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Comprehensive Quantitative Analysis of Country Publication Activity according to Scimago Journal and Country Rank Portal Data

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ABSTRACT

Objective: Analysis of the evolution of methods of analysis of publication activity and citation and development of new analytical tools for their analysis: interdisciplinary coefficients, trend diagnostic chart, binary matrix clustering algorithm.

Methods: The results of scientometric analysis of the occurrence of the term Activity Index using Google Books and Google Scholar, as well as SJR database were used as research materials. In addition to scientometric analysis, diagnostic and matrix analysis methods were used as research methods.

Results: Based on the SJR database (1996-2019), interdisciplinarity coefficients for subject categories and subject area were constructed and calculated for the first 50 countries. The same database allowed the construction of a trend diagnostic chart in the coordinates Activity Index and Average Growth Rate for Documents in order to identify the leaders and outsiders, as well as catch-up countries and countries losing their publication potential. These charts are plotted for the top 20 countries and the top 20 subject categories. For these countries and subject categories, matrices for Activity Index (2019) and Attractivity Index (2017 - 2019) as well as binary matrices for Activity Index (50×20 dimension) before and after applying the clustering algorithm (2019) are constructed.

Conclusion: The calculations performed with relative indices can be useful in planning research and scientific collaboration between countries, as they show the comparative advantages and weaknesses of country scientific systems, and also facilitate in finding partner countries for the implementation of joint scientific programs or projects that are mutually beneficial. In the future, it is advisable to build a trend diagnostic chart, when instead of calculating an increase in publication activity over the last three years, an increase in Activity Index values is considered.

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Introduction

The logic of this study is as follows: we decided to trace the evolution of scientific views on publication activity and citation indicators from the moment of their appearance, along with the databases for their calculations. We managed to identify when research moved from absolute indicators to relative ones and identify what served as the prototype of a key relative indicator now known as the Activity Index. Our extensive analysis showed that the economic index by Izard (1960), should be considered as such a prototype, rather than the economic index by Balassa (1965), which is recognized mostly among scientometricians and was introduced six years later.

Further analysis showed that indices under such name were introduced much earlier in various fields of knowledge, but they had some distinctive features indicating the field of knowledge in which those indices were used, since the name Activity Index does not mean much by itself. Therefore, we suggest using the Publication Activity Index and Citation Activity Index.

A chronological analysis of publications that use this and other relative indices showed from what time and on the basis of which database scientists from developing countries began to actively compare countries based on relative indices of publication activity and citations. As it turned out, this started when launching the public SCimago Journal and Country Rank database in 2007.

A well-known feature of this database is that publications are classified into several subject categories or subject areas through journals in the Scopus database. As a result, the sum of documents in these categories or areas is not equal to the total number of documents produced by the countries. This circumstance led us to the idea of introducing an enlarged measure of interdisciplinarity of publications at the country level, which is calculated for both subject area and subject categories with establishing a correlation between them. Further, the joint use of three-year increases in publication activity and the Activity Index made it possible for the first time in scientometrics to build Trend Diagnostic Charts, which can be found in other fields of knowledge; for example, they were widely used in the early 21st century when constructing the European Innovation Scoreboard. The employment of such diagrams makes it possible to classify countries into leaders, followers, outsiders and losing their potential.

Fundamentally, we convert the Activity Index matrices obvious for constructing, in which the elements of these matrices are distributed by countries and subject categories (subject areas), into a binary form when 1 corresponds to the situation of publication activity in a given subject category (area) exceeding the world average level, and 0 means the opposite. The construction of binary matrices makes it possible to cluster them, when, by rearranging the rows and columns of these matrices, dense submatrices consisting of 1s are identified. Such clustering helps one to clearly see the set of countries specializing in the largest possible number of scientific disciplines. It is the first time that such clustering has been proposed and implemented in scientometrics. Below is a review of the previous studies in chronological order.

We assume that the basis for international comparisons of scientific outputs in terms of publication activity and citations was laid by publishing various specialized abstracts. The first such edition – Science Abstracts –was published in 5 volumes in 1898-1902 and included abstracts of articles on physics and electrical engineering due to the names of the British institutions which published them (The Physical Society and The Institution of Electrical Engineers), but in 1903 it split into two parts: A (Physics) and B (Electrical Engineering).

In 1907, The American Chemical Society started publishing Chemical Abstracts. After analyzing all the bibliographic data of that title from 1907 to 1916, Lotka (1926) arrived at one of the first Scientometric Laws on the frequency distribution of scientific productivity. Bacteriology Abstracts were published from 1917 to 1925, and Botanical Abstracts – from 1919 to 1926, both titles published in Baltimore by Williams and Wilkins. Historical Abstracts date back to 1954 and Geographical Abstracts were launched in 1960. So gradually, in the course of the 20th century, all the major areas of knowledge had their Abstracts.

Irvine and Martin (1989) note that the first reports on country comparisons of publication activity published in the 1960s were based on Chemical Abstracts and Physics Abstracts, that is, on the oldest publications of this type. A study by the American Institute of Physics (Keenan & Atherton, 1964) was considered as an example, though, as Irvine & Martin write, the articles were assigned to the country of a journal publication rather than where research was really carried out. This naturally gave an advantage to the countries where a large number of journals were published, for example, the Netherlands, which was detrimental to smaller countries publishing no journals. They further stated that this problem had been solved by Price (1969) who used the International Directory of Research and Development Scientists (published by the Institute for Scientific Information (ISI), and later renamed Who is Publishing in Science or WIPIS) to analyze 1967 publications in terms of the first-named authors. That study showed for the first time that the majority of scientists were concentrated in 14 countries, and their numbers in each country correlated well with GNP. At the same time, the number of scientists distributed by countries naturally correlates well with their country publications. The Institute for Scientific Information (ISI), the materials of which contributed greatly to this important result, was founded by Eugene Garfield (1925–2017) in 1960.

It is worth mentioning that international comparisons of scientific performance were mainly due to the space race resulted from the launch of the first man-made earth satellite (1957) and the first manned space flight (1961) by the Soviet Union.

A great contribution to the development of such international comparison was made by the US National Science Foundation (NSF), founded in 1950, which in 1973 started regularly publishing Science Indicators, among which were the indicators of publication activity and citation (obtained from the ISI database). A very good historical review of the creation and development of Science and Technology Indicators was conducted by Godin (2003).

Besides the Science Indicators (later Science & Engineering Indicators), NSF created a specialized publication database: NSF's Science Literature Indicators Date-Base (CHI Research). The first results obtained from the analysis of this database were published in Frame, Narin and Carpenter (1977) and Frame and Narin (1977). Although some co-authors of these papers had published the results of their research on country publication and citation in the Journal of the American Society of Information Science a bit earlier (Narin & Carpenter, 1975).

One of the current leaders in disseminating the results of international comparisons of research outputs is *Scientometrics* journal, founded in 1978. The Soviet scientometric school was well represented as early as in its first issues (AYablonsky, V.A. Pokrovsky, V.V. Nalimov, I.V. Marshakova, G.M. Dobrov, etc.), as it was one of the leading schools in the world at that time due to the creation of The All-Union Institute for Scientific and Technical Information (VINITI, Moscow) in 1952. By the way, Eguene Garfield, who was a great friend of VINITI, believed that the foundation of this institution was as important an event as the launch of the first man-made earth satellite, and he later created his institute, being inspired by the example of the creation of VINITI. Even earlier, another leading researcher in the sphere of scientometrics W. Glänzel in his fundamental A Course on Theory and Application of Bibliometric Indicators (2003) gave credit to the Soviet scientist V.V. Nalimov, who was the first to have proposed in 1969 to use the term of the scientometrics in his book under the same title (Nalimov & Mulchenko, 1969). In the same year, Pritchard (1969) introduced the term bibliometrics, so these two terms are now used interchangeably without any difference in their nature or scope (Glänzel, 2003).

Braun, Glänzel and Schubert made a large contribution to comparative research of publication activity and citation, who published a large series of articles in Scientometrics journal in the 1980s-1990s. Braun, Glänzel and Schubert (1987) conducted an analysis of the publication outputs and relative citation impacts of 107 countries for 1978-1980, based on the ISI data. Later that year, they published two articles under very close titles for the following scientific fields: life sciences and chemistry and physics and mathematics, and the in 1988 in the same journal, applying the same patters, three articles were published on the analysis of publication outputs and relative impacts on the same countries for the period of 1981-1985. In 1989, they presented in Scientometrics some unique data on a comprehensive set of indicators on 2649 journals, 96 countries and in the 114 major science fields and subfields for 1981-1985 on 475 pages, showing the leading positions of the USA, the UK, and the USSR (Schubert, Glänzel & Braun, 1989).

Another major study by this group of authors (with H. Grupp instead of A. Schubert) was published in 1995 in the same journal (Braun, Glänzel & Grupp 1995), calculating scientometric weight of 50 countries in 27 science areas for the period of 1989-1993. Unlike the previously published works discussed above, these authors started using an additional relative indicator – Activity Index, which will be discussed later.

In the 1980s, there appeared a series of works on British and world science published by B.R. Martin and J. Irvine, of which the most general article was published in *Scientometrics* (Irvine and Martin 1989). That article, basing on the CHI/NSF Science Literature Indicators Database (1973-1984), looked at the national percentage shares of scientific publications and citations, as well as their trends, for 7 leading world countries (Canada, France, West Germany, Japan, UK, USA, USSR). That paper also examined the world publication shares in 1984 by eight fields of research.

In terms of methodology, the 1980s saw a departure from absolute methods when calculating scientometric indicators, which can be seen in Handbook of Quantitative Studies of Science and Technology (Schubert, Glanzel & Braun 1988). The first relative indicator in scientometrics, proposed by Frame (1977), was intended for cross-field comparison, and is known as Activity Index (AI). AI of a country's in a given field (or subfield) is defined as (the country's share in world's publication output in all fields) or, equivalently, (the given field's share in the country's publication output) / (the given field's share in the world's publication output) (Schubert & Braun, 1996).

A similar indicator for citation was proposed by Schubert and Braun (1986) – Attractivity Index (AAI). If in the above definition of AI, we replace the word "publication" with the word "citation", it will make the definition of an Attractivity Index. To transfer the Activity Index values into the closed symmetric interval [-1.1], Schubert and Braun (1986) proposed the Relative Specialization Index (RSI):

$$RSI = \frac{(AI - 1)}{(AI + 1)}$$

None of the three above indices have any indication that they refer to publications or citations. We assume that it would be more accurate to call the first index as Publication Activity Index, as done by Moed et al. (2011), and the second index – as the Citation Activity Index. But even in this case, these names would not reflect the specialization of countries in certain scientific fields, or in the localization of the publication activity of countries in certain areas, or in the concentration of the country's research in some scientific field. In this regard, the main part of the current paper will show that the name Activity Index has long been used in various fields of knowledge, with additional words indicating its specialization. Such an analysis will support the transformation of the name Activity Index towards considering its scientometric specialization.

In this sense, the Activity Index had been proposed long before in the World economy and Regional Science. For instance, Makhiba and Pouris (2016) noted that AI is related to the Revealed Comparative Advantage (RCA) index which measures specialization in economies as described by Balassa (1965). Li (2017) wrote about the same, pointing out that AI used measure of disciplinary specialization, which calculated in the same way as the RCA, the most popular measure of specialization in trade and technology policy (Dalum, Laursen, and Villumsen 1998). The most recent studies can be found in Mansourzadeh et al. (2019) and in Janavi, Mansourzadeh, and Eshtehardi (2020). But even earlier, Glänzel (2000, 2003) and later Brusoni and Geuna (2004) and Rousseau (2012) recognized that the pioneer in developing the index in question was Balassa (1965). For instance, Glänzel (2003) in his fundamental publication A Course on Theory and Application of Bibliometric Indicators emphasized that Relative Specialization Index is a version of the economists' Comparative Advantage Index. So, in the scientometric community, there is currently a consensus concerning the priority in the development of the index under consideration. At the same time, in the main part of the present paper, we will show that it is the localization coefficient introduced by W. Izard (1960) that should be considered the economic prototype of the index in question rather than the coefficient proposed 6 years later by B. Balassa (1965).

As the early papers (published in the 1970-1990s) described above on using AI, RSI, AAI were solely based on the Web of Science Database, it proves that in the late 20th and early 21st centuries, the scientometric calculations of countries' scientific specialization were also conducted using this database. Among the most recent works are the papers by Pouris (2010) and Makhola and Pouris (2016). The former includes the calculations of AI for 15 SADC (South African Development Community) countries over the period of 2004-2008 for 22 subject Categories of Web of Science, and the latter includes the calculations of AI and AAI for the BRICS countries over the period of 2002-2012. Unfortunately, the share of papers from relatively underdeveloped countries, two of which are mentioned above, is much smaller than the papers by researchers from developed countries, especially Anglo-Saxon, as access to the above database is hampered by high fees.

But the situation started to change dramatically after launching in 2007 a public platform SCimago Journal and Country Rank, which posts Country Bibliometric Scopus-Statistics, using the data since 1996. Further, there will be a scientometric analysis of publications with the calculations of AI and RSI based on the above Public Platform (we will be using SJR Database for this platform). The articles were searched through advanced Google Scholar search by year, from 2009 (as in 2008 there were no such articles) through 2022. Our hypothesis in this case was the following: the majority of the authors of the articles obtained would be from Asia, Africa, or Latin America. This hypothesis will be tested in Results and Discussion, whereas below is a review of the selected publications with selecting one relevant journal publication chosen in each year, which will further facilitate in formulating new research questions.

First comes the study by Arencibia-Jorge and Moya-Anegón (2009), which, based on the Scopus-Statistics from Scimago Journal and Country Rank (1996-2007), built a diagram to show dependence of H-index on RSI, which was linear, with a positive correlation coefficient. It further shows, for instance, that Scopus subject areas in which Cuba is more specialized are Healthy Professions, Psychology, Medicine, Biochemistry, Genetics and Molecular Biology, Nursing, and Computer Sciences (RSI>1). And this lays the foundation for creating a highly effective healthcare system in this country, as indicated by special literature and media. The same study was published in expanded form in *Scientometrics* in 2010 (Arencibia-Jorge & Moya-Anegón, 2010).

Moed et al. (2011) used the same SJR Database to calculate the Overall Disciplinary Specialization (ODS) Index and Publication Activity Index (PAI) for publications over the period of 2003-2007 in 27 main subject fields of all 1500 universities from 40 Countries. ODS Index defined as Gini's index for a university's of the PAI across disciplines. PAI is calculated the same way as AI country index, in which instead of the publications of a country, a university's publications are considered. Both at a national and institutional levels, it was found that a large publication output is associated with a higher citation impact and that higher concentration of university research is not always associated with better research performance. In addition, it shows that multi-disciplinary research is the most promising and visible at the international research front.

Chinchilla-Rodríguez, López-Illescas and de Moya-Anegón F (2012) built an interesting graph showing the values of AI, AAI and number of papers in the form of ellipses of different sizes in Biochemistry, Genetics and Molecular Biology. In this diagram, in the sector AI > 1, AAI > 1 (upper right quadrant), there is the USA, Japan, Sweden, Switzerland, Germany, France, Belgium, Canada, and Israel, and in the sector AI < 1, AAI < 1 (lower left quadrant) – China, India, Brazil, Turkey, Russia, Australia, Poland, South Korea, and Taiwan. The data on publication activity was obtained from the SJR database for the period of 1996-2007.

Rakhi and Nagarajan (2013), using SJR Database (1996-2011), calculated the publication trends of Library & Information Sciences research in Asian countries, recording positive AI dynamics. Zacca-Gonzales et al. (2014), basing on SJR database (2003, 2006, 2010) built radial diagrams of RSI values for subject category Public Health. For 9 Asian countries and all three years RSI>0 was only for Pakistan and Bangladesh, for 10 Eastern European countries in 2010 only Serbia had a positive RSI value of 0.4 and Croatia's index was a bit above zero, the rest of the countries had the negative values of this indicator; as for Western European countries, in 2010 for France, Italy and Germany the RSI values were negative, whereas for the remaining 6 countries they were positive; as for 10 Middle East countries in 2010, UAE, Lebanon, Iraq, Kuwait, and Jordan had positive RSI values, with the rest of the countries having the negative indices; as for 14 Latin American countries over all three years, all the countries, except Panama, had positive RSI values; in all four North African countries in the study, the RSI values were negative; all the 24 Central and South African countries had positive RSI values, ranging from 0.4-0.6 for all three years under study.

Drawan, Gupta and Gupta (2015), basing on this database (1996-2013), studied the Social Sciences landscape in South Asia (Bangladesh, India, Nepal, Pakistan, Sri Lanka). They calculated the Relative Citation Index (RCI, Country Citation per paper/World Citation per paper) and RSI and showed that the small countries (Sri Lanka, Nepal) had the maximum RSI values in Social Sciences General over the period under study (Sri Lanka – 0.920 and Nepal – 0.878), whereas the minimal positive RSI values were calculated for Pakistan (0.361) and India (0.483).

Chinchilla-Rodrigues, Ocaña-Rosa and Vargas-Quesada (2016) calculated AI for 33 countries in Nanoscience and Nanotechnology (NST), showing them on the radial diagram, along the circumference of which AI values are placed at equal distances for the period from 2003 to 2013. Those calculations showed that Asian countries – Singapore, South Korea, Taiwan, Hong Kong, Japan, China, and India, as well as European countries – Germany, Switzerland, Ireland, and France had AI>1. Over the period under study, Brazil, Mexico, Japan, and Greece had their AIs decreasing, whereas Iran, Australia, and India most increased their scientific specialization in the NST. A more comprehensive analysis of the distribution of disciplinary specialization (27 research fields) by country (45 countries, 1996-2015) based on AI and RSI was conducted by N. Li (2017), which, based on quite complicated statistical models, resulted in certain patterns of structural changes in the world's disciplinary profiles and the evolutionary patterns of research profiles in individual countries (G7 and BRICS countries).

Zacca-Gonzalez, Chinchilla-Rodriguez and Vargas-Quesada (2018) studied structural dynamics of publishing activity in the medical subject categories in Latin American countries in the period of 2003-2013 and showed that 80% of total publication output accounted for Brazil, Mexico and Argentina, with the most productive topics being associated with Public Health, Infections Diseases, Surgery, Neurology, Cardiology, and Cardiovascular Medicine. They further constructed the graphs for the volume of publications (size of sphere) of the 10 most prolific subject categories in the field of Medicine in 10 Latin American countries, using as axes of coordinates RSI and NCI (Normalized Citation Impact, which is the same as Attractivity Index). Scopus and SJR databases were used in the analysis.

Gupta and Dhawan (2019) calculated Activity Index values for Indian publications for 9 broad subject areas for the periods 2006-2011 and 2012–2017. For the latter time interval, this index was above 1 in the following broad subject areas: Engineering; Medicine; Pharmacology, Toxicology, and Pharmaceutics; Physics and Astronomy; and Decision science. Moreover, in these broad subject areas in the previous time interval, the values of this index were approximately two times lower (AI < 1). A very interesting matrix approach has been proposed by Iranian researchers Janavi, Mansourzadeh and Eshtehardi (2020), in which for c, an arbitrary number of countries, and d, an arbitrary number of Scientific Domains, the following matrix was proposed:

$$M_{cd} = 1, \text{ if } RCA > 1 \text{ or } 0 \text{ otherwise}$$

This is in fact a binary matrix, although the authors of that research do not use this term. Further, they sum up the elements of this matrix by row, labelling the resulting amount as Divc (Diversity of Country), as well as by column, labelling the resulting amount Ubiq (Ubiquity in Domain), for which they should rather have used the term Diversity of Domain. Using binary matrix operations, they calculate various specific indicators, most of which are borrowed from the economic research areas: subject area proximity, distance between scientific domains, fitness of country, complexity of scientific domain, opportunity value, and opportunity gain. This analytical toolkit was tested on the data from 2015 SJR Database (50 countries, 300 scientific domains). The binary matrix calculation showed that out of 300 scientific domains, Iran has RCA>1 in only 107 domains. This analytical toolkit was shown to allow building scientific diversification strategy of countries (Janavi, Mansourzadeh & Eshtehardi, 2020). However, it was supplemented by the procedure of binary matrix clustering (Moskovkin et al., 2019).

