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"UNIVERSITY CITATION DISTRIBUTIONS"

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Abstract. In this paper we investigate the characteristics of the citation distributions of the 500 universities in the 2013 edition of the CWTS Leiden Ranking. We use a WoS dataset consisting of 3.6 million articles published in 2003-2008, and classified into 5,119 clusters. The main findings are the following four. Firstly, The universality claim, according to which all university citation distributions, appropriately normalized, follow a single functional form, is not supported by the data. Secondly, nevertheless, the 500 university citation distributions are all highly skewed and very similar. Broadly speaking, university citation distributions appear to behave as if they differ by a relatively constant scale factor over a large, intermediate part of their support. Thirdly, citation impact differences between universities account for 3.85% of overall citation inequality. However, this percentage is greatly reduced when university citation distributions are normalized using their Mean Normalized Citation Scores as normalization factors. Finally, the above results have important practical consequences. On one hand, we only need a single explanatory model for the type of high skewness characterizing all university citation distributions. On the other hand, the similarity of university citation distributions goes a long way in explaining the similarity of the university rankings obtained with the *MNCS* and the Top 10% indicator.

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I. INTRODUCTION

Universities constitute a key vehicle in the production of knowledge in contemporary societies. However, the evaluation of the quality, or the relevance of the research done by universities in a myriad of scientific fields is a very difficult problem. For the assessment of the performance of research units of all types during recent decades, academic bodies, public officials in charge of science policy, and specialists in the field of scientometrics have been paying increasing attention to one observable aspect of research in all fields: the citation impact of publications in the periodical literature.

In this paper, we focus on this aspect of research for the 500 universities included in the 2013 edition of the CWTS Leiden Ranking (Waltman *et al.*, 2012a) –the LR universities hereafter. We use a Web of Science (WoS) dataset consisting of 3.6 million publications in the 2005-2008 period, the citations they receive during a five-year citation window for each year in that period, and a classification system consisting of 5,119 clusters (Ruiz-Castillo & Waltman, 2015).

The construction of university citation distributions in the all-sciences case requires the prior solution of two methodological problems: the assignment of responsibility for publications with two or more co-authors belonging to different institutions, and the aggregation of the citation impact achieved by research units working in different scientific clusters. We solve these problems using a fractional counting approach in the presence of co-authorship, and the standard field-normalization procedure where cluster mean citations are used as normalization factors.[1]

Once these two problems have been solved, specialists typically debate the properties of alternative citation impact indicators. In this paper, we study a basic aspect of the research evaluation

[1] Nevertheless, we study the robustness of some of our key results using a multiplicative rather than a fractional counting approach in the co-authorship case, and considering the university un-normalized citation distributions where every article receives the raw number of citations that appear in the initial dataset.

problem that comes *before* the comparison of the advantages and shortcomings of specific indicators, namely, the characteristics of the university citation distributions themselves. These distributions arise from the interplay of a complex set of economic, sociological, and intellectual factors that influence the research performance of each university in every field in a way that is difficult to summarize. In this scenario, it is well known that some universities are more productive or successful than others in terms of the number of publications and/or the mean citation that these publications receive. However, little is known concerning the shape of university citation distributions abstracting from size and mean citation differences. In order to contribute to this knowledge, in this paper we investigate the following four issues.

• Firstly, we inquire whether university citation distributions are universally distributed. The universality condition, borrowed from statistical physics, means that, appropriately normalized, citation distributions follow a unique functional form within the bounds set by random variation. Radichhi *et al.* (2008) suggest a statistical test of this condition in their study of 14 WoS journal subject categories. According to this test, the universality condition is not satisfied for our 500 university citation distributions.[2]

• Secondly, in view of the above finding, we ask: are at least university citation distributions as highly skewed and as similar among one another as previous results indicate for field citation distributions? Using the same size- and scale-independent techniques that have been used in previous research, we confirm that this is the case in our dataset.[3]

[2] This is consistent with previous results for large classification systems in WoS datasets consisting of complete field citation distributions that include publications with zero citations (Albarrán & Ruiz-Castillo, 2011, Albarrán *et al.*, 2011a, Waltman *et al.*, 2012b, and Perianes-Rodriguez & Ruiz-Castillo, 2014).

[3] This result has been established at different aggregation levels, publication years, and citation window lengths, and independently of whether the problem of the multiple assignment of publications to sub-fields in WoS datasets is solved by following a multiplicative or a fractional approach (Glänzel, 2007, Radicchi *et al.*, 2008, Albarrán & Ruiz-Castillo, 2011, Albarrán *et al.*, 2011a, Herranz & Ruiz-Castillo, 2012, Waltman *et al.*, 2012b, Radicci & Castellano, 2012, Li *et al.*, 2013,

• Thirdly, using the measuring framework introduced in Crespo *et al.* (2013), we investigate how important is the effect in the overall citation inequality that can be attributed to differences in citation impact between LR universities. Furthermore, we inquire up to what point this effect can be accounted for by scale factors captured by the universities' Mean Normalized Citation Score (*MNCS* hereafter). The answer is that citation impact differences between universities account for 3.85% of overall citation inequality –a much smaller percentage than what is found in the context of production and citation practice differences between scientific fields (Crespo *et al.*, 2013, 2014, Waltman & Van Eck, 2013, Ruiz-Castillo, 2014, Ruiz-Castillo & Waltman, 2015, and Perianes-Rodriguez & Ruiz-Castillo, 2014). This percentage is greatly reduced when university citation distributions are normalized using their *MNCS* values as normalization factors.

• Finally, we discuss the implications of these results for understanding the high correlation between the university rankings according to two citation impact indicators: the *MNCS*, and the Top 10% indicator of scientific excellence (the $PP_{top\ 10\%}$ indicator hereafter), defined as the percentage of an institution's output included into the set formed by 10% of the world most cited papers in the different scientific fields. The latter indicator has been recently adopted by well-established institutions, such as the CWTS in the Netherlands, and SCImago in Spain.[4]

So far, we have mentioned previous research on individual productivity distributions and citation distributions at the field level in different classification systems. Now we should cite the contributions closer to our own in which research publications are aggregated into the type of

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Ruiz-Castillo & Waltman, 2015, and Perianes-Rodriguez & Ruiz-Castillo, 2014). Similar conclusions concerning the skewness and similarity of individual productivity distributions are found when authors are classified into 30 broad scientific fields (Ruiz-Castillo & Costas, 2014).

[4] The CWTS introduced the $PP_{top10\%}$ indicator as of the *Leiden Ranking 2011/2012* (http://www.leidenranking.com/methodology.aspx), based on a WoS database, while SCImago did so as of the *SCImago Institutions Rankings* (SIR) 2011 World Report (http://www.scimagoir.com/pdf/sir_2011_world_report.pdf), based on the Scopus® database (Elsevier B.V.).

organization unit to which the authors belong. Firstly, using a large WoS dataset consisting of 4.4 million articles published in the period 1998-2003 with a five-year citation window for each year, Albarrán *et al.* (2015) find that, at least in some broad fields and in the all-sciences case, the citation distributions of 36 countries and two residual geographical areas are not only highly skewed, but also very similar across countries –a result parallel to our own for the 500 LR universities. Secondly, Perianes-Rodriguez & Ruiz-Castillo (2015) study a set of 2,530 highly productive economists who work in 2007 in a selection of the top 81 economics departments in the world. Contrary to previous results for field or country citation distributions, we find that productivity distributions are very different across the 81 economics departments. Finally, Chatterjee *et al.* (2014) study 42 academic institutions across the world, their publications in four years, 1980, 1990, 2000, and 2010, and the citations they receive according to the WoS up to July 2014.[5] Contrary to our first result, these authors claim that their 42 citation distributions satisfy the universality condition. As we will see below, when examined in detail, the results of the last two papers can be reconciled with ours.

The rest of the paper is organized into six Sections. Section II presents the data, as well as the methods applied in the construction of university citation distributions, namely, the standard field-normalization procedure, and the address-line fractional counting method. The next three Sections include the empirical results. Section III examines the failure of the universality condition in our dataset. Section IV discusses the skewness and similarity between university citation distributions, as well as the robustness of the results when we consider un-normalized university citation distributions, and the address-line multiplicative counting method. Section V studies the effect in the overall citation inequality of the citation impact differences between universities, as well as the reduction of this effect when the university citation distributions are normalized using their *MNCS* values as normalization

[5] They also study 30 popular academic journals across physics, chemistry, biology, and medicine. However, the characteristics of journal citation distributions are beyond the scope of this paper.

factors. Section VI discusses the practical implications of our results, while Section VII offers some conclusions and suggestions for further research.

II. THE CONSTRUCTION OF THE UNIVERSITY CITATION DISTRIBUTIONS

II.1. The data

Our dataset results from the application of the publication-level algorithmic methodology introduced by Waltman & Van Eck (2012) to a WoS dataset consisting of 9,446,622 million publications from the 2003-2012 period. This is done along a sequence of twelve independent classification systems in each of which the same set of publications is assigned to an increasing number of clusters. In this paper, we use the classification system recommended in Ruiz-Castillo & Waltman (2015), consisting of 5,119 clusters.

Only publications of the document types article and review, referred to in the sequel as 'articles' or 'publications', are considered. Publications in local journals, as well as popular magazines and trade journals, have been excluded. We work with journals in the sciences, the social sciences, and the arts and humanities, although many arts and humanities journals are excluded because they are of a local nature. In this paper, we focus on the set of 3,614,447 articles published in the period 2005-2008, and the citations they receive during a five-year citation window for each year in that period (for further details, see Ruiz-Castillo & Waltman, 2015).

II.2. The all-sciences aggregation problem

Using a measuring framework introduced in Crespo *et al.* (2013), recent research has established that different normalization procedures perform quite well in eliminating most of the effect in overall citation inequality that can be attributed to differences in production and citation practices between fields (Crespo *et al.*, 2013, 2014, Li *et al.*, 2013, Waltman & Van Eck, 2013, Ruiz-Castillo, 2014). We

believe that the reason for the good performance of target (or cited-side) normalization procedures is that field citation distributions, although not universal, are extremely similar. Li *et al.* (2013) indicate that the best alternative among a wide set of target normalization procedures is the two-parameter system developed in Radicci & Castellano (2012). However, recent results indicate that the standard field-normalization procedure where field mean citations are used as normalization factors performs well in the sense already indicated (Radicchi *et al.*, 2008, Leydesdorff *et al.*, 2012, Crespo *et al.*, 2013, 2014, Li *et al.*, 2013, and Ruiz-Castillo, 2014). Consequently, in this paper we adopt this procedure as the solution to the all-sciences aggregation problem, so that the raw citations to the 3.6 million articles in the original dataset are normalized using the 5,119 cluster mean citations as normalization factors.

II.3. The assignment of responsibility in the case of co-authorship

We know the total number of address lines appearing in each publication, but we have information concerning the correspondence between address lines and universities only for the 500 LR universities. As in Waltman *et al.* (2012a), the 2,420,054 distinct articles, or 67% of the total, with at least one address line belonging to an LR university are assigned to universities using the following fractional counting method. An article is fully assigned to an LR university only if all addresses mentioned in the publication belong to the university in question. If a publication is co-authored by two or more LR universities, then it is assigned fractionally to all of them in proportion to the number of address lines in each case. For example, if the address list of an article contains five addresses and two of them belong to a particular university, then 0.4 of the article is assigned to this university, and only 0.2 of the article is assigned to each of the other three universities. Finally, consider a publication co-authored by an LR university and an unknown number of other institutions outside the Leiden Ranking. Assume, for example, that the publication has four address lines, two of

which correspond to the LR university. In this case, only 0.5 of the article will be assigned to the LR university.

This completes the construction of the 500 university field-normalized citation distributions according to the address-line fractional counting method. For simplicity, in the sequel they are referred to as *university citation distributions*, and denoted as c_i, i = 1,…, 500. Note that, for each university, the mean citation of c_i is precisely the *MNCS*. Finally, note also that the fractional counting method implies that the total (fractional) number of articles assigned to LR universities is necessarily smaller than the 2.4 million articles with at least one address line belonging to an LR university. It turns out that this total is 1,886,106.1, or 52.2% of the 3.6 million articles in the initial dataset. The distribution of the 1.9 million articles among the 500 universities is in column 1 in Table A in the Appendix, where universities are ordered by their *MNCS* values.

III. THE UNIVERSALITY OF UNIVERSITY CITATION DISTRIBUTIONS

III.1. Methods

Let c^*_i be the normalized citation distribution of university i using the university *MNCS* as the normalization factor. Let C^* be the union of the universities' normalized citation distributions, $C^* = \cup_i \{c^*_i\}$, where articles are ranked in increasing order of the number of normalized citations. Let X_z be the set of publications in the top z% of distribution C^*, and let x_{zi} be the publications in X_z that belong to the i-th university, so that $X_z = \cup_i \{x_{zi}\}$. If the university citation distributions follow a unique functional form under the universality condition, so that –in the terminology of Radicchi *et al.* (2008) – the ranking in X_z is fair, or unbiased, then the percentage of publications that the set x_{zi} represents within each university should be near z% with small fluctuations. Let N_i be the number of articles in the i-th university. Assuming that publications of the various universities are scattered

uniformly along the rank axis, for any value z% one would expect the average relative frequency of the number of articles in any university to be z% with a standard deviation

$$\sigma_z = \{[z(100 - z)\Sigma_i (1/N_i)]/500\}^{1/2},$$

which is equation (2) in Radicchi *et al.* (2008).

