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Scientific Achievements of Economic Academic Workers in Poland: Bibliometric Analysis

Introduction

An indispensable element of the work of every scientist is the outcome of their research – scientific publications. The prestige of a given publication is proved by the journal it is published in and the publication's bibliometric characteristics based on the number of citations (Citescore, Impact Factor). The higher quality the publications are, the greater the ranks of the authors and the university they represent. The number of researchers' publications and the comparison of citations can be used inside and outside the university. It is possible to evaluate employees during individual assessments, procedures concerning science degrees, granting scholarships and preparing reports on a university's activities that are necessary to obtain funds (Komperda and Mąka-Stolingwa 2017). Information on the number of publications, citations and indexes may also be used during the benchmarking of universities.

The literature review showed the existence of a research gap which was defined as the lack of comparisons of scientific achievements (in terms of citations) among research workers of economic universities in Poland. Therefore, the aim of the study is to present and compare the scientific achievements of employees of economic universities in Poland using a list of bibliometric indicators as basis (number of publications, number of citations, *h*-index). In order to achieve the article's goal, the following research questions were posed:

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1. What is the average number of publications, citations and the Hirsch index amid economic universities in Poland?
2. Which indicators show significant discrepancy?
3. What similarities can be identified in the analyzed indicators of different economic universities in Poland?
4. How is the number of citations related to the number of publications among economic universities in Poland?

In order to answer the research questions, a bibliometric analysis was used. The subject of the study were five economic universities in Poland (University of Economics in Katowice, University of Economics in Kraków, University of Economics in Wrocław, University of Economics in Poznań, Warsaw School of Economics).

The structure of the article is as follows. The first part presents a review of the literature on bibliometric measurement methods and factors that hinder the interpretation of the results. Moreover, the section covers the research conducted so far in the field. The second part concerns research methodology, while the third involves the results of the analysis. The article ends with a discussion and summary.

1. Literature review

1.1. Bibliometric measures

Observing higher education in Poland over past few decades, one can notice the diversity of research centers on many levels. These include research potential, size and complexity of the structure of universities, as well as the number of staff and students. Progressive differentiation is a natural phenomenon that is influenced by many factors. One of the essential aspects of scientific quality is the scientific potential defined by the scientific achievements of research workers. The achievements are influenced by the number of publications and citations which constitute the basis for computational bibliometric indicators.

Bibliometrics is not a new field. The awareness that citations can be a measure of the impact of scientific achievements has been present since the 1960s (Garfield 1965), but only recently there has been a significant increase in the importance of bibliometric research. The reasons behind it are (Siłka et al. 2016):

- an increase in the number of people conducting research activities,
- conditions related to the science management system, including dependence of research funding on bibliometric indicators,
- intensive development of IT systems and databases enabling both quick access to publications and the conduct of relevant statistics and research.

The term "bibliometrics" was first used by Prichard (1969) who defined it as the application of mathematical and statistical methods to the analysis of book development processes and other means of communication. According to the modern, slightly broader definition adopted by Statistics Poland, bibliometrics

can be defined as the application of mathematical and statistical methods to scientific literature, allowing the assessment of the amount of "scientific output", assuming that the essence of scientific activity is the production of "knowledge", which is reflected in the literature research (Statistics Poland 2021). On the other hand, as part of bibliometric analysis, quantitative research is used to assess the scientific potential of both institutions and researchers, along with their participation in world science. The analysis takes into account the number of publications and citation rates.

The number of publications is the basic measure of the knowledge "productivity", but it should be noted that it does not indicate the quality of the publication. The number of scientific publications is influenced by the intensity of research and the ability to describe them in the form of, for instance, scientific articles (Przyłuska and Maczuga 2011). Furthermore, the intensity of publishing varies according to the field of expertise. Most works are created in intensively developing disciplines such as physics, chemistry, astronomy, biology or medicine.

Comparisons in the academic record usually start with a compilation of the number of publications. There are also other indicators that can be derived from the number of publications. These involve the relationship between the publication and its dissemination in the form of citations. One such indicator is the number of citations that shows how many times a given publication has been cited in other scientific papers. It can be concluded that the greater the number, the greater the scientific value of the cited publication. However, this parameter is a quantitative factor that does not provide information about the quality of the publication (Przyłuska and Maczuga 2011).

Another indicator used in a bibliometric analysis is the Impact Factor (IF) which determines the measure of the impact of a scientific journal on a given field of knowledge (Życzkowski 2011). The Impact Factor was introduced by E. Garfield in the 1950s. While working as a librarian at Johns Hopkins University, he created a tool helpful in choosing journal subscriptions. Although initially this index was not very popular, its importance and application increased significantly with time, making it of the main indicators of bibliometric evaluation today. The Impact Factor of a particular journal in a given year is calculated as the quotient of the total number of citations of articles published in this journal in two previous years, to the number of articles published in this journal in the same time period (Przyłuska and Maczuga 2011). This indicator is calculated for each publishing year and applies to journals registered with the Institute of Scientific Information (ISI) database. This method is based on the assumption that by comparing the popularity of journals, expressed by citations, it is possible to identify the most important for researchers, i.e. the most influential (Osiński 2012).

Another indicator of bibliometric analysis is the index defined by Hirsch (2005) – it is considered one of the basic measures of scientific achievements of a scientist or an institution. According to the structure proposed by Hirsch, the index is equal to the number h if h is the number of publications that are cited at least h times (Mrówczyński 2010). The Hirsch index can be considered a supplement to

the IF index, and, most importantly, it covers two aspects of scientific activity – productivity (number of publications) and quality (citation index) (Braun et al. 2006). However, the Hirsch index in the presented form has a certain imperfection – in case of comparing research centers, it is possible for large entities that publish more papers to obtain higher values of the index and this distorts comparability (Kierzek 2009). To avoid this concern, a revised method of calculating the Hirsch index for institutions was introduced (Molinari and Molinari 2008), taking into account the number of published papers depending on the size of a given scientific institution. The modified h_m index shows the following relationship: N: $h_m = h/N^{0.4}$, where h is the Hirsch index and N is the number of publications. The modified Hirsch index can be used to compare research centers or universities.

The last of the indicators discussed in this study is the $i10$ index. This measure is one of the newest bibliometric indicators, introduced by the Google Scholar database in 2011. As a simple index measure, it indicates the number of published works with at least 10 citations (Noruzi 2016).

In addition to the indicators described above, one can also mention an additional factor that intensifies the importance of bibliometric indicators – the evaluation of a given publication in the context of the "scientific position" of the journal in which it is published. It can be expressed in the number of points assigned to journals, the list of which is announced by Ministry of Science and Higher Education Republic of Poland (2021). In the system of higher education and awarding degrees there is, therefore, an approach promoting publication in journals with the highest possible number of points according to the ministerial list. It should be emphasized that the ministerial list is criticized among many academics, including members of the Polish Academy of Sciences (PAN, 2020). Among the main disadvantages of point lists for journals one can identify:

- discrimination against Polish journals despite their high quality,
- extinguishing the potential of journals and publishing houses in Poland – publishing there is unprofitable in terms of the number of points awarded,
- the list is not of an expert nature – the Ministry interferes with the list created by scientists appointed by the communities.

The bibliometric indicators allow to assess the scientific achievements of both scientists and research centers. It is worth mentioning that the bibliometric analyses performed with the use of the presented indicators are based on the citation databases, including Scopus, Web of Science (WoS), and Google Scholar. However, it should be noted that these bases show differences in their construction (Falagas et al. 2008; Kousha and Thelwall 2011; Lopez-Cozar and Robinson-Garcia 2013; Thelwall 2016; Wiechetek 2019; Ortega 2017). This means that the results of a study conducted by the same scientist or institution may differ depending on the databases used (Bar-Ilan 2008).Therefore, in order to maintain the comparability of the studied units, it is justified to analyze within the same database. The most important information on databases is presented in Table 1.

