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The Quartile Index Calculation for the Leading Russian Universities and its Pairwise Correlations with Other Scientific Metrics

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ABSTRACT

Objective: The historical survey of the foundation and development of the quartile index in different fields of knowledge, as well as that one of the percentile index in scientometrics, was conducted.

Materials and Methods: Based on the improved quartile index introduced in scientometrics by A.V. Grinev, the calculations of three types of such indices, based on the CiteScore, SNIP and SJR impact factors for 45 leading Russian universities at the levels of 2019 and 2020, were carried out. The Scopus articles published in quartile-free journals were included into the calculations.

Results: The proportions of Scopus articles published in Q1 and Q2 journals were also calculated. Pairwise correlations were calculated between six indicators supplemented by the h-index. The best results had the pairwise correlations of the Quarterly Indices and their pairwise correlations with the h-index. The worst results were obtained in pairwise correlations between Quarterly Indices and Scopus articles proportions in Q1 and Q2 journals.

Conclusion: Despite the fact that the quartile index has great advantages over the h-index and other h-like indices, since it covers the entire range of publications of the author or another subject of publication activity, as well as the qualitative structure of publications based on their distribution by quartiles, it showed a good correlation with the h-index (in different experiments the values of the Pearson correlation coefficient between these indices varied from 0.81 to 0.85.

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Introduction

Quartile indices are fairly well known in various fields of knowledge, especially when studying the diversity of some objects. In addition to economics and biology, the quartile index is most widely used in medicine, to a lesser extent in psychology and climatology, which we observed when looking into 232 publications obtained by using the Google Scholar search engine (requests were made on October 29, 2021).

This index is very often understood as the Q index itself, which just distributes the one hundred percent interval into four equal parts or what is expressed in absolute value or in percentage in these parts.

Let us have a historical insight into this problem, taking into account only non-trivial procedures for its calculation. In the work of Crum (1939), it is mentioned that the quartile index of variability can serve as a measure of variability or variance. He argues that one of the formulas for its calculation requires to determine the upper and lower quartiles, calculating half of the series between them, and dividing the result by the median of the series. Pitz (1974) writes almost about the same in his work, considering calibration measures. He claims that inter-quartile index is the percentage of terms in a series for which their number falls in the interval between 0.25 and 0.75 of their shares. He also writes that a perfectly calibrated number of personas should have an inter-quartile index of 50%. In his work on the diversity of biological species, Kempton (1978) builds a cumulative curve of the series depending on the logarithm of the percentile (log R), marks the points 0.25S and 0.75S on this curve (S is the maximum value on the cumulative curve) and calculates the tangent of the angle slope on the cumulative curve in the interval between the first and fourth quartiles according to the formula $QI = \frac{0.5S}{\log(R2/_{R1})}$ where the quartile R2 (the first quartile) corresponds to the 0.75S point on the ordinate axis of the cumulative curve, and R2 (the fourth quartile) corresponds to the point of 0.25S on this axis. He determines this index as the quartile index.

From the above description of the last three articles, it follows that the indices proposed in them coincide within an accuracy of a constant, since in those articles it is proposed to calculate half of the series between the upper and lower quartiles.

We also managed to identify a cluster of scientometric works in which percentile indices are constructed instead of quartile ones. This cluster of publications was initiated by Bormann (2010). It identified 6 percentile impact classes: 99th - top 1%, 95th, 90th, 75th, 50th, <50th (bottom 50%), which are used in Science & Technology of the National Science Board of the USA. Each percentile class is given its own reference number from 1 to 6 (number 6 is given to the 99th class - top 1%), which corresponds to its weight. All articles by citation are distributed among these classes taking into account the proportion of these articles (the probability of articles falling into this class), after which the integral indicator EV (expected value) is calculated using the formula $EV(i) = \sum_{i=1}^{6} i \cdot p(i)$, where i is the class number, p (i) is the proportion of articles in the i-th class. In contrast to the work in question, we used clearer mathematical symbols and expressions for its description. To clarify the calculation using this formula, the author gave a simple hypothetical example for 156 articles. It should just be noted that the extreme values obtained by the author EV (max) = 6, EV (min) = 1 are valid for any case.

Another simple example of the distribution of 100 articles by percentile classes with the calculation of the integral indicator according to the above formula is given in the following work (Leydesdorff et al., 2011), in which the EV indicator is denoted as R (6). In the work of Leydesdorff & Bormann (2011), this indicator is named as I3, taking into account the three words in its name, starting with the letter I: Integrated Impact Indicator. In this work, it is considered as an alternative to the classic Impact Factor. Its calculations are made using the example of 65 Library & Information Sciences journals.

Bormann (2013) uses the term “percentile rank class” instead of the term “percentile impact class” and calculates the I3 index on specific examples of publication activity from three and four universities. He notes that this indicator combines the output (the number of publications) and citation impact in one digit, like the h-index, but has the advantage of being normalized to percentile, which allows comparisons between different subject areas. It was also noted that I3 correlates with the number of university publications.

To develop this approach, given the large skewness in the distribution of cited articles (only a few articles are highly - cited (Seglen, 1992), in (Leydesdorff, Bormann, & Adams, 2018) it is proposed to use four percentile classes instead of six (top - 1%, top - 10%, top - 50%, bottom - 50%). The authors are convinced that articles in the top - 1% class are 10 times more significant than in the top - 10% class. So, it seems possible to assess the highly skewed nature of citation using a logarithmic scale. For the above four percentile classes, the weights were distributed as: 100, 10, 2, 1. An example of the calculation of the I3 index for the PLOS One magazine is given (Leydesdorff, Bormann & Adams, 2018). The same calculation example is given in (Bormann, Tekles & Leydesdorff, 2019), which notes that the I3 indicator can be considered as a field-normalized indicator, and that such indicators are traditional in bibliometrics practice, especially when institutions and countries are compared by citation.