III.2. Results

For each z value, columns 2 and 3 in Table 1 present the theoretical standard deviation and coefficient of variation, σ_z and σ_z/z. Columns 4 to 6 contain the values for the average z, the standard deviation σ_z, and the coefficient of variation σ_z/z obtained empirically over the 500 values $(100\ x_{zi})/N_i$ in distribution $\boldsymbol{C}$*.

For comparison purposes, consider the union of the universities' un-normalized citation distributions, $\boldsymbol{C} = \cup_i \{c_i\}$, where articles are equally ranked in increasing order of the number of normalized citations. Let Y_z be the set of publications in the top z% of distribution $\boldsymbol{C}$, and let y_{zi} be the publications in Y_z that belong to the i-th university, so that $Y_z = \cup_i \{y_{zi}\}$. Columns 7 to 9 report the average z, the standard deviation σ_z, and the coefficient of variation σ_z/z obtained empirically over the 500 values $(100\ y_{zi})/N_i$ in distribution $\boldsymbol{C}$ before the normalization of university distributions by *MNCS* values.

Table 1 around here

The following three points should be emphasized. Firstly, although σ_z varies non-linearly with z, the theoretical coefficient of variation in column 3 increases from 0.01 to 0.20 when we proceed from z = 90% towards z = 1%. Secondly, in the union of un-normalized university citation distributions

the range of the coefficients of variation in column 9 is [0.05, 0.63], indicating that the distributions are very different. Thirdly, normalization using university *MNCS* values clearly decrease the coefficients of variation at all z values (column 6). Nevertheless, the differences with the theoretical values in column 3, above all for lower values of z, indicate that for our set of university citation distributions the universality condition is not satisfied.

Following up on Waltman & Van Eck (2012b), the situation is illustrated for z = 10%, in which case the theoretical value of σ_z is 0.59 (Table 1). The histogram of the percentages $(100\ y_{10i})/N_i$ is represented in Figure 1.A. Only 132 universities, representing 25.5% of all articles in Y_{10}, are within the (9, 11) interval. Naturally, the situation improves when we consider the histogram of the percentages $(100\ x_{10i})/N_i$ in Figure 1.B. Now, 295 universities, representing 68.4% of all articles in X_{10}, are within the (9, 11) interval. However, the considerable number of universities outside the theoretical interval illustrates the lack of universality in our dataset.

Figure 1 around here

This conclusion contrasts with the universality claim in Chatterjee *et al.* (2014). We should emphasize that this paper has a number of technical problems. The criterion for selecting their 42 academic institutions is not given, and there is no information on how the following three problems have been solved: the assignment of publications in WoS datasets to multiple journal subject categories, the assignment of responsibility for co-authored publications, and the all-sciences aggregation problem. Nevertheless, we will proceed to discuss their results.

Chatterjee *et al.* (2014) explain that, for each of four publication years, the university normalized citation distributions fit well to a lognormal for most of the range, although the poorly cited publications seem to follow another distribution, while the upper tail is better described by a power

law. This is quite different from the claim that there is a single functional form for the entire domain of definition of the 42 institutions in their sample. Instead, our statistical approach tests whether the universality claim is supported by the data over the *entire domain* of the 500 LR universities. In this sense, our results do not contradict each other. We both agree that the universality claim over the entire domain is not the case in our respective samples.

On the other hand, apart from the technical shortcomings already noted, the main problem with the still unpublished version of Chatterjee *et al.* (2014) is that, in our opinion, their statistical methodology is open to question. Specifically, the authors do not explain the following three aspects: (i) how the partition of the domain into three segments is estimated for each university, and whether this partition is common to all of them or not; (ii) which tests have been used to determine the functional form chosen in each segment versus possible alternatives, and (iii) how the confidence interval for the power law parameter has been estimated, and which is the confidence interval for the lognormal parameters. As a matter of fact, the only clear evidence for the distributions' collapse into a universal curve is the graphical illustration provided for a sample –whose selection is unexplained– of 24 of the original 42 academic institutions (Figure 1 in Chatterjee *et al.*, 2014).

IV. THE SKEWNESS AND SIMILARITY OF UNIVERSITY CITATION DISTRIBUTIONS

IV.1. Methods

Universities are known to be rather different in size, measured by the number of articles, as well as in mean citation per article which, as we know, is simply the *MNCS* (columns 1 and 2 in Table A in the Appendix). Therefore, we should focus on the shape of university citation distributions abstracting from size and scale differences between fields. The skewness of citation distributions is assessed in the following two complementary approaches.

In the first place, we study the broad features of the skewness phenomenon by simply partitioning citation distributions into three classes of articles with low, fair, and very high number of citations. For this purpose, we follow the Characteristic Scores and Scale (CSS hereafter) approach, first introduced in Scientometrics by Schubert *et al.* (1987). In our application of the CSS technique, the following two *characteristic scores* are determined for every university: μ_1 = mean citation, and μ_2 = mean citation for articles with citations greater than μ_1. We consider the partition of the distribution into three broad categories: (i) articles with a low number of citations, smaller than or equal to μ_1; (iii) fairly cited articles, with a number of citations greater than μ_1 and smaller than or equal to μ_2, and (iii) articles with a remarkable or outstanding number of citations greater than μ_2. For each citation distribution, we measure the percentages of publications in the three categories, as well as the percentages of the total citations accounted for by the three categories.

In the second place, we summarize the skewness of citation distributions with a single scalar. The problem, of course, is that extreme observations of publications with a very large number of citations are known to be prevalent in citation distributions. Fortunately, robust measures of skewness based on quartiles have been developed in the statistics literature. Among the size- and scale-independent measures that are also robust to extreme observations, in this paper we use the one suggested by Groeneveld & Meeden (1984).[6] Given a process $\{y_t\}$, $t = 1,\ldots, T$, where the y_t's are independent and identically distributed with a cumulative distribution function F, the Groeneveld & Meeden robust measure, denoted GM, is defined as

$$GM = (\mu - \Theta_2)/\mathrm{E}\left|y_t - \Theta_2\right|, \qquad (1)$$

[6] For references concerning robust measures of skewness in the context of the financial literature on stock market returns, and for the properties of the Groeneveld and Meeden's measure, see Albarrán *et al.* (2015).

where $\Theta_2 = F^{-1}(0.5)$ is the second quartile of y_r, or the median of the distribution, and the expectation in the denominator in expression (1) is estimated by the sample mean of the deviations from the median in absolute value. The *GM* index is bounded in the interval [-1, 1], and whenever the mean is greater than the median –as is always the case in our dataset– the *GM* index takes positive values.

For the interpretation of results, recall that the absence of skewness in a uniform or a normal distribution corresponds to a value of the *GM* index equal to zero, and to a partition of the population into three classes in the CSS approach equal to 50%/25%/25%. Finally, the between-group variability of the results of the CSS approach and the *GM* index is measured by the coefficient of variation of the results over the 500 universities.

IV.2. Results

The information concerning the second mean, μ_2, as well as the percentages of articles and citations in the three categories are presented in columns 3 to 9 in Table A in the Appendix. Finally, the estimates of the *GM* index of skewness are in column 10 of this Table.

The average, standard deviation, and coefficient of variation for the 500 university values are presented in Panel A in Table 2. This panel also includes the results of the CSS approach for two important citation distributions: (i) the union of the 500 field-normalized university citation distributions, $\boldsymbol{C} = \cup_i \{\boldsymbol{c_i}\}$ (the LR union hereafter), consisting of 1.9 million articles according to the fractional approach, and (ii) the overall citation distribution, consisting of the 3.6 million distinct articles in the original dataset.

Table 2 around here

The results are remarkable. In principle, differences in resources, intellectual traditions, organization, the structure of incentives, and other factors lead us to expect large differences between

the 500 LR university citation distributions in different parts of the world. However, judging from the size of the standard deviations and the coefficient of variations for the 500 universities, we find that university citation distributions are extremely similar (row I in Table 2). At the same time, the distributions are highly skewed: on average, the *MNCS* values of the 500 universities is 12.9 percentage points above the median, while the 12.5% of outstanding articles account for 44.4% of all normalized citations. Figure 2 clearly illustrates the situation. In view of the above, it comes as no surprise that the union of the 500 field-normalized university citation distributions exhibits practically the same skewness as the average of the 500 universities (row II.1 in Table 2). Furthermore, the overall field-normalized citation distribution exhibits very similar characteristics (row II.2 in Table 2).

Figure 2 around here

On the other hand, the results concerning the *GM* index confirm that university citation distributions are both highly skewed and extremely similar (row I in Panel A in Table 3). The *GM* index is somewhat smaller for the LR union, and the overall citation distribution (rows II.1 and II.2 in Panel A in Table 3).

Table 3 around here

IV.3. Robustness analysis

For the sake of robustness, we have conducted two more sets of computations. In the first place, in the presence of co-authorship we have assigned publications to universities following a multiplicative approach. Thus, any co-authored article is multiplied as many times as the number of address lines that appear in the by-line of the publication in question. For example, assume that the address-list of an article contains six addresses, two of which belong to a particular LR university, say university A, two other to a non-LR university, say university B, and the remaining two addresses

belong to two other non-LR universities, say universities C and D. Then two articles are assigned to university A, another two articles to university B, and only one article is assigned to each of the universities C and D. In this way, we construct what we call an *extended count* of 8,329,951 articles, or 230.4% of the 3.6 million articles published in 2005-2008, and 4,351,584 articles with at least one address line belonging to a LR university, or 179.8% of the 2.4 million in the original dataset.[7]

Next, field-normalization proceeds using the cluster mean citations in the extended count as normalization factors. In turn, the restriction of the extended count to the set of publications with at least one address line in one of the LR universities has now 4,351,584 million articles, or 180% more than the original 2.4 million. To save space, the information concerning the characteristics included in Table A in the Appendix for each LR university is available on request. The key results for the set of 500 LR universities, as well as for the LR union, and the overall citation distribution, are presented in Panel B in Table 2.[8] The results for the *GM* index are in Panel B in Table 3.

In the second place, we have studied the raw citation distributions without the benefit of any field-normalization procedure. Consider the raw citation distribution consisting of the 2.4 million articles in which there is at least one address line corresponding to one LR university. In this case, we assign co-authored publications to universities according to the fractional counting method, so that the LR un-normalized union has again approximately 1.9 million articles. As before, the information concerning the characteristics included in Table A in the Appendix for each LR university is available on request. The key results for the set of 500 LR universities, as well as for the corresponding LR union, and the overall citation distribution, are presented in Panel C in Table 2. The results for the

[7] Ideally, we would have preferred to assign publications to universities without taking into account the number of address lines corresponding to them. Thus, in the above example we would have multiplied the article only four times, assigning them to each of the four universities A to D. Unfortunately, as we pointed out in Section II.3, we only have information about the number of address lines of specific institutions for the 500 LR universities. Consequently, we could only use the total number of address lines in the construction of the extended count.

[8] Note that the overall citation distribution in this case coincides with the distribution corresponding to the granularity level 0 in Table 2 in Ruiz-Castillo & Waltman (2015).

GM index are in Panel C in Table 3.

Interestingly enough, the results in the two exercises are very similar to those obtained for field-normalized university citation distributions in the fractional case. Perhaps we should note that the *GM* values in Panel C in Table 3 indicate that university citation distributions in the absence of field-normalization are somewhat more skewed than when we consider the standard solution to the all-sciences aggregation problem. Thus, we conclude that the characteristics of university citation distributions are robust to the way the assignment of publications to universities in the presence of co-authorship and the all-sciences aggregation problem are solved.

By way of comparison, we include in Panel D in Table 2 the results from the CSS approach to sub-field citation distributions in a classification system consisting of 219 WoS journal subject categories, or sub-fields, in Albarrán *et al.* (2011a). The results for university citation distributions and for sub-field citation distributions are of the same order of magnitude. The same can be said for authors' productivity distributions in a WoS dataset with a classification system consisting of 30 broad scientific fields for two measures of individual productivity (Ruiz-Castillo & Costas, 2014).

Finally, we should mention the results of two contributions closer to our own in which research publications are aggregated into the type of organization unit to which the authors belong. Firstly, Albarrán *et al.* (2015) study the partition of world citation distributions into 36 countries and two residual geographical areas using a dataset, comparable to ours, consisting of 4.4 million articles published in the period 1998-2003 with a five-year citation window for each year. As indicated in the Introduction, Albarrán *et al.* (2015) find that, at least in some broad fields and in the all-sciences case, the country citation distributions are not only highly skewed, but also very similar across countries –a result parallel to our own for the 500 LR universities.

