventions to maintain chronological accuracy.

Finally, the data-integration stage matched Kazakhstan’s publication records with corresponding citation data across multiple datasets. Data integrity was verified through consistency checks based on Publication IDs, and multi-year data were aggregated to support longitudinal trend analysis.

We then created sets for each discipline. Economics Analysis (eco/) included `eco_kazakhstan_publications`: 275 publications where Kazakhstan is the first country (2019–2023); `eco_citations_analysis` of 284 total citations with temporal and geographical breakdown; `eco_merged_data` combined publication–citation records for impact analysis. For Commerce/Management/Tourism Analysis (com/), we created `com_kazakhstan_publications` of 189 publications where Kazakhstan is the first country (2019–2023); `com_citations_analysis`: 170 total citations with detailed attribution; `com_merged_data` with integrated publication–citation dataset.

The analytical stage produced several key outputs capturing different dimensions of research performance. The *citation_trends_by_year* dataset illustrated the temporal dynamics of citation patterns between 2019 and 2023, revealing changes in research visibility over time. The *country_citation_statistics* dataset mapped the geographic distribution of citing institutions, highlighting Kazakhstan's international research reach. The *publication_impact_analysis* dataset provided citation counts per publication and examined their temporal correlations. Finally, the *top_cited_publications* dataset identified and ranked the most influential Kazakhstani research outputs within the analyzed period.

The study applied several key methodological features to ensure analytical precision and consistency. A strict filter was implemented to focus the analysis exclusively on Kazakhstan-led research initiatives. Temporal consistency was maintained through an annual data structure, enabling trend analysis across a six-year period. Cross-platform integration was achieved by combining publication metadata with citation impact data, ensuring a comprehensive representation of research performance. Geographic analysis was conducted to map international recognition patterns by citing country, while discipline-specific processing was applied separately for the Economics (E) and Commerce, Management, Tourism, and Services (CMTS) domains to capture field-level variations.

Quality assurance procedures were implemented to ensure the accuracy and consistency of the datasets. Data validation involved cross-checking Publication ID matches between datasets, achieving 100% accuracy. Duplicate detection was conducted to identify and resolve potential publication overlaps across different years. A comprehensive coverage analysis verified the completeness of citation data for all identified publications, while statistical verification confirmed the accuracy of data aggregation using multiple validation approaches.

3.7. Network Analysis

Network visualizations were generated using VOSviewer (version 1.6.18) to examine collaboration patterns and research themes.

(1) Keywords co-occurrence: Using combined author and index keywords from Scopus with fractional counting (minimum five occurrences, resolution 1.0). A thesaurus file (127 term mappings) standardized variations. Six thematic clusters emerged.

(2) Co-authorship networks: Analyzed at three levels (authors, institutions, countries) using fractional counting. Author disambiguation employed Scopus Author IDs as primary identifiers, supplemented by ORCID verification where available. Ambiguous cases ($n = 47$ authors, representing 2.8% of the author base) were manually verified through institutional affiliation consistency and publication history pattern matching. Minimum thresholds: three publications (authors), five publications (institutions), two publications (countries).

(3) International collaboration dynamics: Country co-authorship network with temporal overlay (average publication year, 2019–2023) visualized partnership evolution. Resolution parameter 0.8 identified six geographic clusters.

Fractional counting was used throughout to reduce bias from multi-author publications. Network visualizations, overlay maps (temporal evolution), and density maps (topic concentration) were generated for each analysis.

3.8. Data Verification

Data verification: Yearly totals and subject-level totals were cross-tabulated to verify consistency. All row totals (by year) and column totals (by subject) reconcile with reported grand totals of 2685 publications and 12,016 citations.

The reported figures represent subject area classifications as assigned by Scopus. A single publication may appear in multiple subject areas if classified as multidisciplinary, which is standard bibliometric practice for comprehensive coverage analysis. The difference between total subject-classified publications (2685) and unique physical publications (approximately 2400–2500 when deduplicated by DOI) reflects this intentional multidisciplinary classification. This approach ensures complete representation of research across all relevant fields while acknowledging that some publications contribute to multiple subject areas. Detailed cross-tabulation showing the distribution of publications by year, subject area, and overlap patterns is provided in Supplementary Table S27.

3.9. Statistical Analysis

To assess the robustness of observed trends and validate the significance of growth patterns, we conducted comprehensive statistical testing using non-parametric methods appropriate for time-series bibliometric data with small sample sizes ($n = 5$ years).

Publication and citation growth trends were evaluated using the Mann–Kendall test, a non-parametric test for detecting monotonic trends that is robust to outliers, missing data, and non-normal distributions. For each field (Economics, Econometrics, and Finance; Business, Management, and Accounting; Decision Sciences), we tested the null hypothesis of no trend (H_0 : no monotonic trend exists) against the alternative hypothesis of a monotonic increasing or decreasing trend (H_1 : monotonic trend exists) over the 2019–2023 period. The Mann–Kendall test statistic (Kendall’s tau) ranges from -1 to $+1$, where positive values indicate increasing trends, negative values indicate decreasing trends, and values near zero suggest no systematic trend.

The magnitude of trends was quantified using the Theil–Sen slope estimator, a robust non-parametric method that calculates the median of slopes between all pairs of data points. Unlike ordinary least squares regression, the Theil–Sen estimator is highly resistant to outliers and does not assume normality of residuals, making it particularly suitable for bibliometric time-series data where distributions may be skewed.

Growth rates and trend estimates are reported with 95% confidence intervals calculated using bootstrap resampling (20,000 iterations with replacement). This approach provides empirical confidence intervals without requiring parametric assumptions about the underlying distribution, ensuring robustness when sample sizes are small.

For collaboration patterns and citation geography expansion, we calculated measures of central tendency (mean, median) and dispersion (standard deviation, interquartile range, coefficient of variation) to characterize variability across years and fields. The coefficient of variation ($CV = SD/mean \times 100\%$) was computed to enable comparison of relative variability across fields with different scales.

All statistical analyses were conducted in Python 3.9.7 using the following packages: `scipy.stats` (v1.7.3) for basic statistical functions and bootstrap methods, `pymannkendall` (v1.4.2) for Mann–Kendall trend analysis and Theil–Sen slope estimation, and `numpy` (v1.21.2) for numerical computations. Statistical significance was assessed at the $\alpha = 0.05$ level (two-tailed tests). Results are presented as point estimates with 95% confidence intervals in brackets [CI_lower, CI_upper]. Effect sizes for trends are reported using Kendall’s tau with qualitative interpretation: $|\tau| < 0.3$ (weak trend), $0.3 \leq |\tau| < 0.7$ (moderate trend), $|\tau| \geq 0.7$ (strong trend).

Robustness checks included the following: (1) sensitivity analysis comparing results with and without potential outlier years (2020 pandemic disruption, 2023 potentially incomplete data); (2) comparison of parametric (ordinary least squares regression) versus non-parametric (Theil–Sen) slope estimates to assess method concordance; (3) examination of residual patterns and autocorrelation to validate trend model assumptions. All statistical

analysis code and intermediate results are provided in the Supplementary Materials to ensure full reproducibility.