Elango, Oh and Rajendran (2021), basing on the SJR database (1998, 2008, 2018), calculated AI values for 27 subject areas, using the cases of India and South Korea. From the calculations made in that study, it can be seen that both countries give the equal effort in the areas of Chemistry, Chemical Engineering, Energy, Materials Science, Pharmacology, and Physics & Astronomy (AI > 1). But there are some differences across disciplines, for instance, India concentrates in Computer Science, Decision Sciences, Dentistry, Engineering and Mathematics, whereas South Korea concentrates in Biological Sciences, Health Professionals, Medicine and Nursing.

The methodology used in the previous work was further developed for the top 24 countries (10% of all countries in the world) (Elango and Oh 2022). As for calculating AI, a qualitative matrix of dimension (24x27) was constructed, in which horizontal arrows showed an increase or decrease in the number of publications over the interval 1998-2018, and vertical arrows showed the conditions when AI was above 1 in all those three years (1998, 2008, 2018). Besides the paper we reviewed earlier (Janavi et al., 2020), a matrix approach for presenting calculations of AI values for countries and subject areas was proposed by Guevara, Hartmann and Mendoza (2016), who constructed pheamaps for matrices with color gradations in the matrix cells, presenting the values of an RCA matrix in which values below 1 were represented by empty cells. When taking a closer look at the affiliation of the authors of the 14 articles reviewed above in chronological order, one can see that most of them are from Asia, Africa, and Latin America. This also proves our hypothesis that scientists primarily from these countries use the free SJR database in scientometric calculations. However, this hypothesis will be explored more fully later in this paper.

Research Questions

The literature review enabled us to formulate the following research questions in the context of country comparisons of publishing activity by using the SJR database:

- RQ1. Which economic indicator should be considered the first prototype of the Activity Index in scientometrics and who is its author?
- RQ2. Are there established concepts of Activity Index in other fields of knowledge besides scientometrics, and if so, how should its name be transformed in this field?
- RQ3. Since when and on the basis of what database have scientists from developing countries begun to intensively make country comparisons based on relative indices of publication activity and citations?
- RQ4. How can interdisciplinary research be quantified for different countries?
- RQ5. How can a country's publishing activity be detected by means of the Activity Index and its trend?
- RQ6. How can a binary matrix be built from the Activity Index matrix of arbitrary dimension n×m, where n is the number of countries and m is the number of subject categories and how can this binary matrix be clusterized to isolate a dense submatrix.

Materials and Methods

To substantiate the incorrectness of the term Activity Index in scientometrics, experiments were conducted in the advanced search of Google Books (from 1900 onwards) and in the advanced search of Google Scholar (from 1930 onwards) to show that this term has been used in various fields of knowledge, but with indicating its specialization. The experiments were carried out on October 1, 2023.

The equivalence of mathematical formulas for calculating indices proposed in the economic papers by B. Balassa (1965) and W. Izard (1960) is shown, which substantiates the statement that the localization coefficient introduced by W. Izard should be considered as a prototype of the scientometric Activity Index (Frame 1977), rather than RCA introduced by Balassa.

To prove the statement that after the launch of the public SJR database in 2007, calculations of Activity Index values for country comparisons have become more active, conducted mainly by researchers from developing countries, we did some experiments in an advanced search in

Google Scholar (October 13, 2023) with simultaneous occurrence of the terms "Activity Index" and "Scimago" in search results.

Using the Scimago Journal and Country Rank platform, the numbers of documents (D_i) were obtained in a ranked order for all 240 countries and territories of the world for the whole-time interval (1996-2019). The data were downloaded from this platform in October 2020. For each country, the numbers of documents on all subject categories (D_{SC_i}) and subject areas (D_{SA_i}), were calculated, where i is the number of the country,

It came to our attention that

$$D_{SC_i} > D_{SA_i} > D_i . (1)$$

This inequality is due to the fact that the same article can be distributed to different subject categories and subject areas. As the number of subject categories (311) exceeds the number of subject areas (27), it is obvious that the (probability of occurrence) of the total number of articles in a country on subject categories is greater than on subject areas, which results in inequality (1).

This circumstance makes it possible to introduce a coefficient of interdisciplinary publications on subject categories and subject areas for countries of the world in the following way:

$$K_{SC_i} = \frac{D_{SC_i}}{D_i}, K_{SA_i} = \frac{D_{SA_i}}{D_i} . (2)$$

At the same time, as the inequality (1) holds true, then $K_{SC_i} > K_{SA_i} > 1$.

The main part of the article includes the calculations by means of the formulas (2), and using the Microsoft Office Excel tools, a linear regression equation was developed between the two coefficients of interdisciplinarity (K_{SC_i} and K_{SA_i}) on the entire set of countries (n=240).

These coefficients are integral indicators of the distribution of publications in different subject and area categories. They are specific, as they are valid only for the SJR database at the country level, while it is not known how the algorithm of this database automatically distributes publications into the categories in question. A quantitative analysis of the total publication activity for all the countries of the world for the period of 1996-2019 allowed distributing the total number of publications

$$D = \sum_{i=1}^{240} D_i,$$

by subject categories in a ranked order. Taking the first 20 subject categories and the first 20 countries by the documents indicator, the matrix (Dij) was built, where $1 \le i, j \le 20$, Dij is the number of documents for an i-th country in a j-th subject category. A similar matrix (Cij) was built for the Citation per Document indicator.

In Introduction, the Activity Index was described in detail, being similar to the economic indices (1, 2). This index shows a degree of publication specialization in each subject area in a country, compared with the average world level. If this index is in some country for some subject category is above 1, this suggests that research in this country, and, consequently, the publication activity in this particular subject category is more intensive than in the world as a whole.

This coefficient can be represented in the following way:

$$AI_{ij} = \frac{\left(\frac{D_{ij}}{D_i}\right)}{\left(\frac{D_{wj}}{D_w}\right)}, (3)$$

where Dij – see above, Di – total number of Documents for an i-th country, Dwj – total number of Documents in a j-th Subject Category in the world, Dw – total number of Documents in the world. After that, the Average Growth Rate for Documents over the past three years was calculated by using the formula:

$$\Delta D_{ij}^{ave} = \frac{1}{3}\left[\frac{D_{ij}^{(1)} - D_{ij}^{(0)}}{D_{ij}^{(0)}} + \frac{D_{ij}^{(2)} - D_{ij}^{(1)}}{D_{ij}^{(1)}} + \frac{D_{ij}^{(3)} - D_{ij}^{(2)}}{D_{ij}^{(2)}}\right] = \frac{1}{3}\left[\frac{D_{ij}^{(1)}}{D_{ij}^{(0)}} + \frac{D_{ij}^{(2)}}{D_{ij}^{(1)}} + \frac{D_{ij}^{(3)}}{D_{ij}^{(2)}}\right] - 1, (4)$$

where superscripted (0) next to Dij is the number of Documents in 2016, (1) – in 2017, (2) – in 2018, and (3) – in 2019.

Formulas (3, 4) make it possible to build Trend Diagnostic Chart in the coordinates of AI and ΔD^{ave} in order to identify the leaders and outsiders, as well as catch-up countries and countries losing their publication potential (Fig. 1). The coordinates of these countries are distributed among the four sectors. A very similar methodology was used by the experts of the European Commission at the beginning of the XXI century to build Trend Chart in European Innovation Scoreboard.

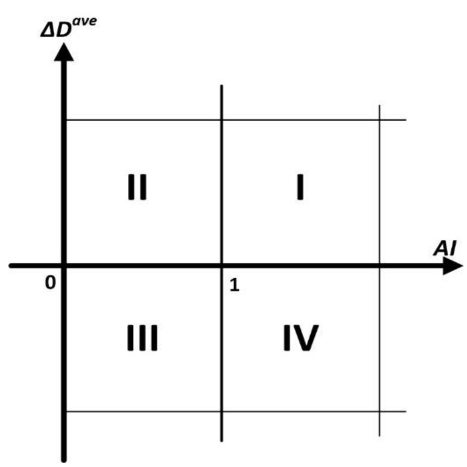

Figure 1. Trend Diagnostic Chart for Country Publication Activity.

I – Country-leaders, II – Catch-up countries, III – Lagging countries, IV – Countries losing publication potential.

Such trend diagnostic charts were built for the 20 first subject categories as of 2019. But the first 20 countries and the first 20 subject categories were selected for 2019, rather than throughout the Documents array for the period of 1996-2019, as before. Except for one case described in Results and Discussion, the other 19 chart can be found in Appendix A.

If in formula (3) Dij is replaced with Cij, then the Attractivity Index will be obtained, which is calculated for 2017-2019 for the first twenty countries and subject categories, isolated for the period of 1996-2019 (Appendix B). The Cij is the Citations per Document indicator for an i-th country and a j-th subject category.

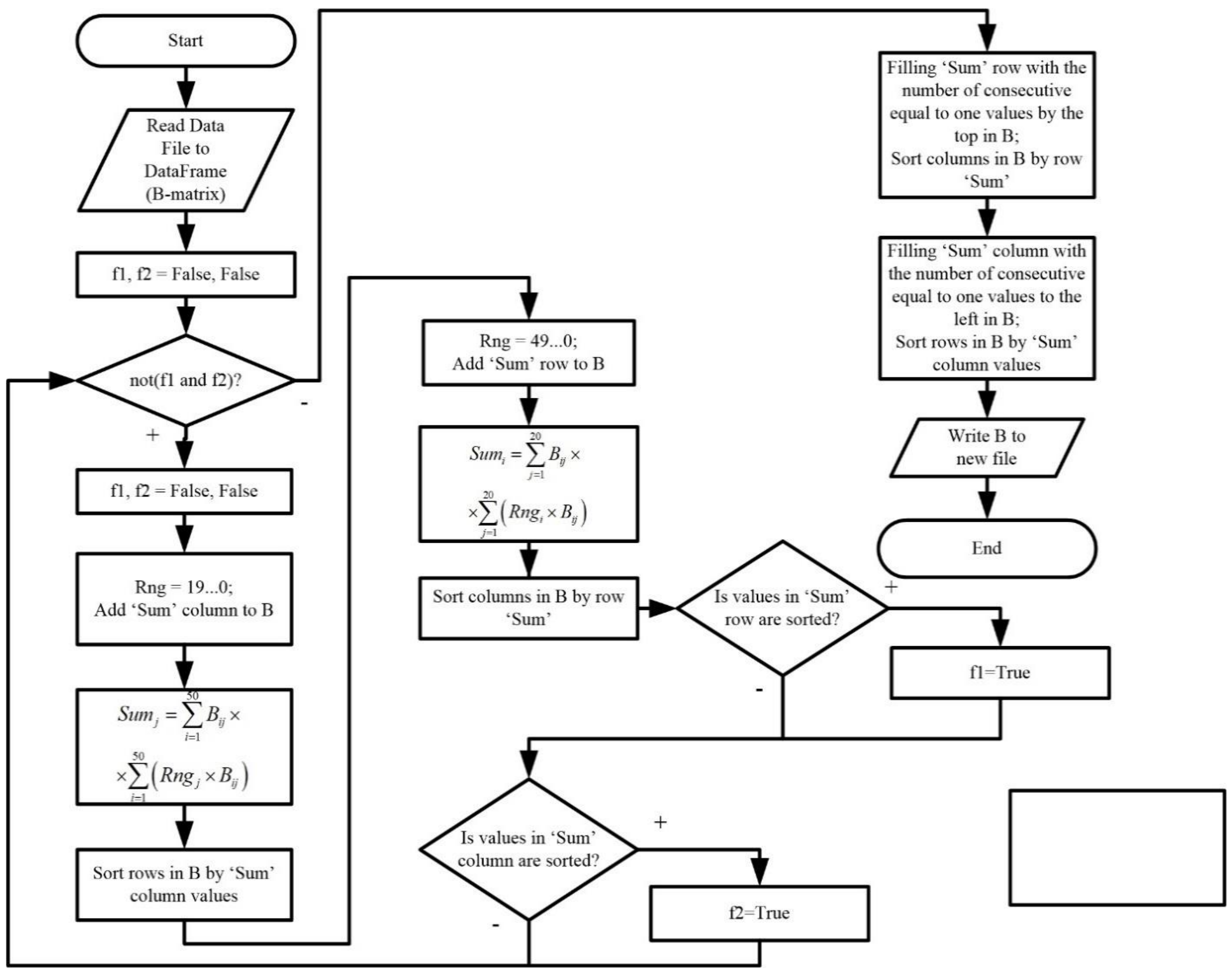

Figure 2. Clustering algorithm of a binary matrix Bij.

Basing on the matrix (AIij) by using the Bij = 1 for AIij >1; Bij = 0 for AI≤1, a binary matrix (Bij) was built, and by means of one of the variants of the clustering algorithm for a binary matrix that we designed (Fig. 2), an original sparse binary matrix was consolidated, which makes it possible to visualize compact country and subject areas with competitive advantages in respect of scientific specialization of countries. The idea of this algorithm was in sorting rows and columns in non-ascending order first by the values of the Sum column, and then by the values of the Sum row. The values of the Sum column/row are calculated by applying the following formula:

$$Sum_i = \sum_{i=1}^{n} B_{ij} \times \sum_{i=1}^{n}\left(Rng_i \times B_{ij}\right), \quad (5)$$

where the vector (Rng) is a sequence of numbers n…0 for columns (subject category) and rows (country), respectively. Following this sorting (5), in the upper left corner of the binary matrix (Bij), there is the maximal number of unities, but in a sparse manner. The final stage of the algorithm made it possible to arrange the rows and columns by the number of consecutive unities on the left and at the top in such a way as to obtain a binary matrix in the upper left corner, fully filled with units (triangular matrix). A similar algorithm was used to group the values at the bottom right part of the binary matrix (Bij).

Results and Discussion

The results of our research will be presented below in the logic described in the Introduction. First, using experiments in Google Scholar and Google Books (October 1, 2023), we will show that the term Activity Index was proposed in various fields of knowledge and practice way earlier than the scientometric index with the same name. Obviously, the formulas for calculating such indices are different, and their structure is far from the Activity Index used in scientometrics. So we have a purely linguistic issue here, which will show the invidiousness of the term used in scientometrics.

Through using Google Books search, we discovered the first mentions of the Business Activity Index, e.g. a reference to this index in the 1916 Annual Report of the Federal Reserve Bank of San Francisco. Within the next 20–30 years, such references to this index could be seen in the reports of the Federal Reserve Bank of New York (Boston, et al), as well as reports of the Scandinavian Bank, where the Business Activity Index was expressed as percentage deviation from calculated long-time trend.

In the early 1930s, The Economist began publishing its Business Activity Index (Crowther 1934; Rhodes 1937). In this regard, Rhodes (1937) writes: “Since October 1933, The Economist has reduced this mass of data to a still more digestible form; a pill in the shape of an “Index of Business Activity” is now on the market.” Around the same time, The Economist began publishing the Building Activity Index.

To control the political activity of American citizens, Woodward and Roper (1950) proposed the Political Activity Index. But the greatest variety of Activity Indices can be seen in the Natural Sciences, especially in Medicine. Geomagnetic Activity Index (K-index) was first introduced in

Bartels, Heck, and Johnston (1939). Later, various versions of the Solar Activity Index were introduced developed (Minnis 1955; Bray 1970). To monitor the sulfide activity of sewer slimes, the Sulfide Activity Index was proposed by Beardsley (1949). Park (1941) proposed the Activity Index for quantitative determinations of rhythmicity in organisms, and is further divided into Arhythmical and Rhythmical Activity Indices. In rheumatology, the Clinical Activity Index was proposed by Shetlar et al (1956) and further developed by Jonsson et al (1964). The Crohn's Disease Activity Index (CDAI) was developed by Best et al (1976) in gastroenterology. Another type of Clinical Activity Index (Score) in gastroenterology was proposed by Powell-Tuck, Bown and Lennard-Jones (1978), which was further developed into the Simple Clinical Colitis Activity Index by Walmsley et al (1998).

Thus, it is clear that all the above Activity Indices have their own specialization, which suggests that the Activity Index term should be used in the scientometrics, along with its root terms – "Publication" and "Citation". That is, the Activity Index should be called the Publication Activity Index, and the Attractivity Index should be called the Citation Activity Index.

We will now show that the index obtained by Balassa (1965) is absolutely the same index (localization coefficient), which was proposed by W. Izard six years earlier in his classic work Methods of Regional Analyses (1960):

$$L_{ij} = \frac{\frac{l_{ij}}{\sum_i l_{ij}}}{\frac{\sum_j l_{ij}}{\sum_i \sum_j l_{ij}}},(6)$$

where lij is employment in an i-th industry and a j-th region.

If Lij = 1, the region has the same proportion of its labour force in an i-th industry as has the nation as a whole. If in formula (6) we replace Lij with Nij, where Nij is the number of scientific publications in an i-th subject scientific area for a j-th country, then we will arrive at the definition of the Activity Index proposed by Frame (1977). Balassa (1965) proposed to calculate RCA in the following way:

$$RCA_{ij} = \frac{\frac{x_{ij}}{\sum_i x_{ij}}}{\frac{\sum_j x_{ij}}{\sum_i \sum_j x_{ij}}},(7)$$

where Xij is export of a j-th product and an i-th country.

If in formula (7) we replace Xij with Nij, changing i (Country) and j (Subject Scientific Area) at the same time, then a little manipulation will result in the definition of AI. Therefore, formulas (6) and (7) are of a similar nature and, when replacing variables, are reduced to AI in the scientometric definition given by Frame (1977).

Now we will show that after the launch of the SJR database in 2007, it began to be actively used by researchers from developing countries, which had not been observed earlier, with the costly Web of Science database dominating. The experiments on searching for journal articles by year (conducted in the Google Scholar advanced search on October 13, 2023), in which the terms Activity Index and Scimago appeared together in the period 2008–2022, provided the following results. The total number of responses in the form of journal articles was 323, of which the number of scientometric articles in which both terms were used was 73 or 22.6% of the total number of publications. At the same time, the largest number of scientometric journal articles – 14 out of 52 – was observed in 2022.

The distribution of scientometric journal articles according to the affiliation of authors to different countries was as follows: India – 26, Spain – 8, Iran – 4, Brazil – 2, Colombia – 2, Saudi Arabia – 2, USA – 2, Russia – 2, China – 1, Pakistan – 1, Uruguay – 1, South Africa – 1, Italy – 1, Croatia – 1, Canada – 1, Cuba+Spain – 4, Argentina+Spain – 3, Netherlands+Spain – 2, Mexico+Spain – 1, Uruguay+Kazakhstan – 1, Chile+Germany – 1, China+Pakistan – 1, South Africa+India – 1, South Korea+India – 1, Chile+Germany+USA – 1, Spain+Italy+Ukraine – 1, China+India+Bangladesh – 1.