In both Polish and foreign literature, one can find information on the differences between the platforms. The number of citations of authors shows large

Table 1

Comparisons of scientific publications databases

Parameter	Google Scholar	Scopus	Web of Science
Description	The database mainly contains articles available online	The database contains only peer-reviewed Scientific publications	Abstract and bibliometric base
Free	Yes	No	No
Algorithm	Citation counter, relevance, publication date, words in the document title	Citation counter, date, words in the document title	Indices: Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), Art & Humanities Citation Index (AHCI), Conference Proceedings Citation Index (CPCI)
Disadvantages	New publications are poorly positioned despite the up-to-date data	Long indexing time, no information about all author's publications (formal requirements)	No information about all the author's publications

Source: own elaboration.

discrepancies resulting from indexing time and formal requirements. The most popular search engine is currently Google Scholar which finds more citations than the other databases (Thelwall and Kouscha 2017). According to Mingers et al. (2012), citations should be analyzed on the basis of Google Scholar due to the precise number of citations. It should be emphasized that this is the most popular database among young scientists (Wiechetek 2019).

Google Scholar is a free and publicly available scientific publication search engine that provides information on the number of publications, citations and indexes. Its greatest advantage is the quick indexing time and the newest data. Creating an account is free and it is possible to index every scientific article. For this reason, the Google Scholar search engine was used to collect data in this study.

1.2. Bibliometric analysis – potential and problems

Bibliometric analysis should be used in the evaluation of the publishing activity of researchers and research units. Thanks to it, it enables to determine the level of institutions within a region, country and on the international arena (Huang et al. 2011). For this to take place, it is necessary to use indicators that make it possible to compare publication activity. The methodology of integer and fractional calculations requires consideration. According to the work of Aknes et al. (2012) and their analysis that was carried out in 23 countries, the relative index shows lower results when counting fractions.

For this purpose, the previously discussed indicators (number of publications, number of citations, Impact Factor, Hirsch index) are used. As can be seen, these measures take into account other criteria, but their common problem is to show the number of publications without taking into account the quality and the number of authors. Because of contemporary challenges posed by science, researchers often work on projects together (Claxton 2005). However, there is a problem of evaluating a given author in terms of their contribution and the way of measuring their research output (Clement 2013). An article published in "Physical Review Letters" journal is signed by 5,154 authors (Aad et al. 2015) and can be used as an example. The following question should be asked: is every author's contribution significant? The multitude of authors in scientific publications is a challenge that should be taken up in future scientific research.

The evaluation of publishing activity requires appropriate IT tools. It may turn out that not all scientists are listed in a given database or that their work has not been entered into this database. The currency of data requires the involvement of research workers and their universities. The database of scientific achievements can be used during individual employee appraisal, competitions, project funding applications, unit appraisal, reports on scientific activity and when allocating funds for research.

1.3. Bibliometric analyses in science

The area of interest of this study is a comparative analysis of economic universities in Poland in terms of scientific publications and rankings. In such comparative analyses conducted so far, one can notice a large diversity both in terms of disciplines and scientific institutions. On international scale, an example may be the comparison of the average number of publications and obtained results cited per one scientist in the USA, as presented in Table 2.

The presented comparison shows a large variation between individual scientific disciplines in terms of bibliometric indicators. This is especially visible when comparing, for instance, mathematics with physics. The American mathematician publishes an average of 0.23 studies per year, while the physicist publishes 1.97 papers per year. At the same time, on average, a mathematician is cited 3.45 times a year, while a physicist is cited 54.81 times. Thus, the average physicist gets almost 16 times more citations than a mathematician. A similar differentiation can also be seen in the comparison of bibliometric indicators in Poland (Table 3).

Referring to the example of the comparison in accordance with Table 2, it can be noted that also in Poland, both in the number of publications and the number of citations, physics gets higher results than mathematics – 259 versus 170 in publications and 9068 versus 1141 in total number of citations. Similar differences can also be observed in other scientific disciplines.

The diversity of scientific disciplines in the area of bibliometric indicators affects the assessment of research centers specializing in a given discipline. An example of such comparison can be found in Table 4 which pre-

Table 2

Average number of publications and the number of citations obtained per year per one scientist in the USA

Branch of science	Works per year (by scientists in the US)	Scientists (in the US)	Average number of authors per work	Average number of papers per year per scientist	Average number of citations per work	Average number of citations per year per researcher	Average number of citations compared to mathematics
Mathematics	4 190.5	37 000	2.0	0.23	14.98	3.45	1.0
Physics	18 227.2	49 000	5.3	1.97	27.82	54.81	15.9
Chemistry	16 429.8	86 000	4.3	0.82	31.68	25.98	7.5
Informatics	2 188.3	20 000	3.0	0.33	17.43	5.75	1.7
Engineering sciences	14 609.1	144 000	3.8	0.39	18.67	7.28	2.1
Earth sciences	11 620.8	21 000	4.0	2.21	33.05	73.04	21.2
Agricultural sciences	3 469.2	22 000	4.3	0.68	20.84	14.17	4.1
Biological sciences	49 614.1	193 000	5.3	1.36	41.06	55.84	16.2
Psychology	9 805.3	114 000	3.2	0.28	46.47	13.01	3.8
Social sciences	12 020.3	100 000	1.9	0.23	26.79	6.16	1.8
Year	2009	2006	2008		2011		

Source: Błocki and Życzkowski 2013, p. 39.

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Table 3

Results of the analysis of the scientific achievements of 19 Polish scientists conducting research in various disciplines

Letter designation of a person	Scientific discipline according to ISI	Number of publications	Total number of citations	Average citation/publication	Number of publications/year	Best cited publication	Number of publications cited over 100 times	Number of publications cited more than 50 times	Index *h*	*h*-index/number of publications	Self-citations percentage	*h*-index without self-citations	*h*-index/number of co-authors	*h*-index/number of years of work	The sum of citations of publications included in the h index pool	Average of citations for publications from the h index pool (*A*-index)	Citation root of publications in the *h* index pool (*R*-index)	Correction factor for different disciplines	*h*-index/correction factor for disciplines	*h*-index/correction factor for disciplines and without self-citations
A	Space science	170	5336	31.39	9.44	254	8	38	45	5.77	62.40	16.90	4.7	2.50	3 853	85.6	62.1	0.74	33.3	12.5
B	Microbiology	186	5076	27.29	7.15	581	8	34	40	4.94	48.60	20.60	8.3	1.54	3 515	87.9	59.3	0.63	25.2	13.0
C	Physics	259	9068	35.01	7.85	2646	12	26	37	4.01	47.10	19.60	6.7	1.12	7 251	196.0	85.2	1.00	37.0	19.6