Secondly, Perianes-Rodriguez & Ruiz-Castillo (2015) study a set of 2,530 highly productive

economists who work in 2007 in a selection of the top 81 economics departments in the world. Contrary to previous results for field or country citation distributions, we find that productivity distributions are very different across the 81 economics departments. However, certain characteristics of the dataset may help to explain the different results. To begin with, the data in Perianes-Rodriguez & Ruiz-Castillo (2015) does not consist of department citation distributions of articles published in a certain period of time with a citation window of common length, but of the individual productivity of faculty members in each department, where individual productivity is measured as a quality index that weights differently the articles published up to 2007 by each researcher in four journal equivalent classes. In the second place, the information about researchers' publications and academic age has been taken from department and the individuals' web pages in 2007. Nevertheless, we cannot rule out that the similarity of citation distributions is a phenomenon present at certain aggregate levels. To settle this issue, we need more work at the department level with citation distributions consisting of articles published in a certain period of time with a common citation window.

V. THE IMPORTANCE OF CITATION IMPACT DIFFERENCES BETWEEN UNIVERSITIES

V.1. Methods

We are interested in measuring how important the citation impact differences are between universities. Formally, this problem is analogous to the measurement of the importance of differences in production and citation practices between scientific fields. For the latter, Crespo *et al.* (2013) suggested measuring the impact of such differences on the overall citation inequality for the entire set of field citation distributions applying an additively decomposable citation inequality index to a double partition into scientific fields and quantiles. Similarly, in our case we measure how much of the overall citation inequality exhibited by the union of the 500 LR university citation distributions can be

attributed to the citation impact differences between universities. (This is also the approach adopted in Albarrán *et al.*, 2015, to assess the effect of citation impact between countries).

For that purpose, we begin with the partition of, say, each university citation distribution into Π quantiles, indexed by $\pi = 1,.., \Pi$. In practice, in this paper we use the partition into percentiles, that is, we choose $\Pi = 100$. Assume for a moment that, in any university u, we disregard the citation inequality within every percentile by assigning to every article in that percentile the mean citation of the percentile itself, μ_u^π. The interpretation of the fact that, for example, $\mu_u^\pi = 2\ \mu_v^\pi$ is that, on average, the citation impact of university u is twice as large as the citation impact of university v, in spite of the fact that both quantities represent a common underlying phenomenon, namely, the same *degree of citation impact* in both universities. In other words, for any π, the distance between μ_u^π and μ_v^π is entirely attributable to the difference in the citation impact that prevails in the two universities for publications with the same degree of excellence in each of them. Thus, the citation inequality between universities at each percentile, denoted by $I(\pi)$, is entirely attributable to the citation impact differences between the 500 LR universities holding constant the degree of excellence in all universities at quantile π. Hence, any weighted average of these quantities, denoted by *IDCU* (*I*nequality due to *D*ifferences in *C*itation impact between *U*niversities), provides a good measure of the total impact on overall citation inequality that can be attributed to such differences. As before, let c_i be university i citation distribution, and let $\boldsymbol{C}$ be the union of the universities citation distributions, $\boldsymbol{C} = \cup \{c_i\}$. We use the ratio

$$IDCU/I(\boldsymbol{C}) \qquad (2)$$

to assess the relative effect on overall citation inequality, $I(\boldsymbol{C})$, attributed to citation impact differences between universities (for details, see Crespo *et al.*, 2013).

Finally, we are interested in estimating how important scale differences between university citation distributions are in accounting for the effect measured by expression (2). Following the experience in other contexts, we choose the university mean citations as normalization factors. To assess the importance of such scale factors, we use the relative change in the *IDCU* term, that is, the ratio

$$[IDCU - IDCU^*]/IDCU, \qquad (3)$$

where *IDCU** is the term that measures the effect on overall citation inequality attributed to the differences in university distributions after the normalization of university citation distributions using university *MNCS* values as normalization factors (for details, see again Crespo *et al.*, 2013).

V.2. Results

The estimates of expressions (2) and (3) are presented in Panel A in Table 4. It is interesting to compare these figures with what was obtained in two instances in the previous literature. The first case concerns the partition into 36 countries and two residual geographical areas in the all-sciences case (Albarrán *et al.*, 2015), while the second case refers to 219 WoS sub-fields (Crespo *et al.*, 2014). Two comments are in order. Firstly, the effect on overall citation inequality due to citation impact differences between the 500 LR universities (3.85%) is comparable to the effect due to citation impact differences between countries (5.4%). However, both of them are considerably smaller than the corresponding effect on overall citation inequality attributable to differences in production and citation practices across the 219 sub-fields (approximately 18%). Secondly, the reduction of the total effect generated by *MNCS* normalization in our dataset (81.3% of the total effect) is of a comparable order of magnitude to the same phenomenon in the context of country (85.2%) or sub-field citation distributions (83.2%).

Table 4 around here

It should be noted that these results summarize in a pair of scalars a complex phenomenon that takes place along the entire support of our university citation distributions. As a matter of fact, the term *IDCU* is simply a weighted average of the $I(\pi)$ terms, $\pi = 1,\ldots, 100$, which capture the effect on overall inequality of the citation impact differences between the 500 LR universities holding constant the degree of excellence in all universities at percentile π. Therefore, it is instructive to study how $I(\pi)$ changes with π both before and after the *MNCS* normalization. The results appear in Figure 3 (since $I(\pi)$ is very high for $\pi < 27$, for clarity these percentiles are omitted from Figure 3).

Figure 3 around here

Figure 3 warrants the following two comments. Firstly, the strong impact of *MNCS* normalization is readily apparent. Secondly, it is useful to informally partition the support into the following three intervals: [0, 57], [58, 96], and [98, 100]. In the first and the third one, $I(\pi)$ values are very high. This means that, since in these two intervals university citation distributions differ by more than a scale factor, the universality condition can hardly be satisfied in them. However, $I(\pi)$ is approximately constant for a wide range of intermediate values in the second interval. Thus, this is the range of values where the search for a single functional form –as in Chatterjee *et al.* (2014)– may give good results in our dataset.

VI. DISCUSSION

Our results have two types of practical implications. In the first place, assume that the top, intermediate, and worse universities have different types of citation distributions. In this case, we would need to build different models to explain the citation impact variability within the universities of the three types. On the contrary, since we have found that, although not universal, university citation distributions are rather similar, we need a single model to explain the high within-universities variability.

In the second place, recall the move in the CWTS and SCImago rankings from an average-based citation impact indicator –such as the *MNCS*– towards a rank percentile approach that throws all the weight on the top x% of most cited papers –such as the $PP_{top\ 10\%}$ indicator. This shift in emphasis is surely due to the idea that, for highly skewed citation distributions, average-based indicators might not represent well the excellence in citation impact.[9] However, we should ask: under what conditions will this move yield a ranking of research units different from a ranking according to average-based indicators? Of course, the skewness of citation distributions is not a sufficient condition. If any pair of citation distributions under comparison were to differ only by a scale factor over their entire domain or, in other words, if the universality condition were to be satisfied, then the ratio of their *MNCS* values would coincide with the ratio of their $PP_{top\ x\%}$ values for all choices of x. Therefore, for the two rankings to differ we need the research units' citation distributions to be sufficiently different.

However, as illustrated in Figure 4, the two rankings are rather similar. The Pearson correlation coefficient between university values is 0.981, while the Spearman correlation coefficient between ranks is 0.986. It should be noted that high correlations between university values and ranks do not preclude important differences for individual universities. As a matter of fact, the positive slope in Figure 4 indicates that to low (high) *MNCS* values there correspond lower (higher) $PP_{top\ 10\%}$ values. Table 5 informs about the re-rankings that take place in the move from the *MNCS* to the $PP_{top\ x\%}$, while Table 6 compares the differences between the university values themselves. In both cases, there are two instances with which to compare our results: the relatively large differences between the university rankings according to the $PP_{top\ x\%}$ indicator in going from the WoS classification system with 236 sub-fields to the classification system with 5,119 clusters we use in this paper (Ruiz-Castillo & Waltman, 2015), and the small differences between two ways of solving the all-sciences aggregation

[9] Among other authors, one of us is on the record as advocating this idea (Albarrán *et al.*, 2011b).

problem, with and without prior field-normalization using our own dataset (Perianes-Rodriguez & Ruiz-Castillo, 2014).

Figure 4, as well as Tables 5 and 6 around here

On one hand, as anticipated in view of Figure 3, cardinal differences in our case are relatively large: the percentage of differences greater than 0.10 is 42% –a figure greater than 2.6% and 19% in the other two contributions. On the other hand, the percentage of universities experiencing relatively large re-rankings greater than 25 positions is 15.6% –a figure similar to 13.4% in Perianes-Rodriguez & Ruiz-Castillo (2014), and well below 39% in Ruiz-Castillo & Waltman (2015). Therefore, ordinal differences between the university rankings according to the *MNCS* and the $PP_{top\ 10\%}$ indicators are of a small order of magnitude. As a matter of fact, we find a strong, more or less linear relationship between the $PP_{top\ 10\%}$ and the *MNCS* in two other instances: for the 500 universities in the 2011/2012 edition of the Leiden Ranking (see Figure 2 in Waltman *et al.*, 2012a), and for the partition of the world into 39 countries and eight geographical areas studied in Albarrán and Ruiz-Castillo (2012).

How can we explain these results? We have already seen that university citation distributions behave as if they differ by a relatively constant scale factor over the [58, 96] percentile interval in their support. In this empirical scenario, it is not surprising that the *MNCS* values, which are reached at approximately the 63th percentile of citation distributions, and the $PP_{top\ 10\%}$ indicator that focus on the last 10 percentiles, provide very similar rankings. A convenient practical consequence is that the citation impact university ranking provided by the *MNCS* indicator is an adequate one. The $PP_{top\ 10\%}$ indicator would only add greater cardinal differences between the best and the worse universities with relatively few re-rankings.

VI. CONCLUSIONS, AND FURTHER RESEARCH

VI. 1. Conclusions

This paper has investigated the citation distributions of the 500 universities in the 2013 edition of the CWTS Leiden Ranking. We have used a WoS dataset consisting of 3.6 million articles published in the period 2003-2008 with a five-year citation window, and classified into 5,119 clusters. The all-sciences aggregation problem is solved by using the standard field-normalization procedure where clusters mean citations are used as normalization factors. The assignment of responsibility of publications to universities in the presence of co-authorship is solved by applying a fractional approach. The main findings can be summarized in the following four points.

1. The universality claim, according to which all university citation distributions, appropriately normalized, follow a single functional form, is not supported by the data.

2. Nevertheless, the 500 university citation distributions are all highly skewed and very similar. This result is essentially maintained regardless of the way we solve the all-sciences aggregation problem, and the assignment of publications to universities in the presence of co-authorship.

3. Citation impact differences between universities account for 3.85% of overall citation inequality. However, these differences are greatly reduced when university citation distributions are normalized using their MNCS values as normalization factors.

4. The above results have important practical consequences. Firstly, we only need a single explanatory model for the type of high skewness characterizing all university citation distributions. Secondly, the similarity of university citation distributions goes a long way in explaining the similarity of the university rankings obtained with the *MNCS* and the $PP_{top\ 10\%}$ indicator.

Naturally, the robustness of these results must be investigated with other datasets characterized by other publication years, and other citation windows, as well as other data sources different from the WoS.

VI. 2. Further research

We would mention for possibilities for further research.

1. The effect on overall citation inequality attributable to the differences in citation impact between universities shows a characteristic pattern: university citation distributions appear to behave as if they differ by a relatively constant scale factor over a large, intermediate part of their support. Consequently, it might be interesting to compute the exchange rates introduced in Crespo *et al.* (2013, 2014) to exploit this feature, and to use them as normalization factors. More generally, one could experiment with other normalization approaches that have been found most useful in other contexts, notably the two parameter scheme introduced by Radicci & Castellano (2012).

2. Chatterjee *et al.*'s (2014) idea of fitting specific functional forms to university citation distributions in different intervals of their support is worth pursuing. The threshold determining the upper tail where a power law might be the best alternative could be estimated following the methods advocated in Clauset *et al.* (2009). Similar grid techniques could be applied to determine the lower bound of the interval where a lognormal might be the best alternative. In any case, standard methods should be used to test which specific functional form is best in each interval, as well as to estimate the parameters' confidence intervals (Thelwall & Wilson, 2014, and Brzezinski, 2015).

3. As we have seen in Section III.4, differences in citation impact between universities after *MNCS* normalization tend to increase when we reach the last few percentiles including the most highly cited articles. The question left for further research is how to complement average-based or

$PP_{top\ 10\%}$ indicators with other measurement instruments that highlight the behavior of citation distributions over the last few percentiles. Given the important role of extreme observations in citation distributions, robustness of alternative high-impact indicators to these extreme situations will be an important element in the discussion.

4. Consider an array of citation distributions with a smaller number of scientific fields than in this paper in the columns, and the 500 LR universities in the rows. We already know a good deal concerning field citation distributions and university citation distributions in the all-sciences case. A possible next step is to study the characteristics of university citation distributions column by column, that is, restricted to each field. The results will determine to what extent the similarities between citation distributions is a question depending on the aggregation level at which the study is conducted.