The number of articles written exclusively by scientists from developed countries was 15 (20.6% of the total number of articles analyzed). At the same time, the large number of articles written by Spanish authors, including the articles they co-authored primarily with Latin American researchers, is due to the fact that the SJR database is a Spanish information and analytical product. Thus, we can assume that our hypothesis about the predominance of publications on using the SJR database in calculating AI by researchers from developing countries is true. We also noticed that when calculating this index using Web of Science before 2007, the prevailing publications were by researchers from developed countries, with a small share of articles by Indian and Chinese authors.

The distribution we obtained through our experiments provided 18 internationally co-authored publications, thus the coefficient of international co-authorship for our sample of articles is 18/73 = 0.25 (25%). As for the remaining 250 journal articles (323–73 = 250), most of them were on medical issues, with the calculation of the Clinical Activity Index, Disease Activity Index, Histological Activity Index, etc., which were mentioned earlier. At the same time, the term Scimago was not found in these publications. The fact is that the Google Scholar algorithm is designed in such a way that if it does not encounter two terms in publications simultaneously, then it begins to render responses with only one term.

Let us now move on to concrete calculations based on the SJR database followed by formulation of new tasks that have not been solved by researchers yet.

Table 1. The Country Values of the Interdisciplinary Coefficients Calculated for the Period of 1996-2019

No.	Country	No. of Documents	Total Documents in all Subject Categories	KSC	Total Documents in all Subject Areas	KSA
1	United States	12,839,607	29,592,833	2.30	20,936,687	1.63
2	China	6,589,695	16,648,278	2.53	12,156,056	1.84
3	United Kingdom	3,715,590	8,180,572	2.20	5,869,026	1.58
4	Germany	3,222,549	7,521,017	2.33	5,459,025	1.69
5	Japan	2,893,614	7,110,917	2.46	5,049,066	1.74
6	France	2,249,498	5,334,047	2.37	3,847,228	1.71
7	Italy	1,881,818	4,427,945	2.35	3,128,899	1.66
8	Canada	1,877,183	4,365,886	2.33	3,092,620	1.65
9	India	1,873,277	4,578,386	2.44	3,302,689	1.76
10	Australia	1,489,730	3,394,830	2.28	2,423,747	1.63
11	Spain	1,483,214	3,494,572	2.36	2,520,077	1.70
12	Russian	1,202,476	2,740,493	2.28	2,094,598	1.74
13	South Korea	1,196,961	3,104,504	2.59	2,237,137	1.87
14	Netherlands	1,038,372	2,415,186	2.33	1,742,645	1.68
15	Brazil	1,027,748	2,340,563	2.28	1,688,366	1.64
16	Switzerland	764,195	1,756,231	2.30	1,268,117	1.66
17	Poland	710,420	1,668,076	2.35	1,237,147	1.74
18	Sweden	704,081	1,666,652	2.37	1,185,986	1.68
19	Taiwan	698,107	1,796,408	2.57	1,275,260	1.83
20	Turkey	639,659	1,467,945	2.29	1,009,630	1.58
21	Iran	581,253	1,442,504	2.48	1,038,705	1.79
22	Belgium	569,812	1,350,138	2.37	969,243	1.70
23	Denmark	425,897	988,254	2.32	705,953	1.66
24	Austria	418,008	975,963	2.33	693,648	1.66
25	Israel	402,878	943,481	2.34	670,780	1.66
26	Finland	359,559	858,212	2.39	615,778	1.71
27	Czech Republic	354,644	829,239	2.34	600,202	1.69
28	Mexico	347,369	810,556	2.33	600,339	1.73
29	Norway	339,620	776,636	2.29	550,951	1.62
30	Greece	338,200	809,373	2.39	562,813	1.66
31	Hong Kong	335,459	848,131	2.53	592,869	1.77
32	Portugal	333,889	812,052	2.43	584,553	1.75
33	Malaysia	325,476	777,143	2.39	589,626	1.81
34	Singapore	317,592	806,240	2.54	573,288	1.81
35	South Africa	303,863	683,903	2.25	490,444	1.61
36	New Zealand	260,615	583,364	2.24	415,952	1.60
37	Egypt	230,156	569,499	2.47	403,495	1.75
38	Argentina	225,079	523,929	2.33	380,450	1.69
39	Ireland	222,091	503,693	2.27	366,208	1.65
40	Romania	217,898	549,222	2.52	388,890	1.78
41	Saudi Arabia	211,269	530,007	2.51	376,302	1.78
42	Ukraine	207,386	500,091	2.41	379,189	1.83
43	Hungary	205,953	476,925	2.32	343,819	1.67
44	Thailand	199,226	478,637	2.40	342,007	1.72
45	Pakistan	176,602	401,120	2.27	292,299	1.66
46	Chile	163,593	367,329	2.25	275,278	1.68
47	Indonesia	158,733	368,153	2.32	283,996	1.79
48	Slovakia	120,871	289,052	2.39	207,905	1.72
49	Colombia	114,495	261,617	2.28	193,518	1.69
50	Croatia	113,256	247,139	2.18	183,006	1.62

In Table 1, the first 50 countries are ranked in descending order of the total number of documents for 1996-2019. This Table shows the maximal values of K_{SC_i}, ranging from 2.53 to 2.59, for China, Hong Kong, Singapore, Taiwan, and South Korea, and the maximal values of K_{SA_i}, ranging from 1.81 to 1.87 – for Malaysia, Singapore, Ukraine, Taiwan, China, and South Korea, which means that interdisciplinary studies over a time period under study prevailed in Chinese-speaking countries and in South Korea.

The linear regression equation between the two interdisciplinary indices can be seen in Formula 8 and Figure 3.

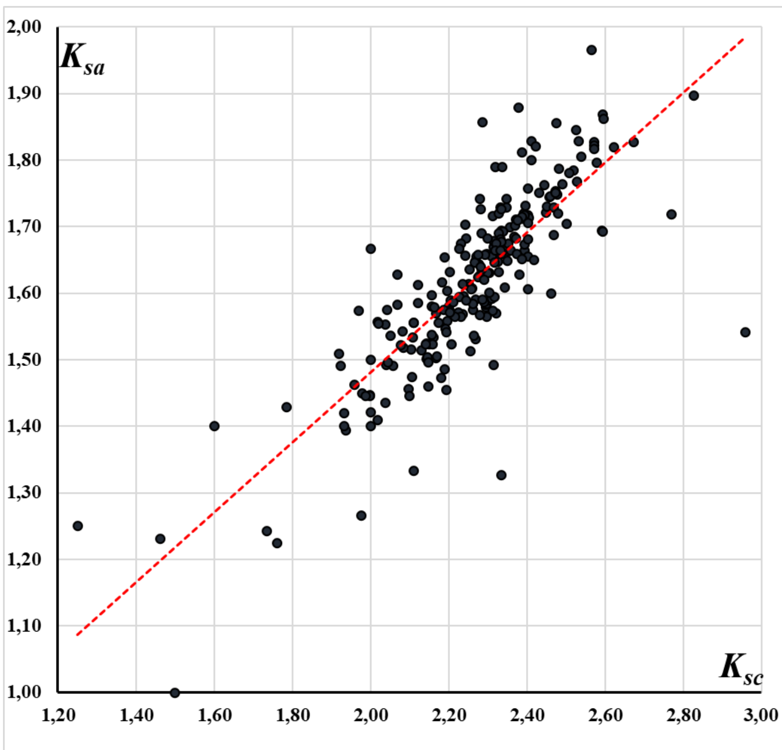

Figure 3. Linear regression equation between KSC and KSA.

$$Ksa = 0.5255 \cdot Ksc + 0.4294,\ R^2 = 0.679. \quad (8)$$

The matrices (Dij) and (Cij) 20x20 in size, built as described in Materials and Methods, are presented in Tables 2 and 3. These matrices make it possible to identify countries and their subject categories in which there are the maximal or minimal values of the elements of these matrices. For example, the maximal values of the Citation per Document indicator can be seen in Molecular Biology for Switzerland (51.96), UK (48.23), Sweden (46.63), and Netherlands (46.47).

Table 2. Matrix (Dij), 1996-2019.

Country	Medicine (miscellaneous)	Electrical and Electronic Engineering	Condensed Matter Physics	Chemistry (miscellaneous)	Electronic, Optical and Magnetic Materials	Computer Science Applications	Physics and Astronomy (miscellaneous)	Materials Science (miscellaneous)	Mechanical Engineering	Biochemistry	Engineering (miscellaneous)	Molecular Biology	Materials Chemistry	Applied Mathematics	Software	Computer Networks and Communications	Mechanics of Materials	Computer Science (miscellaneous)	Physical and Theoretical Chemistry	Atomic and Molecular Physics, and Optics
U. S.	1681732	738458	538390	344528	399177	429980	335703	316776	373433	485363	295200	502927	183654	299489	325427	235919	221282	171583	195907	202475
China	685775	772746	524425	448391	363725	410294	244881	437721	503993	220371	484539	138210	325549	274017	240561	250561	295882	188634	177642	224040
U. K.	519487	160871	132145	97656	86175	97164	101234	85194	92605	110043	71038	108589	54785	64706	71844	61306	60812	63402	52285	52505
Germany	400245	184715	224432	138045	143524	110006	153339	120895	100124	119347	72868	110774	90055	79149	70517	63118	67493	74928	91608	76710
Japan	454658	280061	254391	142675	167104	100441	164716	134694	155315	150240	108144	121813	127508	59592	66865	66096	111567	48603	76722	64323
France	260312	139470	156203	86018	99946	77142	105563	79526	70486	83095	45302	71882	62397	66510	55617	47890	53501	56573	60230	51616
Italy	264561	114411	89318	50497	55709	66191	78282	48022	54756	67944	36006	50353	33236	50688	41688	41167	35249	45161	41303	35943
Canada	249190	112621	63836	52192	44289	61725	41987	42251	49976	61027	41041	63149	28197	41979	47333	41730	29568	33730	29161	29188
India	193807	147677	122004	116287	70246	83586	77128	101430	81684	69932	79349	43414	64736	34747	45479	98316	61866	75874	57725	40534
Australia	194294	60088	43711	38863	28574	43767	28020	37460	34977	37225	25193	35719	20111	24731	33947	30739	26039	27768	18069	20037
Spain	202193	75989	66116	58766	42961	48186	51232	40323	30072	58296	26302	37681	32943	36393	35086	28855	22501	41737	42441	27555
Russian	77326	84359	145291	84375	92263	38736	131252	73581	44450	33854	52618	15254	56019	51511	13028	24511	43680	21181	53940	66331
South Korea	146365	146515	109185	83844	76959	57529	59321	87099	71879	47845	45501	40615	55876	32594	37635	40502	50951	32977	24989	31227
Netherlands	150920	43954	38046	26063	26822	29718	26732	20069	21092	31484	17133	28708	14812	18430	20800	15710	12918	22438	15991	13202
Brazil	144466	41618	46808	34483	21840	25624	33836	30259	26455	32433	16856	23486	17854	16625	22333	19097	20608	19415	16914	14011
Switzerland	119967	38188	37342	29831	27995	20105	35063	20652	16178	30712	13575	28181	12214	13181	16755	12255	10865	13580	17275	15177
Poland	97948	46732	58085	37203	31474	24384	39275	34788	25179	24837	18041	13494	24096	22807	8875	11711	18758	23650	26143	19356
Sweden	112663	36536	34287	19752	20795	19656	23477	20613	19759	27996	15348	24940	13995	11938	14891	14579	13474	10946	14295	11694
Taiwan	84156	104126	56991	33050	48693	47817	27887	30010	34604	20156	39082	15350	27566	23848	32480	30967	21258	20694	16179	23295
Turkey	119709	30204	27376	23223	14690	18031	18241	20612	19782	13976	15266	7763	16957	14394	9508	15341	14600	10063	8443	9329

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Table 3. Matrix (Cij), 1996-2019.

Country	Medicine (miscellaneous)	Electrical and Electronic Engineering	Condensed Matter Physics	Chemistry (miscellaneous)	Electronic, Optical and Magnetic Materials	Computer Science Applications	Physics and Astronomy (miscellaneous)	Materials Science (miscellaneous)	Mechanical Engineering	Biochemistry	Engineering (miscellaneous)	Molecular Biology	Materials Chemistry	Applied Mathematics	Software	Computer Networks and Communications	Mechanics of Materials	Computer Science (miscellaneous)	Physical and Theoretical Chemistry	Atomic and Molecular Physics, and Optics
U. S.	29.66	15.48	21.70	42.16	16.16	16.60	33.62	27.09	19.48	43.87	12.52	45.78	30.11	15.95	21.89	15.51	24.03	17.40	32.48	17.60
China	11.27	6.93	10.31	18.71	9.34	6.48	13.86	14.14	9.14	17.54	3.42	15.49	13.15	6.93	7.96	3.89	11.76	3.97	17.02	7.89
U. K.	28.66	13.39	21.02	35.29	17.91	15.99	27.93	23.27	19.33	41.83	13.02	48.23	27.36	15.76	17.92	9.54	22.81	10.88	27.86	17.55
Germany	25.42	10.87	18.36	32.19	16.80	12.30	28.29	20.11	16.05	38.14	11.32	42.99	22.51	12.21	14.15	8.42	19.38	10.04	26.05	15.16
Japan	16.83	7.72	13.43	27.08	13.49	7.02	19.54	15.44	10.65	31.27	8.33	34.94	19.13	7.81	8.25	4.11	12.78	5.86	23.08	11.94
France	26.75	11.58	18.06	31.47	15.55	12.32	24.77	20.43	17.79	36.06	12.00	43.40	24.63	13.18	14.83	7.24	19.97	10.01	24.54	14.52
Italy	24.76	13.54	16.59	30.43	13.98	12.49	22.32	18.46	15.76	33.73	11.67	34.96	23.54	12.15	14.43	9.03	17.46	8.70	24.20	14.09
Canada	31.35	15.04	18.80	32.52	14.34	15.85	28.00	20.78	16.23	37.76	10.12	39.27	25.98	14.94	19.76	12.49	19.55	12.39	28.16	15.69
India	14.46	6.98	12.74	14.31	12.09	6.06	11.43	12.57	11.65	17.04	3.89	16.30	17.07	8.38	8.60	3.03	12.65	3.59	17.12	10.29
Australia	27.16	15.61	20.29	30.07	17.78	14.96	25.77	24.51	18.75	36.46	11.85	40.10	26.15	14.11	16.15	9.57	20.85	9.07	26.88	18.92
Spain	21.86	12.95	18.00	31.56	16.84	13.29	25.96	21.14	17.34	31.67	12.29	34.81	22.14	11.45	13.38	7.44	17.83	6.72	23.56	15.02
Russian	10.13	4.21	8.23	7.76	7.30	3.36	10.97	6.44	6.46	14.32	4.14	21.32	7.69	3.96	3.53	1.75	5.64	3.25	9.02	7.23
South Korea	17.52	10.15	13.93	21.94	12.62	9.87	18.44	17.55	15.11	24.53	8.64	22.15	19.44	8.79	9.36	6.02	17.68	5.33	23.68	11.06
Netherlands	34.58	14.19	23.10	42.41	19.00	15.35	33.51	28.92	22.02	44.06	15.75	46.47	29.60	17.55	18.89	9.33	29.55	12.29	33.36	18.23
Brazil	15.68	8.51	11.52	14.44	11.65	8.08	15.84	10.66	9.75	20.20	7.64	19.05	16.07	9.21	8.02	4.37	10.30	5.08	16.73	9.89
Switzerland	31.66	17.78	23.43	40.64	20.06	19.36	34.17	29.14	23.70	44.62	19.31	51.96	31.38	17.16	24.57	13.70	26.94	15.26	31.70	19.51
Poland	14.14	5.98	9.80	13.34	9.07	7.55	16.65	9.23	9.09	18.79	7.63	20.70	13.55	6.61	10.46	4.59	9.49	5.20	15.79	10.22
Sweden	30.50	15.69	19.37	33.52	18.12	18.70	26.55	20.92	17.99	41.38	11.70	46.63	25.60	15.22	14.26	8.72	19.96	9.69	28.03	14.89
Taiwan	17.72	10.40	13.75	22.23	10.85	11.52	19.57	17.68	13.95	24.85	8.43	24.24	20.03	10.15	11.28	5.92	16.63	8.24	20.84	10.04
Turkey	11.06	10.75	13.35	14.92	11.59	12.78	12.32	13.58	15.13	19.96	10.29	16.63	15.27	10.81	14.49	4.03	13.72	8.37	15.79	11.75

Table 4 shows the values of the AI calculated by formula (3) as of the year of 2019, with countries and subject categories being ranked basing on the SJR Database for the same year. It is worth mentioning that despite the different years of comparison and different categorization of scientific fields, our calculations were consistent with similar calculations carried out in (Elango, Oh 2022; Guevara, Hartmann, Mendoza 2016; Gupta, Dhawan 2019).

Formula (4) was used to calculate the ΔD^{ave} indicator for the same countries and subject categories, which are shown in Table 5.

Based on Tables 4 and 5, a Trend Diagnostic Chart for Condensed Matter Physics (Fig. 4) was built. This chart shows that for this subject category, the leading countries from Sector 1 of this diagram (Fig. 1) are India, China, Iran, and Russia (Fig. 4). The Trend Diagnostic Charts for the other 19 subject categories can be found in Appendix A.

Using all the 20 charts, we selected all the leading countries with vectors (AI, ΔD^{ave}), which are included in Sector 1 of these charts (Table 6). Their analysis shows that the obvious leaders are China and India, which were included in this sector, 18 and 17 times out of 20, respectively.

Table 7 shows an example of building an Attractivity Index (AAI) matrix for 2017, when countries and subject category were ranked by the Documents indicator for 1996-2019. From the Table, as can see that Australia, USA, UK, China, and India have 19, 18, 17, and 16 AAI values, respectively, exceeding 1. A similar matrix built for 2018 included a much smaller number of elements for which AAI > 1, and in the matrix for 2019, there were no elements with AAI > 1 at all, since the publications by the countries of the world could not gain a reasonable number of citations over such a short period of time (Appendix B). Table 7 also shows that the maximal values of the Citation per Document indicator are recorded in Chemical, Physical and Biomedical sciences, with Switzerland, Netherlands, Sweden, and Australia being the leading countries.

The binary matrix (size 50x20) for the matrix (Aij) for 2019 is represented in Table 8. Using the clustering algorithm we had developed (Fig. 2) made it possible to isolate from it a large dense triangular matrix (Table 9) in the upper left corner. For further clustering, in the lower right corner of the binary matrix, the class interval was limited to the last five columns, starting with the Biochemistry subject category, and the last 33 lines, starting with Czech Republic, so that the re-sorting did not affect the data that had been grouped at the first stage of applying the algorithm.

The other mosaic (segmented) blocks are located more or less densely, which makes it easy to visualize the countries with the maximum and minimal numbers of competitive subject categories. For instance, one can see that China and South Korea have the maximal number of such categories (18 categories each), and with clustering, these countries take the first two places.

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Table 4. Matrix (AIij), 2019.