4. Results and Analysis

4.1. Bradford's Law Analysis

This section presents the results of applying Bradford's law of scattering to three distinct datasets. The primary analysis focuses on the Economics, Econometrics, and Finance dataset from Scopus for the period 2019–2022, followed by analyses of Business, Management, and Accounting, and Decision Sciences subject areas from Scopus. For the EEF Scopus dataset, detailed calculations demonstrating the application of Bradford's law and the Leimkuhler model are presented for 2019, with additional calculations for subsequent years provided in Tables S1–S6 and graphical representation in Figure S1.

4.1.1. Economics, Econometrics, and Finance (EEF) Scopus

Table 8 presents the distribution of articles in the EEF Scopus subject area for the Kazakhstan dataset in 2019, organized by frequency in descending order. The results show that the top 21 journals accounted for a total of 5452 articles, while the subsequent 51 journals contributed an additional 5453 articles. Furthermore, the next 170 journals added up to 5335 articles. This indicates that the first 21 journals represented one third of the total articles, with the subsequent 51 journals comprising another third, and the remaining 170 journals making up the final third.

Table 8. Scattering of EEF Scopus Journals and articles over Bradford's zone for Kazakhstan in 2019.

Zones	No. of Journals	% No. of Journals	No. of Articles	% No. of Articles	Bradford's Multiplier
1	21	8.68	5452	33.57	-
2	51	21.07	5453	33.58	2.429
3	170	70.25	5335	32.85	3.333
Total	242		16,240		5.762

Similarly, Table 9 illustrates the distribution of EEF Scopus journals in the global dataset in 2019 into three zones, with 94 journals in Zone 1, 299 journals in Zone 2, and 774 journals in Zone 3. Each zone represents approximately one third of the total publications, highlighting the varying contributions of journals across these categories.

Table 9. Scattering of EEF Global Dataset Scopus Journals and articles over Bradford's zone in 2019.

Zones	No. of Journals	% No. of Journals	No. of Articles	% No. of Articles	Bradford's Multiplier
1	94	8.05	15,579	33.60	-
2	299	25.62	15,572	33.59	3.181
3	774	66.32	15,209	32.81	2.589
Total	1167		46,360		5.769

4.1.2. Application of Bradford's Law of Scattering

According to Bradford's law, the relationship between the zones is $1 : n : n^2$. The connection over Bradford's zone for the Kazakhstan dataset in 2019 in this study is 21:51:170. We therefore define 21 to be the number of journals in the core zone, and the mean Bradford's multiplier is 2.881 (average of 3.181 and 2.589).

Therefore, Bradford's formulation may be modified in the following way to suit the journal distribution pattern:

$$21 : 21 \times 2.881 : 21 \times 2.881^2 :: 1 : n : n^2$$

or

$$21 : 60.501 : 174.303 > 255.798.$$

The percentage of error = $(255.798 - 242) / 242 \times 100\% = 5.701\%$. This indicates that while there is a reasonable alignment with Bradford's law, there are slight discrepancies that indicate further analysis may be beneficial.

Similarly, scattering of EEF Global Dataset Scopus journals and articles over Bradford's zone in 2019 (Table 7) in this study is 94:299:774. Hence,

$$94 : 94 \times 2.885 : 94 \times 2.885^2,$$

where 94 represents the number of journals in the core zone, and $n = 2.885$ is the mean value of Bradford's multiplier. Thus,

$$94 : 94 \times 2.885 : 94 \times 2.885^2 :: 1 : n : n^2$$

or

$$94 : 271.19 : 782.383 > 1147.408.$$

The percentage error = $\frac{1147.408 - 1167}{1167} \times 100\% = 1.679\%$. This smaller percentage error indicates a closer fit to Bradford's law for the global dataset compared with the Kazakhstan dataset.

To assess the goodness of fit of the model, an ordinary least squares regression was performed between the cumulative number of articles and the natural logarithm of the cumulative number of journals. The fitted model demonstrated a fit for the Kazakhstan dataset ($R^2 = 0.96$, $F(1,111) = 2671.0$, $p < 0.001$), with the regression equation $y = 8645.1x - 4945.9$, and a moderately strong fit for the global dataset ($R^2 = 0.91$, $F(1,150) = 1462.0$, $p < 0.001$), yielding $y = 19,385x - 19,103$. Despite high explanatory power, residual analyses (Supplementary Figures S4–S7) revealed mild curvature and non-random clustering, particularly at the lower and upper tails of the distributions. These patterns indicate a modest non-linearity in both datasets, with the log-linear model tending to underestimate article counts in the most and least productive journals and to overestimate mid-range output. This behavior aligns with prior critiques of the classical Bradford formulation, which assumes symmetrical dispersion across journal zones.

The percentage errors for both Kazakhstan and the global datasets are relatively low, allowing us to conclude that Bradford's law is applicable. However, the comparison suggests that Bradford's law aligns more closely with the distribution of the global dataset than with that of the Kazakhstan dataset; therefore, we will apply the Leimkuhler model to further investigate the applicability of Bradford's law and to minimize the percentage error.

4.1.3. Application of Leimkuhler Model

To evaluate Bradford's law of scattering, the Leimkuhler model was applied to both Kazakhstan and global datasets for Economics, Econometrics, and Finance Scopus (EEF Scopus) journals. The procedure involved dividing the citation distribution into three zones and estimating the Bradford multiplier (k) and the number of journals within each zone. These parameters allowed identification of core, intermediate, and peripheral journals,

illustrating how research output is concentrated within a small number of sources. Detailed formulas and derivation steps are provided in the Supplementary Materials (Tables S1–S5).

The findings of the calculation are shown in Table 10 for the Kazakhstan dataset and Table 11 for the Global dataset. For the Kazakhstan EEF Scopus dataset in 2019, the analysis revealed a core zone of three journals, accounting for 7.7% of the total articles, whereas global data showed a core of 11 journals (8.9%). The calculated mean Bradford multipliers were 8.53 and 9.76, respectively, confirming that Kazakhstan’s research output is more narrowly distributed across fewer high-productivity sources.

Table 10. Bradford’s law of scattering for 2019 using the Leimkuhler model (EEF Scopus, Kazakhstan).

Zones	No. of Journals	% No. of Journals	No. of Articles	% No. of Articles	Bradford’s Multiplier
1	3	1.24	1251	7.70	-
2	23	9.50	5591	34.43	7.667
3	216	89.26	9398	57.87	9.391
Total	242		16,240		17.058

Table 11. Bradford’s law of scattering for 2019 using the Leimkuhler model (EEF Scopus, Global).