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APPENDIX

Table A. Number of articles (column 1), and mean citations μ_1 and μ_2 (columns 2 and 3) for the 500 LR universities. Results for the skewness of citation distributions according to the CSS approach: percentage of articles, and percentage of citations by category (columns 4 to 9), and *GM* index of skewness (column 10). Universities are ordered by μ_1 (or MNCS) values

	University	Number of articles	μ_1	μ_2	Percentage of articles in category:			Percentage of citations in category:			GM Index
		(1)	(2)	(3)	1 (4)	2 (5)	3 (6)	1 (7)	2 (8)	3 (9)	(10)
1	Massachusetts Institute of Technology	8350.4	1.96	4.07	62.7	25.4	12.0	22.4	32.5	45.1	0.69
2	Princeton University	4548.4	1.83	3.74	61.8	25.4	12.8	21.9	32.1	46.0	0.68
3	Harvard University	26879.2	1.8	3.67	63.1	25.3	11.6	24.7	31.9	43.4	0.67
4	California Institute of Technology	5265.5	1.78	3.61	61.6	26.2	12.1	22.2	31.8	46.0	0.71
5	Stanford University	11938.8	1.78	3.6	62.4	25.4	12.2	23.7	32.1	44.2	0.66
6	University of California, Berkeley	9186.5	1.73	3.59	63.2	25.1	11.7	23.5	32.5	44.0	0.66
7	University of Göttingen	3653.1	1.72	5.59	77.1	21.5	1.4	25.4	28.1	46.5	0.79
8	University of California, Santa Barbara	4192.5	1.66	3.45	63.1	25.5	11.4	23.0	32.4	44.6	0.66
9	London School of Hygiene & Tropical Medicine	1275.8	1.58	3.18	64.0	23.8	12.3	27.4	30.5	42.1	0.66
10	University of California, San Francisco	8760.7	1.54	2.86	59.9	26.5	13.6	25.2	32.1	42.8	0.64
11	Yale University	8674.7	1.54	2.98	60.7	26.3	13.0	23.7	32.3	44.0	0.66
12	University of Chicago	6134.8	1.52	3.02	61.2	26.6	12.2	23.1	33.3	43.6	0.65
13	Carnegie Mellon University	2914.7	1.52	3.31	64.0	24.9	11.1	21.5	33.8	44.8	0.68
14	Northwestern University	8079.8	1.5	2.97	61.4	26.0	12.6	23.5	32.4	44.1	0.66
15	University of California, San Diego	9990.4	1.5	3.01	62.2	25.4	12.4	23.9	32.2	43.9	0.66
16	École Polytechnique Fédérale de Lausanne	3762	1.49	3.19	64.0	24.1	11.9	22.8	31.9	45.3	0.67
17	University of Washington - Seattle	12523.9	1.49	2.92	61.5	25.8	12.7	24.4	32.2	43.4	0.65
18	University of California, Santa Cruz	1746.5	1.47	2.92	61.4	26.6	12.0	23.2	33.4	43.4	0.66
19	ETH Zurich	6710.8	1.46	3.04	63.6	24.7	11.8	24.3	32.2	43.5	0.65
20	Columbia University	10667.6	1.46	2.95	62.5	25.1	12.4	24.3	31.9	43.8	0.65
21	Rice University	2082.3	1.46	3.06	63.0	24.9	12.1	22.5	32.3	45.3	0.67
22	University of California, Los Angeles	13270.9	1.46	2.94	62.4	25.2	12.4	24.1	31.8	44.1	0.65
23	University of Oxford	10913	1.45	3.05	63.8	24.9	11.2	24.0	32.3	43.7	0.67
24	University of Cambridge	11146.7	1.44	3.04	64.4	24.6	11.0	24.7	32.2	43.1	0.66
25	Duke University	9018.5	1.43	2.79	61.4	26.1	12.5	24.7	32.3	43.0	0.64
26	University of Texas Southwestern Med Center at Dallas	1205.8	1.42	2.6	59.0	27.3	13.7	24.9	32.4	42.8	0.64
27	University of Pennsylvania	11439	1.42	2.82	62.1	25.3	12.6	24.6	32.2	43.2	0.64
28	University of Colorado Boulder	4335.5	1.42	2.76	60.7	25.8	13.5	23.4	32.5	44.0	0.64
29	Weizmann Institute of Science	2523.4	1.42	2.95	63.1	24.4	12.5	23.2	32.4	44.4	0.65
30	Johns Hopkins University	12895.5	1.41	2.68	60.1	26.9	13.0	24.1	32.5	43.4	0.66
31	Washington University in St. Louis	7676	1.41	2.71	61.2	26.0	12.8	25.2	32.3	42.5	0.63
32	New York University	6364.3	1.41	2.91	63.4	24.4	12.2	24.2	31.7	44.2	0.65
33	Georgia Institute of Technology	5368.5	1.4	3.06	65.0	23.5	11.5	23.2	32.3	44.5	0.64
34	University of Michigan	14287.7	1.39	2.81	62.4	25.7	11.9	24.1	32.8	43.1	0.64
35	University of St Andrews	1793.3	1.39	3.2	67.1	23.6	9.4	24.2	31.0	44.9	0.68
36	Cornell University	10369	1.39	2.8	62.4	25.2	12.4	24.2	32.2	43.6	0.64
37	Imperial College London	9129.1	1.36	2.75	62.1	25.2	12.8	23.6	32.4	44.0	0.65
38	University of North Carolina at Chapel Hill	8073.7	1.36	2.66	61.7	26.2	12.1	25.2	32.3	42.4	0.64
39	University College London	10140.3	1.35	2.68	61.7	25.6	12.7	24.3	32.3	43.5	0.65

	University	Number of articles	μ_1	μ_2	Percentage of articles in category: 1	2	3	Percentage of citations in category: 1	2	3	GM Index
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
40	University of Illinois at Urbana-Champaign	8958.1	1.35	2.89	64.1	24.7	11.2	23.3	32.6	44.1	0.64
41	Dartmouth College	1959.5	1.35	2.73	62.6	24.3	13.2	24.0	31.7	44.3	0.63
42	Boston University	5410.9	1.35	2.59	60.6	26.2	13.2	24.1	32.3	43.6	0.64
43	Emory University	5734.1	1.35	2.59	61.0	25.7	13.3	25.1	32.4	42.6	0.63
44	University of Texas at Austin	6915.1	1.34	2.78	63.1	25.1	11.9	23.5	32.4	44.2	0.63
45	University of California, Irvine	5614.9	1.34	2.65	61.4	25.0	13.6	23.3	31.2	45.5	0.65
46	University of California, Riverside	2955.9	1.33	2.73	61.6	25.8	12.6	21.4	32.9	45.7	0.66
47	University of Dundee	1938.7	1.32	2.88	65.6	24.9	9.5	24.9	32.4	42.7	0.68
48	Tufts University	3335.2	1.32	2.61	62.1	25.3	12.6	24.8	31.6	43.6	0.65
49	University of Bristol	5215	1.32	2.67	62.7	24.8	12.5	24.4	31.7	43.9	0.63
50	University of Wisconsin - Madison	11123.2	1.31	2.62	61.7	25.6	12.7	23.6	33.0	43.4	0.63
51	University of Maryland, College Park	5771	1.31	2.68	61.9	25.0	13.1	22.0	33.0	45.0	0.64
52	Oregon Health & Science University	2108.3	1.3	2.49	60.9	26.6	12.6	24.9	33.1	42.0	0.65
53	University of Massachusetts Medical School	1870.2	1.3	2.47	60.7	25.5	13.9	25.0	31.6	43.3	0.63
54	Vanderbilt University	6161.4	1.29	2.45	60.3	26.4	13.3	24.4	32.7	42.9	0.62
55	Baylor College of Medicine	4744.3	1.29	2.5	61.4	24.5	14.2	25.1	31.3	43.6	0.63
56	University of Lausanne	2692.2	1.29	2.61	62.9	25.3	11.9	24.6	32.6	42.8	0.64
57	University of Rochester	4490.2	1.29	2.51	60.5	27.1	12.5	22.8	34.0	43.3	0.64
58	Brown University	3875.5	1.28	2.54	61.6	25.3	13.1	24.1	32.0	43.9	0.63
59	Icahn School of Medicine at Mount Sinai	2941.4	1.28	2.44	60.7	26.0	13.4	25.1	31.9	43.0	0.62
60	University of Minnesota, Twin Cities	10591.7	1.28	2.65	63.3	25.2	11.5	24.3	32.6	43.1	0.65
61	University of Southern California	6507.2	1.28	2.57	62.3	25.0	12.8	24.2	32.0	43.8	0.63
62	Delft University of Technology	3425.7	1.28	2.9	66.1	23.9	10.0	23.1	33.5	43.4	0.64
63	University of Twente	2158.7	1.27	2.71	63.6	24.5	11.9	22.4	33.1	44.5	0.63
64	Arizona State University	4378.3	1.27	2.84	66.1	24.5	9.5	24.1	33.1	42.9	0.66
65	Queen Mary, University of London	1825	1.26	2.62	63.4	26.5	10.1	24.1	33.7	42.3	0.65
66	University of Virginia	5363	1.26	2.48	61.4	25.1	13.5	24.1	31.6	44.3	0.63
67	University of Pittsburgh	9974.9	1.26	2.39	60.2	27.0	12.8	24.5	33.2	42.3	0.62
68	Technical University of Denmark	3408	1.26	2.52	62.2	24.9	12.9	24.6	32.8	42.6	0.64
69	Trinity College, Dublin	2034.8	1.26	2.91	67.0	23.0	10.0	23.9	31.3	44.9	0.67
70	University of Edinburgh	5681	1.25	2.5	61.6	25.2	13.2	23.4	32.5	44.2	0.65
71	ParisTech - École Polytechnique	1294.4	1.25	2.68	62.4	25.4	12.2	19.3	32.4	48.3	0.72
72	University of Massachusetts Amherst	2995.8	1.25	2.47	60.9	26.3	12.9	22.6	32.8	44.6	0.65
73	Stony Brook University, The State University of New York	3289	1.24	2.5	62.2	25.3	12.6	23.7	31.8	44.4	0.64
74	Pennsylvania State University	9558.7	1.24	2.58	63.4	24.8	11.9	23.8	32.9	43.3	0.63
75	University of Utah	5414.1	1.23	2.47	62.1	25.3	12.6	24.1	32.9	43.1	0.65
76	University of Geneva	3962.5	1.23	2.45	61.7	25.8	12.4	23.8	32.4	43.8	0.65
77	Rutgers State University at New Brunswick	4411.1	1.23	2.59	63.4	24.6	12.0	23.0	32.5	44.5	0.64
78	University of Toronto	16287.9	1.23	2.52	63.1	25.0	12.0	24.3	32.7	43.0	0.62
79	King's College London	4978.5	1.23	2.43	62.2	25.4	12.4	25.3	32.1	42.6	0.63
80	Eindhoven University of Technology	2738.4	1.23	2.71	64.7	24.7	10.7	22.2	34.0	43.8	0.64
81	Erasmus University Rotterdam	5122.1	1.23	2.3	60.0	26.6	13.4	25.3	32.1	42.6	0.63
82	Durham University	2447.6	1.23	2.49	62.7	25.0	12.4	24.5	33.0	42.5	0.64
83	University of California, Davis	9628	1.23	2.42	61.7	25.7	12.7	24.5	33.1	42.5	0.62
84	University of Zurich	5645.2	1.22	2.37	60.9	25.5	13.6	24.4	32.4	43.2	0.63
85	Yeshiva University	2915	1.22	2.36	61.7	25.2	13.1	26.2	31.2	42.7	0.63