D	Molecular biology & genetics	65	5136	79.02	2.32	538	18	32	37	6.97	46.60	19.80	8.8	1.32	4 821	130.3	69.4	0.44	16.3	8.7
E	Chemistry	86	4644	51.60	2.64	1103	12	32	36	6.06	32.80	24.20	8.0	1.09	4 183	116.2	64.7	0.92	33.1	22.2
F	Biology & biochemistry	137	2737	19.98	3.91	227	5	14	29	4.05	55.80	12.80	6.9	0.83	1 911	65.9	43.3	0.60	17.4	7.7
G	Immunology	87	6569	75.51	2.64	1482	17	23	27	4.52	29.00	19.20	5.9	0.82	6 228	230.7	79.9	0.52	14.0	9.9
H	Pharmacology & toxicology	159	2333	14.67	4.54	144	2	9	26	3.42	49.30	13.20	5.5	0.74	1 330	51.1	36.5	0.84	21.8	11.1
I	Plant & animal science	85	2053	24.15	3.15	342	2	12	26	4.40	35.20	16.80	4.6	0.96	1 577	60.6	39.7	1.08	28.1	18.2
J	Environment & ecology	78	1717	22.01	3.90	118	2	7	26	4.55	47.50	13.60	6.4	1.30	1 204	46.3	34.7	0.88	22.9	13.7
K	Psychiatry & psychology	238	1779	7.47	6.80	159	2	6	23	2.58	26.60	16.90	5.4	0.66	1 306	48.2	33.3	0.88	20.2	14.8
L	Clinical medicine	171	1696	9.92	5.07	195	2	7	23	2.94	28.10	16.50	1.4	0.77	1 220	53.0	34.9	0.76	17.5	12.6
M	Neurosciences & behaviour	103	1358	13.18	3.03	106	1	4	21	3.29	38.40	12.90	5.9	0.62	895	42.6	29.9	0.56	11.8	7.3
N	Geosciences	47	1815	38.62	1.31	239	6	11	19	4.08	49.40	9.60	6.5	0.53	1 593	83.8	39.9	0.88	16.7	9.6
O	Mathematics	70	1141	16.30	2.06	120	1	5	19	3.47	43.10	10.80	9.5	0.56	749	39.4	27.2	1.83	34.8	19.7
P	Computer science	120	1231	10.26	4.14	187	3	3	18	2.65	49.70	9.10	5.2	0.62	784	43.6	28.0	1.75	31.5	15.8
R	Agricultural sciences	145	1129	7.79	6.30	77	3	0	17	2.32	43.80	9.60	4.8	0.74	593	34.9	24.3	1.27	21.6	12.1
S	Materials science	56	471	8.41	1.65	56	0	2	13	2.60	36.10	8.30	5.1	0.38	346	26.6	18.6	1.36	17.7	11.3
T	Engineering	75	286	3.81	2.59	54	0	1	8	1.42	48.30	4.10	2.8	0.28	194	24.2	13.9	1.70	13.6	7.0

Source: Kierzek 2009.

Table 4

List of publications of selected institutes of the Polish Academy of Sciences and Polish universities in the period from 1973 to April–May 2008

Organization	1973–2008					2000–2008				
	Number of publications	Total number of citations	Avg. number of citations	h-index	h_m-index	Number of publications	Total number of citations	Avg. number of citations	h-index	h_m-index
Institute of Physics – Polish Academy of Sciences	10 926	93 590	8.89	87	2.11	3 896	21 919	5.63	47	1.72
Institute of Physical Chemistry Polish Academy of Sciences	3 953	39 692	10.04	63	2.29	1 602	8 322	5.19	28	1.46
Centre of Molecular and Macromolecular Studies – Polish Academy of Sciences	2 276	28 115	12.35	61	2.77	716	5 095	7.12	29	2.09
Institute of Organic Chemistry – Polish Academy of Sciences	2 879	29 246	10.16	53	2.19	909	5 169	5.69	25	1.64
Nencki Institute of Experimental Biology	2 231	20 656	9.26	52	2.38	760	4 482	5.90	29	2.04
Institute of Biochemistry and Biophysics – Polish Academy of Sciences	1 769	20 900	11.81	51	2.56	652	5 549	8.51	31	2.32
Maj Institute of Pharmacology – Polish Academy of Sciences	1 682	17 523	10.42	51	2.61	890	6 146	6.91	31	2.05
Institute of Bioorganic Chemistry – Polish Academy of Sciences	1 018	12 775	12.55	48	3.01	516	3 875	7.51	26	2.14
Institute of Nuclear Physics – Polish Academy of Sciences	1 521	13 316	8.75	47	2.51	1 163	9 296	7.99	42	2.49
Mossakowski Medical Research Institute – Polish Academy of Sciences	2 277	14 650	6.43	42	1.91	1 008	4 150	4.12	23	1.45
Institute of Low Temperature And Structure Research	3 929	21 932	5.58	41	1.50	1 671	6 300	3.77	25	1.28
Jerzy Haber Institute of Catalysis and Surface Chemistry – Polish Academy of Sciences	970	10 053	10.36	40	2.55	514	2 770	5.39	21	1.73
Nicolaus Copernicus Astronomical Center – Polish Academy of Sciences	285	5 030	17.65	38	3.96	192	1 865	9.71	20	2.44
Institute of Molecular Physics – Polish Academy of Sciences	2 739	13 847	5.06	35	1.48	1 192	3 911	3.28	22	1.29
Institute of Fundamental Technological Research – Polish Academy of Sciences	1 775	7 514	4.23	31	1.55	458	1 186	2.59	13	1.12
Institute of Mathematics – Polish Academy of Sciences	1 113	6 027	5.42	31	1.87	395	1 008	2.55	13	1.19
Polish Academy of Sciences	62 938	463 941	7.37	136	1.64	22 735	109 549	4.82	73	1.32

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University of Warsaw	21 000	231 886	11.04	143	2.67	7 693	52 353	6.81	72	2.01
Jagiellonian University in Kraków	18 008	147 832	8.21	105	2.08	9 401	54 636	5.81	68	1.75
Warsaw University of Technology	8 764	52 569	6.00	72	1.91	4 024	18 329	4.55	46	1.66
University of Wrocław	10 945	76 302	6.97	70	1.70	4 254	19 916	4.68	43	1.52
University of Gdańsk	5 125	41 660	8.13	69	2.26	2 528	13 519	5.35	40	1.74
Medical University of Warsaw	5 026	29 301	5.38	63	2.08	2 443	10 350	4.24	39	1.72
Adam Mickiewicz University, Poznań	10 553	66 293	6.28	62	1.52	4 836	20 367	4.21	39	1.31
Maria Curie-Skłodowska University	6 675	45 194	6.77	58	1.71	2 643	10 417	3.94	28	1.20
Nicolaus Copernicus University in Toruń	5 527	38 103	6.89	57	1.82	2 364	10 602	4.48	33	1.48
Medical University of Łódź	4 786	28 497	5.95	55	1.86	2 498	10 557	4.23	34	1.49
Łódź University of Technology	7 231	36 077	4.99	54	1.54	3 065	8 270	2.70	26	1.05
University of Łódź	6 035	34 811	5.77	52	1.60	2 483	10 470	4.22	34	1.49
Medical University of Gdańsk	4 152	25 190	6.07	52	1.86	2 232	9 952	4.46	34	1.56
University of Silesia in Katowice	5 440	31 882	5.86	51	1.63	2 794	11 931	4.27	36	1.51
Wrocław University of Science and Technology	8 325	41 058	4.93	50	1.35	3 703	13 053	3.52	29	1.08
Gdańsk University of Technology	4 619	29 877	6.47	49	1.68	2 287	8 879	3.88	33	1.50
AGH University of Science and Technology	4 227	21 697	5.13	47	1.67	2 669	8 434	3.16	27	1.15
Poznań University of Technology (PUT)	3 645	21 148	5.80	46	1.73	1 672	7 144	4.27	32	1.64
Poznań University of Medical Sciences	3 969	17 753	4.47	46	1.67	1 998	5 318	2.66	26	1.24
Silesian University of Technology	3 239	13 992	4.32	42	1.66	1 677	4 690	2.80	25	1.28
Medical University of Lublin	2 206	11 403	5.17	40	1.84	1 072	2 722	2.54	20	1.23
Pomeranian Medical University in Szczecin	1 338	8 270	6.18	39	2.19	862	4 441	5.15	29	1.94
Medical University of Silesia in Katowice	2 148	9 491	4.42	38	1.77	1 295	4 809	3.71	26	1.48
Medical University of Białystok	2 956	12 970	4.39	37	1.51	1 545	5 737	3.71	26	1.38
Szczecin University of Technology	2 589	10 753	4.15	35	1.51	1 459	4 321	2.96	23	1.25
Wrocław Medical University	2 498	9 286	3.72	33	1.44	1 298	3 983	3.07	26	1.48
Poznań University of Life Sciences	1 837	8 706	4.74	33	1.63	832	2 110	2.54	18	1.22
Warsaw University of Life Sciences – SGGW (WULS – SGGW)	1 874	9 055	4.83	31	1.52	933	3 252	3.49	21	1.36

Source: Kierzek 2008, p. 32.