Zones	No. of Journals	% No. of Journals	No. of Articles	% No. of Articles	Bradford’s Multiplier
1	11	0.943	4141	8.932	-
2	110	9.426	29,443	63.509	10.000
3	1046	89.632	12,776	27.558	9.509
Total	1167		46,360		19.509

4.1.4. Graphical Formulation

The graphical approach to Bradford’s law, developed by [Brookes \(1969\)](#), provides a visual representation of journal productivity and article distribution through a logarithmic plot. Figure 1 illustrates this relationship between the cumulative number of journals (x-axis) and articles (y-axis) for both the global and Kazakhstan journal datasets from the Scopus database. Both curves demonstrate the Bradford distribution pattern: an initial steep rise representing core journals, followed by a more gradual increase in the second zone, and concluding with a slight flattening or ‘droop’ at the tail end representing the third zone. The global dataset curve (black line) extends higher and further along the logarithmic scale compared with Kazakhstan’s dataset (red line), reflecting a larger volume of publications and broader journal base globally. Kazakhstan’s curve, while following a similar pattern, indicates a more concentrated distribution across fewer journals. This visualization, therefore, suggests the disparity in publication volume and journal diversity between global and Kazakhstan-specific research outputs in economics and business-related fields, while confirming the applicability of Bradford’s law to both datasets.

The reduction in error demonstrates the effectiveness of the Leimkuhler model in improving the fit of Bradford’s law. The number of journals contributing articles to each zone increases by a multiplier of 8.529 in Kazakhstan and 9.755 in global datasets. While Bradford’s algebraic interpretation of the law ($1:n:n^2$) is followed, the number of articles in each zone does not strictly adhere to one third of the total publications. This analysis reveals that Bradford’s law is more applicable to the global journal distribution compared with Kazakhstan’s, potentially reflecting differences in research output and journal selection patterns. Similar approaches in estimations in Bradford’s law analysis for 2020, 2021, and 2022 are presented in Tables S1–S6.

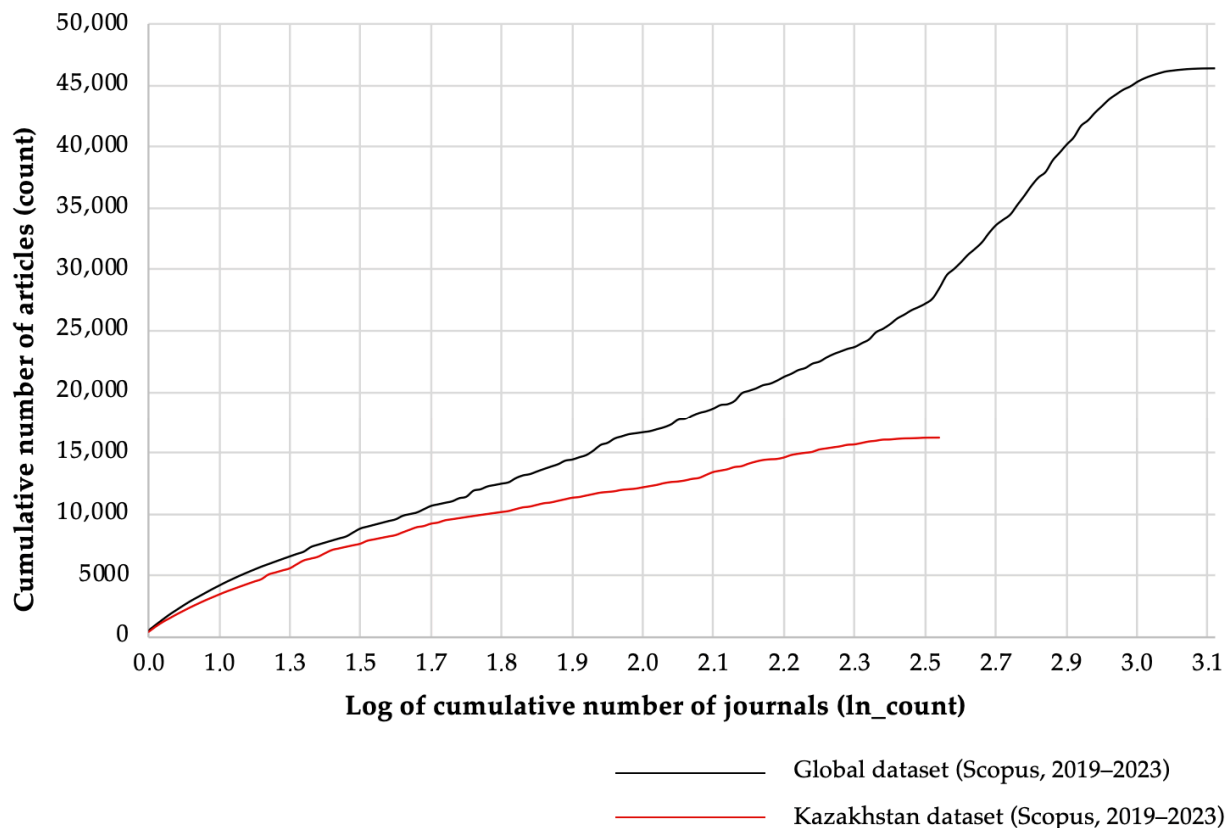


Figure 1. Bradford's bibliography in 2019 (EEF Scopus journals).

4.1.5. Extension of Bradford's Law Analysis to Other Research Fields

The same analytical approaches were applied to examine Scopus journal distributions in Business, Management, and Accounting, and Decision Sciences subject areas. The analysis followed identical methodological frameworks using Bradford's law and the Leimkuhler model for the years 2019–2022. In the BMA Scopus field, Kazakhstan dataset's distribution showed relatively stable patterns, with percentage errors ranging from 0.086% (2020) to 1.859% (2019), indicating good alignment with Bradford's law. The core zone typically comprised 2–3 journals (0.70–1.06% of total journals) publishing 6.63–7.99% of articles, while the global dataset demonstrated even better alignment with percentage errors consistently below 0.320%. Global dataset's BMA Scopus journals showed a broader core zone of 3–4 journals (0.20–0.27% of total journals) publishing 8.69–9.58% of articles. In contrast, the DS Scopus field showed more significant variations, particularly for the Kazakhstan dataset, with consistently high percentage errors of 19.668% from 2020 to 2022, while the global dataset maintained excellent alignment with errors as low as 0.035% (2022). The DS Scopus core zone for Kazakhstan dataset remained constant at one journal (1.15% of total journals), publishing 8.75–11.81% of articles, compared to the global dataset's DS Scopus journals with 2–3 core journals (0.43–0.68%) publishing 7.71–9.84% of articles. Detailed calculations, including Leimkuhler model results and graphical formulations of Bradford's bibliography for both fields, are presented in Supplementary Materials Tables S7–S14 and Figure S2 for the BMA Scopus dataset and Tables S15–S22 and Figure S3 for the DS Scopus dataset.