	University	Number of articles	μ_1	μ_2	Percentage of articles in category: 1	2	3	Percentage of citations in category: 1	2	3	GM Index
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
86	Wageningen University and Research Centre	3569.6	1.22	2.34	61.5	24.3	14.2	26.1	31.2	42.8	0.59
87	Technische Universität München	4688.9	1.21	2.54	63.5	24.8	11.8	23.6	32.3	44.0	0.65
88	University of East Anglia	1613.8	1.21	2.56	64.4	24.7	11.0	24.9	32.3	42.8	0.65
89	VU University Amsterdam	5258.4	1.21	2.27	60.2	26.3	13.5	25.5	32.4	42.1	0.62
90	University of Notre Dame	2130.7	1.21	2.52	61.8	26.1	12.1	20.6	32.9	46.5	0.67
91	Utrecht University	7465.8	1.21	2.28	60.5	26.6	13.0	25.2	33.1	41.7	0.62
92	Lancaster University	1474.7	1.2	2.45	61.7	24.8	13.6	21.9	31.1	47.0	0.66
93	University of Amsterdam	6406.3	1.2	2.31	60.8	25.9	13.3	24.6	32.0	43.4	0.63
94	University of Basel	3336.8	1.2	2.42	63.0	24.4	12.7	25.6	31.9	42.5	0.66
95	University of Stuttgart	2209.1	1.2	2.84	67.1	23.5	9.4	22.1	32.8	45.1	0.67
96	Leiden University	4895.4	1.2	2.28	60.6	25.6	13.9	25.1	31.5	43.4	0.64
97	University of Colorado Denver	3968.8	1.2	2.27	60.5	26.2	13.4	25.3	32.4	42.3	0.62
98	Paris Diderot University	2662.4	1.2	2.38	61.2	25.7	13.0	23.0	32.3	44.6	0.67
99	University of British Columbia	9776.9	1.2	2.41	62.2	25.2	12.5	24.1	32.5	43.5	0.63
100	McMaster University	4993.2	1.19	2.52	63.9	25.2	10.9	23.7	33.0	43.3	0.64
101	University of York	2578.5	1.19	2.41	62.4	25.1	12.5	23.7	33.2	43.2	0.62
102	Katholieke Universiteit Leuven	8559.5	1.19	2.43	62.8	24.8	12.4	23.7	32.3	44.0	0.65
103	Australian National University	4178.1	1.18	2.49	63.9	24.0	12.2	23.7	31.8	44.6	0.65
104	University of Melbourne	7279.6	1.18	2.43	63.6	24.5	11.9	24.8	32.1	43.1	0.63
105	University of Exeter	1620	1.18	2.31	61.4	25.7	12.9	24.0	33.3	42.7	0.62
106	University of Cincinnati	4893.8	1.17	2.2	59.3	26.6	14.1	23.5	32.2	44.3	0.61
107	RWTH Aachen University	3600.9	1.17	2.66	65.6	24.9	9.5	22.0	33.2	44.9	0.69
108	University of Bern	3643.5	1.17	2.36	62.7	25.7	11.7	24.9	32.9	42.2	0.65
109	Ohio State University	9339.9	1.17	2.35	61.8	25.6	12.7	23.0	32.3	44.7	0.63
110	Oregon State University	3112.9	1.17	2.41	63.6	24.7	11.7	24.8	32.7	42.5	0.62
111	University of Iowa	5751	1.16	2.34	62.3	25.3	12.4	23.9	32.5	43.7	0.63
112	Indiana University Bloomington	3223.9	1.16	2.34	61.5	25.6	13.0	22.4	32.4	45.3	0.64
113	University of New Mexico	2779.9	1.16	2.41	62.8	25.5	11.8	22.5	33.0	44.5	0.69
114	Case Western Reserve University	5211.8	1.16	2.31	62.7	24.7	12.7	25.3	31.9	42.8	0.63
115	University of Southampton	4746.5	1.15	2.43	63.7	24.6	11.7	23.6	32.6	43.8	0.65
116	Northeastern University	1355.6	1.15	2.38	61.7	26.6	11.7	20.9	34.4	44.7	0.66
117	University of Copenhagen	7765.3	1.15	2.32	62.9	24.9	12.2	25.2	32.5	42.4	0.63
118	University of Glasgow	4221.8	1.15	2.37	62.7	25.0	12.2	23.2	32.7	44.1	0.66
119	University of Sheffield	5147.1	1.15	2.37	63.3	24.0	12.7	24.3	31.5	44.2	0.62
120	Stockholm University	2614.4	1.15	2.25	61.1	25.7	13.1	23.9	32.9	43.3	0.64
121	University of Freiburg	3726.2	1.14	2.2	60.1	26.1	13.8	23.3	33.5	43.2	0.62
122	University of Arizona	6435.2	1.14	2.33	62.9	24.9	12.2	24.6	32.2	43.1	0.63
123	Michigan State University	5923.2	1.14	2.35	62.5	25.2	12.3	22.8	33.2	44.0	0.62
124	University of Aberdeen	2700.6	1.14	2.27	61.6	24.8	13.6	23.6	31.7	44.7	0.63
125	University of Miami	4026.4	1.14	2.31	62.7	25.1	12.2	24.5	32.5	43.0	0.63
126	University of Paris-Sud 11	4559.3	1.14	2.37	63.0	24.5	12.6	22.9	32.3	44.8	0.67
127	Ludwig-Maximilians-Universität München	6373.6	1.14	2.32	62.8	24.6	12.6	24.2	32.3	43.5	0.64
128	McGill University	8492.4	1.13	2.27	61.7	25.5	12.8	23.3	32.8	44.0	0.63
129	Hong Kong University of Science and Technology	2835.7	1.13	2.31	61.9	24.8	13.3	22.4	33.2	44.5	0.6
130	Aarhus University	5391.8	1.13	2.19	61.2	25.5	13.3	24.7	32.7	42.7	0.63
131	Purdue University - Lafayette	6619.5	1.13	2.34	62.5	25.0	12.5	22.5	32.8	44.8	0.63
132	Karlsruhe Institute of Technology	3593.4	1.13	2.46	63.4	24.5	12.1	20.2	33.0	46.8	0.68

	University	Number of articles	μ_1	μ_2	Percentage of articles in category:			Percentage of citations in category:			GM Index
		(1)	(2)	(3)	1 (4)	2 (5)	3 (6)	1 (7)	2 (8)	3 (9)	(10)
133	Université Bordeaux Segalen	1434.1	1.13	2.09	59.4	27.4	13.3	24.6	33.9	41.5	0.64
134	Wake Forest University	2583.3	1.13	2.13	60.5	26.5	13.1	25.2	33.0	41.9	0.62
135	Florida State University	3068.6	1.13	2.38	63.3	24.7	12.0	22.4	32.6	45.0	0.64
136	University of Delaware	2834	1.13	2.3	62.6	25.0	12.5	23.6	33.7	42.8	0.61
137	University of Bath	1846.1	1.12	2.26	62.4	24.8	12.8	24.3	32.7	43.0	0.59
138	University of Texas Health Science Center at San Antonio	602.9	1.12	2.07	59.5	23.8	16.7	25.3	29.9	44.9	0.61
139	Georgetown University	2277.1	1.12	2.28	62.9	24.7	12.4	24.7	32.1	43.1	0.64
140	University of Maryland, Baltimore	3614.7	1.12	2.09	59.9	25.9	14.2	25.3	32.6	42.2	0.62
141	University of Nottingham	5269.6	1.12	2.25	62.2	24.7	13.1	24.0	32.4	43.7	0.62
142	Radboud University Nijmegen	4909.3	1.12	2.18	61.2	25.5	13.4	24.4	31.4	44.2	0.63
143	University of Groningen	5407.7	1.12	2.14	60.8	26.4	12.9	24.8	32.5	42.7	0.62
144	University Pierre and Marie Curie	6656.1	1.12	2.16	60.5	25.1	14.3	23.6	32.0	44.3	0.63
145	University of Würzburg	3205.5	1.11	2.13	60.7	24.8	14.5	24.9	31.9	43.2	0.63
146	Karolinska Institute	6898.5	1.11	2.15	61.7	25.3	13.0	25.9	31.9	42.2	0.63
147	University of Queensland	6715.1	1.11	2.32	63.8	24.0	12.3	24.3	32.2	43.4	0.63
148	University of Leeds	5134.1	1.11	2.23	62.2	25.0	12.8	24.2	32.2	43.6	0.63
149	Université Montpellier 2	2116.9	1.11	2.37	64.5	24.1	11.4	24.3	32.9	42.9	0.64
150	University of Nice Sophia Antipolis	1238	1.11	2.39	64.7	23.4	11.9	24.2	31.9	43.9	0.66
151	University of Liverpool	3779.9	1.11	2.11	59.5	25.8	14.7	22.6	31.9	45.5	0.64
152	University of Warwick	2613.9	1.11	2.23	61.4	25.4	13.2	22.1	32.1	45.8	0.63
153	Joseph Fourier University	2804.9	1.1	2.2	61.4	25.7	13.0	23.0	32.7	44.3	0.65
154	Friedrich-Alexander-Universität Erlangen-Nürnberg	4040.2	1.1	2.28	63.1	24.6	12.3	23.7	32.3	43.9	0.64
155	Paris Descartes University	2834.4	1.1	2.12	61.5	25.3	13.2	26.1	31.7	42.3	0.62
156	Iowa State University	4560.2	1.1	2.29	62.5	25.6	11.9	21.9	33.8	44.4	0.63
157	University of Sussex	1634.1	1.1	2.28	63.7	23.7	12.7	24.5	31.9	43.6	0.6
158	Tulane University	1785.6	1.1	2.24	63.1	24.2	12.7	24.6	31.3	44.1	0.64
159	Johannes Gutenberg Univ Mainz	2962.6	1.1	2.12	60.6	26.4	13.0	23.7	32.1	44.2	0.65
160	University of South Carolina	2544.2	1.1	2.14	60.0	26.5	13.5	22.0	33.2	44.8	0.63
161	Colorado State University	3335.7	1.1	2.16	61.4	25.3	13.2	23.9	32.2	43.9	0.62
162	Newcastle University	3562.8	1.09	2.23	63.1	24.5	12.4	24.8	32.7	42.6	0.63
163	University of Vermont	1836.5	1.09	2.15	62.0	25.0	13.1	25.3	32.3	42.3	0.61
164	Maastricht University	3286.1	1.09	2.04	60.1	26.2	13.7	25.7	32.2	42.1	0.61
165	University of Bordeaux 1 Science and Technology	1953	1.09	2.29	63.4	24.8	11.8	23.2	33.2	43.6	0.63
166	University of Strasbourg	3102	1.09	2.16	61.8	25.9	12.3	24.2	32.7	43.2	0.64
167	University of Connecticut	4514.9	1.09	2.18	62.2	25.0	12.8	24.3	33.0	42.7	0.6
168	University of Bonn	3891.6	1.08	2.19	62.0	25.1	12.9	23.4	32.6	44.0	0.65
169	Université Catholique de Louvain	2898.7	1.08	2.12	60.9	25.3	13.8	23.3	32.7	44.0	0.6
170	University of Reading	1948.3	1.08	2.24	63.4	24.4	12.2	24.2	32.8	43.1	0.6
171	University of Manchester	8214	1.08	2.2	62.0	25.5	12.5	22.6	32.9	44.4	0.63
172	National University of Singapore	9155.5	1.08	2.34	64.5	23.7	11.9	23.0	32.6	44.4	0.63
173	Drexel University	1901	1.08	2.36	65.3	24.2	10.5	23.8	32.8	43.4	0.65
174	Medical University of South Carolina	2331.1	1.08	1.97	59.1	26.4	14.5	25.1	31.9	43.0	0.6
175	University of Hawaii, Manoa	2743.3	1.08	2.12	61.1	24.5	14.5	23.2	31.8	45.0	0.64
176	Heidelberg University	5924	1.08	2.07	60.7	26.0	13.3	24.3	32.3	43.4	0.63
177	University of Auckland	3238.4	1.07	2.42	66.4	23.5	10.1	24.1	32.8	43.1	0.64
178	Vrije Universiteit Brussel	1914.7	1.07	2.19	62.2	25.2	12.6	22.8	33.4	43.9	0.63