As we have established, if we move from percentiles to quartiles, the origins of the construction of a similar integral indicator go back to the report of the National Bureau of Economic Research (1996) by Charls Hulten, who wrote: “The procedure adopted in this report attempts to deal with the aggregation and non-linearity problems by taking each World Bank performance indicator and sorting it into quartiles. The top quartile is assigned a value of 1.00, the second, 0.75, the next 0.5, and the bottom assigned a value of 0.25. This produces a quartile ranking for each of the four systems separately, and this is then converted into aggregate index by simple averaging" (Hulten, 1996).

In this report, the author refers to this index as aggregated, without using the term "quartile index". But at its core, it is a quartile index, which is clearly stated in the work (Calderón & Chong, 2004), in which the normalized values of the measured indicators of infrastructure (telecommunications, energy capacities, roads, railways, irrigated lands) were distributed by quartiles.

In scientometrics, this index was first proposed by the Russian historian A.V. Grinev (2019, 2020). He writes this index (like Hulten (1996)) as:

$$Q_k = (\sum k_i n_i)/N, (1)$$

but additionally divides it by the total number of objects, in this case, by the total number of publications N. In formula (1), ki is the weighting coefficient of the i-th quartile of the journal, ni is the number of publications of the author in the journals of the i-th quartile, the numbers of quartiles i change from 1 to 4. The weighting coefficient of the first quartile is equal to 4, decreasing by one unit when moving from the first to the fourth quartile. Within an accuracy of a constant, such a change in the weight coefficients with the same step is equivalent to the distribution of similar coefficients of Hulten (1996).

It is important to say that dividing by the total number of objects in the sample does not make sense, foreign authors do not do this when working with this index in their fields of expertise, and Grinev (2019, 2020), having made test calculations of this index for 18 Russian academicians of the History and Philology Department of the Russian Academy of Sciences, noted that index (1) "works well only with relatively large statistical samples."

In the development of this index for the purposes of scientometric analysis, Moskovkin (2021) proposed to take into account a large cluster of publications in non-quartile journals, giving them a point weighting factor of 1 and shifting the rest of the point weighting factors by one, then the weight of articles published in the first quartile will be 5. Providing that the sum of the weighting factors equals 1

$$\sum_{i=1}^{5} w_i = 1.(2)$$

Formula (1) without considering its denominator (Moskovkin, 2021) a slightly different notation is written in the form as

$$IQ = (5N1 + 4N2 + 3N3 + 2N2 + N5)/15, (3)$$

where Ni is the number of publications of the author in the journals of the i-th quartile at i = 1 ÷ 4, and at i = 5 the number of non-quartile articles is equal to N5.

In this work, the interval was determined in which the quartile index changes for an arbitrary N = N1 + N2 + N3 + N4 + N5. It follows the formula (3): min{IQ} = N/15, max{IQ} = (1/15)5N = N/3.

Thus, for an arbitrary number of publications, the maximum possible IQ value exceeds its minimum value by a factor of 5, which follows from the ratio of the extreme point weights of the quartiles. We observe the same thing in the following works (Bormann, 2010; Leydesdorff et al., 2011), where the ratio of extreme point weights of percentiles was 6. Potentially, Bormann's (2010) percentile approach includes a quartile approach, but we can see the advantage of the latter in the coverage of non-quartile publications, the percentage of which for the authors, scientific departments and institutes is large, as well as the convenience of numerical experiments with the quartile index in the Scopus database, using three impact factors: Cite Score, SNIP, SJR.

Materials and Methods

To test the formula (3), we used a fairly large sample of Russian universities included in the lists of global (project "5-100"), federal, national research universities (43 universities in total), to which Moscow State University and St. Petersburg State University were added.

Vectors (N1, N2, N3, N4, N5) of the number of publications in Scopus journals, for the Cite Score (CS), SNIP and SJR impact factors for 2019 and 2020, were built for the 45 universities identified in such a way. For their identification, the Elsevier SciVal and Scopus tools were used. Apart from them, the script (Appendix A) created through the Python 3.9 programming language was applied. For the analysis and processing the big Pandas data, the script uses the structure of the Data Frame library. Unloading from the scientometrics Scopus database was carried out on July 25, 2021. Further calculations for three different quartile indices were made according to formula (3) together with pairwise correlations between them, h-indices and the proportion of the publications of the first two quartiles.

Results and Discussion

The vectors of the number of publications by quartile (N1, N2, N3, N4, N5), calculated for three journal impact factors for two different years, are given in Appendix B. On their basis, using formula (3), the quartile indices for the years under consideration were calculated, as well as the proportions of articles in the first two quartiles (ρ(Q1, Q2))These calculated data are given in Appendix C. In this Appendix, for comparison, the h-indices (Hi) are also given.

Matrices of pairwise correlation coefficients between the values of the seven considered indices are presented in Table 1.

Table 1. Values of paired correlation coefficients between the considered indices for 2019 and 2020.

2019 Correlation	$I_{Q(CS)}$	$I_{Q(SNIP)}$	$I_{Q(SJR)}$	Hi	$\rho_{(Q1, Q2, CS)}$	$\rho_{(Q1, Q2, SNIP)}$	$\rho_{(Q1, Q2, SJR)}$
$I_{Q(CS)}$	1	0.99903	0.99905	0.85163	0.49296	0.40429	0.49428
$I_{Q(SNIP)}$	0.99903	1	0.99722	0.84797	0.47970	0.39757	0.48387
$I_{Q(SJR)}$	0.99905	0.99722	1	0.84716	0.49888	0.41198	0.50271
Hi	0.85163	0.84797	0.84716	1	0.58043	0.48038	0.56073
$\rho_{(Q1, Q2, CS)}$	0.49296	0.47970	0.49888	0.58043	1	0.94225	0.97444
$\rho_{(Q1, Q2, SNIP)}$	0.40429	0.39757	0.41198	0.48038	0.94225	1	0.95327
$\rho_{(Q1, Q2, SJR)}$	0.49428	0.48387	0.50271	0.56073	0.97444	0.95327	1