Table 5
Characteristics of global university rankings

Evaluation criteria	ARWU	Leiden Ranking	Quacquarelli Symonds	Scimago	THE
Reflecting reality	MEDIUM – STRONG – the problem of Nobel laureates graduates (10%)	STRONG – results are based on publications and citations	POOR – results strongly determined by the methods	STRONG – results are based on publications and citations	POOR – results strongly determined by the methods
Objectivity	STRONG – awards and publications only	STRONG – publications and citations only	POOR – the survey results account for 50% of the final position	STRONG – publications and citations only	POOR – the survey results account for 34.5% of the final position
External data sources	MEDIUM – STRONG – HEIs can affect the number of staff (10%)	STRONG – All data comes from Web of Science	MEDIUM– WEAK – data negotiated with HEIs in some areas	STRONG – all data comes from the SCOPUS database	WEAK – in some areas, data negotiated with HEIs
Versality	POOR–research Orly	Poor – based only on research data	MEDIUM – research reputation, internationalization	POOR – based only on research data	MEDIUM – STRONG – as in QS plus PhDs and financial resources
Detailed	AVERAGE – a multivalued indicator, internally correlated	STRONG –standal one indicators	WEAK – approximations, arbitrary weights within the multivariate	STRONG –standal one indicators	WEAK – arbitrary weights within the multivariate
The peoportionality of assigning ranks	MEDIUM – ranks up to 100, followed by large groups	STRONG – indicators allow you to assign individual ranks	POOR – single ranks up to 400, further groups up to 1000+	STRONG – indicators allow you to assign individual ranks	POOR – single ranks up to 200, further groups 1000+
Align the results	MEDIUM – WEAK – research bias; the Nobel blockade at the top of the hierarchy	MEDIUM – research bias; clear goals, steep hierarchy	(MEDIUM) POOR – false range, volatility.	MEDIUM – research bias; clear goals, steep hierarchy.	(MEDIUM) POOR –. false range, volatility.
Transparency	MEDIUM – scale not transparent to non–specialists	MEDIUM – STRONG – partially opaque to non–specialists	POOR – scale and questionnaires not transparent to specialists	MEDIUM–STRONG – partially opaque to non–specialists	POOR – complex scale and non–transparent to specialists

Source: Marginson 2016, p. 189, cited after: Szadkowski 2019, p. 16.

sents a list of scientific institutes of the Polish Academy of Sciences (PAS) and universities, with the evaluation of scientific achievements in the form of the Hirsch index at a level of at least 30, over the years 1973–2008. Scientific institutes of the Polish Academy of Sciences and universities are shown separately and arranged according to the decreasing values of the Hirsch index.

The presented data shows that the University of Warsaw (21 000), the Jagiellonian University (18 008), the University of Wrocław (10 945), the Adam Mickiewicz University (10 553) and the Warsaw University of Technology (8 764) had the greatest number of publications among universities here listed.

It is worth noting that universities are compared not only in terms of the results of bibliometric analysis. Additionally, there are also university rankings prepared by various institutions and magazines. Based on the adopted criteria and methodology, the rankings present the grades of individual universities. According to the different evaluation methods, the position of the same university may vary in different rankings. Due to their imperfections, rankings of this type are subject to many critical assessments. Table 5 presents the global university rankings (Academic Ranking of World Universities (ARWU), Leiden Ranking, Quacquarelli Symonds, Scimago, Times Higher Education World Universities Rankings (THE)) along with their analysis under the criteria proposed by Marginson (2016).

The rankings of universities in Poland are mainly prepared by the following magazines: "Perspektywy", "Wprost", "Newsweek" or "Polityka". These rankings, as in the case of world rankings, differ in terms of the criteria underlying the valuation, hence the position of a given university may be different depending on the type of ranking (Domański et al. 2008). An example of this is the ranking of universities prepared annually by "Perspektywy". In this type of rankings, the bibliographic analysis is one of the many criteria taken into account for university evaluation. In addition to publications, the following criteria are also analyzed ("Perspektywy" 2020):

- prestige,
- a graduate on the labor market,
- innovativeness,
- scientific potential,
- scientific effectiveness,
- training conditions,
- internationalization.

As an example of the ranking of Polish universities, Table 6 presents the ranking created according to the methodology of the "Perspektywy" magazine under the "publication" criterion. Based on the review of the existing bibliometric research, it can be concluded that the research covering economic universities is carried out to a very limited extent. There are comparisons of many universities, but they do not distinguish economic universities. Moreover, these comparisons are not up-to-date. Hence, it is justified to perform a bibliometric analysis of the above-mentioned universities on the basis of current data, and then to compare the obtained results.

Table 6

Ranking of the first 25 public universities according to the "Perspektywy" magazine for 2020 in the publications category (scientific effectiveness)

Score (2020)	Organization	WSK	Publ. 3%	Cit. 3%	FWCI 3%	FWVI 3%	ICI 2%	TOP 10 3%
1	The Jagiellonian University of Kraków	100.0	100.00	63.47	79.37	75.18	53.57	91.99
2	Wrocław Medical University	93.3	27.88	90.51	100.00	66.67	100.00	63.89
3	The University of Warsaw	92.0	82.53	61.76	67.72	69.50	50.97	94.43
4	University of Zielona Góra	90.0	13.40	100.00	97.35	61.70	100.00	62.17
5	University of Białystok	88.0	8.59	88.06	81.48	75.89	86.36	80.83
6	Medical University of Łódź	82.3	31.06	70.52	79.89	62.06	81.49	68.75
7	Pomeranian Medical University in Szczecin	81.2	12.73	66.06	77.25	85.11	71.43	73.26
8	The Medical University of Gdańsk	80.5	24.17	73.21	80.42	54.96	67.21	81.12
9	AGH University of Science and Technology	75.5	74.71	37.73	58.20	68.44	39.29	71.12
10	Warsaw University of Technology	72.2	70.13	35.44	55.56	70.21	35.06	67.16
11	University of Opole	70.8	7.19	44.01	86.24	100.00	42.21	50.12
12	The Adam Mickiewicz University in Poznań	70.2	46.82	45.68	56.08	52.13	36.36	87.98
13	Medical University of Warsaw	67.2	43.97	50.78	61.90	46.10	52.27	62.08
14	Medical University of Silesia in Katowice	66.4	27.61	57.15	59.79	50.00	72.40	53.23
15	Medical University of Białystok	62.8	15.14	51.95	56.08	47.16	48.05	77.53
16	University of Wrocław	61.3	32.82	40.62	53.97	42.91	29.87	83.04
17	University of Silesia in Katowice	61.3	28.66	38.06	46.56	56.03	34.09	81.22
18	Poznań University of Medical Sciences	60.0	30.12	49.77	53.44	39.36	45.45	64.43
19	The Maria Grzegorzewska University	59.3	0.35	46.69	51.32	41.84	36.36	100.00
20	Warsaw University of Life Sciences – SGGW (WULS–SGGW)	58.1	25.16	38.71	50.79	46.10	34.09	75.46
21	Poznań University of Technology (PUT)	58.0	33.97	32.77	59.26	50.71	29.87	61.74
22	Gdańsk University of Technology	57.8	34.55	36.46	57.14	42.91	30.19	66.21
23	University of Gdańsk	57.5	24.46	35.93	48.15	42.20	27.27	87.47
24	Nicolaus Copernicus University in Toruń	57.2	33.53	40.96	50.79	43.62	34.09	63.41
25	University of Rzeszów	56.7	15.54	42.22	52.38	60.64	37.99	56.60

Source*:* https://ranking.perspektywy.pl/2020/ranking/ranking-uczelni-akademickich.