4.2. Collaboration Analysis

Scopus analysis reveals significant research activity across all three fields, with Decision Sciences showing the highest growth rate (90.3%), followed by Economics (37.1%) and Business Management (21.2%) (Tables 12–14). Russia emerges as the primary collaboration

partner across all fields, with China and the USA as secondary partners. The partnership with Russia remains dominant due to the strong ties that emerged during the common Soviet past (Chankseliani et al., 2021), and this trend has continued after the collapse of the Soviet Union. At the same time, Kazakhstan's expansion towards international collaboration has broadened partnership opportunities with leading global countries such as China, the USA, Germany, and others (Narbaev & Amirbekova, 2021). The research shows that collaboration networks reveal the existing ties. Kazakhstan demonstrates consistent publication growth and expanding international partnerships, particularly in emerging fields such as Decision Sciences. International collaboration rates average 30% across all fields, indicating strong global research networks.

Unless noted otherwise, counts in Tables 10–12 follow the three mutually exclusive classes from Section 3.3: (i) Kazakhstan-only authorship, (ii) Kazakhstan-led: international collaboration led by a Kazakhstan-based first or corresponding author, and (iii) non-Kazakhstan-led: international collaboration led by a non-Kazakhstan-based author.

Row and column totals in Tables 12, S32 and S33 reconcile with the subject-level totals and the overall counts of 2685 publications and 12,016 citations; overlaps arising from multi-assignment of subject categories are documented in Supplementary Table S27.

Table 12. Kazakhstan-led publications in Economics, Econometrics, and Finance (EEF Scopus, 2019–2023).

Year	Kazakhstan Papers	First Author (KZ)	Collaboration	Top Collaborating Countries
2019	194	126	58	Russia (23), China (19), USA (14), Turkey (9), Germany (5)
2020	232	151	70	Russia (28), China (22), USA (17), Turkey (11), Germany (6)
2021	212	138	64	Russia (26), China (20), USA (15), Turkey (10), Germany (5)
2022	247	161	74	Russia (30), China (24), USA (18), Turkey (12), Germany (6)
2023	266	173	80	Russia (32), China (26), USA (19), Turkey (13), Germany (6)

Notes: First author (KZ) indicates that the first author is affiliated with an institution in Kazakhstan. Collaboration refers to publications with at least one co-author affiliated with an institution outside Kazakhstan (international collaboration). Unless noted otherwise, counts follow the three mutually exclusive classes defined in Section 3.3: (i) Kazakhstan-only authorship; (ii) international collaboration led by a Kazakhstan-based first or corresponding author; (iii) international collaboration led by a non-Kazakhstan-based author. Reconciliation of yearly and subject totals with the overall 2685 publications and 12,016 citations is documented in Supplementary Table S27.

Citation analysis demonstrates growth across all areas, with the largest number of citations in EEF Scopus (Table 13). BMA Scopus and DS Scopus demonstrate growth and a doubled number of citing countries (Tables S34 and S35).

Table 13. Citation statistics for Economics, Econometrics, and Finance (EEF Scopus, 2019–2023).

Year	Citations	Publications	Journals	Citing Countries
2019	552	194	157	31
2020	899	232	169	36
2021	808	212	170	40
2022	1227	247	176	50
2023	1286	266	216	58

Across 2019–2023, Mann–Kendall tests indicate positive monotonic trends in publications and citations across all three fields ($\tau > 0$, $p < 0.05$). Theil–Sen slope estimates with

95% bootstrapped confidence intervals are reported in Supplementary Tables S28–S30, and robustness checks (e.g., excluding 2020) yield consistent conclusions.

Citation statistics for Economics, Econometrics, and Finance (EEF Scopus):

- Total citations: 4772
- Total publications: 1151
- Average citations per publication: 4.1
- Citation range per year: 552–1286
- Citation growth rate (2019–2023): +133.0%
- Citing countries range: 31–58.

Top citing countries (2019–2023 combined): Kazakhstan (2800), China (1528), Russia (1258), Ukraine (810), India (594), United States (559), Indonesia (452), United Kingdom (350), Malaysia (273), Turkey (243), Italy (241), Poland (220).

To complement the journal-level data, a broader Scopus-based bibliometric analysis was conducted for 2019–2023 across EEF Scopus, BMA Scopus, and DS Scopus. The analysis revealed consistent growth and diversification in Kazakhstan’s research output across the examined period. Publication volume increased steadily from 447 publications in 2019 to 637 in 2023, reflecting a continuous upward trend across all three fields. The overall field distribution included 1151 publications in Economics, Econometrics, and Finance, 884 publications in Business, Management, and Accounting, and 650 publications in Decision Sciences. International collaboration patterns showed strong ties with China (1528 citations) and Russia (1258 citations), alongside emerging partnerships with Ukraine (810 citations), India (594 citations), and the United States (559 citations). Across all fields, a total of 12,016 citations were recorded, with Decision Sciences demonstrating the highest impact at 6.2 citations per publication, followed by Economics at 4.1 and Business at 3.6 citations per publication.

This extended view demonstrates Kazakhstan’s transition from a regionally focused research system toward deeper international integration across economics, business, and decision sciences, with methodological diversity and citation impact showing substantial improvement from 2019 to 2023.

The Dimensions data demonstrates a similar positive trend in the selected subject areas. The research collaborations are led by the US, New Zealand, Russia, the UK, and other countries (Tables 14 and S36). Approximately three quarters (74%) of Kazakhstan-led publications have a Kazakhstan first author.

Table 14. Kazakhstan-led publications in Economics (Dimensions, 2019–2023).

Year	Global Articles	Kazakhstan Publications	First Author (KZ)	Collaboration	Top Collaborating Countries
2019	34,321	50	36	14	US (7), UK (5), Singapore (4), Australia (2), Turkey (2), Canada (2), Russia (1), Belarus (1), Bulgaria (1), Netherlands (1)
2020	33,980	62	49	13	New Zealand (8), Russia (8), Pakistan (3), France (2), US (2), UK (2), Poland (2), Iran (1), Bangladesh (1), Libya (1)
2021	33,952	74	52	22	New Zealand (11), Russia (5), Ireland (5), Pakistan (4), Belgium (3), Turkey (3), Germany (2), UK (2), Czechia (2), Saudi Arabia (2)
2022	32,509	78	57	21	Russia (8), Uzbekistan (5), China (4), Germany (4), New Zealand (3), India (2), UAE (2), Belgium (2), Japan (2), Pakistan (2)
2023	31,864	96	81	15	Russia (6), Azerbaijan (3), New Zealand (3), China (3), Poland (2), UK (2), Italy (2), Netherlands (2), Tanzania (1), US (1)

Citation data suggest various citation numbers in Economics (Table 15), while CMTS demonstrates growth (Table S37). Top citing countries (2019–2023 combined): Kazakhstan (194), China (22), New Zealand (10), Turkey (7), United States (4), Tanzania (4), Ireland (3), Russia (3), North Macedonia (3), Indonesia (3).

Table 15. Citation statistics for Economics Dimensions (Dimensions, 2019–2023).