	University	Number of articles	μ_1	μ_2	Percentage of articles in category: 1	2	3	Percentage of citations in category: 1	2	3	GM Index
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
179	Université Libre de Bruxelles	2532.2	1.07	2.31	64.4	23.7	11.9	23.3	32.8	44.0	0.64
180	Monash University	4901.9	1.07	2.26	64.5	23.6	11.9	24.8	32.3	42.9	0.63
181	Technische Universität Berlin	1845	1.07	2.34	64.5	23.5	12.0	22.4	33.5	44.1	0.64
182	University of Helsinki	6246.1	1.07	2.09	61.2	26.2	12.6	24.3	32.9	42.8	0.64
183	Texas A&M University - College Station	7195.1	1.07	2.29	64.1	23.7	12.3	22.9	31.8	45.3	0.63
184	University of New South Wales	5188.7	1.07	2.28	64.2	24.0	11.8	23.6	32.3	44.1	0.64
185	University Claude Bernard Lyon 1	3552.8	1.07	2.13	61.9	25.2	12.9	23.7	32.4	43.9	0.64
186	University of Sydney	7449.6	1.07	2.18	62.7	25.3	12.0	23.6	33.4	43.0	0.63
187	University of Georgia	4499.8	1.07	2.21	63.9	24.2	11.9	25.0	32.6	42.4	0.62
188	University of Hong Kong	5420.9	1.07	2.28	64.5	24.3	11.2	23.9	33.1	43.0	0.61
189	Medical College of Wisconsin	2040.7	1.07	1.99	60.1	24.2	15.8	25.4	31.3	43.3	0.6
190	Universitat Politècnica de Catalunya	1711.7	1.06	2.63	67.8	23.2	9.0	20.3	33.5	46.2	0.67
191	University of Hamburg	3492.8	1.06	2.19	63.2	24.6	12.3	24.1	32.0	43.9	0.65
192	University Paris-Est Créteil Val de Marne	884.9	1.06	2.15	62.0	22.4	15.7	23.0	31.1	45.9	0.65
193	University of Alabama at Birmingham	4577.7	1.06	1.99	60.1	25.8	14.1	24.9	32.1	43.0	0.62
194	University of Birmingham	5138.4	1.06	2.08	60.8	25.4	13.8	23.0	32.7	44.3	0.62
195	University of Tübingen	4272	1.06	2.14	62.5	25.0	12.5	24.1	32.9	43.0	0.65
196	George Washington University	2055.3	1.06	2.32	64.5	23.8	11.7	22.0	32.2	45.8	0.68
197	University of Vienna	3346.6	1.06	2.21	63.4	24.3	12.3	23.5	32.5	44.0	0.66
198	Swedish University of Agricultural Sciences	1837.7	1.06	2	60.7	26.2	13.1	25.5	33.6	40.9	0.57
199	Philipps-Universität Marburg	2398.4	1.06	2.18	63.8	23.7	12.5	25.3	31.5	43.2	0.65
200	Queen's University	3175.8	1.05	2.15	62.3	25.7	12.0	23.4	33.5	43.2	0.61
201	Goethe University Frankfurt	3540	1.05	2.17	62.7	24.2	13.1	23.4	31.6	45.0	0.63
202	University of Illinois at Chicago	5036.1	1.05	2.08	61.7	25.4	12.9	24.3	32.4	43.3	0.61
203	University of Central Florida	2153	1.05	2.37	65.6	22.3	12.1	22.4	31.6	46.0	0.64
204	University of Ottawa	3757.4	1.05	2.18	63.2	24.9	12.0	23.5	32.9	43.6	0.63
205	Virginia Commonwealth University	2807.2	1.05	2.14	63.8	24.6	11.7	26.2	31.8	42.0	0.63
206	Humboldt-Universität zu Berlin	5874.6	1.05	2.05	61.6	24.5	14.0	24.9	31.6	43.5	0.62
207	Norwegian University of Science and Technology	2870.1	1.05	2.21	63.6	25.0	11.4	23.6	33.7	42.8	0.6
208	University of Bergen	2523	1.05	2.13	62.5	26.1	11.4	23.7	33.0	43.3	0.64
209	Simon Fraser University	2112.3	1.05	2.13	62.2	24.9	13.0	23.2	32.5	44.4	0.61
210	Ghent University	6694	1.05	2.17	63.3	24.7	12.0	24.0	33.0	43.0	0.62
211	University of South Florida at Tampa	2985.6	1.04	2.19	63.7	24.1	12.2	24.0	31.3	44.7	0.64
212	University of Montreal	4790.4	1.04	2.01	60.8	25.9	13.3	24.1	32.7	43.2	0.62
213	University of Gothenburg	4202.5	1.04	2.01	61.5	25.7	12.7	25.6	32.3	42.1	0.62
214	Medical University of Vienna	2993.4	1.04	2.02	61.3	25.5	13.2	24.8	32.1	43.2	0.62
215	Washington State University	2964.7	1.04	2.11	63.0	24.9	12.1	24.9	33.2	41.9	0.59
216	Indiana University - Purdue University Indianapolis	3636.1	1.04	2.02	61.3	25.0	13.7	24.8	32.9	42.4	0.61
217	University of Duisburg-Essen	2662.5	1.04	2.12	62.4	25.0	12.6	23.2	32.9	43.9	0.65
218	Aix-Marseille University	3429.6	1.04	2.16	63.5	24.0	12.5	24.0	32.0	44.0	0.64
219	University of Waterloo	3919.3	1.04	2.24	64.0	23.8	12.2	22.2	33.0	44.8	0.63
220	University of Antwerp	2411.7	1.04	2.05	61.2	25.8	13.0	23.3	33.5	43.2	0.63
221	North Carolina State University	4878.6	1.04	2.2	63.9	24.3	11.9	23.3	32.9	43.8	0.63
222	University of Alberta	7629.1	1.04	2.12	62.5	24.9	12.6	23.3	32.3	44.4	0.63
223	City University of Hong Kong	3019.8	1.04	2.32	64.6	23.2	12.2	20.8	33.2	46.1	0.62
224	Heinrich Heine Univ Düsseldorf	2479.5	1.03	1.96	60.3	25.9	13.9	24.6	32.3	43.1	0.63
225	Virginia Polytechnic Institute and State University	3951.9	1.03	2.14	62.5	23.8	13.7	22.5	32.3	45.2	0.62

	University	Number of articles	μ_1	μ_2	Percentage of articles in category: 1	2	3	Percentage of citations in category: 1	2	3	GM Index
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
226	Freie Universität Berlin	5630.9	1.03	2.01	61.4	25.0	13.6	25.0	32.1	42.9	0.61
227	Ruhr-Universität Bochum	3130.9	1.03	2.12	62.2	24.2	13.6	22.2	32.0	45.8	0.66
228	Universität Regensburg	2482.9	1.03	2.09	62.8	24.4	12.8	24.6	32.2	43.2	0.63
229	University of Houston	2049.1	1.03	2.14	62.5	24.2	13.4	22.1	32.6	45.3	0.62
230	University of Leicester	2598.9	1.03	2.02	61.4	25.6	13.0	24.1	32.2	43.7	0.63
231	University of Cologne	2962.2	1.03	2.04	62.0	25.2	12.9	24.7	32.3	43.0	0.61
232	Cardiff University	3525	1.03	2.02	61.6	25.6	12.8	24.5	33.2	42.3	0.6
233	University of Otago	2613	1.03	2.16	64.3	23.7	12.0	24.7	32.1	43.2	0.63
234	Paul Sabatier University	3659.4	1.03	2.09	62.8	24.0	13.3	24.4	31.7	43.9	0.62
235	University of Barcelona	5558.2	1.03	2.03	61.8	26.1	12.1	24.4	33.5	42.1	0.62
236	Chalmers University of Technology	1567.4	1.03	2.22	63.5	24.2	12.3	21.1	32.8	46.1	0.65
237	University of Florida	10500.7	1.03	2.08	62.3	24.9	12.8	23.5	32.5	44.0	0.62
238	University of Southern Denmark	1839.3	1.03	1.99	61.5	25.3	13.2	25.1	32.3	42.6	0.6
239	Thomas Jefferson University	2122.1	1.02	1.86	58.6	26.4	15.1	24.8	32.6	42.6	0.59
240	University of Oslo	5235.6	1.02	1.99	61.6	24.8	13.6	25.1	32.0	42.9	0.59
241	Lund University	6826.2	1.02	1.97	60.7	26.2	13.1	24.3	32.9	42.8	0.61
242	University of Adelaide	2975.5	1.02	2.07	62.9	24.0	13.1	24.6	32.2	43.2	0.6
243	Universitat Politècnica de València	2225.8	1.02	2.47	67.5	22.9	9.7	21.2	33.0	45.9	0.65
244	University of Western Australia	3704.5	1.02	2.11	63.1	24.4	12.5	23.7	32.9	43.3	0.62
245	Aalto University	2102	1.02	2.3	65.1	23.8	11.1	21.4	32.9	45.7	0.65
246	University of Texas Medical Branch at Galveston	2375.8	1.02	1.96	61.2	26.0	12.8	25.5	32.9	41.6	0.6
247	University of Tennessee	4345.6	1.02	2.07	62.4	25.0	12.7	23.4	32.7	44.0	0.63
248	George Mason University	1240.8	1.02	2.34	66.0	22.9	11.1	21.6	33.8	44.6	0.66
249	University of Western Ontario	4647.5	1.02	2.11	63.5	23.5	13.0	24.1	31.5	44.5	0.62
250	University of Münster	3766.2	1.02	2.01	61.7	25.1	13.3	24.1	32.2	43.7	0.62
251	University of Medicine and Dentistry of New Jersey	2997.3	1.02	1.97	61.2	24.9	13.9	24.9	32.1	43.0	0.61
252	Kansas State University	2080.6	1.02	2.13	63.1	24.2	12.7	22.5	32.0	45.5	0.62
253	Wayne State University	3789.7	1.02	1.98	60.6	25.7	13.8	23.1	32.4	44.5	0.64
254	Laval University	3613.6	1.01	2.03	62.4	25.2	12.4	24.7	32.8	42.5	0.6
255	Hebrew University of Jerusalem	5598.6	1.01	2.12	63.6	24.8	11.6	23.9	33.2	42.9	0.63
256	Pohang University of Science and Technology	2413.9	1.01	2.17	62.6	24.8	12.6	19.8	34.0	46.2	0.63
257	Technische Universität Dresden	2970.9	1.01	2.06	61.8	25.5	12.8	22.2	33.1	44.7	0.66
258	Vienna University of Technology	1616.5	1.01	2.41	66.5	21.3	12.1	20.2	32.6	47.3	0.67
259	University of Kansas	3321.8	1.01	2.07	62.5	26.0	11.5	23.3	33.4	43.4	0.64
260	University College Dublin	2762.7	1.01	2.08	62.4	25.3	12.4	22.6	32.4	45.0	0.63
261	Hannover Medical School	1761.8	1.01	1.95	61.7	24.9	13.4	26.0	32.9	41.1	0.6
262	University of Calgary	5129.3	1.01	2.06	62.7	24.7	12.6	23.8	32.2	44.0	0.6
263	University of Wollongong	1539.8	1.01	2.17	64.1	23.4	12.6	22.6	31.9	45.5	0.61
264	University College Cork	1713.4	1	2.09	63.5	24.7	11.8	24.1	33.5	42.4	0.6
265	University at Buffalo, The State University of New York	3710.8	1	2.05	62.4	25.4	12.2	23.1	33.4	43.5	0.62
266	University of Victoria	1797	1	1.91	58.7	27.3	14.0	21.3	34.7	44.1	0.6
267	Uppsala University	4916.4	1	2.01	62.2	24.9	12.9	24.0	32.5	43.4	0.63
268	Umeå University	2446.5	1	1.97	62.0	25.2	12.9	25.2	32.3	42.4	0.62
269	University of Trieste	1215.9	1	1.95	59.0	27.6	13.5	20.2	33.0	46.8	0.68
270	University of Parma	1741.3	1	2.17	65.0	24.7	10.3	24.1	32.5	43.5	0.65
271	Montpellier 1 University	1093.5	1	1.89	60.6	26.4	13.0	25.6	33.4	41.0	0.6

	University	Number of articles	μ_1	μ_2	Percentage of articles in category: 1	2	3	Percentage of citations in category: 1	2	3	GM Index
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
272	University of Liège	2335.9	1	2.04	62.7	25.0	12.3	23.9	32.2	43.9	0.64
273	Queensland University of Technology	1427.8	1	2.04	62.8	24.2	13.0	24.0	32.8	43.2	0.59
274	Kiel University	2945.5	1	2.05	63.4	23.9	12.7	24.9	32.1	43.1	0.63
275	Giessen University	2109.7	0.99	2.02	63.2	24.6	12.2	25.0	31.5	43.6	0.62
276	University of Newcastle	1532	0.99	2.07	62.7	24.3	13.0	22.1	33.0	44.9	0.64
277	University of Rennes 1	1992.8	0.99	2.03	62.0	25.1	12.9	22.2	33.0	44.8	0.63
278	University of Jena	2693.2	0.99	2.11	64.7	24.5	10.9	24.6	33.3	42.1	0.64
279	University of Cape Town	1970.4	0.99	2.05	63.7	23.7	12.6	24.8	32.4	42.8	0.62
280	University of Nebraska - Lincoln	2950.6	0.99	2.14	63.9	24.0	12.1	22.1	33.0	44.9	0.63
281	Queen's University Belfast	2740.7	0.99	1.97	61.3	26.4	12.3	23.1	34.2	42.7	0.61
282	Universidad Autónoma de Barcelona	4139.1	0.99	1.93	60.9	26.3	12.8	23.4	33.6	43.0	0.62
283	University of Padova	5023.8	0.99	1.97	61.0	25.7	13.3	22.1	32.7	45.2	0.65
284	Macquarie University	1329.5	0.99	2	62.3	24.8	13.0	23.5	32.8	43.7	0.62
285	Politecnico di Torino	1644.5	0.99	2.18	63.7	23.6	12.7	19.8	33.6	46.6	0.64
286	Politecnico di Milano	2087.2	0.98	2.21	64.7	23.2	12.1	20.6	32.8	46.6	0.64
287	University of Strathclyde	1825.6	0.98	2.15	64.7	23.8	11.5	22.7	32.4	44.9	0.65
288	University of Missouri	4029.2	0.98	2.04	63.4	25.0	11.7	24.0	33.6	42.4	0.6
289	University of Ulm	2331.8	0.98	1.92	61.4	24.7	13.9	24.5	32.4	43.2	0.62
290	Dalhousie University	3037.1	0.98	1.98	62.4	25.0	12.6	24.1	33.1	42.8	0.61
291	University of Bremen	1312.5	0.98	2.13	64.8	23.2	12.0	23.2	31.9	44.9	0.64
292	Saarland University	1951.8	0.97	1.98	62.4	24.5	13.1	23.7	32.1	44.3	0.63
293	Nanyang Technological University	5578.5	0.97	2.22	66.0	23.3	10.8	22.1	33.7	44.3	0.62
294	Technische Universität Darmstadt	2003.8	0.97	2.29	66.0	22.3	11.7	19.6	32.1	48.4	0.69
295	Innsbruck Medical University	1509	0.97	1.89	61.7	24.4	13.9	25.2	31.2	43.6	0.61
296	Universidad Autónoma de Madrid	3653.2	0.97	2.05	64.3	24.0	11.8	24.1	32.2	43.7	0.64
297	University of Pavia	2082.1	0.96	2	63.3	24.8	11.9	23.7	32.8	43.5	0.65
298	University of Ferrara	1420.7	0.96	1.94	61.0	26.6	12.4	20.8	33.8	45.4	0.68
299	Chinese University of Hong Kong	4652.6	0.96	2.02	63.8	24.3	11.9	23.5	33.2	43.3	0.6
300	University of Milan Bicocca	817.1	0.96	2.06	64.6	22.2	13.1	23.6	30.0	46.4	0.64
301	University of Milan	6083.4	0.95	1.94	62.1	24.8	13.1	22.9	32.7	44.4	0.64
302	University of Kentucky	4690.1	0.95	1.99	63.5	24.3	12.2	23.9	32.9	43.2	0.61
303	University of Rostock	1685.5	0.95	1.84	58.8	27.2	14.0	20.3	33.6	46.1	0.65
304	Temple University	2038.6	0.95	1.89	61.7	25.2	13.1	24.1	33.2	42.7	0.6
305	KTH Royal Institute of Technology	3135.2	0.95	1.97	62.1	24.8	13.0	21.3	33.6	45.1	0.62
306	York University	1608.2	0.95	1.96	62.3	24.8	12.8	22.2	32.7	45.1	0.64
307	University of Oklahoma	3060.2	0.95	1.87	61.0	25.6	13.4	23.1	32.8	44.2	0.6
308	University of Zaragoza	2387.4	0.94	1.96	62.9	25.1	12.1	22.6	33.4	44.0	0.62
309	University of Louisville	2419.8	0.94	1.82	60.0	26.5	13.6	22.1	33.9	44.0	0.61
310	University of Guelph	2846.2	0.94	1.93	63.7	24.2	12.1	25.3	33.2	41.5	0.6
311	Gottfried Wilhelm Leibniz Universität Hannover	870.6	0.94	2.08	65.1	22.9	12.1	22.4	32.2	45.4	0.63
312	Hong Kong Polytechnic University	3539.8	0.94	2.05	64.1	23.7	12.2	21.5	33.7	44.9	0.62
313	Louisiana State University	3277.1	0.93	1.99	63.9	24.5	11.6	22.8	33.3	43.8	0.63
314	Clemson University	1873.1	0.93	1.94	62.8	24.9	12.4	22.6	33.5	43.9	0.58
315	University of Seville	2243.8	0.93	1.96	63.5	23.6	12.9	23.2	31.7	45.0	0.61
316	Massey University	1466.6	0.93	2.09	66.1	23.7	10.2	23.7	33.2	43.1	0.64
317	Indian Institute of Technology Kharagpur	2359.1	0.93	2.06	64.3	23.6	12.0	21.0	34.1	44.9	0.62
318	Universidade Nova de Lisboa	1290.4	0.93	2.09	65.6	23.1	11.4	22.6	32.6	44.8	0.66