2. Methodology

The subject of the study were scientific achievements of employees of the following economic universities in Poland:

1. University of Economics in Katowice (UE Katowice),
2. University of Economics in Kraków (UE Kraków),
3. University of Economics in Wrocław (UE Wrocław),
4. University of Economics in Poznań (UE Poznań),
5. Warsaw School of Economics (WSE).

The used data was primary and included the 100 most cited authors from each of the universities under consideration. The data collection process took place in November and December 2020. The data was collected using the Google Scholar database. The collected information concerned: the number of publications in the entire scientific career, the total number of citations, the number of citations since 2015, h – total index, h-index since 2015, $i10$ – total index and $i10$-index since 2015. Then, on the basis of the official databases of research workers in Poland, the academic degree of employees was determined (https://nauka-polska.pl) and assigned to a scientific discipline (https://radon.nauka.gov.pl).

The research methods used in the study were bibliometric analysis and statistical inference. The course of the study was two-stage for each of the analyzed variables (number of publications, number of citations and the Hirsch index).

Research hypotheses were defined and verified in relation to two approaches. In the first attempt, the 100 most cited authors of each university were treated as the population of those scientific employers, so descriptive statistics were used for comparison. In the second one, they were treated as a sample. Therefore, fluctuations provide some randomness as a range-shaping factor. In the first stage, the average values of variables for all economic universities were checked together. If it was found that at least one university differs from the rest, a second stage of the study, consisting of comparing all universities in pairs, would be carried out. The median was taken as the average measure in the comparisons.

The comparison of the distribution of ranges in relation to the k-th factor ($k = 1, 2, 3, 4, 5$) was carried out using the Kruskal–Wallis test [Kruskal and Wallis 1952]. The significance level was set at 0.05. The hypotheses were as follows:

$$H_0: F_1 = F_2 = ... = F_k \text{ (}\textit{the k population distributions are identical}\text{)}$$
$$H_1: \exists\, i, j \in \{1, ..., k\}\ F_i \neq F_j \text{ (}\textit{at least two of the population distributions differ}\text{)}$$

If these differences turned out to be statistically significant, then the pairs of fasting ranges were compared for a given factor. For this purpose, the Mann – Whitney U-test was used, and the hypotheses for $\forall\, i, j \in \{1, ..., k\} \wedge i \neq j$ were as follows (Mann and Whitney 1947):

$$H_0: m(p)_i = m(p)_j$$
$$H_1: m(p)_i \neq m(p)_j$$

where $m(p)_i$, $m(p)_j$ are respectively the average rank for the analyzed factor.

3. Results

The analysis of the achievements of employees of economic universities in Poland began with the calculation of basic statistics, which then served as measures in a further stage of the discussion. The results are presented in Table 7.

Table 7

Statistics of the number of publications, citations and the Hirsch index in individual economic universities in Poland

Parameter		University				
		WSE	UE Katowice	UE Kraków	UE Poznań	UE Wrocław
Number of publications	Average	88.7	79.2	78.1	89.8	97.8
	Standard deviation	63	45	51	53	58
	Coef. of variation	0.714	0.5734	0.6534	0.5852	0.5885
Number of citations	Average	678.9	338.3	397.1	681.6	570.6
	Standard deviation	592	401	520	683	936
	Coef. of variation	0.871	1.1859	1.3085	1.0028	1.6406
Hirsch index	Average	11.1	8.3	8.3	11.0	9.0
	Standard deviation	4	3	4	5	5
	Coef. of variation	0.3775	0.4206	0.5293	0.4324	0.5330

Source: own elaboration.

It should be noted that the average number of publications in individual economic universities is at a similar level. On average, scientific employees in the UE Wrocław publish the most – 97.8 per person, and the least figure is found in the UE Kraków. The difference between universities is moderate (57% to 71%).

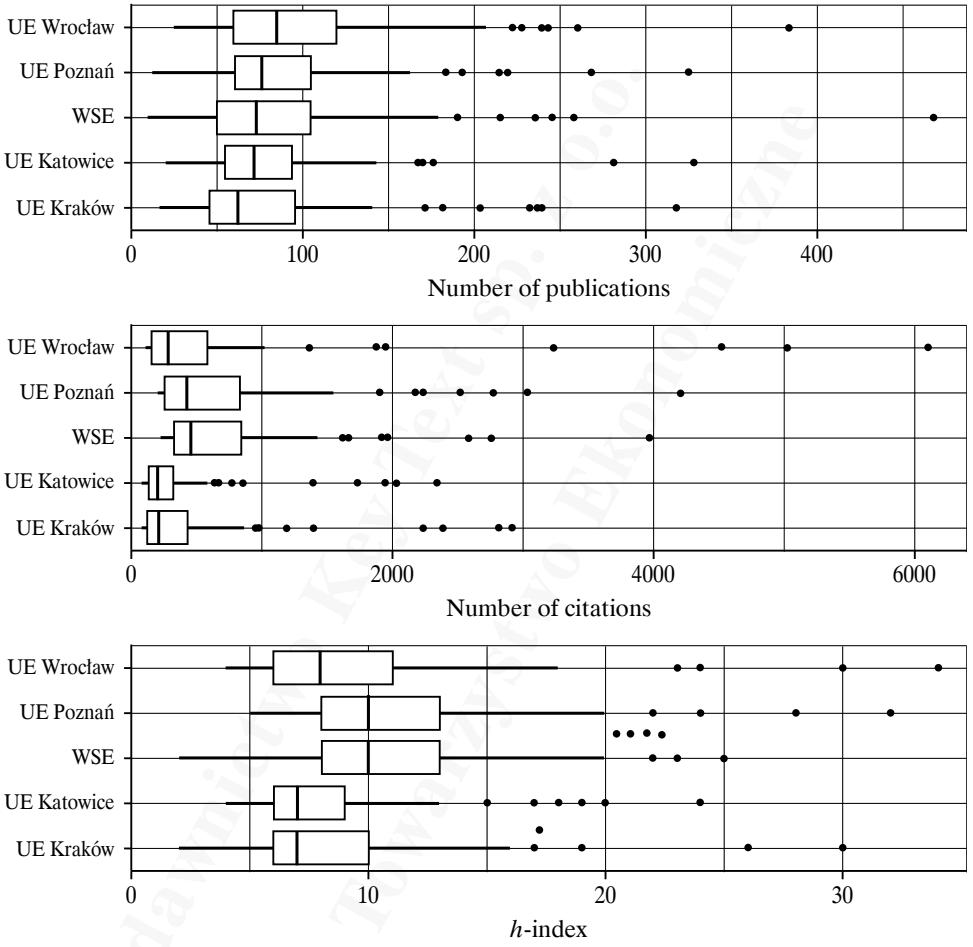
The average number of citations is characterized by the greatest diversification among all the analyzed features – the highest number is as much as 164% in the UE Wrocław, and the lowest one at the Warsaw School of Economics – 87%. This allows us to conclude that although employees reportedly publish a considerable number of scientific articles and books, the citation rate of their publications varies. Furthermore, there are high differences between universities (e.g. the average number of citations of an UE employee in Katowice is only 49.83% of the average number of citations of an employee of the Warsaw School of Economics).