Country	Medicine (miscellaneous)	Electrical and Electronic Engineering	Materials Science (miscellaneous)	Computer Science Applications	Chemistry (miscellaneous)	Condensed Matter Physics	Computer Networks and Communications	Mechanical Engineering	Physics and Astronomy (miscellaneous)	Electronic, Optical and Magnetic Materials	Engineering (miscellaneous)	Computer Science (miscellaneous)	Biochemistry	Software	Energy Engineering and Power Technology	Mechanics of Materials	Molecular Biology	Artificial Intelligence	Materials Chemistry	Control and Systems Engineering
China	0.94	1.57	1.82	1.33	1.66	1.58	1.29	1.86	0.98	1.55	1.48	1.10	1.43	1.31	1.69	1.60	1.14	1.37	1.95	1.82
U. S.	1.11	0.65	0.58	0.82	0.71	0.66	0.71	0.68	0.65	0.76	0.43	0.49	0.97	1.03	0.59	0.62	1.24	0.72	0.56	0.66
U. K.	1.15	0.60	0.59	0.73	0.68	0.61	0.69	0.70	0.72	0.61	0.53	0.67	0.75	0.86	0.66	0.62	0.92	0.71	0.47	0.59
India	0.58	1.77	1.13	1.69	1.13	1.33	1.77	1.28	1.11	1.29	2.89	2.98	0.93	1.11	1.00	2.56	0.70	1.65	1.30	1.48
Germany	0.99	0.79	0.82	0.92	1.06	1.08	0.84	0.81	1.11	1.16	0.53	0.81	0.99	1.00	0.69	0.79	1.21	0.70	0.84	0.80
Japan	1.30	1.24	0.90	1.05	1.13	1.40	1.04	1.11	1.26	1.47	0.83	0.79	1.30	0.95	0.76	1.05	1.35	1.33	1.40	0.76
Italy	1.13	0.81	0.69	0.96	0.65	0.69	0.84	0.89	0.89	0.64	0.52	0.99	0.98	0.84	0.88	0.78	1.01	0.71	0.48	0.91
France	0.93	0.82	0.77	0.87	0.95	1.08	0.86	0.85	1.05	1.08	0.50	0.92	0.87	1.03	0.60	0.87	1.05	0.72	0.88	0.88
Canada	1.15	0.73	0.57	0.77	0.67	0.57	0.75	0.71	0.53	0.59	0.52	0.63	0.84	0.91	0.78	0.64	1.04	0.72	0.56	0.73
Russian	0.44	1.02	1.62	0.86	1.05	1.75	0.97	0.98	3.19	1.72	1.72	1.27	0.66	0.47	1.32	1.22	0.47	0.60	1.27	1.05
Australia	1.15	0.56	0.73	0.75	0.73	0.57	0.70	0.66	0.50	0.51	0.48	0.65	0.73	0.91	0.72	0.73	0.84	0.78	0.53	0.67
Spain	1.03	0.69	0.74	0.78	0.91	0.68	0.71	0.55	0.76	0.61	0.58	0.95	1.07	0.87	0.84	0.50	0.87	0.68	0.68	0.70
South Korea	1.09	1.56	1.68	1.19	1.48	1.37	1.07	1.33	0.92	1.42	1.14	0.92	1.33	1.01	1.30	1.41	1.26	1.03	1.60	1.18
Brazil	1.10	0.60	0.59	0.68	0.77	0.72	0.70	0.63	0.65	0.50	0.40	0.75	1.03	0.97	0.85	0.72	0.92	0.92	0.71	0.67
Iran	1.02	1.18	0.95	0.81	1.33	1.55	0.63	1.63	0.83	1.25	0.85	0.54	1.30	0.87	1.50	1.67	1.08	0.87	1.91	0.88
Netherlands	1.16	0.48	0.44	0.66	0.65	0.53	0.51	0.49	0.62	0.55	0.38	0.69	0.78	0.77	0.55	0.42	0.88	0.58	0.40	0.53
Poland	1.02	0.92	1.32	0.91	1.15	1.43	0.54	1.07	1.13	1.08	1.19	1.31	1.16	0.50	0.82	1.05	0.97	0.80	1.22	1.32
Turkey	1.24	0.87	0.70	0.92	0.80	0.93	1.07	0.92	0.86	0.94	0.74	0.68	0.83	0.68	1.28	0.93	0.66	1.41	1.26	0.58
Switzerland	1.27	0.60	0.62	0.69	0.97	0.74	0.50	0.55	1.17	0.89	0.39	0.51	0.91	0.85	0.55	0.52	1.10	0.60	0.50	0.49
Sweden	1.17	0.65	0.65	0.73	0.78	0.74	0.75	0.68	0.82	0.70	0.51	0.62	0.93	0.91	0.79	0.64	1.13	0.53	0.67	0.76

Table 5. Average Growth Rate for Documents Over 3 Years (2017-2019), %.

Country	Medicine (miscellaneous)	Electrical and Electronic Engineering	Materials Science (miscellaneous)	Computer Science Applications	Chemistry (miscellaneous)	Condensed Matter Physics	Computer Networks and Communications	Mechanical Engineering	Physics and Astronomy (miscellaneous)	Electronic, Optical and Magnetic Materials	Engineering (miscellaneous)	Computer Science (miscellaneous)	Biochemistry	Software	Energy Engineering and Power Technology	Mechanics of Materials	Molecular Biology	Artificial Intelligence	Materials Chemistry	Control and Systems Engineering
China	10.22%	8.66%	21.53%	11.01%	10.34%	8.28%	17.78%	8.74%	20.07%	12.36%	23.01%	26.57%	17.10%	12.88%	18.14%	7.02%	15.55%	28.54%	12.82%	15.30%
U. S.	1.78%	-3.74%	6.05%	-0.11%	3.60%	-2.40%	-2.63%	1.14%	3.17%	2.72%	1.99%	6.37%	1.72%	2.55%	1.73%	4.47%	1.70%	6.46%	3.68%	-0.02%
U. K.	2.50%	-0.26%	9.15%	0.71%	3.91%	-1.71%	1.11%	3.90%	3.20%	3.84%	10.04%	5.77%	0.69%	1.98%	11.44%	2.17%	2.46%	4.20%	3.29%	-1.88%
India	-1.83%	22.67%	17.51%	30.19%	1.73%	10.13%	13.73%	14.31%	14.58%	9.70%	57.88%	39.88%	3.72%	12.63%	14.35%	51.99%	6.11%	25.49%	10.33%	8.14%
Germany	1.86%	-0.77%	6.17%	0.07%	1.47%	-2.31%	2.20%	2.14%	0.03%	3.65%	0.18%	2.80%	2.16%	1.06%	7.34%	1.46%	5.61%	2.57%	-0.49%	-5.99%
Japan	2.06%	0.10%	2.68%	2.96%	0.49%	-0.39%	-2.93%	1.31%	-1.21%	6.83%	1.29%	4.71%	-0.39%	-4.46%	-1.94%	-2.30%	3.07%	8.39%	2.08%	-4.08%
Italy	3.53%	2.57%	11.77%	4.82%	5.33%	-3.11%	3.66%	6.24%	0.93%	0.94%	4.20%	9.64%	5.66%	0.00%	14.90%	2.01%	11.34%	1.90%	1.46%	6.35%
France	0.66%	-3.74%	3.28%	-3.21%	0.61%	-6.00%	-3.78%	0.39%	-1.93%	1.37%	0.20%	2.16%	-0.09%	-3.61%	5.94%	-2.09%	4.11%	-2.38%	0.03%	-4.37%
Canada	4.62%	-1.86%	11.01%	-0.52%	4.74%	-1.65%	0.03%	1.94%	5.35%	2.21%	8.24%	6.65%	3.35%	-0.57%	5.84%	1.22%	2.36%	5.94%	3.83%	0.33%
Russian	10.89%	18.05%	15.70%	12.80%	3.16%	3.75%	16.73%	10.69%	16.32%	13.44%	7.28%	24.24%	4.71%	13.10%	31.86%	4.56%	14.66%	44.66%	7.18%	19.96%
Australia	6.48%	5.53%	13.17%	7.31%	7.04%	5.77%	5.73%	3.87%	8.07%	6.32%	16.14%	11.33%	5.04%	4.76%	12.04%	5.03%	5.36%	8.56%	5.91%	4.93%
Spain	3.72%	1.56%	12.23%	2.31%	3.49%	-2.32%	1.53%	-0.62%	0.40%	-1.56%	8.41%	7.81%	5.37%	-0.80%	15.63%	-6.51%	5.37%	-2.03%	3.07%	-0.53%
South Korea	3.10%	4.60%	6.05%	8.06%	-2.11%	-2.89%	5.47%	3.97%	3.15%	1.11%	15.08%	16.82%	5.80%	-0.64%	16.47%	6.54%	4.92%	10.70%	5.95%	7.33%
Brazil	5.27%	5.73%	8.08%	6.61%	10.28%	2.42%	3.51%	5.12%	1.55%	5.06%	2.30%	6.67%	11.80%	11.63%	23.18%	6.59%	6.65%	21.62%	13.15%	4.72%
Iran	7.66%	7.50%	3.69%	4.40%	-0.53%	4.30%	5.13%	6.82%	5.54%	8.60%	3.64%	4.52%	13.84%	15.39%	15.36%	6.81%	30.58%	17.63%	13.24%	6.22%
Netherlands	2.02%	-1.43%	8.59%	-1.33%	5.11%	-6.11%	-4.08%	4.62%	2.60%	-1.69%	9.40%	5.41%	2.02%	1.64%	11.67%	0.94%	2.29%	2.87%	2.70%	-1.10%
Poland	3.91%	4.48%	12.50%	1.57%	4.50%	-0.07%	-13.50 %	8.20%	-0.37%	4.03%	19.44%	0.25%	5.58%	-7.04%	31.72%	0.81%	16.52%	8.22%	4.16%	1.81%
Turkey	-3.08%	11.68%	3.92%	15.71%	8.55%	3.85%	28.28%	8.10%	2.30%	14.23%	4.72%	7.10%	8.46%	10.93%	32.47%	3.37%	13.31%	46.98%	8.56%	-11.08%
Switzerland	4.36%	-2.30%	6.87%	-0.05%	4.25%	-5.21%	-7.43%	2.53%	4.81%	-0.24%	2.79%	0.49%	1.59%	-0.62%	12.93%	0.81%	2.29%	3.17%	-0.36%	-5.87%
Sweden	2.12%	-1.91%	8.33%	-1.04%	8.03%	-2.03%	-3.11%	-3.11%	4.30%	3.40%	6.23%	4.46%	4.93%	-0.05%	8.16%	-4.38%	6.30%	-0.12%	2.88%	-3.41%

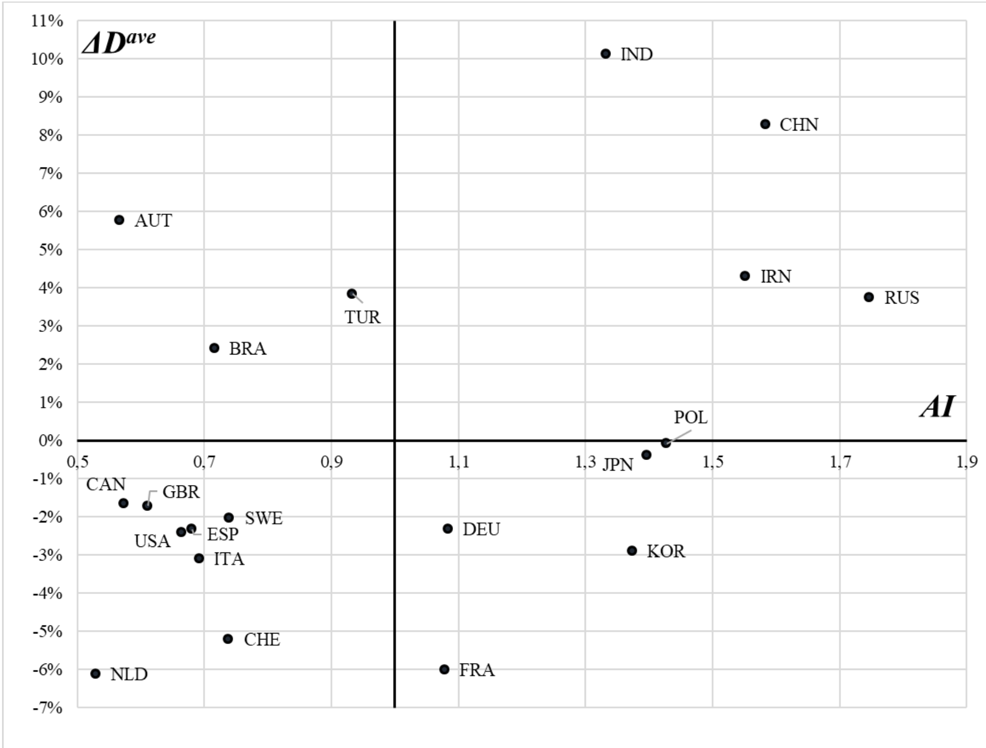

Figure 4. Trend Diagnostic Chart for Condensed Matter Physics, 2019.

Table 6. Vectors (AI,) Included in Sector 1 of Trend Diagnostic Chart.

Subject category	Country (AI, ΔD^{ave})
Medicine (miscellaneous)	USA (1.1087, 0.0178), UK (1.1485, 0.0250), Japan (1.3027, 0.0206), Italy (1.1293, 0.0353), Canada (1.1523, 0.0462), Australia (1.1450, 0.0648), Spain (1.0304, 0.0372), South Korea (1.0948, 0.0310), Brazil (1.1006, 0.0527), Iran (1.0174, 0.0766), Netherlands (1.1567, 0.0202), Poland (1.0200, 0.0391), Switzerland (1.2668, 0.0436), Sweden (1.1685, 0.0212)
Electrical and Electronic Engineering	China (1.5659, 0.0866), India (1.7686, 0.2267), Japan (1.2418, 0.0010), Russian Federation (1.0208, 0.1805), South Korea (1.5596, 0.0460), Iran (1.1789, 0.0750)
Materials Science (miscellaneous)	China (1.8202, 0.2153), India (1.1255, 0.1751), Russian Federation (1.6153, 0.1570), South Korea (1.6844, 0.0605), Poland (1.3184, 0.1250)
Computer Science Applications	China (1.3316, 0.1101), India (1.6889, 0.3019), Japan (1.0550, 0.0296), South Korea (1.1895, 0.0806)
Chemistry (miscellaneous)	China (1.6552, 0.1034), India (1.1253, 0.0173), German (1.0600, 0.0147), Japan (1.1321, 0.0049), Russian Federation (1.0472, 0.0316), Poland (1.1516, 0.0450)
Condensed Matter Physics	China (1.5833, 0.0828), India (1.3322, 0.1013), Russian Federation (1.7468, 0.0375), Iran (1.5520, 0.0430)
Computer Networks and Communications	China (1.2894, 0.1778), India (1.7743, 0.1373), South Korea (1.0716, 0.0547), Turkey (1.0667, 0.2828)
Mechanical Engineering	China (1.8597, 0.0874), India (1.2808, 0.1431), Japan (1.1143, 0.0131), South Korea (1.3274, 0.0397), Iran (1.6282, 0.0682), Poland (1.0661, 0.0820)
Physics and Astronomy (miscellaneous)	India (1.1094, 0.1458), German (1.1059, 0.0003), Russian Federation (3.1900, 0.1632), Switzer-land (1.1699, 0.0481)
Electronic, Optical and Magnetic Materials	China (1.5471, 0.1236), India (1.2949, 0.0970), German (1.1612, 0.0365), Japan (1.4726, 0.0683), France (1.0833, 0.0137), Russian Federation (1.7232, 0.1344), South Korea (1.4192, 0.0111), Iran (1.2463, 0.0860), Poland (1.0766, 0.0403)
Engineering (miscellaneous)	China (1.4751, 0.2301), India (2.8895, 0.5788), Russian Federation (1.7179, 0.0728), South Korea (1.1366, 0.1508), Poland (1.1888, 0.1944)
Computer Science (miscellaneous)	China (1.1039, 0.2657), India (2.9834, 0.3988), Russian Federation (1.2697, 0.2424), Poland (1.3060, 0.0025)
Biochemistry	China (1.4321, 0.1710), Spain (1.0724, 0.0537), South Korea (1.3322, 0.0580), Brazil (1.0254, 0.1180), Iran (1.2952, 0.1384), Poland (1.1623, 0.0558)
Software	China (1.3077, 0.1288), USA (1.0336, 0.0255), India (1.1145, 0.1263)
Energy Engineering and Power Technology	China (1.6930, 0.1814), Russian Federation (1.3212, 0.3186), South Korea (1.3049, 0.1647), Iran (1.5042, 0.1536), Turkey (1.2784, 0.3247)
Mechanics of Materials	China (1.6006, 0.0702), India (2.5623, 0.5199), Russian Federation (1.2207, 0.0456), South Korea (1.4124, 0.0654), Iran (1.6725, 0.0681), Poland (1.0451, 0.0081)
Molecular Biology	China (1.1421, 0.1555), USA (1.2373, 0.0170), German (1.2077, 0.0561), Japan (1.3544, 0.0307), Italy (1.0102, 0.1134), France (1.0458, 0.0411), Canada (1.0402, 0.0236), South Korea (1.2598, 0.0492), Iran (1.0815, 0.3058), Switzerland (1.1000, 0.0229), Sweden (1.1338, 0.0630)
Artificial Intelligence	China (1.3733, 0.2854), India (1.6497, 0.2549), Japan (1.3336, 0.0839), South Korea (1.0271, 0.1070), Turkey (1.4147, 0.4698)
Materials Chemistry	China (1.9544, 0.1282), India (1.2999, 0.1033), Japan (1.4012, 0.0208), Russian Federation (1.2705, 0.0718), South Korea (1.5954, 0.0595), Iran (1.9130, 0.1324), Poland (1.2190, 0.0416), Turkey (1.2560, 0.0856)
Control and Systems Engineering	China (1.8159, 0.1530), India (1.4826, 0.0814), Russian Federation (1.0482, 0.1996), South Korea (1.1760, 0.0733), Poland (1.3225, 0.0181)

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Table 7. Matrix (AAIij), 2017.