2020 Correlation	$I_{Q(CS)}$	$I_{Q(SNIP)}$	$I_{Q(SJR)}$	Hi	$\rho_{(Q1, Q2, CS)}$	$\rho_{(Q1, Q2, SNIP)}$	$\rho_{(Q1, Q2, SJR)}$
$I_{Q(CS)}$	1	0.99857	0.99898	0.81742	0.56517	0.53648	0.58673
$I_{Q(SNIP)}$	0.99857	1	0.99654	0.81151	0.54114	0.51811	0.56307
$I_{Q(SJR)}$	0.99898	0.99654	1	0.80831	0.57025	0.54349	0.59551
Hi	0.81742	0.81151	0.80831	1	0.78712	0.75791	0.76924
$\rho_{(Q1, Q2, CS)}$	0.56517	0.54114	0.57025	0.78712	1	0.96051	0.98551
$\rho_{(Q1, Q2, SNIP)}$	0.53648	0.51811	0.54349	0.75791	0.96051	1	0.95570
$\rho_{(Q1, Q2, SJR)}$	0.58673	0.56307	0.59551	0.76924	0.98551	0.95570	1

The Table shows that quartile indices have a very high Pearson correlation coefficient between themselves at the level of 0.99 for the two years under consideration, the quartile indices have correlation coefficients with the proportions of publications in journals of the first two quartiles in the range of 0.4 to 0.5 in 2019 and in the range of 0.5 to 0.6 in 2020. With the h-index, the quartile indices have correlation coefficients at the level of 0.85 in 2019 and at the level of 0.81 in 2020.

This implies that the share of publications in journals of the first two quartiles characterizes the qualitative composition of publications of university scientists worse than their h-index, while we consider the quartile index itself as a standard indicator of the qualitative composition of publications, since it takes into account all quartile and non-quartile publications with reasonable weights.

These calculations also show that when calculating the quartile index, one can rely on any of the three impact factors, since the values of the Pearson correlation coefficients between them on a fairly large sample of universities (45 leading Russian universities) were at the level of 0.99 for two different years.

Therefore, the year-to-year changes in these correlation coefficients were not significant, in contrast to the change in the correlation coefficients between the proportion of publications in journals in the first two quartiles and the h-index (Table 1).

Table 2 shows the correlations between the same quartile indices and proportion of publication in journals in the first two quartiles for different years.

Table 2. Values of cross-correlation of the considered indices for 2019 and 2020.

$I_{Q(CS)}$	$I_{Q(SNIP)}$	$I_{Q(SJR)}$
0.98677	0.98616	0.98951

$\rho_{(Q1, Q2, CS)}$	$\rho_{(Q1, Q2, SNIP)}$	$\rho_{(Q1, Q2, SJR)}$
0.71422	0.57982	0.73614

The Table shows that if we operate with the concept of rankings of these indicators, we will see that such rankings of quartile indices are stable over a two-year time interval, and there is no share of publications in journals of the first two quartiles. However, these are only preliminary results, since calculations are needed over a wider time interval.

In addition to the calculations given in Table 1, and for the purpose of their visualization, Figure 1 shows the empirical field of points and linear regression between quartile indices and the h-index, and Figure 2 similarly shows the linear regression between these indices and the shares of Scopus publications in journals of the first two quartiles. These graphs are based on the empirical data for 2020.

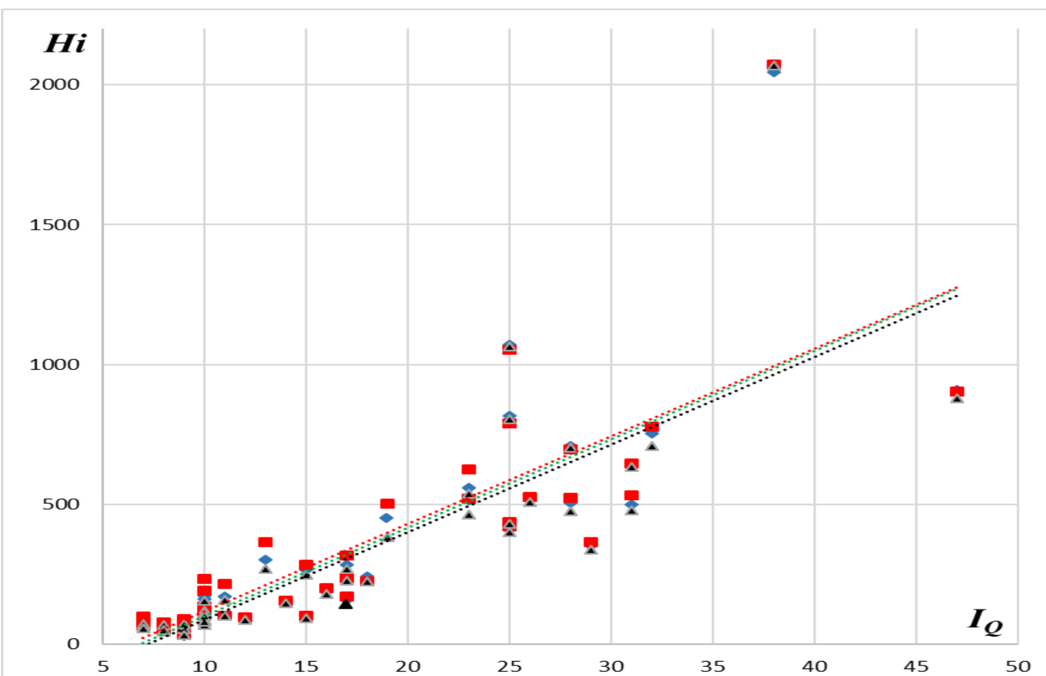

Figure 1. Linear regression dependencies between quartile indices and h-index, 2020.