	University	Number of articles	μ_1	μ_2	Percentage of articles in category:			Percentage of citations in category:			GM Index
		(1)	(2)	(3)	1 (4)	2 (5)	3 (6)	1 (7)	2 (8)	3 (9)	(10)
319	Loughborough University	1941.1	0.93	2.07	64.7	22.9	12.4	21.6	32.8	45.6	0.62
320	University of Surrey	1866.8	0.93	1.98	63.1	23.6	13.3	21.2	32.8	46.1	0.64
321	University of Torino	3402.8	0.93	1.82	60.2	26.1	13.8	21.7	33.2	45.1	0.65
322	University of Warsaw	1823.7	0.93	2.68	72.4	22.8	4.8	19.8	33.4	46.7	0.78
323	Hunan University	1385.9	0.92	1.86	60.5	25.2	14.3	20.5	34.4	45.1	0.59
324	Technion - Israel Institute of Technology	4948.2	0.92	2.1	65.4	24.0	10.6	21.5	33.7	44.8	0.62
325	University of Porto	2863.9	0.92	1.89	62.6	24.8	12.7	23.2	33.6	43.2	0.58
326	University of Bologna	5637.7	0.92	1.88	61.9	25.3	12.8	22.2	33.1	44.8	0.63
327	University of Manitoba	3015.8	0.92	1.92	63.6	24.0	12.3	24.2	32.6	43.2	0.61
328	University of Burgundy	1311.1	0.92	1.85	61.8	24.1	14.1	23.0	32.1	45.0	0.63
329	University of Turku	2309.2	0.92	1.77	60.7	25.9	13.5	24.2	32.7	43.2	0.6
330	Universität Leipzig	2920	0.92	1.89	63.2	24.0	12.9	24.2	31.2	44.6	0.62
331	University of Tokyo	14624.1	0.92	2	64.3	23.8	11.9	22.1	32.2	45.7	0.67
332	Lanzhou University	2325.1	0.92	2.02	65.2	23.4	11.4	23.0	33.1	43.9	0.63
333	Tel Aviv University	6571.3	0.91	1.93	63.6	24.2	12.1	23.2	32.6	44.3	0.64
334	University of Mississippi	1709	0.91	1.78	59.5	26.4	14.1	20.8	32.9	46.4	0.66
335	University of Santiago de Compostela	2618.9	0.91	1.85	62.4	25.6	12.1	23.4	33.9	42.7	0.59
336	Henri Poincaré University	1804.5	0.91	1.94	63.9	24.0	12.1	23.1	32.4	44.6	0.66
337	Otto-von-Guericke University Magdeburg	1568.7	0.91	1.88	63.1	24.2	12.8	23.8	32.6	43.6	0.62
338	Oklahoma State University - Stillwater	1523.5	0.9	1.85	62.2	25.0	12.8	22.7	33.0	44.3	0.62
339	Auburn University	2110.7	0.9	1.93	63.7	24.8	11.5	22.6	34.4	43.0	0.61
340	Technical University of Lisbon	2338.1	0.9	1.99	64.2	23.9	11.9	20.8	33.8	45.4	0.63
341	University of Valencia	3588.6	0.9	1.83	61.4	24.9	13.7	21.9	32.2	45.8	0.62
342	University of Florence	3890.5	0.9	1.87	62.7	24.9	12.4	22.9	33.5	43.6	0.64
343	University of Science and Technology of China	4833.6	0.9	1.9	62.5	24.1	13.4	20.6	32.7	46.7	0.63
344	Korea Advanced Institute of Science and Technology	3837.5	0.89	2	64.1	23.5	12.4	20.0	33.2	46.8	0.64
345	University of Tasmania	1279	0.89	1.75	61.6	24.8	13.6	24.8	33.8	41.3	0.59
346	Martin Luther University of Halle-Wittenberg	1814.6	0.89	1.79	62.2	25.5	12.3	24.3	33.5	42.2	0.61
347	Griffith University	1453.8	0.89	1.87	63.2	23.8	13.0	22.9	33.1	44.1	0.63
348	University of Eastern Finland	1523	0.89	1.64	59.3	25.7	15.0	25.0	32.7	42.3	0.58
349	University of Perugia	1804.6	0.89	1.8	60.7	26.0	13.2	20.6	33.1	46.3	0.67
350	Sun Yat-sen University	3372.9	0.89	1.88	63.3	24.2	12.5	22.5	32.8	44.7	0.62
351	National Tsing Hua University	3114.6	0.89	1.83	61.4	24.7	13.9	20.5	32.5	46.9	0.61
352	University of Genoa	2574.5	0.89	1.88	62.7	25.8	11.5	21.0	34.0	45.0	0.7
353	University of Lübeck	1491	0.89	1.71	61.6	23.5	14.9	25.7	30.9	43.4	0.62
354	Linköping University	2393.4	0.88	1.73	60.9	24.6	14.6	23.3	32.1	44.6	0.6
355	Peking University	6393.2	0.88	1.95	64.8	23.6	11.7	22.2	32.7	45.1	0.63
356	Indian Institute of Technology Madras	1925.5	0.88	1.96	63.8	22.9	13.3	19.4	33.0	47.6	0.6
357	University of Aveiro	1705.7	0.88	1.9	63.6	23.3	13.1	21.1	33.3	45.6	0.6
358	Dalian University of Technology	2792.9	0.88	2.02	65.1	23.0	11.9	19.6	33.9	46.5	0.64
359	University of Modena and Reggio Emilia	1610.5	0.88	1.82	62.8	24.2	13.0	22.8	32.1	45.1	0.63
360	Pontifical Catholic University of Chile	1169.1	0.87	1.69	60.3	24.8	14.9	23.2	32.6	44.1	0.61
361	Stellenbosch University	1393.7	0.87	1.82	63.5	23.8	12.7	23.9	31.7	44.4	0.59
362	University of Oulu	1837.9	0.87	1.78	63.1	24.4	12.5	24.5	32.1	43.4	0.62
363	National Sun Yat-sen University	1588.2	0.87	1.99	65.4	23.2	11.4	20.9	32.9	46.2	0.67
364	University of Naples Federico II	3984.3	0.87	1.72	60.5	25.8	13.7	21.7	32.9	45.5	0.63

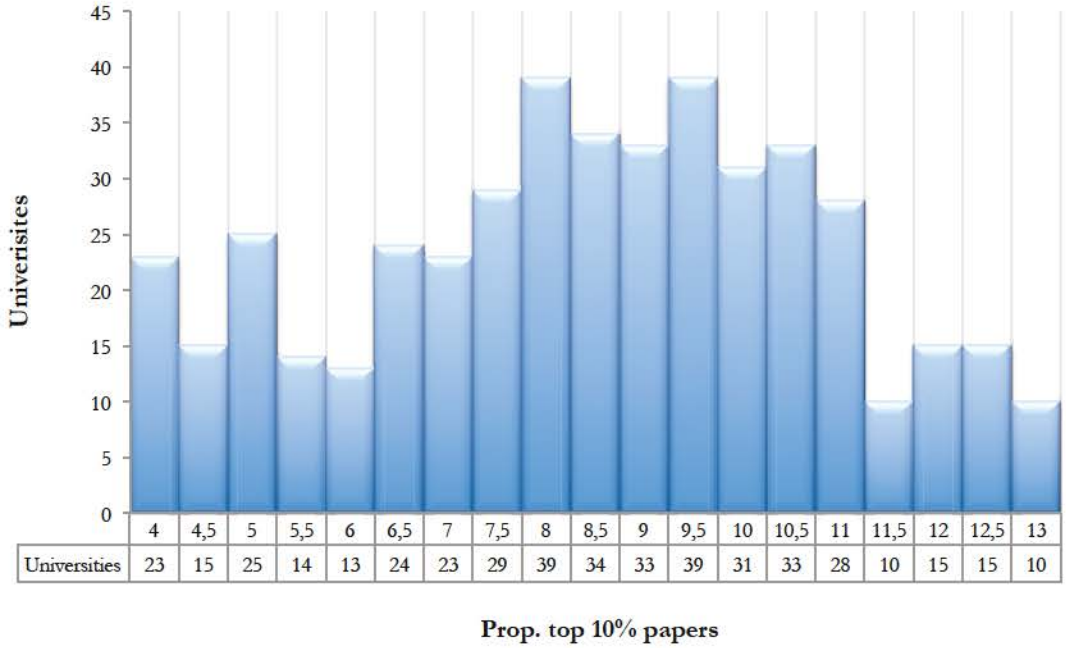
	University	Number of articles	μ_1	μ_2	Percentage of articles in category:			Percentage of citations in category:			GM Index
		(1)	(2)	(3)	1 (4)	2 (5)	3 (6)	1 (7)	2 (8)	3 (9)	(10)
365	Harbin Institute of Technology	3197.9	0.87	2.17	67.7	22.7	9.6	19.3	33.7	47.0	0.66
366	University of the Basque Country	2287.1	0.87	1.83	63.0	24.9	12.1	21.7	34.7	43.6	0.62
367	Flinders University	1183.4	0.87	1.6	58.6	26.0	15.5	23.7	33.0	43.3	0.59
368	Kyoto University	11923.8	0.87	1.86	63.8	24.3	11.9	22.1	32.6	45.3	0.65
369	University of the Witwatersrand	1457.3	0.86	1.92	65.6	22.7	11.7	23.6	32.0	44.4	0.62
370	Sharif University of Technology	1453.7	0.86	2	65.4	21.7	12.9	19.3	31.8	48.9	0.65
371	Amirkabir University of Technology	936.3	0.86	2.15	67.8	21.2	11.0	19.3	31.3	49.4	0.64
372	University of Lisbon	1553.3	0.85	1.75	62.3	23.9	13.8	22.8	32.5	44.7	0.6
373	University of Pisa	3734.8	0.85	1.75	61.4	25.2	13.4	20.7	32.4	46.9	0.65
374	National Technical University of Athens	2109	0.85	1.86	63.3	24.2	12.5	19.5	34.9	45.6	0.61
375	Seoul National University	9543.9	0.85	1.77	62.7	25.2	12.2	22.0	33.5	44.5	0.63
376	West Virginia University	1837.5	0.85	1.75	62.7	24.0	13.4	23.0	32.5	44.5	0.59
377	Tsinghua University	8362	0.85	2.02	66.1	22.4	11.5	19.1	33.3	47.6	0.66
378	Università Cattolica del Sacro Cuore	1576.5	0.85	1.63	61.1	25.0	13.9	24.8	31.3	43.9	0.61
379	National Taiwan University	8402.7	0.84	1.76	62.9	24.3	12.7	22.4	32.9	44.7	0.62
380	Fudan University	5077.3	0.84	1.79	63.8	24.1	12.1	22.8	32.9	44.3	0.62
381	Texas Tech University	2109.5	0.84	1.79	63.5	24.7	11.9	21.9	33.8	44.2	0.63
382	Universidad de Granada	2764.8	0.84	1.81	64.0	23.6	12.4	22.2	33.1	44.7	0.61
383	Nankai University	2893	0.84	1.92	65.4	22.6	12.0	20.5	33.3	46.3	0.66
384	Indian Institute of Science	3155.3	0.83	1.87	65.2	23.2	11.7	21.8	32.9	45.4	0.62
385	University of Nantes	1398.4	0.83	1.66	61.2	25.4	13.5	22.2	34.2	43.7	0.61
386	University of Rome Tor Vergata	2365.8	0.83	1.67	61.6	25.0	13.4	22.6	33.9	43.6	0.6
387	Aristotle University of Thessaloniki	4176.4	0.82	1.81	64.2	23.3	12.5	21.5	32.1	46.4	0.63
388	University of KwaZulu-Natal	1122.1	0.82	1.98	67.3	24.2	8.5	21.5	34.7	43.8	0.65
389	Nagoya University	5775.7	0.82	1.74	63.1	24.4	12.5	21.7	32.7	45.6	0.66
390	Complutense University	4515.5	0.82	1.72	63.4	24.4	12.2	23.3	32.9	43.8	0.63
391	Osaka University	9701	0.82	1.83	64.9	23.7	11.4	21.4	33.0	45.7	0.66
392	Tokyo Medical and Dental University	1635.6	0.82	1.61	61.8	25.2	13.0	24.6	32.5	42.9	0.63
393	University of Murcia	1613.3	0.82	1.71	62.8	24.3	12.9	21.9	32.8	45.3	0.62
394	Central South University	1856.4	0.81	1.79	64.6	23.7	11.7	22.1	33.2	44.7	0.61
395	University of Bari Aldo Moro	2163.5	0.81	1.62	60.2	25.1	14.6	20.9	32.6	46.5	0.65
396	Sapienza University of Rome	6444.1	0.81	1.68	62.2	24.1	13.8	21.7	31.9	46.4	0.64
397	University of Ulsan	1635	0.81	1.58	60.5	25.3	14.2	23.3	32.2	44.5	0.63
398	University of Patras	2292.9	0.81	1.79	64.2	24.0	11.8	20.9	33.6	45.5	0.64
399	East China University of Science and Technology	1752	0.81	1.75	64.1	23.8	12.1	22.8	33.0	44.2	0.61
400	Xiamen University	1594.2	0.81	1.79	64.8	24.0	11.3	22.0	34.1	43.9	0.63
401	National Central University	1666.6	0.81	1.77	62.9	24.3	12.8	18.9	34.1	47.1	0.66
402	Nanjing University	4638.3	0.81	1.88	66.2	22.4	11.4	21.3	33.0	45.8	0.65
403	South China University of Technology	1628.8	0.81	1.77	63.9	23.5	12.7	20.4	33.7	45.9	0.61
404	National Chung Hsing University	1890	0.8	1.72	63.9	22.9	13.2	22.3	32.1	45.6	0.63
405	Shanghai Jiao Tong University	7445.5	0.8	1.83	65.4	22.5	12.2	20.6	32.6	46.9	0.63
406	University of Oviedo	1895.2	0.8	1.6	61.6	25.2	13.2	23.0	32.5	44.6	0.58
407	Wuhan University	3323.1	0.8	1.72	64.3	23.2	12.6	22.6	33.0	44.4	0.61
408	Bar-Ilan University	1736	0.79	1.81	65.9	22.7	11.5	22.3	32.3	45.5	0.62
409	Southeast University	1796.3	0.79	1.96	67.7	21.1	11.2	19.8	32.4	47.8	0.66
410	Federal University of Santa Catarina	1193.5	0.79	1.58	60.5	23.7	15.9	20.5	33.0	46.5	0.59
411	National Chiao Tung University	3424.9	0.79	1.82	65.4	21.9	12.6	19.8	32.4	47.8	0.63