Country		**Medicine (miscellaneous)**	**Electrical and Electronic Engineering**	**Condensed Matter Physics**	**Chemistry (miscellaneous)**	**Electronic. Optical and Magnetic Materials**	**Computer Science Applications**	**Physics and Astronomy (miscellaneous)**	**Materials Science (miscellaneous)**	**Mechanical Engineering**	**Biochemistry**	**Engineering (miscellaneous)**	**Molecular Biology**	**Materials Chemistry**	**Applied Mathematics**	**Software**	**Computer Networks and Communications**	**Mechanics of Materials**	**Computer Science (miscellaneous)**	**Physical and Theoretical Chemistry**
	CpD Aver	9.31	5.69	6.80	12.21	5.77	5.13	9.76	9.60	6.97	9.79	5.29	9.30	7.94	4.39	6.30	3.60	7.22	3.58	8.08
U. S.	7.05	0.855	1.098	1.136	1.317	0.996	1.145	1.224	1.337	1.097	1.119	1.233	1.061	1.192	1.087	1.098	1.389	1.173	1.410	1.015
China	6.53	0.839	1.082	1.029	1.175	1.068	1.095	1.011	1.257	1.039	0.988	1.018	0.892	1.039	1.042	1.258	0.970	1.172	1.132	1.093
U. K.	7.59	0.918	1.214	1.074	1.141	1.022	1.157	1.160	1.084	1.073	1.106	1.150	1.094	1.116	1.239	0.980	1.206	0.962	1.168	1.009
Germany	7.32	0.928	0.808	0.938	1.040	0.956	0.858	1.037	0.893	0.880	1.006	1.020	0.996	0.883	0.778	0.779	0.940	0.778	0.883	0.924
Japan	5.32	0.818	0.705	0.977	1.141	0.991	0.708	1.052	0.970	0.812	0.953	1.033	0.939	0.968	0.735	0.745	0.749	0.781	0.895	1.073
France	7.01	1.049	0.850	0.883	0.930	0.819	0.821	0.951	0.800	0.889	1.011	1.047	1.009	0.918	0.779	0.775	0.971	0.747	0.863	0.938
Italy	7.39	0.957	1.070	1.042	0.890	0.912	1.071	0.967	0.888	1.019	0.988	1.223	1.010	0.978	0.975	0.893	1.114	0.920	0.931	1.002
Canada	7.73	0.971	1.226	0.998	0.937	0.831	1.102	1.317	1.034	0.941	1.001	1.217	0.932	0.912	1.067	0.972	1.520	0.905	1.215	0.904
India	4.22	1.022	1.106	1.474	0.992	1.633	0.902	1.011	0.984	1.184	1.108	0.757	1.149	1.642	1.459	1.147	1.056	1.303	1.030	1.468
Australia	8.18	0.939	1.499	1.075	1.135	1.215	1.489	1.305	1.423	1.254	1.066	1.566	1.056	1.062	1.242	1.276	1.436	1.110	1.257	1.003
Spain	7.07	1.012	1.149	1.029	0.990	0.968	1.140	1.217	0.980	1.084	1.086	1.342	1.000	1.041	0.829	0.812	1.042	0.963	0.853	0.999
Russian	3.34	1.324	0.942	1.125	0.691	1.182	0.895	0.799	0.704	1.023	1.081	1.041	1.223	0.991	1.000	0.961	0.940	0.973	1.053	1.060
South Korea	6.42	0.963	1.067	0.991	0.937	1.009	1.067	1.134	1.075	1.072	0.891	1.045	0.817	1.098	1.088	0.819	1.159	1.195	1.072	1.193
Netherlands	9.49	0.948	0.682	0.800	1.025	0.659	0.720	1.221	0.867	0.861	0.929	1.052	0.918	0.866	0.696	0.648	0.677	0.814	0.920	0.817
Brazil	4.76	1.028	0.973	1.088	0.736	1.184	1.093	1.415	0.612	0.883	1.011	1.351	0.959	1.200	1.054	0.931	0.924	0.830	0.981	1.125
Switzerland	10.00	0.869	0.826	0.883	0.936	0.823	0.956	1.091	0.912	0.918	0.901	1.552	0.899	0.999	0.748	0.916	1.130	0.714	0.830	0.789
Poland	5.23	1.234	0.679	0.969	0.727	0.881	0.914	1.176	0.629	0.991	0.926	1.080	1.013	1.038	0.903	1.000	0.823	0.883	0.846	1.056
Sweden	8.87	0.932	1.075	0.810	0.857	0.807	1.072	0.947	0.862	0.876	0.874	1.150	0.910	0.769	1.110	0.628	1.125	0.631	0.848	0.787
Taiwan	5.76	1.002	0.864	0.908	0.882	0.842	0.729	1.725	0.988	0.743	1.072	1.156	0.999	0.956	0.930	0.740	0.754	0.932	0.994	1.020

Table 8. Binary Matrix for Activity Index (50×20 dimension), 2019.

Country	Medicine (miscellaneous)	Electrical and Electronic Engineering	Materials Science (miscellaneous)	Computer Science Applications	Chemistry (miscellaneous)	Condensed Matter Physics	Computer Networks and Communications	Mechanical Engineering	Physics and Astronomy (miscellaneous)	Electronic, Optical and Magnetic Materials	Engineering (miscellaneous)	Computer Science (miscellaneous)	Biochemistry	Software	Energy Engineering and Power Technology	Mechanics of Materials	Molecular Biology	Artificial Intelligence	Materials Chemistry	Control and Systems Engineering	Total
China	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	18
U. S.	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	3
U. K.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
India	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	16
Germany	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	5
Japan	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	1	1	1	1	0	14
Italy	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
France	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	5
Canada	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
Russia	0	1	1	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	1	1	12
Australia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Spain	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
South Korea	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	18
Brazil	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Iran	1	1	0	0	1	1	0	1	0	1	0	0	1	0	1	1	1	0	1	0	11
Netherlands	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Poland	1	0	1	0	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	1	13
Turkey	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	5
Switzerland	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	3
Sweden	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
Indonesia	0	0	1	1	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	7
Taiwan	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	0	1	1	1	1	16
Malaysia	0	1	1	1	0	0	1	1	1	0	1	1	0	0	1	1	0	1	0	1	12
Belgium	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Denmark	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	3
Portugal	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	4
South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Austria	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	3
Saudi	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	17

Arabia																					
Mexico	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	6
Czech Republic	0	0	1	0	1	1	0	1	1	1	0	1	1	0	0	1	1	0	1	1	12
Egypt	1	1	1	0	1	1	1	0	0	1	1	0	1	0	1	0	1	1	1	0	13
Norway	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
Pakistan	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	0	1	1	0	15
Hong Kong	0	1	1	1	1	0	1	1	0	1	0	1	0	1	1	1	0	1	1	1	14
Israel	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	4
Singapore	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	17
Finland	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Greece	1	0	0	1	0	0	1	0	0	0	0	1	0	1	1	0	0	1	0	0	7
Thailand	1	1	1	1	0	0	1	0	1	0	1	1	0	1	1	1	0	1	1	0	13
New Zealand	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ireland	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Romania	0	1	1	0	1	0	1	1	1	0	1	1	0	0	1	1	0	1	1	0	12
Ukraine	0	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1	0	0	1	1	14
Chile	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	3
Argentina	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	3
Colombia	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	4
Iraq	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	1	0	0	11
Vietnam	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	17
Hungary	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	4
Total	29	18	19	16	18	18	21	15	20	18	17	23	15	18	22	16	20	20	19	14	376

Table 9. Binary Matrix for Activity Index (50×20 dimension) After Applying the Clustering Algorithm, 2019.

Country	Materials Chemistry	Computer Networks and Communications	Electrical and Electronic Engineering	Materials Science (miscellaneous)	Computer Science Applications	Artificial Intelligence	Software	Electronic, Optical and Magnetic Materials	Chemistry (miscellaneous)	Condensed Matter Physics	Energy Engineering and Power Technology	Engineering (miscellaneous)	Mechanical Engineering	Mechanics of Materials	Control and Systems Engineering	Biochemistry	Molecular Biology	Medicine (miscellaneous)	Physics and Astronomy (miscellaneous)	Computer Science (miscellaneous)
China	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1
South Korea	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Viet Nam	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1
Saudi Arabia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1
Taiwan	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	1
Pakistan	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1
Singapore	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1
India	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	1	1
Hong Kong	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	0	0	0	1
Thailand	1	1	1	1	1	1	1	0	0	0	1	1	0	1	0	0	0	1	1	1
Ukraine	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	0	0	1	1
Romania	1	1	1	1	0	1	0	0	1	0	1	1	1	1	0	0	0	0	1	1
Egypt	1	1	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	1	0	0
Japan	1	1	1	0	1	1	0	1	1	1	0	0	1	1	0	1	1	1	1	0
Turkey	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Russian	1	0	1	1	0	0	0	1	1	1	1	1	0	1	1	0	0	0	1	1
South Africa	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iran	1	0	1	0	0	0	0	1	1	1	1	0	1	1	0	1	1	1	0	0
Germany	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	1	0
France	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0
Hungary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
Israel	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0
Switzerland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
Denmark	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
United States	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0
Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Finland	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Belgium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Netherlands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
New Zealand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Australia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ireland	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Norway	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Austria	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1
Chile	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Greece	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	1
Mexico	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	1	0	1
Portugal	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1
Colombia	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1
Czech Republic	1	0	0	1	0	0	0	1	1	1	0	0	1	1	1	1	1	0	1	1
Indonesia	0	1	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1
Iraq	0	1	1	1	1	1	0	0	1	0	0	1	1	0	0	1	0	0	1	1
Malaysia	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0	0	0	1	1
Poland	1	0	0	1	0	0	0	1	1	1	0	1	1	1	1	1	0	1	1	1

Conclusion

This paper is a retrospective analytical review of international comparisons of publishing activity based on the Web of Science database, and then the Scopus database by means of using the Scimago Journal and Country Rank platform. In the 1980s, there was a shift from absolute to relative scientometric indicators of research outputs when carrying out international comparisons of publication activity.

The review showed that the principles of constructing such indicators were borrowed from economic papers (Izard, 1960; Balassa, 1965), though the idea underlying the Activity Index was first suggested, as shown in the present paper, by W. Izard, rather than B. Balassa, as was thought to be in scientometrics. The experiments in Google Books and Google Scholar have shown that the term Activity Index has been widely used since the 1910s in various fields of knowledge, especially in business and medicine, with the index obtaining the specialization in these fields. In this regard, the Activity Index, which is non-specific in scientometrics, is proposed to be called the Publication Activity Index, and a similar index for citations, known the Attractivity Index, is proposed to be called the Citation Activity Index

Through the experiments in Google Scholar, it was shown that after the launch of the public SJR database in 2007, publications by researchers from developing countries, mainly from Asia and Latin America, began to prevail in country comparisons for calculating Activity Index values. At the same time, before the launch of this public database, the number of publications (based on the Web of Science subscription database) by researchers from these countries had been negligible. Methodologically, when working with the statistical data from the SJR database on Publication Activity, we proposed the following:

1. a measure or coefficient of interdisciplinarity of publications by subject categories and subject area for countries, as well as studying the correlation and regression relationship between them;
2. Trend Diagnostic Chart, using as axes the Activity Index and Average Growth Rate for Documents; this chart makes it possible to classify countries as leaders and outsiders, catch-up countries and countries losing their publication potential, the coordinates of which lie in the four corresponding sectors;
3. a binary matrix, based on the original Activity Index matrix by countries and subject categories, to help identify countries with competitive subject categories;
4. a binary matrix clustering algorithm, which makes it possible to consolidate an original sparse binary matrix (isolating a dense triangular binary submatrix).

All the four proposed analytical instruments have been tested on publication activity over different years, mainly for the first 20 countries and subject categories (SJR Database). The results of their testing are the following:

1. An interdisciplinarity coefficient of publications for the first 50 countries of the world by subject categories there was above 2 and exceeded the similar coefficient for subject area, which was under 2, which is due to the exceeding number of subject categories over the

number of area categories, with the maximal coefficients being recorded for Chinese-speaking countries and South Korea.

2. Twenty Trend Diagnostic charts were constructed for 20 leading subject categories, from which the leading countries from the first sector of these charts were isolated; the obvious leaders being China and India, which got into that sector, 18 and 17 times out of 20, respectively.
3. For the Activity Index matrix with a dimension 50 (country) × 20 (subject category), a binary matrix was constructed using the data of 2019, which helps identify countries with competitive subject categories for which the Activity Index is above 1.
4. For more clarity and convenience to analyze the countries' competitiveness by the Activity Index, the original binary matrix was clustered according to the computer algorithm we developed, which helps visualizing countries with the maximal and minimal numbers of competitive subject categories, for example, China and South Korea had the maximal number of such categories, 18 each.

In addition to these results that were obtained by using the analytical instruments we had developed, three Attractivity Index (AAI) matrices, with a dimension of 20×20, were built using the data of 2017-2019, in which countries and subject categories were ranked by the Documents Indicator for the period of 1996-2019. The first matrix showed that Australia, USA, UK, China, and India had 19, 18, 17 and 16 values for AAI indicators, respectively, exceeding 1. A similar matrix constructed for 2018 included much fewer elements for which AAI>1, and the matrix for 2019 had no elements with AAI>1 at all, since the publications by the countries of the world could not gain a reasonable number of citations over such a short period of time. An additional line of the first matrix for 2017 shows that the maximal values of the Citation per Document indicator are observed in Chemical, Physical and Biomedical Sciences, and in an additional column, we can see that Switzerland, Netherlands, Sweden, and Australia are the leaders by this indicator.

The calculations performed with relative indices can be useful in planning research and scientific collaboration between countries, as they show the comparative advantages and weaknesses of country scientific systems, and also facilitate in finding partner countries for the implementation of joint scientific programs or projects that are mutually beneficial.

In the future, it is advisable to build a trend diagnostic chart, when instead of calculating an increase in publication activity over the last three years, an increase in Activity Index values is taken into account, as it was done in the Trend Chart Project on Innovation in Europe.

Limitations

1. There is a limitation due to classifying publications into different subject areas or subject categories, which should be taken into account when working with the SJS database.

2. When working with the SJR database, we noticed that often there happens recalculation the data already published, so when working with this database it is necessary to fix the interval for obtaining the data from it.

3. Another limitation is that in the comparison of the scientometric indicators, the size of the countries was not taken into account. The solution to this problem is seen in calculating the number of publications or citations per researcher in a given field of study. But UNESCO scientific statistics do not provide country-by-country data on the number of researchers according to subject areas or subject categories.

Author Contributions

All authors contributed equally to the conceptualization and writing (original draft preparation, review, and editing) of the manuscript.

Data Availability Statement

All data are available in the article and its appendices.

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Ethical considerations

Not applicable.

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Not applicable.

Conflict of interest

The authors declare no conflict of interest.

Appendix A

Appendix A1. Trend Diagnostic Chart for 19 Subject Categories, 2019

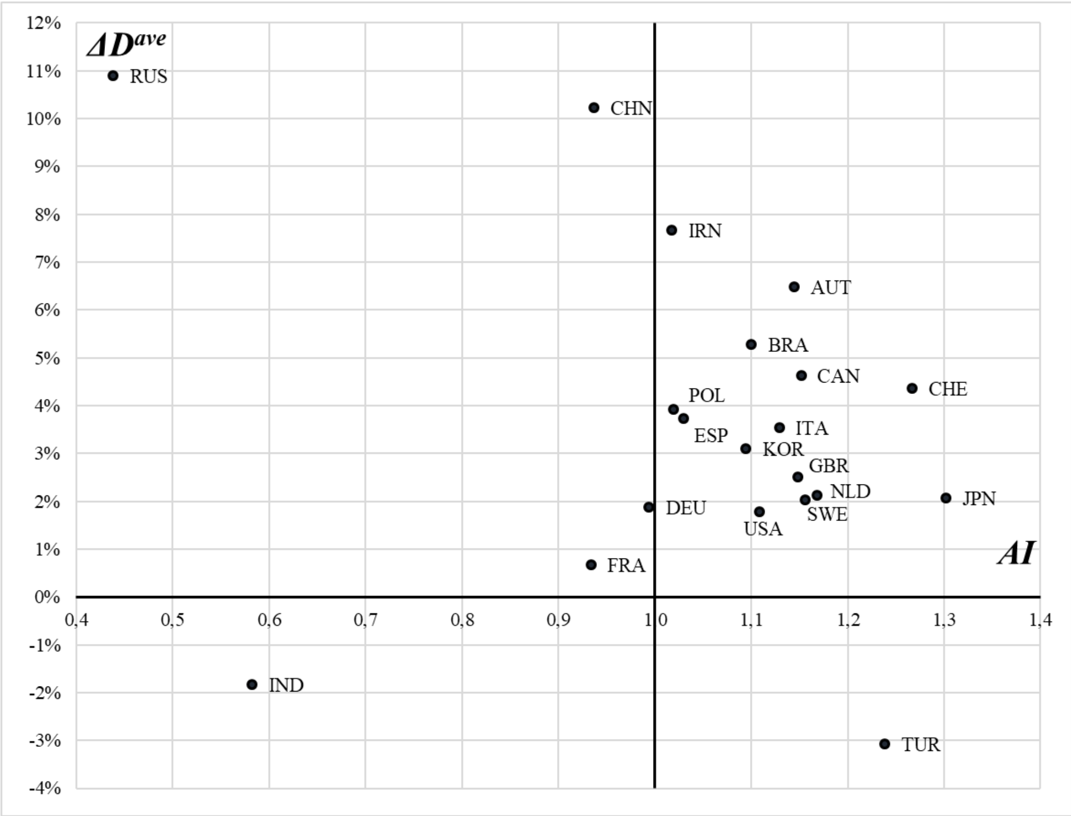

Figure1A. Trend Diagnostic Chart for Medicine (miscellaneous), 2019

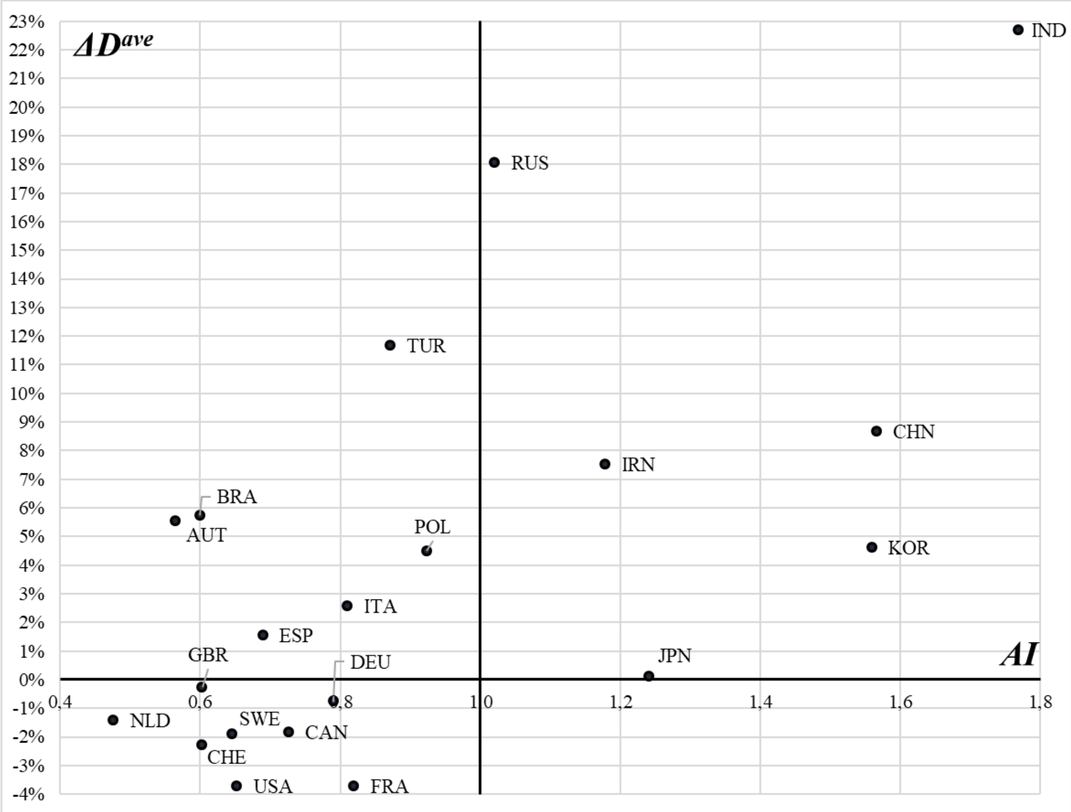

Figure 2A. Trend Diagnostic Chart for Electrical and Electronic Engineering, 2019