◆ $Hi = 31.628 \cdot I_{Q(CS)} - 217.59$; $R^2 = 0.6682$
■ $Hi = 31.335 \cdot I_{Q(SNIP)} - 197.67$; $R^2 = 0.6585$
▲ $Hi = 31.317 \cdot I_{Q(SJR)} - 225.16$; $R^2 = 0.6534$

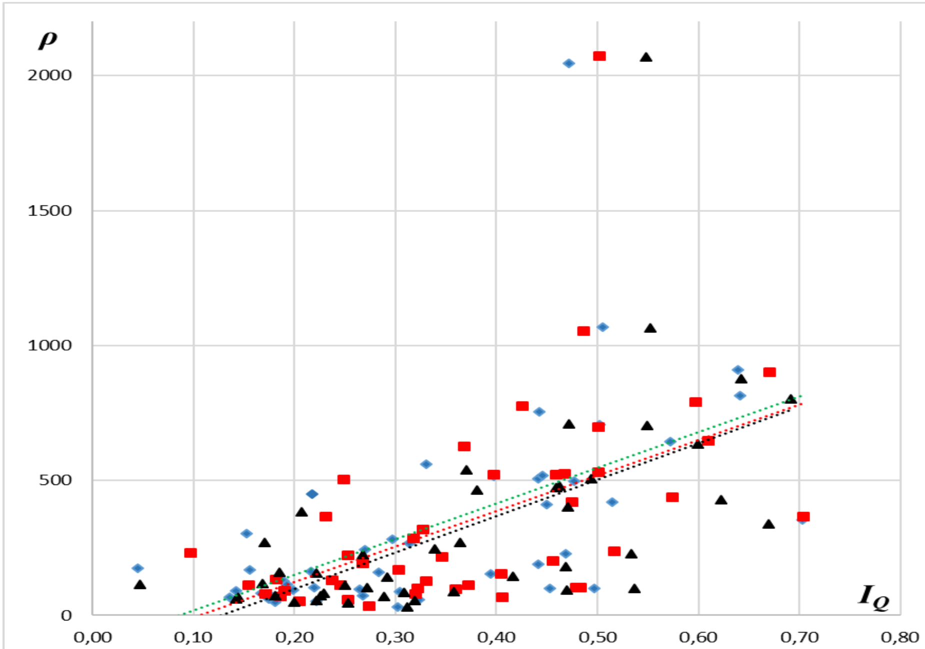

Figure 2. Linear regression dependencies between quartile indices and the proportion of Scopus publications in journals for Q1 and Q2, 2020.

◆ $\rho = 1323.4 \cdot I_{Q(CS)} - 114.39; R^2 = 0.3194$
■ $\rho = 1316.7 \cdot I_{Q(SNIP)} - 140.62; R^2 = 0.2684$
▲ $\rho = 1346.1 \cdot I_{Q(SJR)} - 170.19; R^2 = 0.3546$

Conclusion

The review of works on quartile indices has been carried out, a compact cluster of percentile indices has been revealed, for which the quartile index is a special case. However, taking into account a large number of publications in non-quartile journals, which have not been considered in previous studies, and the presence of three types of impact factors in the Scopus database, makes the comparative calculations for a large sample of Russian universities relevant.

Despite the fact that the quartile index has great advantages over the h-index and other h-like indices, since it covers the entire range of publications of the author or another subject of publication activity, as well as the qualitative structure of publications based on their distribution by quartiles, it showed a good correlation with the h-index (in different experiments the values of the Pearson correlation coefficient between these indices varied from 0.81 to 0.85 (Table 2).

We believe that for further approbation of the proposed quartile indices, which were built on the base of different impact factors of the Scopus database, it is reasonable for similar experiments to be carried out applying a different choice of universities and longer time intervals. At present, it is especially relevant for the Russian situation, since the Ministry of Education and

Science of the Russian Federation, and, accordingly, the heads of research and scientific and educational institutions encourage scientists to publish in high-quartile journals.

We believe that agencies generating databases of scientometric indicators (Clarivate Analytics (Web of Science), Elsevier (Scopus), Scimago Journal & Country Rank and others) should pay attention to this index, and the Ministry of Education and Science of different countries could introduce it into monitoring practices of publication activities and assessment of its quality.

Author Contributions

Vladimir M. Moskovkin – conceptualization, methodology, formal analysis and original draft preparation; Oleg S. Reznichenko – software, calculation and visualization; Andrey P. Peresypkin – supervision, data curation; Anna N. Doborovich – review and editing.

Data Availability Statement

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Ethical considerations

The authors avoided from data fabrication and falsification.

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Conflict of interest

The authors declare no conflict of interest.

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Appendix A. Source code of the script for generating vectors of the number of publications by quartile (N1, N2, N3, N4, N5), calculated for three impact factors of journals for two different years in Python

```
import pandas as pd

#Crit = 'CiteScore percentile (publication year) *'
#Crit = 'SNIP percentile (publication year) *'
Crit = 'SJR percentile (publication year) *'
fout = open('out1.txt', 'w')
for i in range(1,46):
   if i<10: filename = '0'+str(i)
   else: filename = str(i)
   df = pd.read_excel('Data/'+filename+'.xlsx')
   df1 = df[df['Year'] == 2020]
   result = str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2019]
   result += str(df1.shape[0])+'\t'
   df = df.replace({Crit:{'-':0}})
   df1 = df[df['Year'] == 2020]
   df1 = df1[(df1[Crit] >= 1) & (df1[Crit] <= 25)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2019]
   df1 = df1[(df1[Crit] >= 1) & (df1[Crit] <= 25)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2020]
   df1 = df1[(df1[Crit] >= 26) & (df1[Crit] <= 50)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2019]
   df1 = df1[(df1[Crit] >= 26) & (df1[Crit] <= 50)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2020]
   df1 = df1[(df1[Crit] >= 51) & (df1[Crit] <= 75)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2019]
   df1 = df1[(df1[Crit] >= 51) & (df1[Crit] <= 75)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2020]
   df1 = df1[(df1[Crit] >= 76)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2019]
   df1 = df1[(df1[Crit] >= 76)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2020]
   df1 = df1[(df1[Crit] == 0)]
   result += str(df1.shape[0])+'\t'
   df1 = df[df['Year'] == 2019]
   df1 = df1[(df1[Crit] == 0)]
   result += str(df1.shape[0])
   print(str(i)+'Number of rows :', result)
   fout.write(result+'\n')
   fout.close()
```