Year	Citations	Publications	Journals	Citing Countries
2019	83	65	57	19
2020	67	63	42	13
2021	57	51	34	11
2022	49	46	23	7
2023	28	28	17	6

Citation statistics for Economics:

- Total citations: 284
- Total publications: 253
- Average citations per publication: 1.1
- Citation range per year: 28–83
- Citation growth rate (2019–2023): –23%
- Citing countries range: 6–19.

The analysis demonstrates Kazakhstan’s transition from a locally focused research system to deeper international integration, with growth in research areas and an increase in the number of citing countries. This suggests a positive trend in the expansion of research beyond local topics and following the international interest and research agenda.

4.3. Network Analysis

4.3.1. Research Themes and Keywords Clustering

The keyword co-occurrence analysis identified six major thematic clusters (Figure 2), reflecting the dominant research priorities within the field. The first cluster, Economic Development and Sustainability (42 keywords), encompassed topics such as sustainable development, economic growth, GDP, and poverty reduction. The second cluster, Financial Markets and Investment (38 keywords), was associated with stock markets, portfolio management, risk management, and foreign direct investment. The third cluster, Energy and Environment (35 keywords), focused on renewable energy, carbon emissions, energy efficiency, and climate change. The fourth cluster, COVID-19 and Crisis Management (28 keywords), included pandemic-related themes such as resilience, economic recovery, and supply chain disruption. The fifth cluster, Tourism and Services (22 keywords), centered on hospitality, destination competitiveness, and cultural heritage. Finally, the sixth cluster, Digital Economy and Innovation (19 keywords), comprised emerging areas such as e-commerce, fintech, blockchain, and artificial intelligence.

These thematic clusters have direct implications for Kazakhstan’s research policy and institutional development. Academic institutions should prioritize establishing research centers aligned with the six identified clusters, particularly in underrepresented areas such as Digital Economy and Innovation (19 keywords) compared to Economic Development and Sustainability (42 keywords). Journal editors and funding agencies can use this clustering to identify emerging research gaps—for instance, the intersection between Digital Economy and Energy clusters represents a promising area for interdisciplinary initiatives. Research evaluation frameworks could incorporate cluster-specific metrics to ensure balanced portfolio development across all thematic areas rather than concentration in traditional economic topics.

co-supervised PhD projects. The Russian–Kazakhstan Collaborative Network demonstrates a successful cross-border model that could be replicated with other strategic partners. Policymakers could incentivize such collaboration through targeted funding mechanisms, such as bilateral research grants requiring institutional partnerships or increased citation-based rewards for multi-institutional publications. Additionally, emerging authors with high productivity but low link strength (≥ 8 publications, link strength < 10) represent untapped potential for network expansion through mentorship programs or collaborative research projects.

The country co-authorship network in Figure 3 visualizes international collaboration patterns ($N = 63$ countries, ≥ 2 publications). Node sizes are proportional to publication counts, and link thickness indicates collaboration strength (fractional counting). Color overlay represents average publication year: Blue (2019–2020, established partnerships including Russia, Germany, Poland), Green–Yellow (2020–2022, growing partnerships including China, South Korea, Turkey), Yellow–Red (2022–2023, emerging partnerships including UAE, Malaysia, Brazil). Six geographic clusters were identified: Central Asia, Post-Soviet, Western Europe, Asia, Anglophone, Middle East, and Türkiye. Generated using VOSviewer, resolution 0.8.

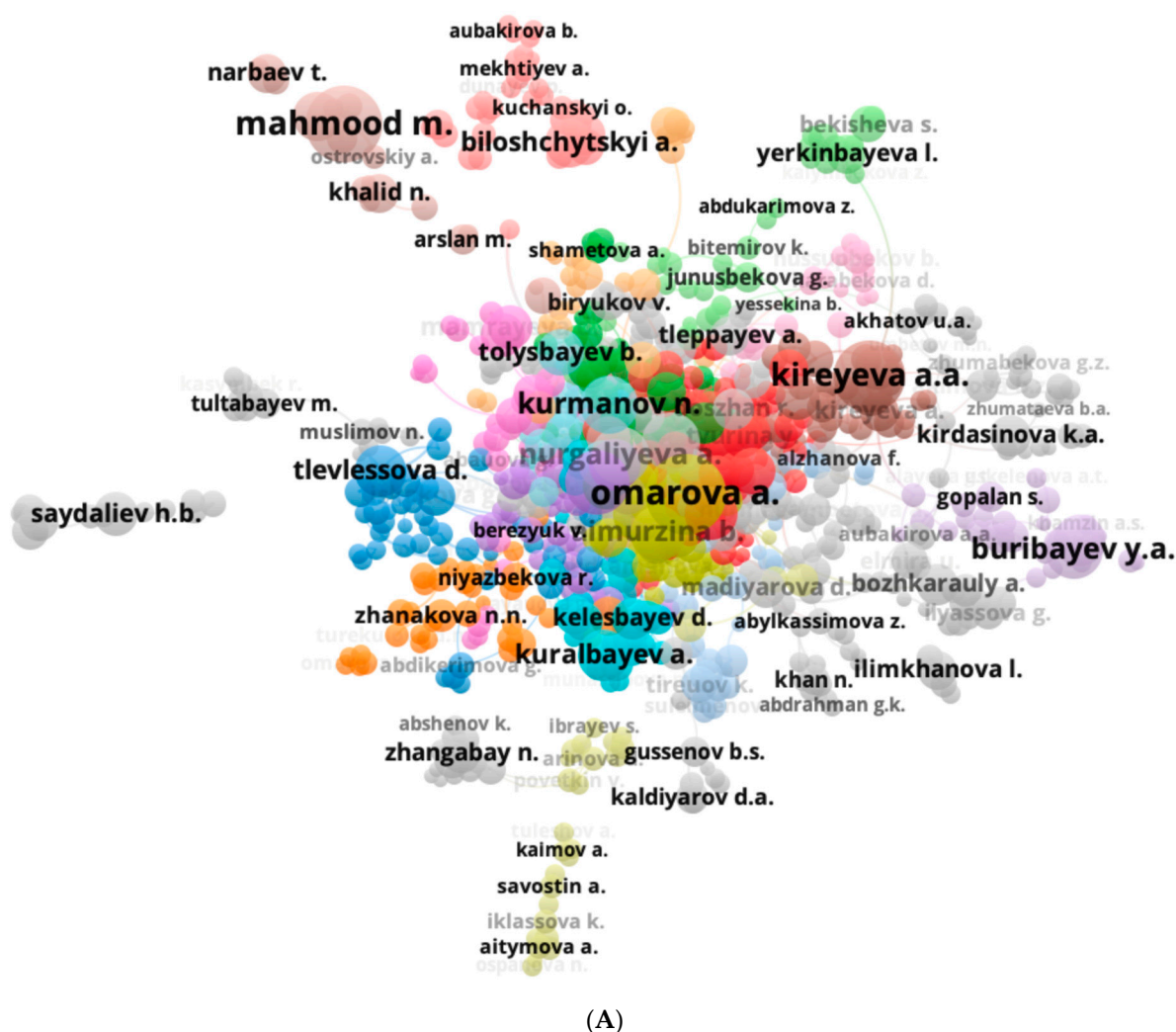


Figure 3. Cont.