Although high values of differences in citation rates are observed in individual universities, the average Hirsch index for employees is similar between universities. Moreover, inside universities, employees also have similar values of the Hirsch index, which is reflected in the values of the coefficients of variation.

The next step was to determine the positional measures of the studied variables. The distributions with quantile values are presented in Figure 1 for the number of publications (A), the number of citations (B) and the Hirsch index (C), respectively.

Figure 1

Number of publications, number of citations and Hirsch index in economic universities in Poland



Source: own study.

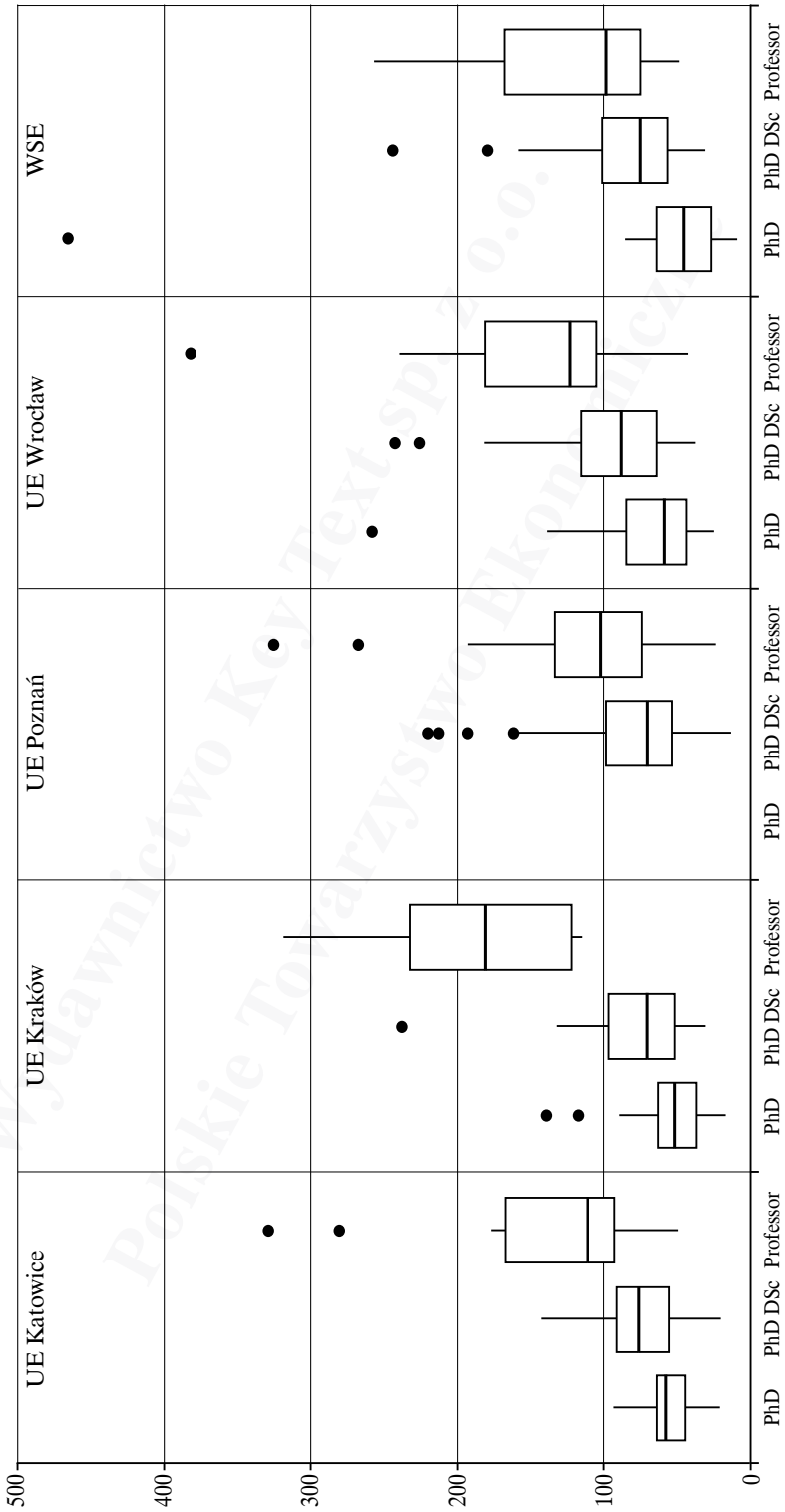
Visualizing the distributions of the variables allowed us to draw several observations:

1. The average number of publications measured with the median is similar for all economic universities under consideration.
2. Although an employee of the Warsaw School of Economics has over 400 publications, the most cited author is affiliated in the UE Wrocław.
3. Employees at the UE Katowice are, on average, the least cited and are characterized by the lowest differentiation.
4. For only four researchers, the Hirsch index is higher than 30. The average values for universities do not exceed 10.

The next step was to check the number of publications and citations among given groups of researchers. The results are presented in Figures 2 and 3.

Figure 2

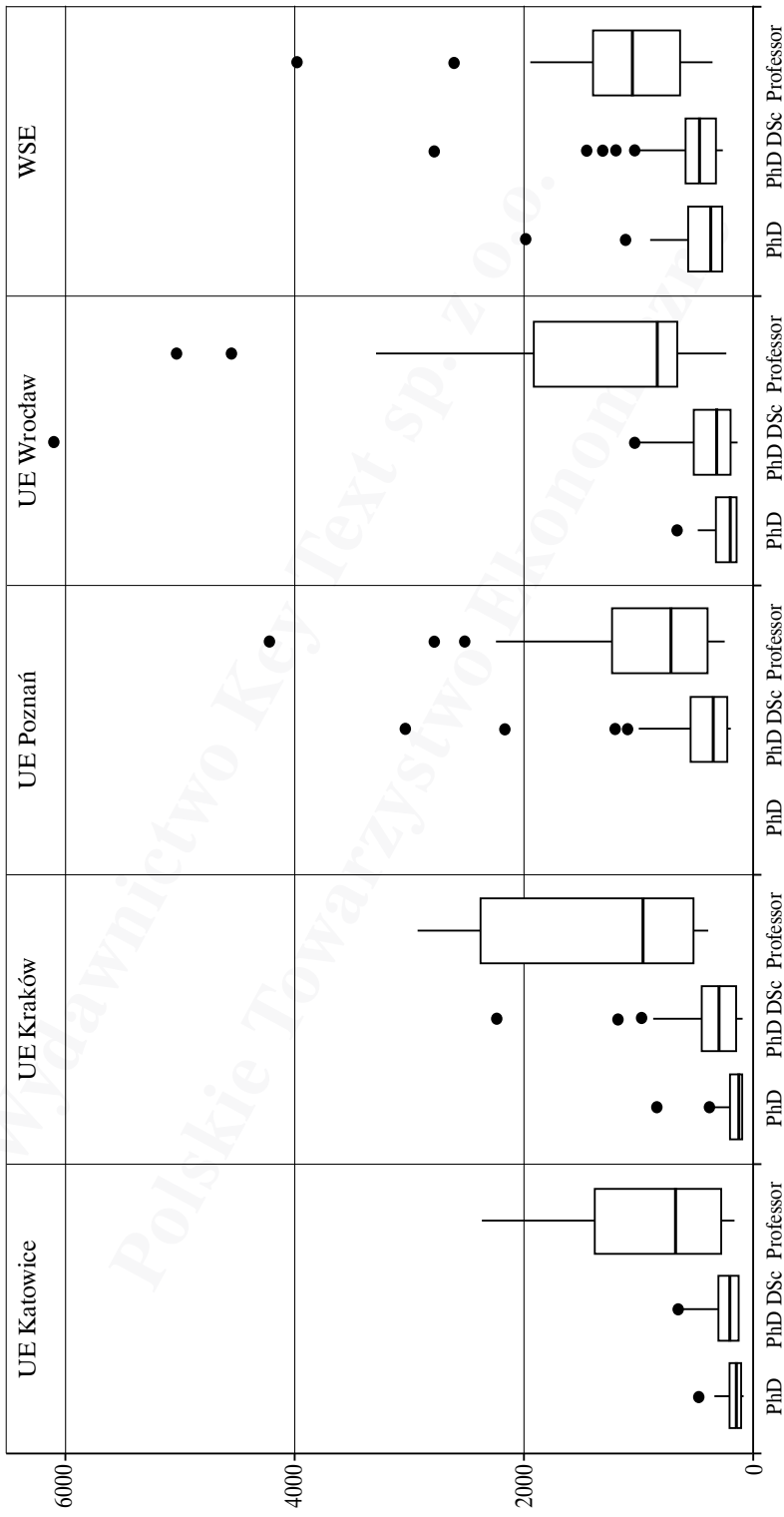
Number of publications of individual groups of research workers in economic universities in Poland