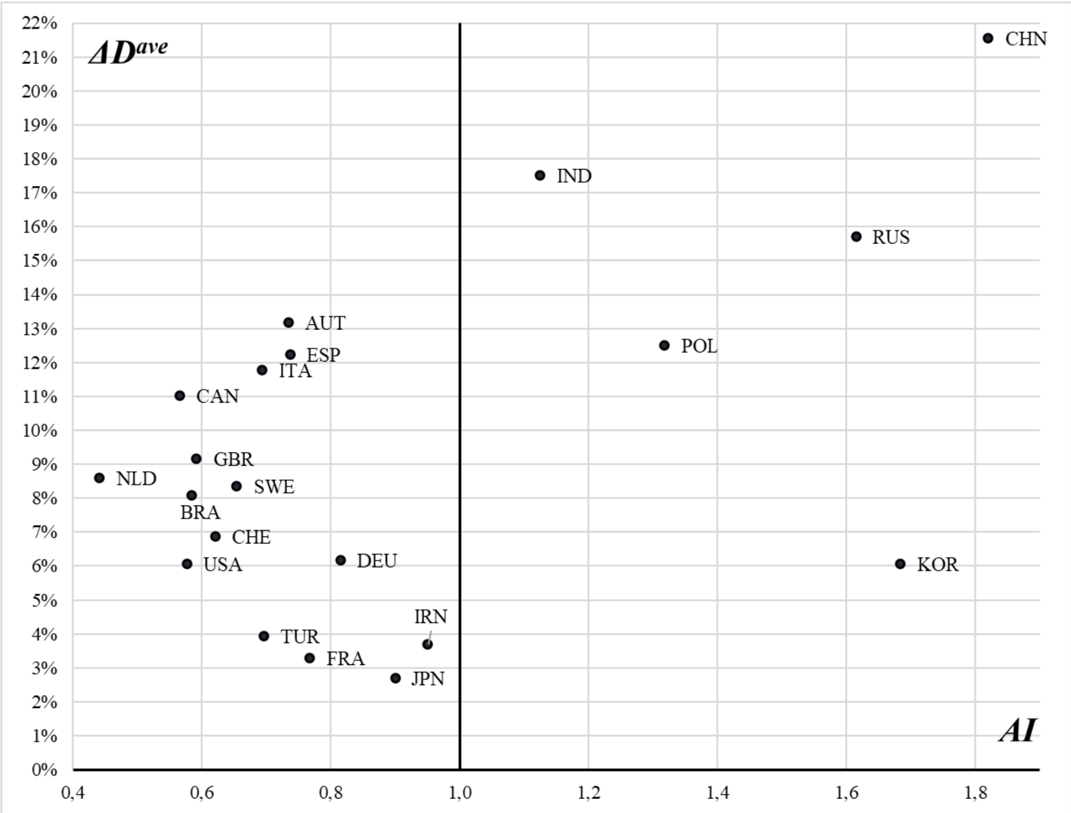

Figure 3A. Trend Diagnostic Chart for Materials Science (miscellaneous), 2019

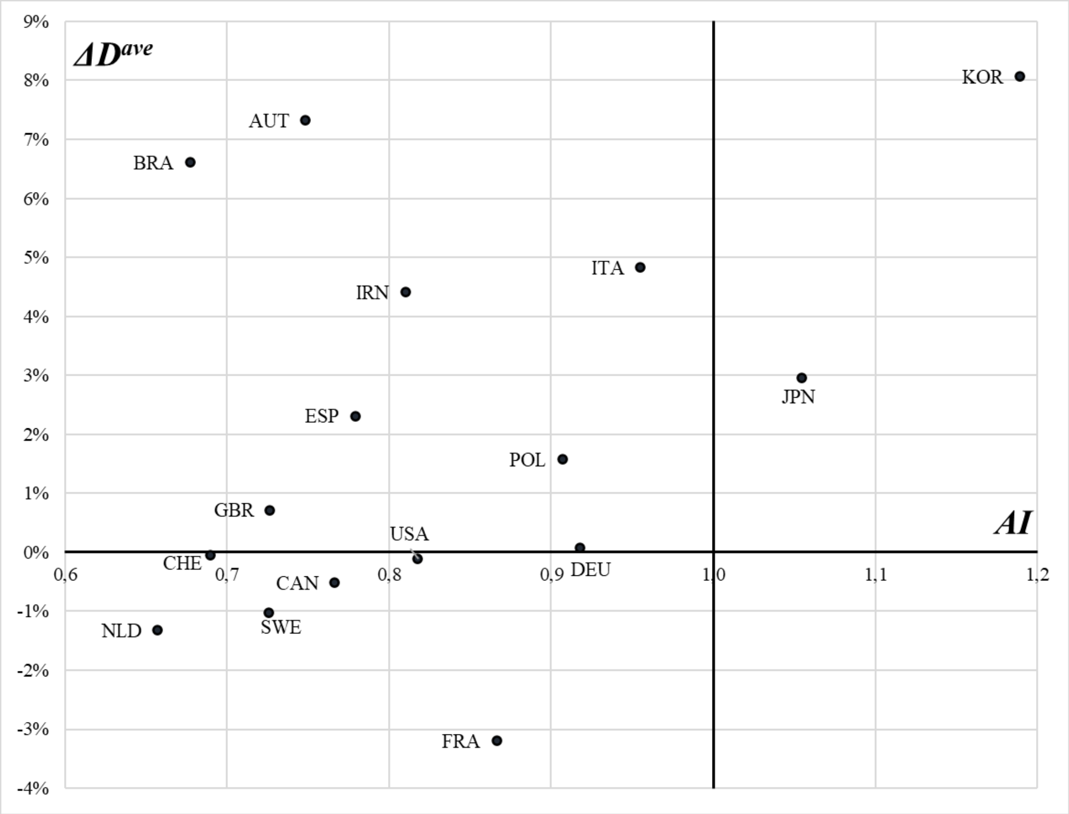

Figure 4A. Trend Diagnostic Chart for Computer Science Applications, 2019

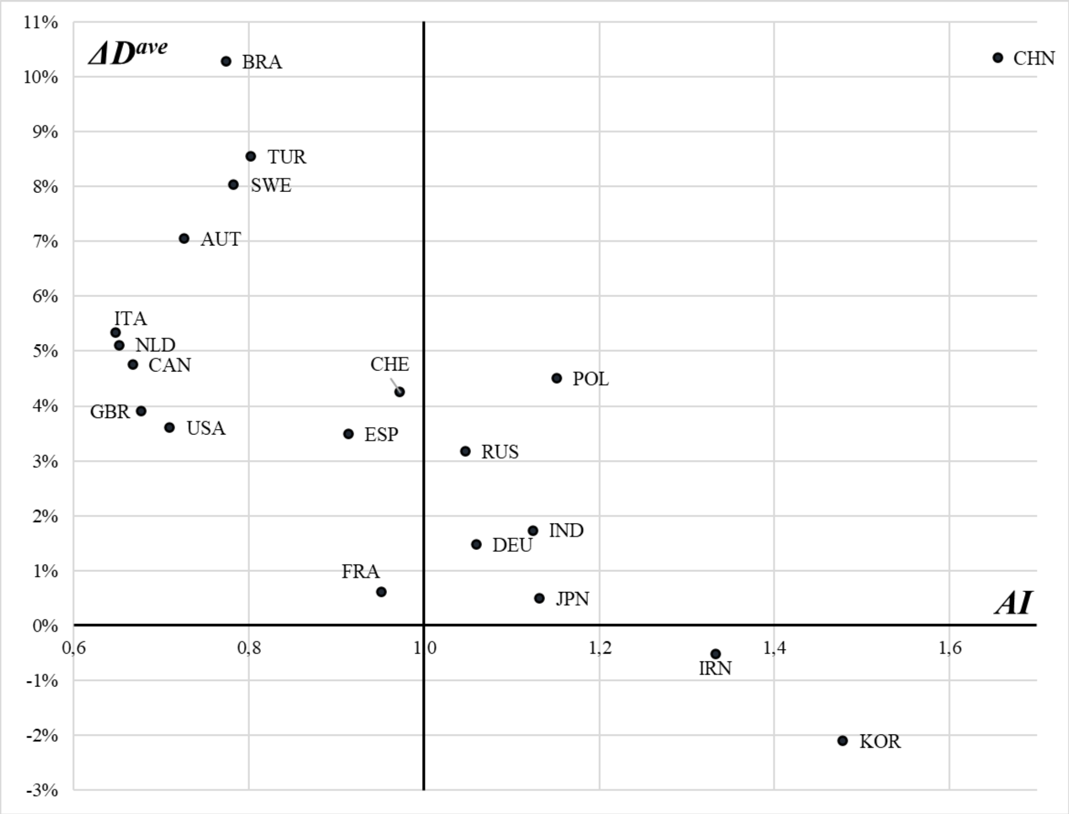

Figure 5A. Trend Diagnostic Chart for Chemistry (miscellaneous), 2019

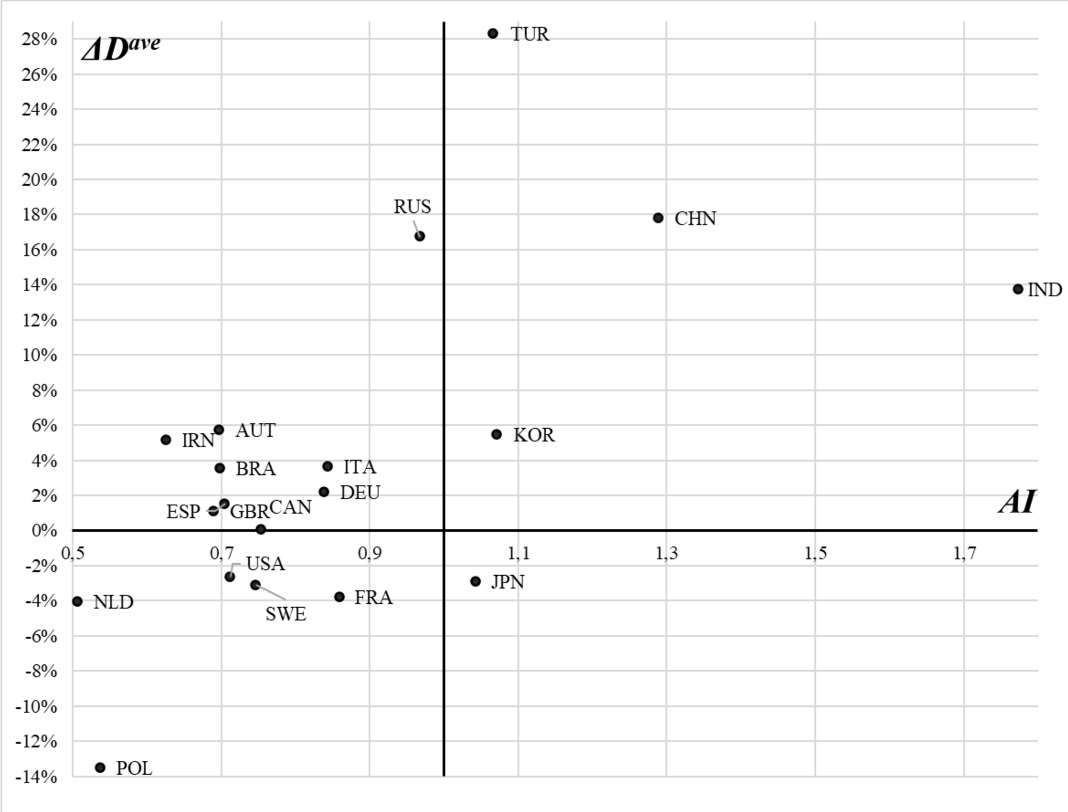

Figure 6A. Trend Diagnostic Chart for Computer Networks and Communications, 2019

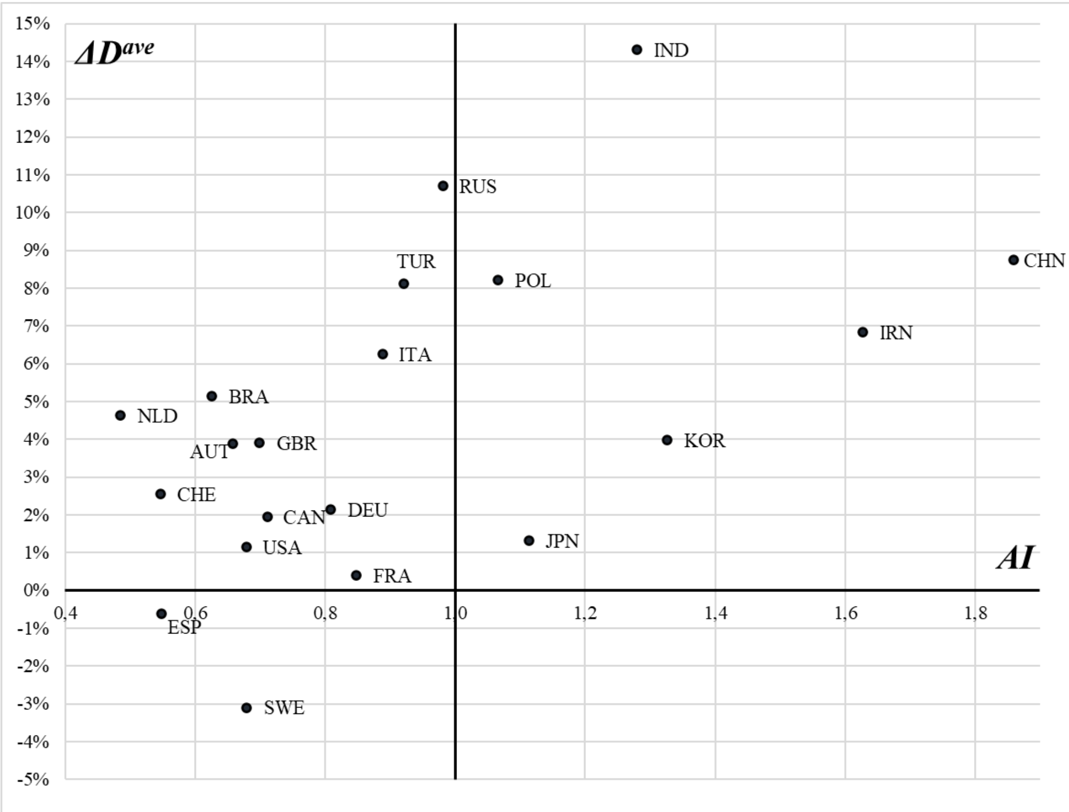

Figure 7A. Trend Diagnostic Chart for Mechanical Engineering, 2019

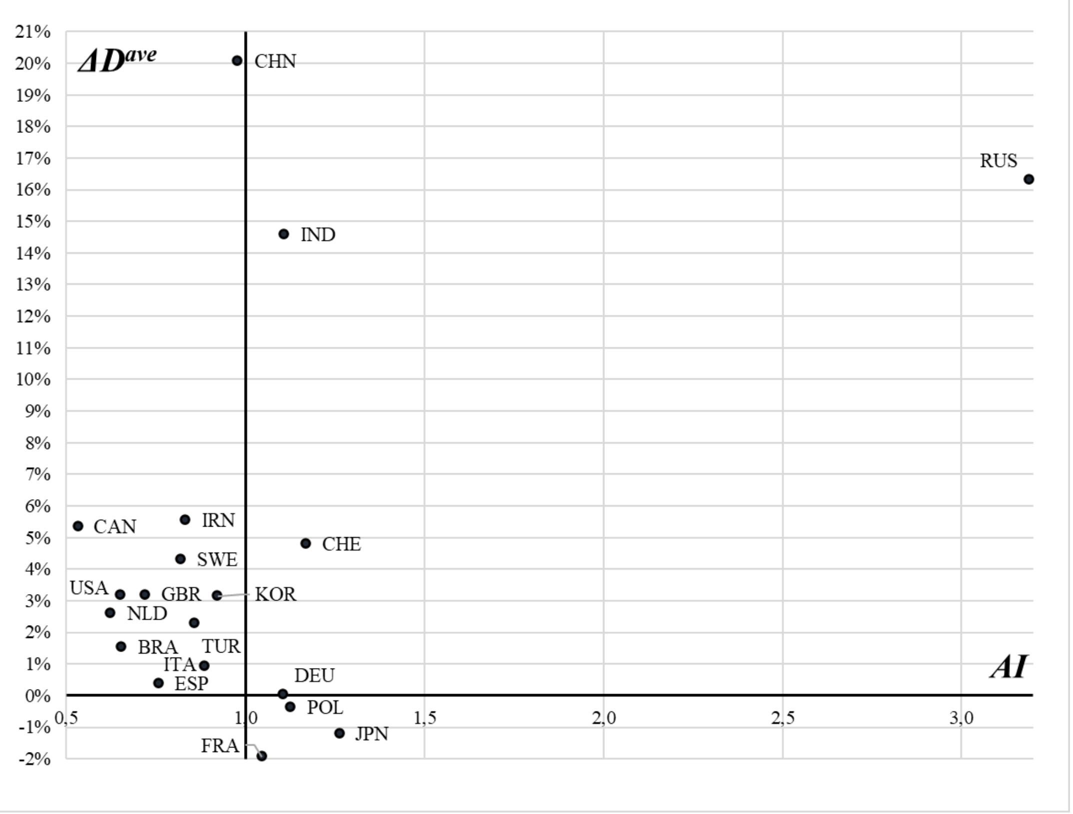

Figure 8A. Trend Diagnostic Chart for Physics and Astronomy (miscellaneous), 2019

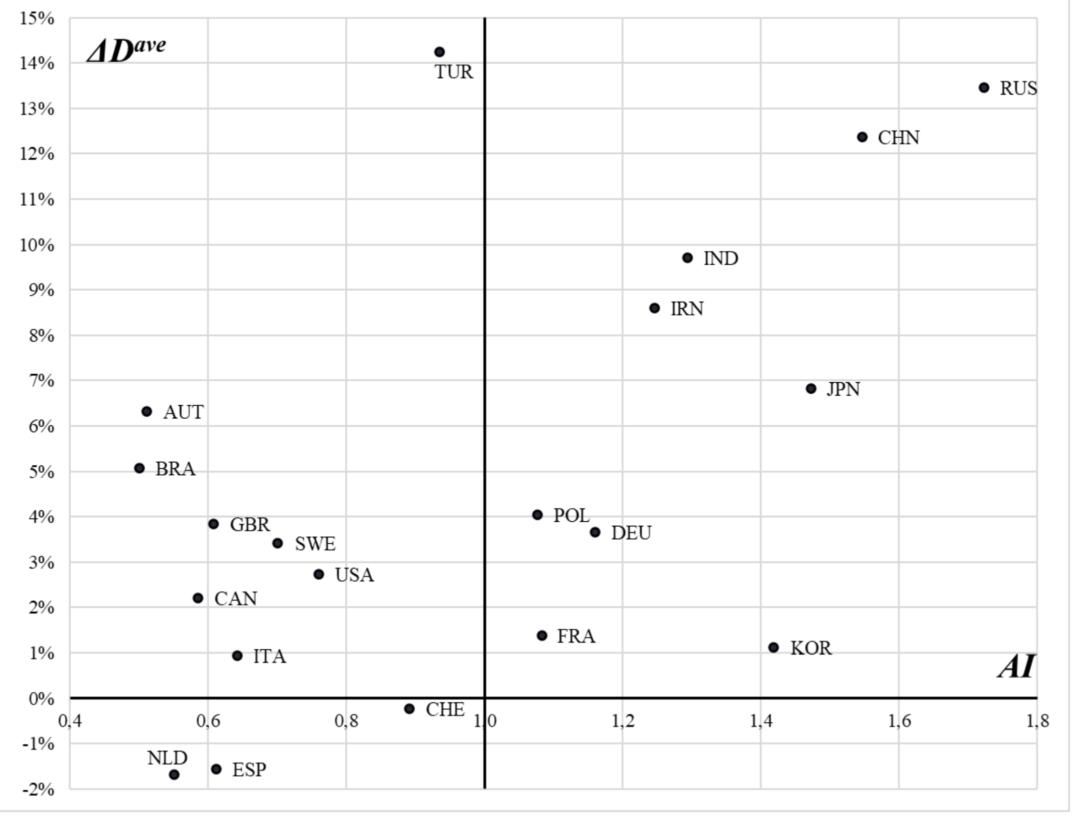

Figure 9A. Trend Diagnostic Chart for Electronic, Optical and Magnetic Materials, 2019