Appendix B. Vectors of the number of publications by quartile (N1, N2, N3, N4, N5), calculated for three journal impact factors for two different years

№	University	2019				2020			
		Vector N (CiteScore)	Vector N (SNIP)	Vector N (SJR)	Total no. of publications	Vector N (CiteScore)	Vector N (SNIP)	Vector N (SJR)	Total No. of publications
1.	Saint Petersburg National Research University of Information Technologies, Mechanics and Optics	[631; 282; 540; 414; 535]	[493; 547; 611; 216; 535]	[626; 340; 467; 50; 919]	2,402	[650; 304; 384; 858; 378]	[473; 483; 740; 427; 451]	[626; 289; 348; 319; 992]	2,574
2.	Samara National Research University named after Academician Sergey P. Korolyov	[168; 93; 183; 361; 130]	[153; 138; 370; 136; 138]	[182; 98; 298; 53; 304]	935	[173; 92; 97; 340; 195]	[148; 136; 243; 169; 201]	[122; 151; 103; 104; 417]	897
3.	Immanuel Kant Baltic Federal University	[109; 74; 118; 103; 26]	[94; 136; 109; 50; 41]	[97; 111; 87; 62; 73]	430	[105; 90; 101; 143; 17]	[83; 123; 147; 75; 28]	[102; 100; 84; 68; 102]	456
4.	the National Research Tomsk State University	[609; 256; 467; 531; 125]	[631; 440; 624; 158; 135]	[568; 359; 512; 63; 486]	1,988	[594; 300; 336; 421; 122]	[497; 447; 499; 213; 117]	[567; 368; 355; 159; 324]	1,773
5.	Siberian Federal University	[219; 129; 393; 560; 74]	[202; 305; 631; 136; 101]	[221; 209; 520; 45; 380]	1,375	[258; 151; 340; 626; 91]	[162; 288; 835; 120; 61]	[247; 254; 246; 330; 389]	1,466
6.	Kazan (Privolzhsk)) Federal University	[741; 569; 630; 985; 238]	[810; 618; 1033; 484; 218]	[692; 522; 831; 475; 643]	3,163	[592; 455; 634; 633; 445]	[532; 633; 1164; 266; 164]	[587; 586; 450; 332; 804]	2,759
7.	Ural Federal University named after the first President of Russia B.N. Yeltsin	[643; 460; 792; 1033; 357]	[606; 706; 1302; 249; 422]	[642; 681; 758; 125; 1079]	3,285	[838; 616; 536; 1364; 324]	[586; 812; 1234; 721; 325]	[843; 707; 563; 341; 1224]	3,678
8.	National Research University «Higher School of Economics»	[855; 654; 627; 484; 426]	[801; 877; 646; 271; 451]	[896; 835; 511; 153; 651]	3,046	[1,110; 842; 729; 417; 297]	[918; 901; 845; 390; 341]	[1,166; 941; 442; 289; 557]	3,395
9.	Far Eastern Federal University	[233; 141; 202; 219; 88]	[227; 216; 242; 105; 93]	[232; 187; 162; 94; 208]	883	[235; 155; 165; 246; 62]	[213; 190; 334; 68; 58]	[226; 188; 134; 119; 196]	863
10.	Moscow Institute of Physics and Technology (State University)	[1,000; 394; 541; 364; 326]	[896; 779; 471; 155; 324]	[974; 581; 494; 77; 499]	2,625	[995; 508; 503; 464; 235]	[672; 929; 645; 217; 242]	[948; 626; 417; 312; 402]	2705
11.	Tyumen State University	[84; 123; 115; 98; 25]	[65; 157; 154; 33; 36]	[115; 134; 100; 21; 75]	445	[86; 135; 124; 73; 27]	[74; 141; 160; 40; 30]	[113; 126; 96; 43; 67]	445
12.	First Moscow State Medical University named after I.M. Sechenov 1	[676; 425; 503; 1,285; 88]	[612; 537; 544; 939; 345]	[779; 357; 554; 1,099; 188]	2,977	[1,262; 641; 694; 1,232; 234]	[1,189; 807; 629; 1036; 402]	[1,266; 647; 457; 1,195; 498]	4,063
13.	RUDN University	[482; 400; 475; 579; 147]	[393; 560; 537; 389; 204]	[453; 453; 463; 308; 406]	2,083	[539; 381; 509; 809; 215]	[466; 490; 781; 483; 233]	[501; 456; 383; 534; 579]	2,453
14.	Saint Petersburg Electrotechnical University 'LETI'	[68; 84; 171; 230; 398]	[56; 186; 258; 49; 402]	[65; 110; 233; 22; 521]	951	[81; 99; 116; 221; 321]	[69; 104; 246; 85; 334]	[70; 90; 147; 108; 423]	838
15.	South Ural State University	[213; 173; 245; 326; 151]	[210; 265; 322; 154; 157]	[189; 242; 361; 45; 271]	1,108	[496; 283; 230; 389; 234]	[394; 386; 478; 152; 222]	[403; 339; 326; 170; 394]	1,632
16.	the National Research Tomsk State University	[687; 368; 684; 579; 103]	[690; 589; 735; 254; 153]	[709; 457; 520; 104; 631]	2,421	[723; 355; 499; 570; 88]	[544; 588; 704; 302; 97]	[680; 515; 437; 242; 361]	2,235
17.	National University of Science and Technology "MISIS"	[637; 209; 477; 303; 123]	[538; 447; 491; 150; 123]	[579; 465; 420; 37; 248]	1,749	[630; 271; 362; 452; 92]	[419; 586; 601; 104; 97]	[626; 462; 297; 151; 271]	1,807
18.	Peter the Great St. Petersburg Polytechnic University	[343; 170; 815; 934; 516]	[315; 404; 1,325; 232; 502]	[279; 365; 745; 76; 1313]	2,778	[332; 274; 520; 998; 423]	[231; 460; 1208; 267; 381]	[261; 315; 372; 481; 1118]	2,547
19.	National Research Lobachevsky State University of Nizhni Novgorod	[247; 156; 269; 186; 101]	[194; 296; 279; 85; 105]	[246; 193; 292; 71; 157]	959	[281; 168; 232; 291; 68]	[198; 298; 357; 119; 68]	[255; 257; 210; 156; 162]	1,040
20.	National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)	[727; 288; 483; 640; 176]	[707; 487; 812; 139; 169]	[666; 447; 685; 102; 414]	2,314	[666; 439; 286; 685; 168]	[470; 689; 819; 139; 127]	[603; 466; 316; 496; 363]	2,244