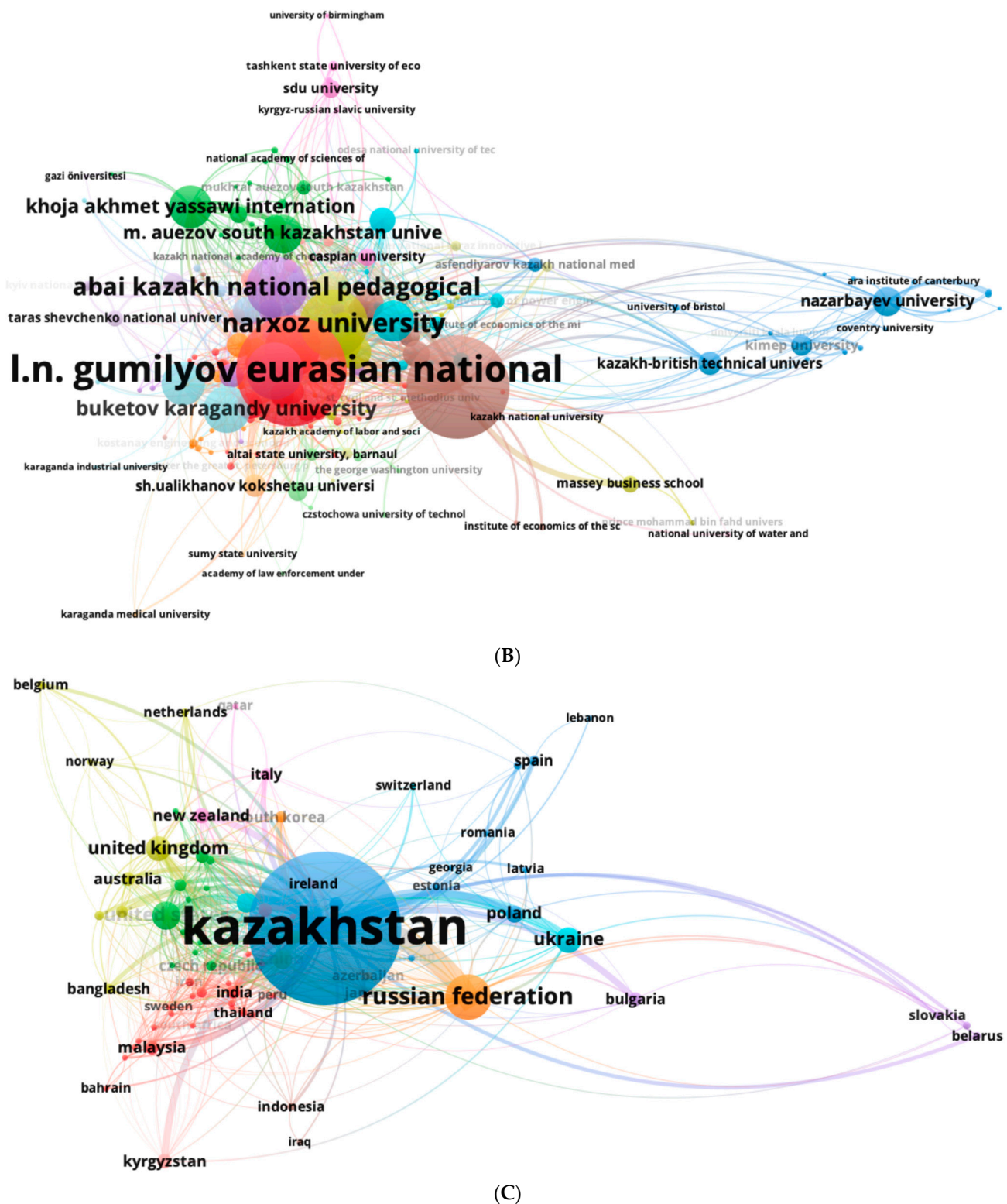


Figure 3. (A) Co-authorship network (authors). (B) Co-authorship network (organizations). (C) Co-authorship network (countries).

To enhance visual clarity, the following design improvements were implemented: (1) institution names were abbreviated where length >25 characters, (2) edge transparency adjusted to prevent overlap ($\alpha = 0.6$), (3) legend positioned to avoid data obscuring, (4) zoom level calibrated to maintain a minimum 10pt font size for the top 20 nodes. These

5. Discussion

5.1. Journal Publications in Kazakhstan Compared with Global Publications

The assessment of the applicability of Bradford's law of scattering and the Leimkuhler model across three Scopus subject areas—Economics, Econometrics, and Finance (EEF Scopus), Business, Management, and Accounting (BMA Scopus), and Decision Sciences (DS Scopus)—for both Kazakhstani and global datasets was found applicable across these fields, although the accuracy varied between Kazakhstan and global contexts. The analysis reveals several key differences between Kazakhstani and global publication patterns in economics and business-related fields.

First, while Bradford's law proved applicable to both Scopus datasets, the global dataset demonstrates more stable and predictable distribution patterns, with consistently low percentage errors (below 0.5%), whereas the Kazakhstan dataset shows more variation, particularly in Decision Sciences, where percentage errors reached 19.668%.

Second, the analysis of Bradford's scattering reveals distinct patterns in core journal distribution: in EEF Scopus, Kazakhstan's core zone comprises 1–2 journals (0.41–0.82% of total journals) compared with 5–12 journals in the global dataset (0.42–1.01%); in DS Scopus, Kazakhstan consistently maintains one core journal (1.15%) versus 2–3 in the global dataset (0.45–0.68%); while BMA Scopus shows the most balanced distribution, with Kazakhstan's core journals (2–3) closer to global patterns (3–4).

Third, the most significant difference appears in the Decision Sciences field, where Kazakhstan's high percentage errors contrast sharply with global figures (as low as 0.035%), suggesting DS is significantly less developed in Kazakhstan compared with international standards.

These differences can be attributed to limited research funding in Kazakhstan, historical emphasis on STEM disciplines, fewer established research institutions in economics and business-related fields, and evolving research infrastructure. Moreover, the research indicates that bibliometric indicators represent research quality and visibility. Bradford's law helped to assess journal influence and the maturity of the field. The revealed conclusions suggest that publishing in high-impact journals requires advanced methodological expertise, strong international networks, and developed research infrastructure. Therefore, the results show the current state of research quality and access to infrastructure in Kazakhstan and globally.