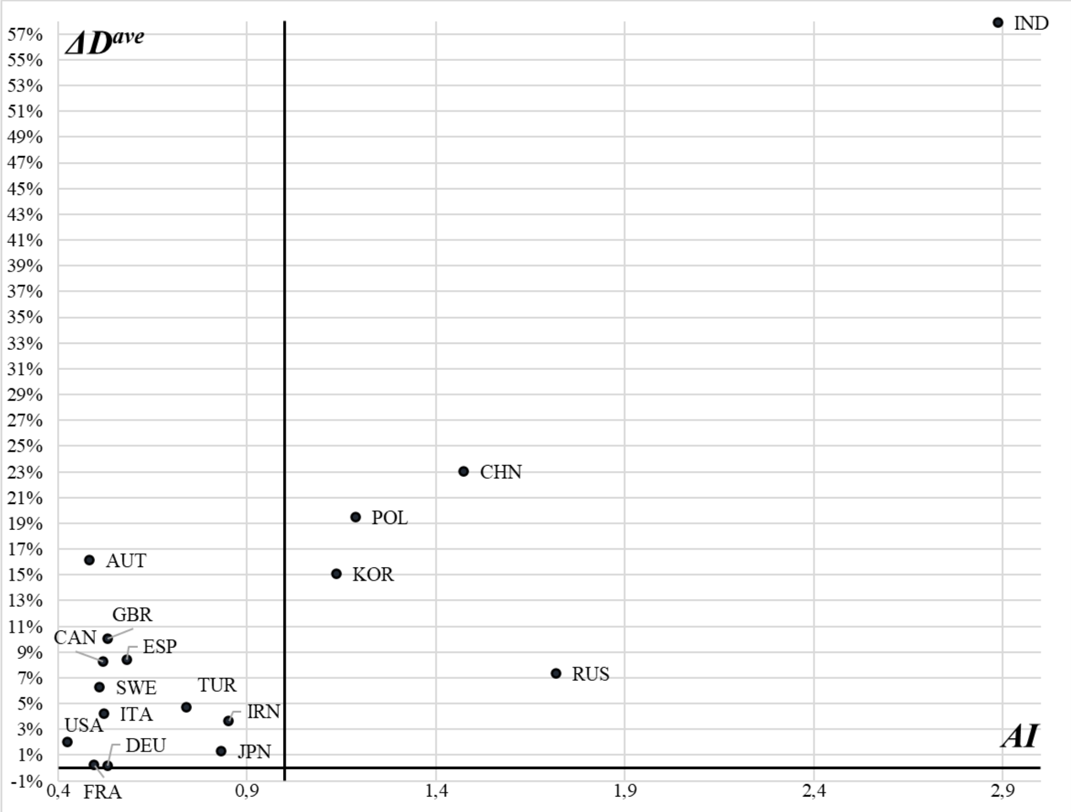

Figure 10A. Trend Diagnostic Chart for Engineering (miscellaneous), 2019

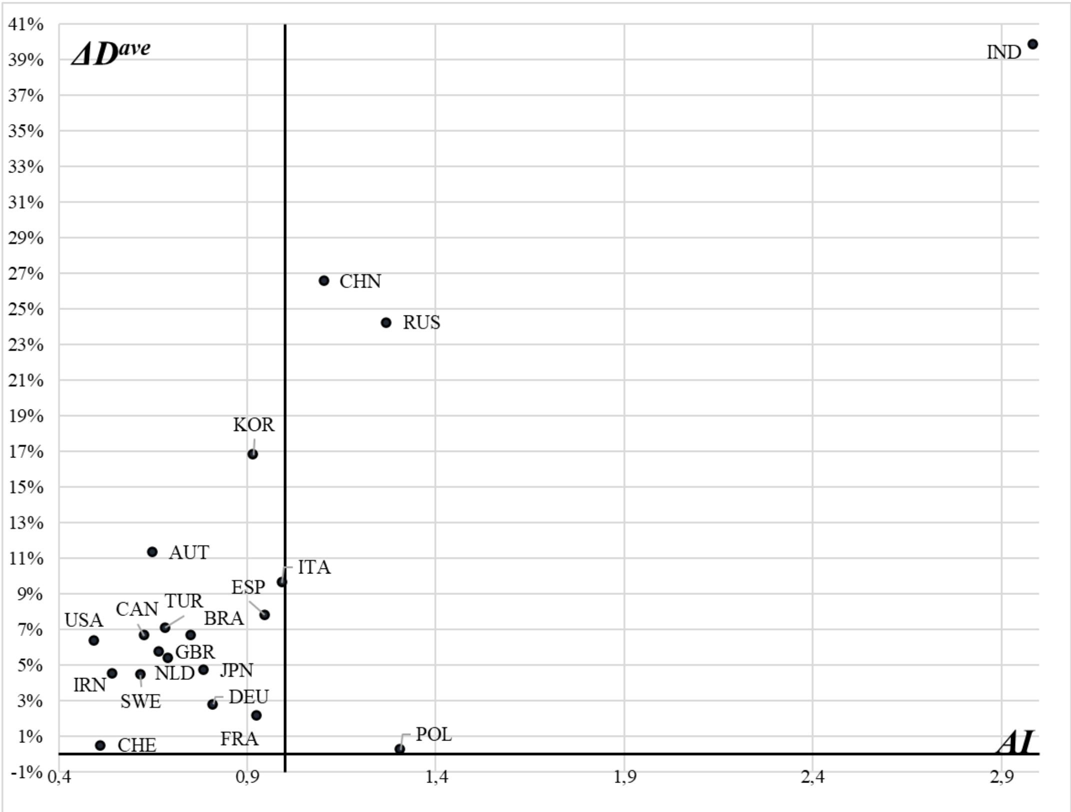

Figure 11A. Trend Diagnostic Chart for Computer Science (miscellaneous), 2019

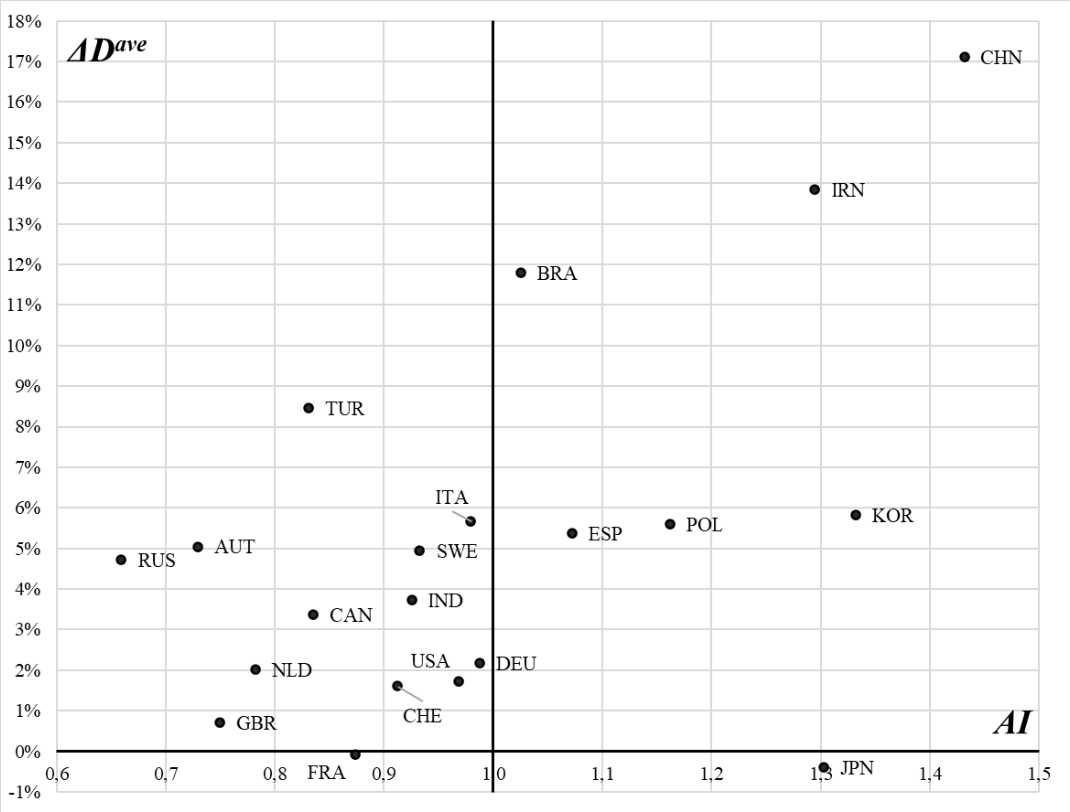

Figure 12A. Trend Diagnostic Chart for Biochemistry, 2019

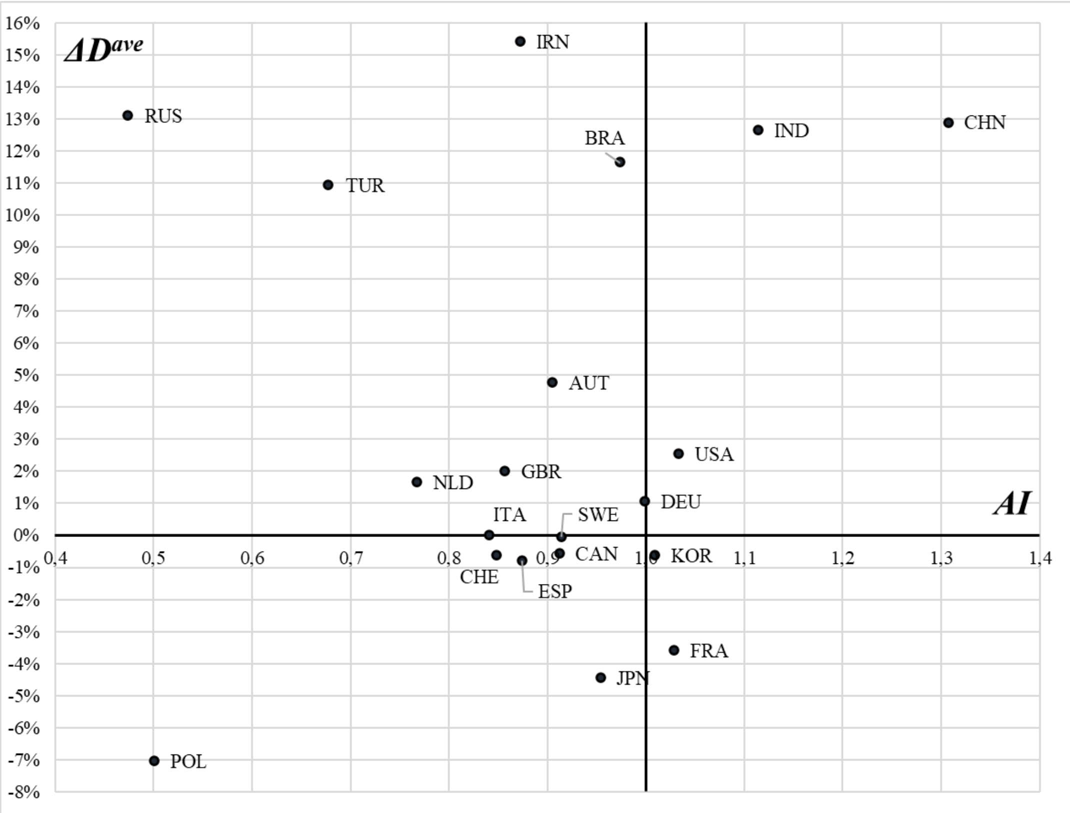

Figure 13A. Trend Diagnostic Chart for Software, 2019

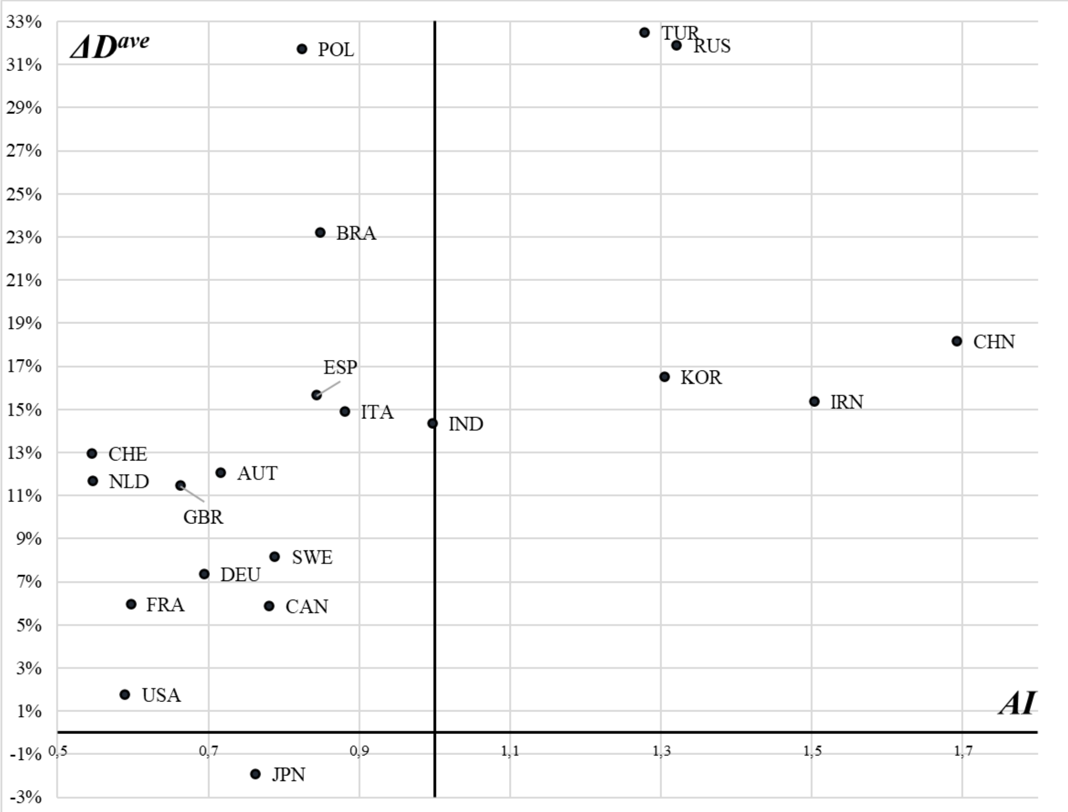

Figure 14A. Trend Diagnostic Chart for Energy Engineering and Power Technology, 2019