Source: own study.

Figure 3

Number of citations of individual groups of research workers in economic universities in Poland



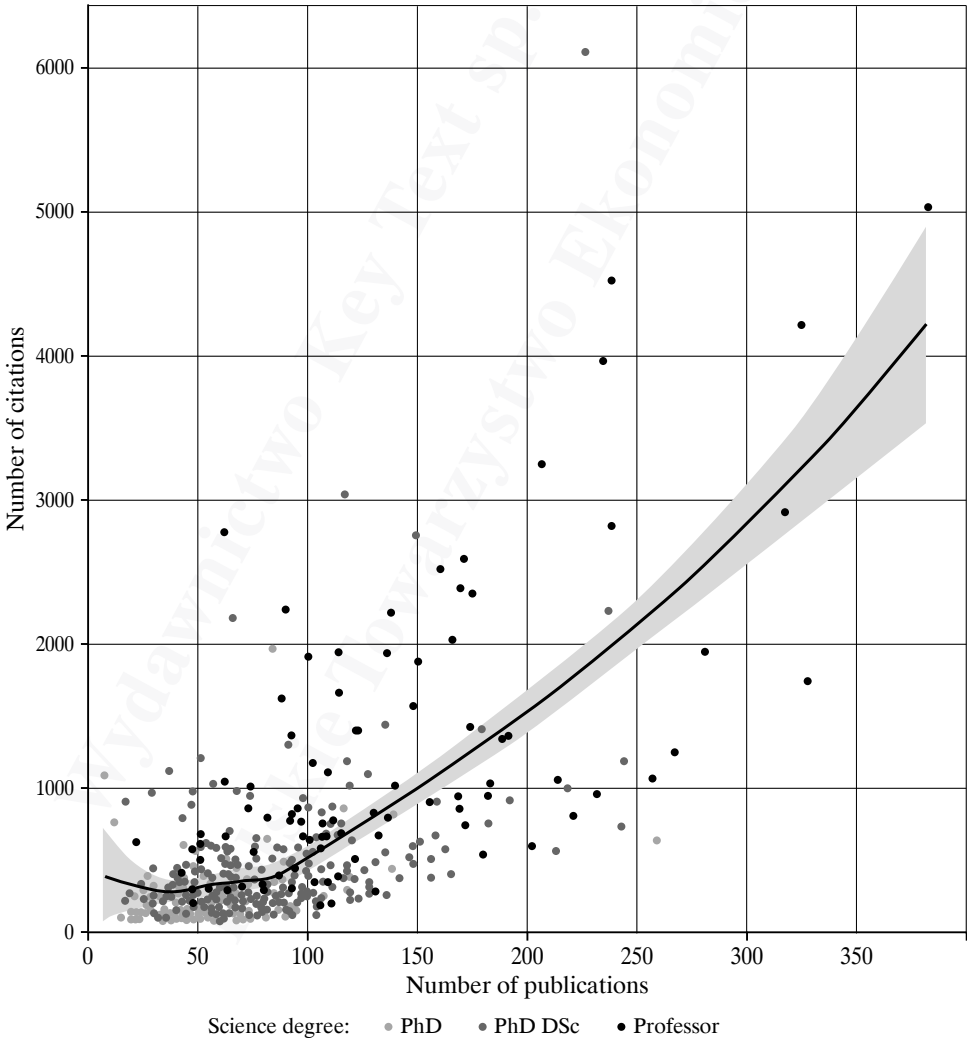
Source: own study.

Visualizing the results allows to observe a certain relationship: the higher the grade, the higher the average number of publications and citations – regardless of the university. It should also be noted that among the 100 most cited authors of the EU in Poznań, all employees have a PhD, DSc or Professor title.

Then, the number of citations and the number of publications were compared with the academic degree. The results are presented in Figure 4[1].

Figure 4

The number of publications and the number of citations, taking into account individual groups of researchers in economic universities in Poland



Source: own study.

[1] One person with only a master's degree and one outlier for the number of publications (over 400) are not included.

Figure 4 shows the following relationship: people with higher academic degrees have more publications and are cited more often. Moreover, it should be observed that the estimated trend function shows that the average increase in the number of publications increases the number of citations.

After the analysis of the structure and dependence, the hypotheses were verified by means of non-parametric tests. In each case, universities were used as the grouping variable (factor). Note that all 5 trials are equal ($n = 100$). Non-parametric tests use the median values presented in Table 8 for individual universities.

Table 8

Median number of publications, citations and the Hirsch index in individual economic universities in Poland

Parameter	WSE	UE Katowice	UE Kraków	UE Poznań	UE Wrocław
Number of publications	73.5	71,5	62	76	85
Number of citations	468	207.5	219.5	431	290.5
Hirsch index	10	7	7	10	8

Source: own elaboration.

The results of the hypothesis verification are as follows:

Number of publications

The KW test showed that at least one university is significantly different from the others in the number of publications (test statistic = 14.007, number of degrees of freedom = 4, p-value < 0.01). The results of the pair comparison using the MWW test are presented in Table 9.

Table 9

Mann-Whitney-Wilcoxon test results for the number of publications (p-values)

	WSE	UE Katowice	UE Kraków	UE Poznań
UE Katowice	0.5600	–	–	–
UE Kraków	0.1626	0.3223	–	–
UE Poznań	0.3094	0.0698	0.0149*	–
UE Wrocław	0.0800*	0.0086*	0.0010*	0.3917

*Differences significant at the significance level of 0.05.

Source: own study.

UE Wrocław differs significantly from WSE, UE Katowice and UE Kraków in terms of the average number of publications. On the other hand, UE Poznań differs from UE Kraków. The remaining pairs of universities do not differ significantly in terms of the number of publications.