5.2. Collaboration Analysis

The collaborative patterns in datasets from Scopus and Dimensions demonstrate growth in collaborations with several countries and positive results in continuous collaborative activities. The bibliometric data suggest a dynamic yet uneven trajectory of research outputs in Kazakhstan. Expanding international collaboration and increased citation visibility highlight continuous positive changes. Some subject areas, such as Decision Sciences from Scopus, have shown more substantial progress in both publications and citations, suggesting that research in this area is growing globally with relevant frameworks and methodologies; however, other fields show slower growth and expansion.

The three-part classification reveals a mature collaboration structure, with 59% domestic-only research providing a solid foundation, 31.5% Kazakhstan-led international collaborations demonstrating research leadership, and 9.5% junior partnerships enabling learning from leading research groups. International collaborations yield 69–92% higher citation impact, providing strong evidence for policies promoting international engagement. Notably, even junior partnership roles (Category 3) achieve high per-publication citations (6.9), suggesting value in diverse collaboration modalities. The stable proportions across 2019–2023 (variation < 2%) indicate established patterns rather than transitional dynamics.

The collaboration patterns rely heavily on regional partnerships, indicating the strong links that were created and sustained over the years. Russia is the top collaborator in the majority of research fields. Other countries, such as China, the U.S., Turkey, and some European countries, demonstrate the diversification of research networks and integration of Kazakhstani research into the global research community. These collaborations facilitate access to an advanced research infrastructure, knowledge base, and stronger research links that support knowledge creation; however, Kazakhstan-led research is dominant, with 85.1% of publications having Kazakhstan-affiliated first or corresponding author (65.0% as first author, an additional 20.1% as corresponding author with non-Kazakhstan-led first author), demonstrating strong local research capacity and leadership.

Citations provide evidence of increasing international visibility. The steady expansion of citing countries from 31 in 2019 to nearly 60 in 2023 in Scopus suggests growth and expansion. Growth in Decision Sciences suggests not only quantitative growth but also qualitative improvements in its research relevance through citations.

However, the Dimensions data reveal some divergence in publication activity. Economics publications from Dimensions show strong publication activity, while citation impact is relatively modest. This suggests that despite the expansion of publication outputs, the global impact of some research remains limited.

The different classification systems employed by Scopus and Dimensions yield complementary insights rather than contradictory findings. Scopus's journal-level approach captures Kazakhstan's presence in established, peer-reviewed outlets, while Dimensions' publication-level approach provides broader coverage, including emerging venues. The substantial growth observed in both databases (Scopus: +37–90%; Dimensions: +84–136% across fields) provides convergent evidence of expanding research output, with Dimensions' higher growth rates likely reflecting its more inclusive coverage. The sensitivity analysis of the "Kazakhstan-led" criterion confirms that key findings regarding temporal dynamics and collaboration patterns remain robust across different operational definitions (Scopus semantic approach: 100% by design; Dimensions field-order approach: 72.7–72.8%).

The results demonstrate Kazakhstan's transition from primary local and regional research towards international integration. Historically, Kazakhstan's scientific collaborations have been anchored within the post-Soviet research space, which is reflected in the strong, continued partnership with Russia. This collaboration is sustained through language and similar disciplinary interests. Moreover, significant and growing ties with China and the U.S. highlight the influence of geopolitical priorities and participation in global knowledge networks. Emerging partnerships with New Zealand, the UK, and European countries point to diversification. At the same time, the analysis reveals gaps that demonstrate limitations in the research quality.

Overall, the research landscape in Kazakhstan demonstrates clear progress in terms of publication volume, collaboration network, and citations. To sustain this growth, the partnership should focus on expansion beyond traditional partners, positioning scholar outputs more prominently with global topics in the studied fields. The results show that Kazakhstan's integration has a positive trend, and internal policy changes have resulted in consistent improvement. Evidence suggests that national research programs and international collaborations could strengthen already existing ties through the promotion of academic co-operation, grant schemes, and more structured partnerships among institutions. The positive trend of collaboration promises improved quality of partnerships and strategic distribution of available resources to further strengthen links and produce high-quality publications.

5.3. Research Themes and Network Dynamics

Network analysis reveals six major thematic clusters in Kazakhstan's economic and business research. The prominence of Economic Development and Sustainability (42 keywords) and Energy and Environment (35 keywords) clusters reflects Kazakhstan's national priorities in diversification and green transition. The emergence of Digital Economy and Innovation as a distinct cluster (19 keywords, predominantly 2022–2023) indicates rapid adaptation to global digital transformation trends. The COVID-19 and Crisis Management cluster (28 keywords) demonstrates Kazakhstan researchers' responsiveness to the pandemic, although the temporal overlay shows that these topics emerged primarily in 2020–2021, with a decline in prominence by 2023. The evolution from established topics (sustainability, economic growth) in blue tones to emerging themes (digitalization, blockchain, artificial intelligence) in yellow–red tones on the temporal overlay visualization provides clear evidence of research portfolio diversification over the 2019–2023 period.

Temporal dynamics of international partnerships reveal strategic shifts in Kazakhstan's research collaboration networks. Established Western European partnerships (Germany, Poland, UK) and the dominant Russian partnership maintain stable intensity (average publication years 2020.2–2020.4), providing continuity. However, Asian partnerships show marked acceleration, with China (average year 2021.3) and South Korea (2021.5) demonstrating increasing collaboration intensity. The emergence of new partnerships with the UAE (2022.3), Malaysia (2022.1), and Brazil (2022.8) suggests active diversification beyond traditional post-Soviet and European networks. This geographic diversification aligns with Kazakhstan's multi-vector foreign policy and may reduce dependence on any single partner country. The six identified geographic clusters (Central Asia, Post-Soviet, Western Europe, Asia, Anglophone, Middle East, and Türkiye) represent distinct collaboration ecosystems with varying characteristics: Anglophone countries have the highest citation impact (8.0+ per publication), while Central Asian regional partnerships support capacity building (4.5–5.0 per publication). Russia's dual role as both a dominant partner by volume and a member of the post-Soviet cluster highlights the continuing importance of historical scientific ties while new partnerships develop.

The co-authorship network analysis at the author, institutional, and country levels provides complementary perspectives on collaboration structure. At the author level, five distinct research groups emerged, suggesting specialized research communities rather than a fragmented landscape. The identification of a Russian–Kazakhstan Collaborative Network as a separate cluster (38 authors) highlights the depth of cross-border research integration, extending beyond opportunistic co-authorship to sustained research programs. Institutional link strength metrics reveal that collaborative intensity does not always correlate with publication volume; some smaller institutions demonstrate high link strength relative to output, indicating strategic positioning in collaborative networks. At the country level, fractional counting ensures that partnership strength reflects genuine collaboration rather than nominal co-authorship, providing a more accurate picture of international research integration.

5.4. Study Limitations

This study provides valuable insights into Kazakhstan's publication patterns in the fields of economics and business research; however, several limitations need to be acknowledged.

Firstly, the reliance on Scopus and Dimensions databases. Each database differs in journal and publication coverage. Therefore, the data might lead to an underrepresentation of all the research that is being published.