21.	Novosibirsk State University	[1,102; 617; 736; 548; 253]	[1021; 918; 869; 160; 288]	[1,102; 779; 689; 211; 475]	3,256	[1,005; 630; 618; 543; 134]	[704; 929; 826; 281; 190]	[1,045; 744; 437; 346; 358]	2,930
22.	North Caucasus Federal University (NCFU)	[31; 26; 119; 137; 53]	[36; 44; 152; 81; 53]	[32; 38; 108; 52; 136]	366	[37; 27; 74; 166; 80]	[26; 42; 186; 64; 66]	[38; 43; 45; 57; 201]	384
23.	M. K. Ammosov North-Eastern Federal University	[57; 64; 111; 206; 42]	[68; 93; 209; 55; 55]	[50; 78; 175; 29; 148]	480	[81; 46; 93; 265; 52]	[88; 91; 223; 75; 60]	[63; 85; 72; 108; 209]	5,37
24.	Northern (Arctic) Federal University (NArFU)	[44; 26; 73; 167; 37]	[28; 64; 194; 32; 29]	[39; 53; 79; 39; 137]	347	[40; 37; 54; 125; 17]	[46; 42; 118; 50; 17]	[41; 47; 28; 55; 102]	273
25.	Southern Federal University	[230; 199; 426; 299; 292]	[174; 303; 569; 90; 310]	[221; 229; 444; 94; 458]	1446	[247; 207; 365; 326; 188]	[173; 287; 637; 107; 129]	[236; 254; 235; 199; 409]	1333
26.	V.I. Vernadsky Crimean Federal University	[34; 43; 101; 185; 31]	[33; 64; 149; 110; 38]	[33; 52; 120; 75; 114]	394	[28; 41; 131; 222; 66]	[28; 47; 246; 116; 51]	[40; 49; 86; 112; 201]	488
27.	Irkutsk National Research Technical University	[20; 26; 254; 176; 59]	[22; 45; 380; 27; 61]	[18; 51; 104; 10; 352]	535	[38; 38; 78; 359; 55]	[34; 49; 404; 30; 51]	[26; 51; 57; 90; 344]	568
28.	Saint Petersburg Mining University	[24; 74; 195; 282; 193]	[82; 87; 383; 38; 178]	[21; 163; 225; 7; 352]	768	[42; 106; 146; 242; 158]	[70; 112; 296; 68; 148]	[53; 139; 123; 108; 271]	694
29.	Pirogov Russian National Research Medical University (Pirogov Medical University)	[126; 90; 121; 726; 24]	[101; 130; 193; 549; 114]	[141; 99; 171; 604; 72]	1087	[180; 113; 200; 816; 51]	[158; 117; 156; 694; 235]	[184; 107; 108; 752; 209]	1360
30.	Perm State University, PSU	[64; 57; 118; 149; 27]	[55; 97; 178; 52; 33]	[70; 63; 148; 70; 64]	415	[53; 58; 95; 134; 37]	[40; 93; 163; 43; 38]	[61; 59; 88; 64; 105]	377
31.	Kazan National Research Technical University A.N. Tupolev-KAI	[62; 52; 114; 202; 105]	[69; 74; 245; 46; 101]	[64; 68; 191; 32; 180]	535	[36; 37; 57; 204; 79]	[33; 59; 208; 47; 66]	[19; 57; 97; 78; 162]	413
32.	Moscow Aviation Institute (National Research University)	[46; 109; 274; 360; 122]	[120; 205; 359; 113; 114]	[91; 148; 322; 99; 251]	911	[53; 89; 304; 399; 210]	[138; 177; 516; 85; 139]	[36; 133; 321; 156; 409]	1,055
33.	Moscow State University of Civil Engineering - National Research University	[22; 19; 230; 584; 51]	[30; 30; 740; 59; 47]	[13; 45; 98; 49; 701]	906	[23; 18; 266; 767; 86]	[30; 58; 1002; 27; 43]	[13; 30; 94; 219; 804]	1,160
34.	Kazan National Research Technological University	[57; 52; 155; 205; 20]	[53; 76; 296; 47; 17]	[59; 76; 162; 68; 124]	489	[56; 41; 115; 266; 75]	[43; 77; 339; 66; 28]	[49; 63; 81; 123; 237]	553
35.	National Research Saratov State University named after N.G. Chernyshevsky	[156; 67; 150; 228; 106]	[128; 168; 164; 151; 96]	[147; 126; 148; 27; 259]	707	[184; 95; 137; 252; 73]	[128; 158; 216; 163; 76]	[175; 119; 146; 96; 205]	741
36.	Perm National Research Polytechnic University	[23; 47; 190; 112; 75]	[47; 120; 198; 22; 60]	[20; 105; 140; 18; 164]	447	[22; 53; 124; 220; 78]	[53; 91; 212; 77; 64]	[16; 65; 137; 58; 221]	497
37.	Belgorod State National Research University	[115; 89; 126; 243; 42]	[157; 115; 189; 113; 41]	[122; 88; 163; 149; 93]	615	[57; 78; 121; 247; 84]	[114; 89; 244; 84; 56]	[75; 92; 106; 156; 158]	587
38.	National Research Mordovian State University. N.P. Ogaryova 3	[27; 39; 52; 112; 24]	[36; 44; 61; 76; 37]	[22; 50; 77; 62; 43]	254	[31; 51; 74; 118; 62]	[49; 54; 128; 70; 35]	[28; 53; 87; 66; 102]	336
39.	St. Petersburg Academic University – Scientific and Educational Nanotechnology Center of the Russian Academy of Sciences (Academic University of the Russian Academy of Sciences)	[55; 18; 56; 75; 8]	[36; 74; 85; 7; 10]	[53; 28; 102; 5; 24]	212	[49; 15; 19; 54; 4]	[32; 26; 72; 7; 4]	[50; 16; 31; 33; 11]	141
40.	National Research University "MIET"	[35; 22; 86; 62; 170]	[36; 53; 77; 42; 167]	[35; 33; 74; 7; 226]	375	[43; 25; 47; 57; 177]	[27; 50; 82; 7; 183]	[38; 37; 66; 11; 197]	349
41.	Russian State University of Oil and Gas (National Research University) named after I.M. Gubkin	[54; 34; 146; 112; 68]	[63; 108; 137; 38; 68]	[50; 65; 150; 21; 128]	414	[80; 46; 112; 156; 67]	[78; 71; 218; 30; 64]	[76; 72; 155; 33; 125]	461
42.	National Research	[67; 73; 190;	[109; 139;	[64; 153; 231;	874	[70; 119; 144;	[114; 120;	[59; 135; 162;	1,095