Number of citations

The KW test showed that at least one university is significantly different from the others in the number of citations (test statistic = 92.709, number of degrees of freedom = 4, p-value < 0.01). The results of the pair comparison using the MWW test are presented in Table 10.

Table 10
The results of the Mann-Whitney-Wilcoxon test for the number of citations (p-values)

	WSE	UE Katowice	UE Kraków	UE Poznań
UE Katowice	1.0*e*–14*	–	–	–
UE Kraków	1.7*e*–10*	0.90857	–	–
UE Poznań	0.18458	5.4*e*–12*	1.3*e*–08*	–
UE Wrosław	8.2*e*–06*	0.00317*	0.00970*	0.00015*

*Differences significant at the significance level of 0.05.

Source: own study.

The pair comparison showed that almost all universities differ in the average number of citations. Two pairs differ only insignificantly: UE Katowice and UE Kraków, UE Poznań and Warsaw School of Economics.

Hirsch index

The KW test showed that at least one university significantly differed from the others in terms of the Hirsch index value (test statistic = 67,448, number of degrees of freedom = 4, p-value < 0.01). The results of the pair comparison using the MWW test are presented in Table 11.

Table 11
Mann-Whitney-Wilcoxon test results for the Hirsch index (p-values)

	WSE	UE Katowice	UE Kraków	UE Poznań
UE Katowice	3.6*e*–09*	–	–	–
UE Kraków	6.9*e*–09*	0.38	–	–
UE Poznań	0.33	1.3*e*–07*	8.2*e*–08*	–
UE Wrocław	2.8*e*–06*	0.39	0.12	4.1*e*–05*

*Differences significant at the significance level of 0.05.

Source: own study.

The Hirsch index differs significantly between 6 university pairs, with no significant differences for 4 pairs.

Discussion and summary

Assessment of the scientific achievements of researchers and universities is possible through the general availability of data in data bases such as Google Scholar, Scopus and WoS. The number of publications, number of citations, Impact Factor, Hirsch index and *i*10 index make it possible to compare and analyze scientific achievements. In both Polish and foreign literature, as well as in generally available trade magazines, one can find information on university rankings. However, there are no studies that would deal with the evaluation of the research performed in the Polish economic universities in terms of bibliometric analysis. This research gap was filled by this study.

The study compared three variables: the number of publications, the number of citations and the Hirsch index for the 100 most cited authors in five economic universities in Poland. Based on the analysis, it was found that the differences in all three measures were statistically significant. On average, EU employees in Wrocław have the largest number of publications – 50% of them have at least 85 publications and there are 97.8 publications per employee. On average, WSE employees were quoted most often – 50% of the authors have at least 468 citations, and there is an average of 678.9 citations per one. The largest Hirsch index belongs to an employee of UE Wrocław; however, on average, employees of the Warsaw School of Economics and UE Poznań have the highest rates – 50% of them have a Hirsch index of at least 11. Moreover, the dependence of the number of citations on the number of publications in individual groups of researchers (due to the academic degree) was presented.

There are some limitations of the study. Firstly, the analysis carried out in this study was limited to 100 employees from 5 public universities. Secondly, comparison with the use of Hirsch index does not take into account the rank of the journal. Thirdly, not every researcher may have a profile on Google Scholar.

The analysis has many practical implications. The results can be the basis for examining the scientific potential of economic universities in Poland and Polish scientists. Comparison on a national scale would make it possible to compare the position of economic universities in Poland in the international perspective. It can be seen that the higher the academic degree, the greater the number of citations. This should provide scientists with additional motivation for self-development.

Comparing the academic achievements of research workers from given universities can serve as a benchmark of scientific quality. In addition to citation analysis, the rank and prestige of the journal should be considered. It may happen that an author publishing in a currently narrow field will have a low citation rate, despite the high quality of the study. Therefore, the evaluation of research workers should take into account not only the number of citations and the ministerial list, which raises doubts in the scientific community, but also the prestige of the journal.

Further research on the issue of comparing the scientific achievements of research workers of economic universities in Poland may concern the examination

of all employees in all institutions (including private universities). Another aspect of studies in this field could be the extension of research in individual groups due to the academic degree held.

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SCIENTIFIC ACHIEVEMENTS OF ECONOMIC ACADEMIC WORKERS IN POLAND: BIBLIOMETRIC ANALYSIS

Summary

University rankings take many features into account when making an evaluation. One of them are scientific achievements of employees. Based on the literature review, a research gap was identified and defined as the lack of comparisons of scientific achievements, at least in terms of citations, among research workers of economic universities in Poland. The aim of the article was defined as presenting and comparing the scientific achievements of employees of economic universities in Poland, using a set of bibliometric indicators as basis (number of publications, number of citations, *h*-index). The research shows that UE Wrocław employees have, on average, the most publications, Warsaw School of Economics (WSE) employees were quoted most often, the highest Hirsch index belongs to one of the UE Wrocław employees, while, on average, employees of WSE and UE Poznań have the highest rates.

Keywords: bibliometric analysis, scientific achievements, economic universities, citations, Hirsch index, publications

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OSIĄGNIĘCIA NAUKOWE POLSKICH EKONOMISTÓW AKADEMICKICH: ANALIZA BIBLIOMETRYCZNA

Streszczenie

Rankingi wyższych uczelni uwzględniają wiele kryteriów w swych ocenach. Jednym z nich są osiągnięcia naukowe zatrudnionych w nich pracowników. Przegląd literatury wskazuje, że brakuje porównań osiągnięć naukowych pracowników akademickich zatrudnionych w polskich uczelniach ekonomicznych, choćby w kategoriach liczby cytowań ich publikacji. Celem artykułu jest przedstawienie i porównanie dorobku naukowego pracowników wyższych uczelni ekonomicznych za pomocą analizy bibliometrycznej (liczba publikacji, liczba cytowań, indeks *h*). Przeprowadzona analiza pokazuje, że najwięcej publikacji – średnio biorąc – mają pracownicy Uniwersytetu Ekonomicznego we Wrocławiu, najczęściej cytowani są pracownicy Szkoły Głównej Handlowej, najwyższą wartość indeksu Hirscha ma jeden z pracowników Uniwersytetu Ekonomicznego we Wrocławiu, a średnio biorąc – pracownicy SGH i Uniwersytetu Ekonomicznego w Poznaniu.

Słowa kluczowe: analiza bibliometryczna, osiągnięcia naukowe, uniwersytety ekonomiczne, cytowania, indeks Hirscha, publikacje

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НАУЧНЫЕ ДОСТИЖЕНИЯ ПОЛЬСКИХ ВУЗОВСКИХ ПРЕПОДАВАТЕЛЕЙ ЭКОНОМИКИ: БИБЛИОМЕТРИЧЕСКИЙ АНАЛИЗ

Резюме

При составлении рейтингов вузов учитываются различные критерии. Одним из них являются научные достижения работающих там преподавателей. Обзор литературы показывает, что сравнение научных достижений вузовских преподавателей, хотя бы в таких категориях как количество цитирования и публикаций, отсутствует. Автор статьи решил представить и сравнить научные достижения вузовских преподавателей с помощью библиометрического анализа (число публикаций, число цитирований, *h*-индекс). Проведенный анализ показывает, что наибольшее число публикаций имеют преподаватели Экономического университета во Вроцлаве, наиболее часто цитируются преподаватели Главной торговой школы в Варшаве, самый высокий показатель индекса Хирша у одного из преподавателей Экономического университета во Вроцлаве, а в среднем – у работников Главной торговой школы в Варшаве и Экономического университета в Познани.

Ключевые слова: библиометрический анализ, научные достижения, экономические университеты, цитирование, индекс Хирша, публикации

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