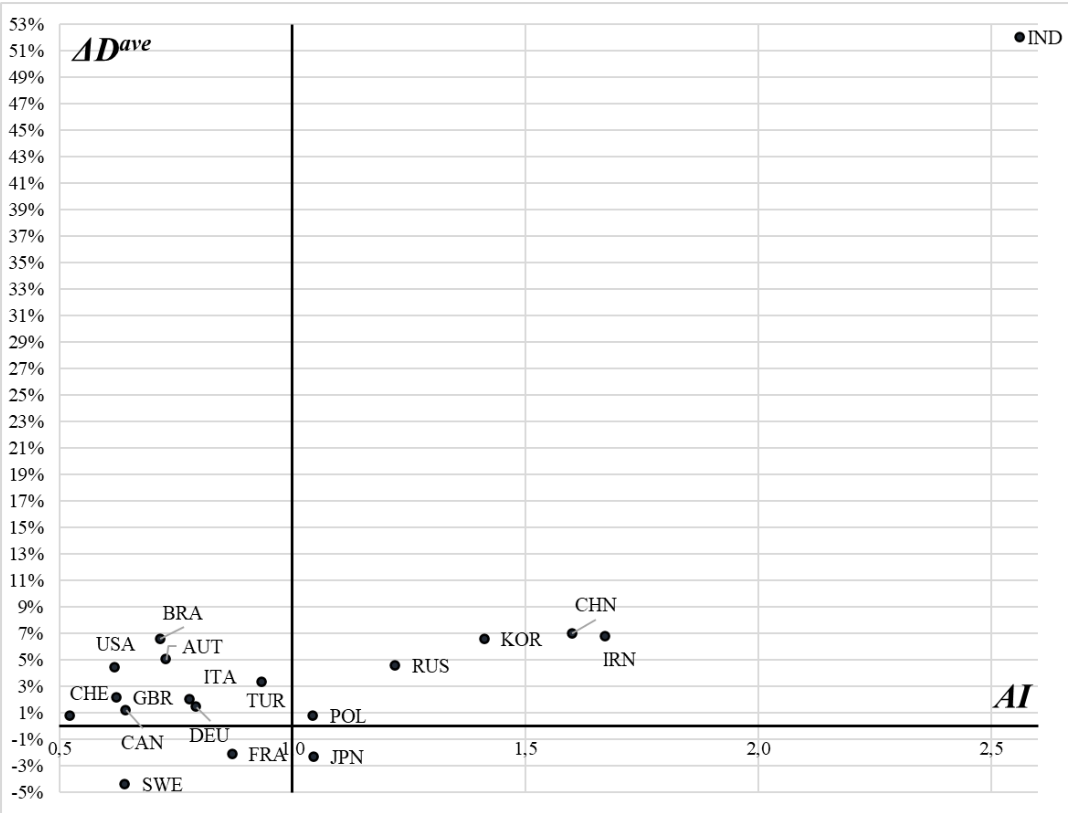

Figure 15A. Trend Diagnostic Chart for Mechanics of Materials, 2019

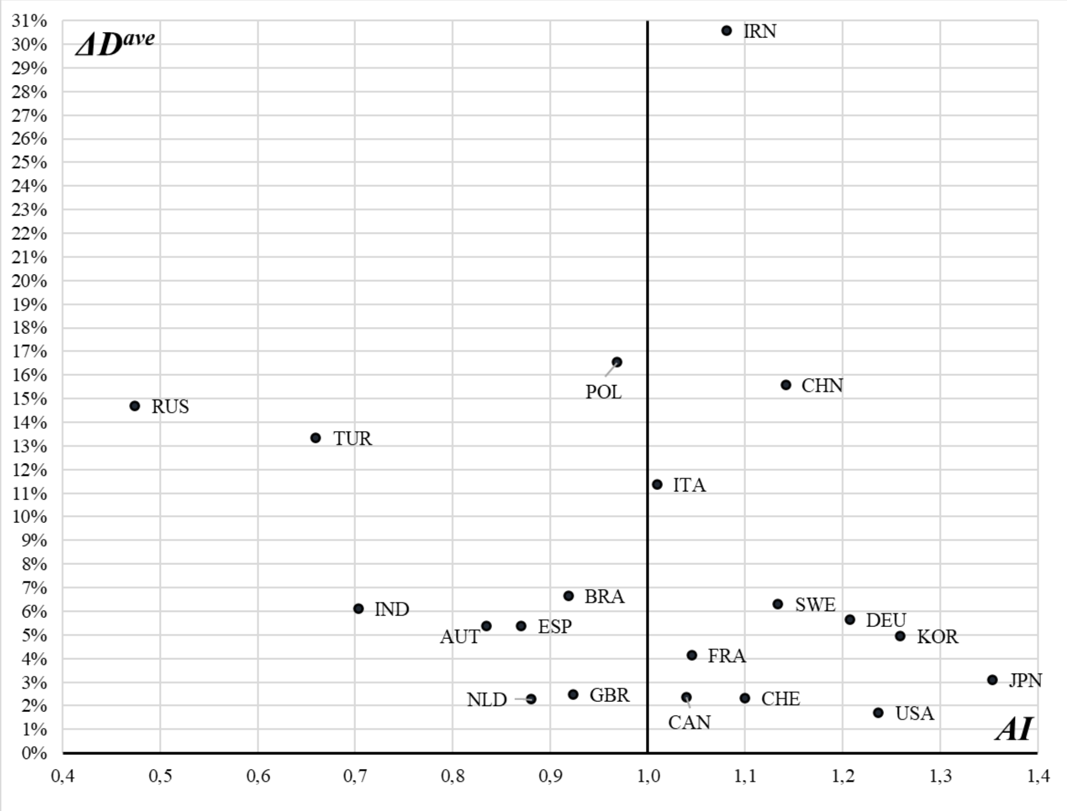

Figure 16A. Trend Diagnostic Chart for Molecular Biology, 2019

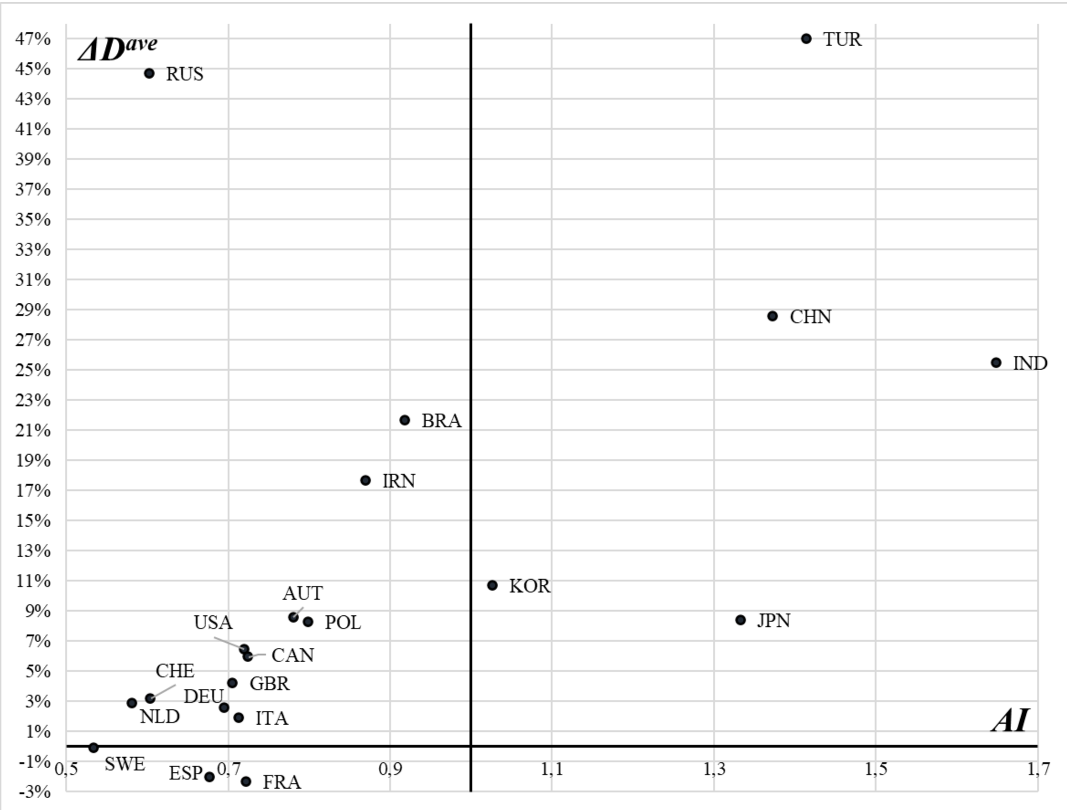

Figure 17A. Trend Diagnostic Chart for Artificial Intelligence, 2019

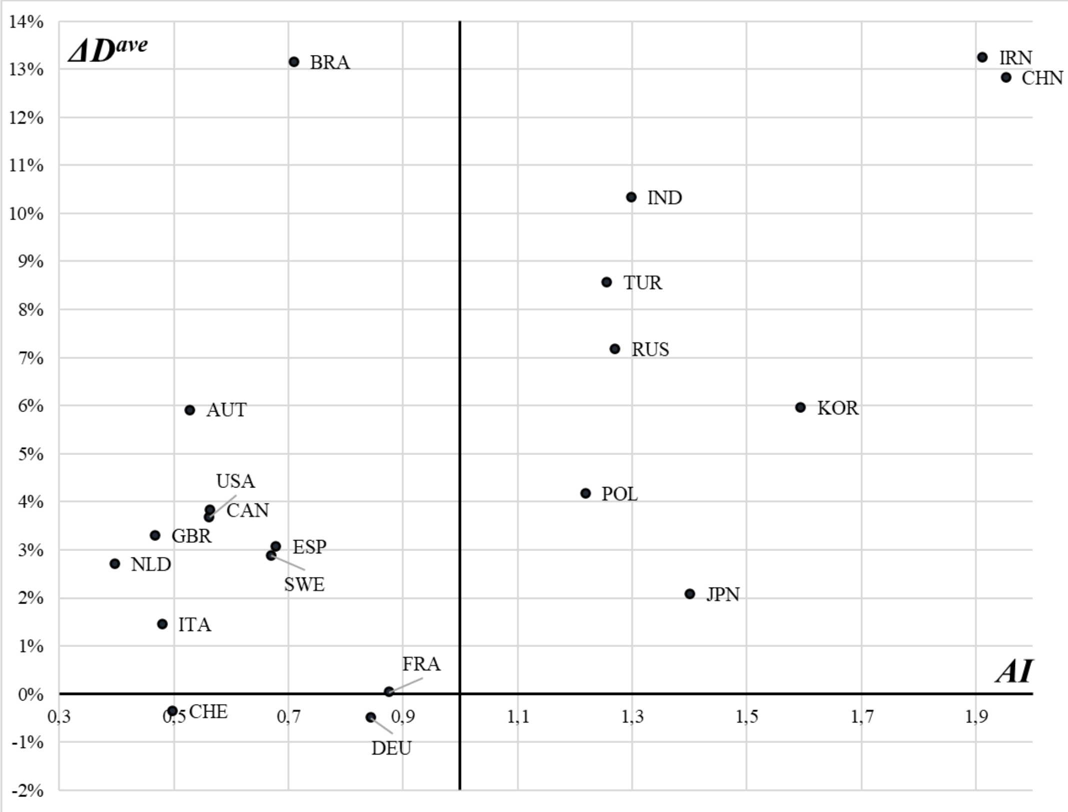

Figure 18A. Trend Diagnostic Chart for Materials Chemistry, 2019

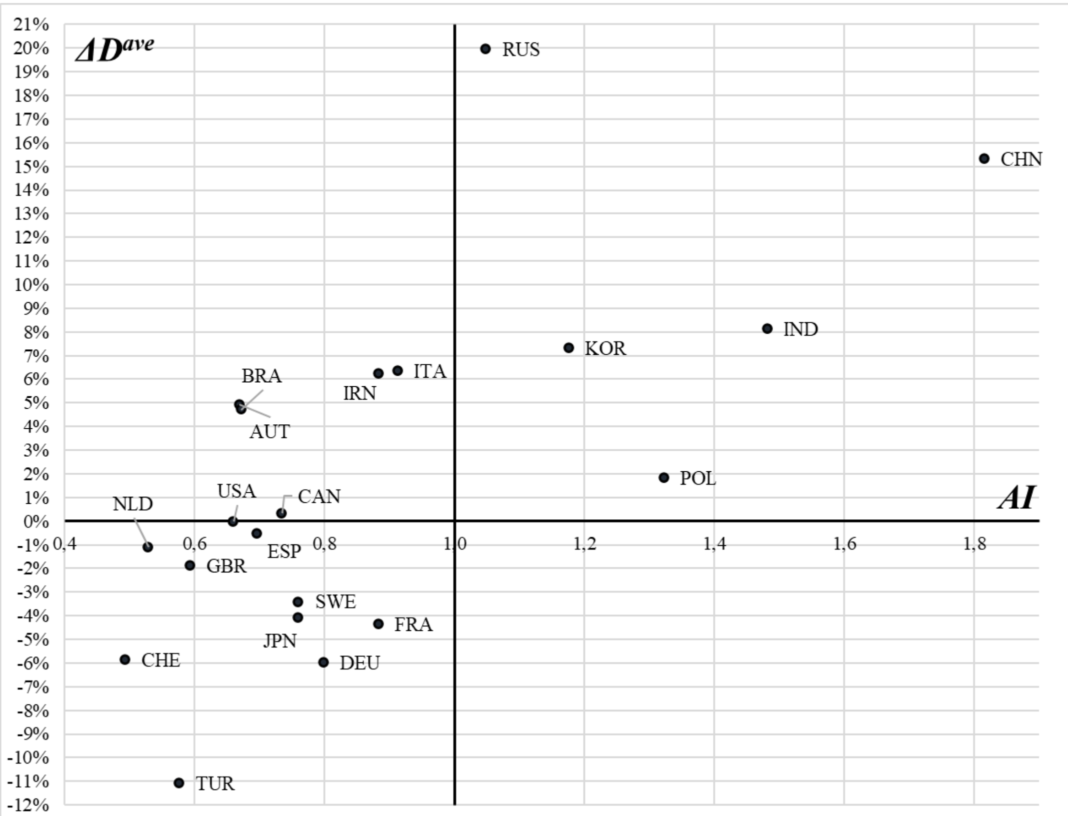

Figure 19A. Trend Diagnostic Chart for Control and Systems Engineering, 2019

Appendix B

Table 1B. Matrix (AAIij), 2018.

Country	CpD Aver	Medicine (miscellaneous)	Electrical and Electronic Engineering	Condensed Matter Physics	Chemistry (miscellaneous)	Electronic. Optical and Magnetic Materials	Computer Science Applications	Physics and Astronomy (miscellaneous)	Materials Science (miscellaneous)	Mechanical Engineering	Biochemistry	Engineering (miscellaneous)	Molecular Biology	Materials Chemistry	Applied Mathematics	Software	Computer Networks and Communications	Mechanics of Materials	Computer Science (miscellaneous)	Physical and Theoretical Chemistry	Atomic and Molecular Physics. and Optics
	CpD Aver	4.45	2.99	3.81	6.17	3.48	2.75	5.38	4.89	3.73	5.00	2.67	4.92	4.44	2.49	3.49	1.78	3.92	2.00	4.25	3.60
U. S.	3.63	0.911	1.122	1.076	1.313	1.011	1.137	1.220	1.360	1.169	1.126	1.332	1.028	1.156	0.971	1.065	1.381	1.117	1.227	1.073	1.082
China	3.57	0.893	1.065	1.008	1.188	1.082	1.102	0.965	1.227	0.971	0.994	1.022	0.889	0.986	1.051	1.131	0.971	1.131	1.124	0.915	0.864
U. K.	4.00	0.930	1.181	0.995	1.044	0.971	1.205	1.138	1.043	1.006	1.030	1.321	1.070	1.037	1.228	1.118	1.347	0.978	1.114	0.995	1.043
Germany	3.85	0.941	0.813	0.901	1.042	0.929	0.856	1.075	0.935	0.971	1.047	1.133	0.975	0.906	0.802	0.736	0.978	0.902	0.836	0.980	0.984
Japan	2.73	0.834	0.744	0.958	1.107	0.917	0.859	1.033	1.010	0.735	0.985	1.147	1.012	0.928	0.819	0.793	0.900	0.745	0.790	1.089	1.055
France	3.75	1.051	0.790	0.784	0.897	0.751	0.889	1.055	0.798	0.884	0.973	1.131	0.957	0.871	0.740	0.696	0.930	0.789	0.844	0.926	0.888
Italy	3.97	0.997	1.038	0.930	0.852	0.848	1.104	0.912	0.831	0.995	0.992	1.231	0.985	0.929	0.966	0.941	1.213	0.884	0.989	1.019	1.051
Canada	3.92	1.014	1.130	0.980	0.949	0.817	1.252	1.267	1.022	0.942	0.909	1.311	0.894	0.835	1.094	0.940	1.355	0.856	1.173	0.905	1.019
India	2.14	1.186	1.054	1.591	1.038	1.625	0.725	0.788	0.974	1.066	1.197	0.778	1.214	1.760	1.528	1.617	0.880	1.252	1.074	1.658	1.515
Australia	4.44	0.950	1.372	1.201	1.103	1.315	1.343	1.296	1.393	1.397	0.946	1.577	0.970	1.106	1.295	1.354	1.544	1.327	1.171	1.003	1.151
Spain	3.77	1.041	1.052	0.974	1.013	0.906	1.034	1.176	0.982	1.143	1.007	1.258	0.935	0.906	0.894	0.905	1.099	0.854	0.844	0.941	1.127
Russian	1.72	1.213	1.030	1.073	0.735	1.055	1.014	0.797	0.646	1.002	1.104	0.999	1.394	1.035	1.012	0.824	1.452	0.936	1.388	1.159	1.008
South Korea	3.30	0.995	1.056	1.088	1.034	1.054	1.111	1.048	1.200	1.044	0.907	1.237	0.787	1.103	1.116	0.874	1.189	1.158	1.141	1.156	0.964
Netherlands	4.87	0.932	0.706	0.771	0.930	0.685	0.748	1.262	0.864	0.857	0.888	1.213	0.893	0.870	0.680	0.617	0.793	0.848	0.755	0.759	0.887
Brazil	2.40	1.034	1.014	1.074	0.763	1.077	1.127	1.301	0.719	0.907	1.038	1.723	1.014	1.136	0.979	0.755	1.057	0.806	1.053	1.111	1.187
Switzerland	5.32	0.805	0.832	0.861	0.971	0.697	0.894	1.188	1.021	1.182	0.909	1.460	0.927	0.762	0.617	0.862	1.054	0.820	0.798	0.759	0.983
Poland	2.78	1.167	0.773	0.924	0.603	0.791	1.024	0.989	0.587	0.957	1.041	0.760	1.030	0.946	0.845	1.034	1.005	0.851	0.712	1.073	1.117
Sweden	4.70	0.839	0.990	0.973	0.989	0.876	0.985	1.160	1.012	1.094	0.727	1.302	1.008	0.813	0.840	0.545	1.029	1.066	0.812	0.825	0.879
Taiwan	3.07	1.008	0.931	0.912	0.863	0.812	0.894	1.348	1.032	0.842	1.002	1.192	0.905	0.958	1.079	0.765	0.749	0.814	1.157	0.990	0.998

Table 2B. Matrix (AAIij), 2019.

Country		Medicine (miscellaneous)	Electrical and Electronic Engineering	Condensed Matter Physics	Chemistry (miscellaneous)	Electronic. Optical and Magnetic Materials	Computer Science Applications	Physics and Astronomy (miscellaneous)	Materials Science (miscellaneous)	Mechanical Engineering	Biochemistry	Engineering (miscellaneous)	Molecular Biology	Materials Chemistry	Applied Mathematics	Software	Computer Networks and Communications	Mechanics of Materials	Computer Science (miscellaneous)	Physical and Theoretical Chemistry	Atomic and Molecular Physics. and Optics
	CpD Aver	0.92	0.66	0.94	1.39	0.79	0.67	1.14	1.04	0.92	1.10	0.61	1.03	1.04	0.61	0.79	0.43	1.01	0.51	1.06	0.80
U. S.	3.63	0.226	0.249	0.238	0.277	0.240	0.249	0.291	0.304	0.247	0.245	0.315	0.244	0.239	0.217	0.209	0.344	0.256	0.289	0.222	0.248
China	3.57	0.200	0.242	0.221	0.270	0.244	0.249	0.205	0.259	0.226	0.226	0.226	0.198	0.241	0.247	0.256	0.201	0.260	0.244	0.239	0.204
United Kingdom	4.00	0.238	0.284	0.225	0.219	0.197	0.274	0.268	0.237	0.229	0.233	0.319	0.242	0.231	0.230	0.223	0.279	0.220	0.262	0.221	0.215
Germany	3.85	0.229	0.177	0.202	0.229	0.197	0.200	0.258	0.220	0.194	0.238	0.266	0.241	0.197	0.173	0.165	0.187	0.201	0.173	0.204	0.187
Japan	2.73	0.200	0.172	0.219	0.263	0.221	0.174	0.266	0.255	0.182	0.233	0.256	0.232	0.188	0.171	0.179	0.194	0.201	0.198	0.228	0.223
France	3.75	0.257	0.178	0.178	0.184	0.152	0.195	0.263	0.186	0.189	0.227	0.273	0.245	0.177	0.175	0.169	0.187	0.194	0.169	0.184	0.176
Italy	3.97	0.238	0.249	0.231	0.193	0.212	0.267	0.226	0.219	0.206	0.220	0.308	0.235	0.236	0.222	0.243	0.238	0.214	0.196	0.209	0.207
Canada	3.92	0.259	0.281	0.219	0.224	0.196	0.289	0.306	0.234	0.206	0.219	0.230	0.206	0.193	0.276	0.223	0.352	0.190	0.239	0.202	0.243
India	2.14	0.322	0.318	0.356	0.242	0.378	0.199	0.202	0.260	0.307	0.308	0.182	0.322	0.372	0.356	0.345	0.283	0.294	0.371	0.341	0.360
Australia	4.44	0.223	0.348	0.298	0.257	0.285	0.327	0.295	0.298	0.328	0.252	0.318	0.234	0.259	0.262	0.306	0.311	0.293	0.257	0.228	0.288
Spain	3.77	0.234	0.243	0.220	0.215	0.209	0.243	0.294	0.210	0.219	0.224	0.293	0.223	0.213	0.209	0.242	0.236	0.210	0.223	0.202	0.215
Russian	1.72	0.308	0.201	0.252	0.181	0.266	0.191	0.155	0.164	0.227	0.280	0.235	0.359	0.261	0.225	0.223	0.308	0.211	0.286	0.286	0.283
South Korea	3.30	0.219	0.228	0.233	0.234	0.236	0.225	0.250	0.252	0.242	0.218	0.289	0.185	0.253	0.202	0.252	0.269	0.269	0.250	0.231	0.215
Netherlands	4.87	0.241	0.173	0.181	0.210	0.164	0.195	0.289	0.185	0.175	0.223	0.251	0.226	0.193	0.156	0.149	0.163	0.187	0.147	0.178	0.166
Brazil	2.40	0.265	0.216	0.242	0.164	0.247	0.279	0.341	0.176	0.196	0.247	0.381	0.258	0.240	0.256	0.203	0.276	0.178	0.159	0.266	0.270
Switzerland	5.32	0.199	0.160	0.182	0.191	0.176	0.186	0.285	0.199	0.204	0.203	0.303	0.213	0.204	0.148	0.160	0.188	0.193	0.203	0.166	0.173
Poland	2.78	0.263	0.213	0.212	0.188	0.161	0.250	0.300	0.200	0.208	0.264	0.218	0.248	0.221	0.187	0.269	0.218	0.232	0.183	0.224	0.262
Sweden	4.70	0.210	0.203	0.192	0.213	0.186	0.202	0.261	0.207	0.198	0.205	0.269	0.211	0.158	0.148	0.183	0.201	0.192	0.159	0.175	0.185
Taiwan	3.07	0.239	0.197	0.217	0.232	0.179	0.195	0.344	0.247	0.234	0.224	0.276	0.225	0.218	0.191	0.196	0.172	0.239	0.243	0.220	0.215
Turkey	2.38	0.208	0.374	0.356	0.185	0.493	0.241	0.356	0.257	0.306	0.317	0.407	0.363	0.331	0.477	0.332	0.222	0.302	0.347	0.323	0.549

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