	University MEI	273; 271]	308; 54; 264]	43; 383]		423; 339]	443; 90; 328]	294; 445]	
43.	Moscow State Technical University named after N.E. Bauman (National Research University)	[146; 126; 758; 828; 259]	[236; 334; 1134; 162; 251]	[145; 323; 633; 78; 938]	2,117	[172; 151; 391; 817; 274]	[187; 302; 922; 184; 210]	[153; 208; 360; 284; 800]	1,805
44.	Saint Petersburg State University	[1,187; 855; 1118; 946; 341]	[907; 1,323; 1,321; 524; 372]	[1,351; 1,038; 948; 456; 654]	4,447	[1,285; 962; 1,099; 1107; 253]	[849; 1,312; 1,565; 611; 369]	[1,445; 1013; 905; 640; 703]	4,706
45.	Moscow State University named after M.V. Lomonosov	[2,421; 1,473; 2,298; 2,089; 561]	[2,147; 2,553; 2,635; 770; 737]	[2444; 2,108; 2,167; 869; 1,254]	8,842	[2,556; 1,620; 2,290; 2,083; 390]	[1,801; 2,636; 3,063; 908; 531]	[2,610; 2,241; 1,879; 1,164; 1,,045]	8,939

Appendix C. Comparison of quartile indices with the h-index and the share of publications of the first two quartiles for leading Russian universities

№	Universities	2019							2020						
		Hi	$I_{Q(CS)}$	$I_{Q(SNIP)}$	$I_{Q(SJR)}$	$\rho_{(Q1, Q2, CS)}$	$\rho_{(Q1, Q2, SNIP)}$	$\rho_{(Q1, Q2, SJR)}$	Hi	$I_{Q(CS)}$	$I_{Q(CS)}$	$I_{Q(SNIP)}$	$\rho_{(Q1, Q2, CS)}$	$\rho_{(Q1, Q2, SNIP)}$	$\rho_{(Q1, Q2, SJR)}$
1	Saint Petersburg National Research University of Information Technologies, Mechanics and Optics	40	484.4	496.9	460.7	0.35	0.40	0.38	23	514.1	521.5	464.0	0.40	0.40	0.38
2	Samara National Research University named after Academician Sergey P. Korolyov	22	174.2	189.1	173.7	0.29	0.32	0.31	17	159.9	170.1	143.2	0.28	0.30	0.29
3	Immanuel Kant Baltic Federal University	15	95.1	98.8	92.5	0.40	0.50	0.46	15	99.4	101.7	93.3	0.45	0.48	0.47
4	the National Research Tomsk State University	34	443.8	482.5	428.3	0.49	0.60	0.52	25	409.5	420.9	400.9	0.45	0.47	0.47
5	Siberian Federal University	25	265.6	299.7	264.7	0.24	0.35	0.29	17	283.8	317.9	269.2	0.30	0.33	0.36
6	Kazan (Privolzhsk)) Federal University	34	671.9	720.5	642.3	0.47	0.52	0.44	23	559.5	625.3	539.8	0.33	0.37	0.37
7	Ural Federal University named after the first President of Russia B.N. Yeltsin	36	656.9	712.0	635.8	0.30	0.36	0.36	32	754.3	776.5	709.2	0.44	0.43	0.47
8	National Research University "Higher School of Economics"	31	677.7	696.3	687.3	0.44	0.49	0.51	25	815.7	790.0	803.7	0.64	0.60	0.69
9	Far Eastern Federal University	22	190.7	201.9	186.0	0.43	0.51	0.49	16	189.6	201.4	181.2	0.44	0.46	0.47
10	Moscow Institute of Physics and Technology (State University)	49	616.9	642.9	621.9	0.52	0.62	0.57	31	645.3	645.8	634.7	0.57	0.61	0.60
11	Tyumen State University	15	98.5	101.1	101.9	0.47	0.50	0.56	11	101.0	101.6	100.7	0.50	0.48	0.54
12	First Moscow State Medical University named after I.M. Sechenov 1	45	616.5	604.2	624.7	0.27	0.28	0.28	47	910.3	902.3	878.5	0.64	0.67	0.64
13	RUDN University	39	449.3	453.2	432.5	0.36	0.39	0.37	28	505.3	522.1	475.0	0.44	0.46	0.46
14	Saint Petersburg Electrotechnical University 'LETI'	15	136.5	153.2	135.3	0.18	0.29	0.21	10	127.5	133.5	119.3	0.19	0.18	0.17
15	South Ural State University	33	219.7	236.1	223.8	0.24	0.29	0.26	29	354.3	364.9	338.9	0.70	0.70	0.67
16	the National Research Tomsk State University	44	548.0	578.1	518.1	0.47	0.57	0.52	26	517.3	525.7	507.7	0.45	0.47	0.49
17	National University of Science and Technology "MISIS"	33	412.1	424.9	422.5	0.47	0.55	0.58	25	421.1	436.5	429.5	0.52	0.57	0.62
18	Peter the Great St. Petersburg Polytechnic University	33	481.6	542.1	437.0	0.20	0.28	0.25	19	449.0	502.3	384.1	0.22	0.25	0.21
19	National Research Lobachevsky State University of Nizhni Novgorod	25	209.3	217.7	211.8	0.39	0.47	0.42	17	228.2	237.3	227.1	0.47	0.52	0.53
20	National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)	48	512.8	557.7	519.4	0.45	0.53	0.50	31	498.8	531.2	478.8	0.48	0.50	0.46
21	Novosibirsk State University	45	769.0	799.5	772.7	0.59	0.66	0.64	28	707.9	697.7	704.1	0.50	0.50	0.55
22	North Caucasus Federal University (NCFU)	13	62.9	68.5	58.4	0.15	0.21	0.18	9	61.8	70.0	54.1	0.17	0.19	0.22
23	M. K. Ammosov North-Eastern Federal University	14	88.5	100.3	86.2	0.23	0.30	0.24	10	96.7	112.2	86.4	0.26	0.37	0.31
24	Northern (Arctic) Federal University (NArFU)	11	60.9	71.4	57.3	0.26	0.34	0.34	8	51.8	57.9	45.9	0.22	0.25	0.25
25	Southern Federal University	21	274.3	285.3	266.6	0.32	0.36	0.34	15	266.5	284.5	247.2	0.31	0.32	0.34
26	V.I. Vernadsky Crimean Federal University	13	69.7	75.1	66.5	0.16	0.20	0.17	9	80.5	89.9	71.9	0.18	0.19	0.23
27	Irkutsk National Research Technical University	13	91.8	103.0	65.2	0.08	0.12	0.12	10	89.9	112.6	68.6	0.14	0.16	0.14