For Bradford's law analysis, notable discrepancies associated with the Decision sciences were identified. The findings may reflect the relatively small number of publications in Kazakhstan compared with global outputs, which might influence the generalizability of the results in a broader context.

This study does not consider peer-review rigor or thematic novelty in publications. While citation counts and journal distribution provide interesting insights into the visibility of research, they do not fully capture the novelty in the global context; moreover, higher citation rates in some areas might be driven by a small number of good-quality publications, rather than improvements in the field.

Finally, the analysis is limited to a five-year period (2019–2023) chosen to capture both pre- and post-COVID-19 developments. While this timeframe provides a focused view of recent trends, it does not reflect longer-term historical patterns in Kazakhstan's research evolution, which should be explored in future studies.

6. Conclusions

Research outputs in the economics and business fields demonstrate both the associated progress and challenges. Bibliometric analysis across fields reveals strong growth in the number of publications and international collaborations, reflecting the country's strategic priorities to expand its research horizon. Decision sciences has the highest citation impact, suggesting good alignment with global research and interest.

From a policy perspective, this research provides some relevant insights for future decision-making at the country level. The growth and expansion of Kazakhstan's science and research visibility is evident through the increased number of citing countries, which also aligns with the strategic goals to position the country as a regional knowledge hub. This suggests that the country is gaining greater recognition and integration into the global research networks. Policymakers can use the findings of this research to refine national research funding, encourage publications in high-impact journals, and foster international collaboration aimed at promoting the quality of research publications. Collaboration with leaders such as Russia, China, and the U.S. demonstrates a strong interest in collaborative research, as well as a growing interest in this region. The dominance of Kazakhstan authorship demonstrates a strong orientation towards local research, as well as the capability to lead the research agenda without necessarily relying on external knowledge and expertise in the field. In comparison to global patterns, the distribution of journals in Kazakhstan is less stable. This reflects some constraints, such as limited funding in the economics and business fields, prioritization of STEM over economic research, and inadequate institutional support mechanisms. It is essential to overcome these limits as the country shifts towards diversification and innovations. Academic institutions can leverage the findings to strengthen research capacity through practical-oriented steps such as mentorship programs, academic writing support, and internal policies promoting quality publication. Moreover, in an emerging economy, country-specific tactics might be related to the improved editorial standards, internationally experienced members of the editorial board. Collaboration development through sustained partnership with institutions in high-performing research countries could promote knowledge exchange and stronger research foundations.

Our findings provide valuable country-level insights that can be applied in other emerging economies to shape research in these fields. First, the expansion of research networks beyond traditional geographic borders represents diversification of partnerships beyond existing research links and ties. Diversification may facilitate better collaboration with leading research countries and countries with a similar scientific structure. Second, increases in publications in globally recognized journals can help increase the citations and visibility of research. This could be achieved through targeted incentives focused on

capacity building, bringing international expertise to local research networks, and focusing on the quality rather than quantity of publications. Third, alignment of research outputs with economic priorities could lead to socio-economic challenges and other needs associated with the development of the economy being better addressed. Developing roadmaps that focus on new challenges, such as digitalization, green economy, and strategic development goals (SDGs), would improve the relevance of research, encourage collaboration with industries, and increase the impact of research on the country's economic development.

The findings correspond with broader patterns observed in emerging economies. Kazakhstan's experience is exemplary for countries transitioning from predominantly locally oriented scientific production towards more globally oriented research and international exposure. The rise of Kazakhstan's publication outputs, ongoing systemic changes in national research policy, reflect a phase of sustained system development. It is characterized by openness to the global research networks, improved collaboration patterns, and publication in recognized journals. The existing knowledge suggests that countries in the development stage of their economy tend to prioritize research areas that align with economic development. Therefore, this research contributes by providing an evidence-based understanding of how research policies evolve and contribute to science development through internationalization, institutional capacity.

The study has several limitations, including the use of only the Scopus database to evaluate Bradford's law; this creates potential database coverage bias. Additionally, the publications were limited to the English language, thus excluding any research published in Kazakh or Russian. English-language publications receive higher citation visibility, which creates a language bias. Scopus does not index all journals, and local journals, in most cases, are not indexed in Scopus. This may result in the underrepresentation of locally relevant research that is not published in the English language. Future research would benefit from incorporating additional databases and local journals to provide a more balanced and comprehensive mapping of the research landscape. Comparative cross-database analysis would also provide a deeper understanding of how various indexing practices affect research positioning. Another limitation is associated with the focus on bibliometric indicators and the exclusion of any qualitative dimensions. This limits the current scope of research but provides direction for further studies that can include qualitative evaluations of research impact and research networks. Moreover, the evaluation of regional co-operation can provide a better understanding of research mechanisms that shape the research environment in emerging economies. Investigation of targeted funding initiatives for economics and business-related fields will provide insights and understanding of the structure of research partnerships, including international co-operation that could serve as an effective knowledge transfer mechanism.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/publications13040058/s1>, Figure S1: Bradford's bibliography for EEF journals in 2019–2022; Figure S2: Bradford's bibliography for BMA journals in 2019–2022; Figure S3: Bradford's bibliography for DS journals in 2019–2022; Figure S4: OLS Regression of Cumulative Articles vs. Log Cumulative Journals (EEF Scopus Global 2019); Figure S5: Residual Plot (EEF Scopus Global 2019); Figure S6: OLS Regression of Cumulative Articles vs. Log Cumulative Journals (EEF Scopus Kazakhstan 2019); Figure S7: Residual Plot (EEF Scopus Kazakhstan 2019); Tables S1–S6: Bradford's law of scattering for 2020–2022 using the Leimkuhler model for EEF Kazakhstan and global datasets; Tables S7–S14: Bradford's law of scattering for 2020–2022 using the Leimkuhler model for BMA Kazakhstan and global datasets; Tables S15–S22: Bradford's law of scattering for 2020–2022 using the Leimkuhler model for DS Kazakhstan and global datasets; Table S23: Detailed ranked lists for EEF Journals 2019 (Kazakhstan); Table S24: Detailed ranked lists for EEF Journals 2019 (Global). Table S25: Sensitivity analysis of KZ-led criterion across databases; Table S26: Subject classification mapping between

Scopus and Dimensions; Table S27: Cross-tabulation of publications and citations by year and subject area; Tables S28–S31: Mann-Kendall trends and Theil-Sen slopes; Tables S32–S37: Collaboration analysis for BMA, DS, CMTS.

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Abbreviations

The following abbreviations are used in this manuscript:

OECD	Organization for Economic Co-operation and Development
PISA	Program for International Student Assessment
STEM	Science, Technology, Engineering, Mathematics
R&D	Research and development
EEF	Economics, Econometrics, and Finance
BMA	Business, Management, and Accounting
DS	Decision sciences
E	Economics
CMTS	Commerce, Management, Tourism, and Services

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