28	Saint Petersburg Mining University	15	117.2	144.1	119.9	0.14	0.24	0.27	10	114.3	131.3	111.8	0.19	0.24	0.25
29	Pirogov Russian National Research Medical University (Pirogov Medical University)	21	188.6	187.7	192.9	0.16	0.17	0.18	18	242.3	223.3	225.7	0.27	0.25	0.27
30	Perm State University, PSU	11	81.8	88.9	83.3	0.32	0.40	0.35	8	72.5	79.0	69.2	0.27	0.32	0.29
31	Kazan National Research Technical University A.N. Tupolev-KAI	13	91.3	104.6	93.9	0.28	0.35	0.32	7	65.7	79.0	62.1	0.14	0.17	0.14
32	Moscow Aviation Institute(National Research University	28	155.3	189.1	164.1	0.15	0.31	0.23	11	169.4	217.0	159.7	0.16	0.35	0.19
33	Moscow State University of Civil Engineering - National Research University	14	139.7	177.0	89.2	0.04	0.05	0.05	10	173.7	232.3	113.9	0.05	0.10	0.05
34	Kazan National Research Technological University	12	92.5	104.5	89.7	0.20	0.23	0.24	10	93.1	113.3	81.5	0.20	0.25	0.23
35	National Research Saratov State University named after N.G. Chernyshevsky	23	137.3	146.8	133.1	0.30	0.40	0.37	14	152.5	154.8	145.7	0.39	0.40	0.42
36	Perm National Research Polytechnic University	9	78.1	94.2	76.0	0.14	0.34	0.25	7	80.8	98.9	72.5	0.17	0.32	0.18
37	Belgorod State National Research University	15	122.5	138.6	122.8	0.35	0.46	0.36	10	102.5	125.5	102.1	0.22	0.33	0.27
38	National Research Mordovian State University. N.P. Ogaryova 3	10	46.3	48.5	47.2	0.20	0.24	0.21	7	58.6	68.0	56.5	0.32	0.41	0.32
39	St. Petersburg Academic University – Scientific and Educational Nanotechnology Center of the Russian Academy of Sciences (Academic University of the Russian Academy of Sciences)	12	44.9	50.3	47.8	0.52	0.78	0.57	9	31.6	33.2	32.3	0.30	0.27	0.31
40	National Research University "MIET"	10	54.3	58.3	51.3	0.16	0.26	0.19	8	49.8	51.9	50.3	0.18	0.21	0.20
41	Russian State University of Oil and Gas (National Research University) named after I.M. Gubkin	16	75.7	86.8	75.3	0.19	0.37	0.25	12	86.6	96.8	88.3	0.30	0.36	0.36
42	National Research University MEI	16	134.3	159.8	139.6	0.13	0.23	0.20	10	162.9	192.5	156.9	0.22	0.27	0.22
43	Moscow State Technical University named after N.E. Bauman (National Research University)	23	361.5	496.9	334.0	0.15	0.32	0.26	13	303.0	365.8	269.7	0.15	0.23	0.17
44	Saint Petersburg State University	39	996.1	189.1	1021.1	0.43	0.47	0.51	25	1069.1	1051.9	1065.0	0.51	0.49	0.55
45	Moscow State University named after M.V. Lomonosov	61	1975.3	98.8	2009.7	0.44	0.53	0.51	38	2045.7	2072.3	2068.3	0.47	0.50	0.55