	University	Number of articles	μ_1	μ_2	Percentage of articles in category: 1	2	3	Percentage of citations in category: 1	2	3	GM Index
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
412	Tokyo Institute of Technology	5474.3	0.78	1.86	66.0	22.9	11.0	19.6	32.6	47.8	0.69
413	University of Coimbra	1685.6	0.78	1.59	61.3	24.5	14.2	21.4	34.1	44.6	0.57
414	University of Siena	1818.1	0.78	1.5	59.7	26.2	14.1	22.5	33.9	43.5	0.62
415	Tohoku University	9298.7	0.78	1.76	65.0	23.7	11.3	21.0	33.0	46.1	0.67
416	National Cheng Kung University	5309.6	0.77	1.65	62.8	24.3	12.9	20.8	33.8	45.4	0.61
417	East China Normal University	1179.7	0.77	1.68	63.2	23.5	13.3	20.1	33.9	46.0	0.62
418	Mahidol University	1652.8	0.77	1.56	62.5	24.5	13.0	24.4	33.2	42.4	0.61
419	Middle East Technical University	1815.9	0.77	1.75	64.8	22.4	12.8	19.8	33.0	47.2	0.62
420	Yonsei University	5279.3	0.77	1.65	63.5	24.5	12.0	21.3	34.3	44.5	0.64
421	Ewha Womans University	1161.2	0.76	1.69	65.4	24.0	10.7	23.3	32.7	44.0	0.63
422	University of Catania	1745.1	0.76	1.58	62.1	25.1	12.8	20.9	33.4	45.7	0.65
423	University of Palermo	2178.9	0.75	1.56	62.7	24.6	12.7	23.0	33.2	43.9	0.59
424	University of Saskatchewan	2791.7	0.75	1.56	62.9	23.4	13.7	23.1	32.4	44.5	0.56
425	Zhejiang University	9489.8	0.75	1.67	64.5	23.1	12.4	21.4	32.9	45.7	0.6
426	University of Ljubljana	2890.9	0.75	1.67	64.0	24.4	11.7	20.3	33.3	46.4	0.65
427	Ben-Gurion University of the Negev	3550.1	0.75	1.7	65.0	23.6	11.4	20.5	34.0	45.5	0.62
428	Technical University of Madrid	1597.8	0.75	1.7	64.2	22.5	13.4	18.8	33.0	48.3	0.62
429	Kyushu University	6392	0.75	1.66	64.7	23.7	11.6	21.6	33.0	45.5	0.64
430	Shanghai University	1621	0.75	1.74	65.8	21.6	12.6	20.2	31.9	47.9	0.63
431	Keio University	2988.4	0.75	1.59	63.3	23.9	12.8	22.1	32.8	45.1	0.63
432	Shandong University	3701.3	0.75	1.7	65.2	23.6	11.2	20.7	33.8	45.5	0.64
433	National and Kapodistrian University of Athens	5455.5	0.74	1.57	63.7	24.1	12.2	22.8	32.9	44.4	0.62
434	Jilin University	3400.7	0.74	1.6	63.7	23.8	12.5	21.4	33.9	44.7	0.58
435	Xi'an Jiaotong University	2967.8	0.74	1.77	66.5	22.7	10.8	19.3	33.8	46.8	0.64
436	China Agricultural University	1692	0.73	1.51	63.4	23.7	12.9	23.7	32.8	43.5	0.58
437	Cairo University	1398	0.72	1.58	64.4	23.0	12.6	21.9	32.2	45.9	0.59
438	Tongji University	1475.4	0.72	1.62	65.0	23.0	12.1	21.4	33.5	45.1	0.63
439	Chiba University	2678.6	0.72	1.44	61.2	25.3	13.5	22.2	32.7	45.1	0.64
440	Chulalongkorn University	1707	0.71	1.5	64.0	23.8	12.2	24.4	33.7	41.9	0.59
441	University of Buenos Aires	3087.6	0.71	1.44	62.1	24.6	13.3	22.7	33.2	44.1	0.58
442	University of Science Malaysia	1191	0.71	1.68	65.8	22.8	11.5	18.6	32.8	48.6	0.69
443	University of Science and Technology Beijing	982.5	0.71	1.62	64.5	22.8	12.8	18.5	33.3	48.3	0.62
444	University of Chile	1935.3	0.7	1.38	60.4	25.6	14.0	22.4	34.0	43.6	0.56
445	Hokkaido University	6463.7	0.7	1.51	63.8	23.4	12.9	22.2	32.3	45.4	0.63
446	Korea University	3772.2	0.7	1.54	63.3	23.5	13.3	19.7	32.6	47.8	0.66
447	Sichuan University	3612.4	0.7	1.56	64.4	23.7	12.0	21.0	33.8	45.2	0.62
448	Beijing Normal University	1524.8	0.7	1.54	64.1	24.3	11.6	21.2	33.0	45.8	0.6
449	University of Tsukuba	3415.4	0.7	1.53	64.1	23.7	12.2	21.5	32.8	45.8	0.65
450	Universidade de São Paulo	10690.6	0.69	1.46	63.2	23.9	12.9	22.6	33.0	44.4	0.6
451	Chonbuk National University	1324.8	0.69	1.48	63.3	24.0	12.7	21.5	32.7	45.8	0.61
452	Federal University of Rio Grande do Sul	2556	0.69	1.47	63.3	25.1	11.6	22.2	34.9	42.9	0.59
453	National Yang-Ming University	1896	0.69	1.31	60.5	25.4	14.1	25.1	32.5	42.4	0.59
454	Hiroshima University	3490.8	0.69	1.48	62.8	24.2	13.1	20.6	32.7	46.7	0.65
455	Hanyang University	3014.9	0.69	1.6	65.2	23.0	11.8	19.6	33.3	47.1	0.64
456	Universidade Federal de Minas Gerais	2020	0.69	1.46	63.8	23.7	12.5	23.3	33.3	43.4	0.59
457	Sungkyunkwan University	3842.3	0.69	1.43	61.2	25.0	13.8	19.4	33.4	47.2	0.64
458	State University of Campinas	4191.6	0.69	1.48	64.1	24.1	11.8	22.7	33.6	43.7	0.58

	University	Number of articles	μ_1	μ_2	Percentage of articles in category:			Percentage of citations in category:			GM Index
		(1)	(2)	(3)	1 (4)	2 (5)	3 (6)	1 (7)	2 (8)	3 (9)	(10)
459	Tianjin University	2692.1	0.68	1.57	64.6	22.8	12.6	18.9	33.6	47.5	0.59
460	Kyung Hee University	1453.5	0.68	1.45	63.5	23.9	12.7	22.5	32.9	44.6	0.61
461	Ege University	1860.4	0.68	1.5	65.0	23.1	11.9	22.5	32.6	44.8	0.6
462	University of Tehran	1986.7	0.68	1.64	67.0	21.3	11.7	19.9	32.6	47.6	0.67
463	Jagiellonian University in Krakow	2387.2	0.68	1.49	64.6	22.8	12.6	22.0	31.9	46.1	0.64
464	Tarbiat Modares University	934.3	0.68	1.46	63.6	23.2	13.2	21.5	33.2	45.4	0.63
465	Chang Gung University	1909.1	0.67	1.32	60.3	25.5	14.2	22.5	33.4	44.2	0.59
466	Chonnam National University	1841.9	0.67	1.33	60.4	26.0	13.6	21.6	32.7	45.8	0.62
467	Kanazawa University	2014.8	0.67	1.35	61.9	25.8	12.3	23.2	34.9	41.8	0.6
468	Federal University of Rio de Janeiro	3222	0.67	1.52	65.4	24.3	10.3	21.4	34.5	44.1	0.64
469	University of Pretoria	1336	0.66	1.44	63.7	23.2	13.1	21.4	32.6	46.0	0.59
470	Kobe University	2539.5	0.66	1.41	63.6	24.7	11.8	22.6	34.3	43.2	0.6
471	Waseda University	1883.8	0.66	1.46	62.8	24.2	13.0	17.7	33.3	49.0	0.68
472	Chungnam National University	1432.6	0.66	1.47	64.3	22.6	13.1	20.5	32.7	46.8	0.63
473	National Autonomous University of Mexico	5182.5	0.66	1.46	64.9	23.2	12.0	21.9	33.5	44.6	0.6
474	Charles University in Prague	3689.2	0.65	1.4	63.4	23.8	12.9	21.0	33.0	46.0	0.62
475	Okayama University	3007.2	0.65	1.34	62.0	24.7	13.3	22.1	32.6	45.3	0.63
476	Northwestern Polytechnical University	1208.4	0.65	1.61	66.6	21.4	12.0	17.6	33.5	48.9	0.61
477	Banaras Hindu University	1271.3	0.64	1.53	66.3	22.7	11.0	20.0	32.9	47.1	0.64
478	Universidade Estadual Paulista	2586.2	0.64	1.32	61.7	24.6	13.8	21.3	33.5	45.2	0.61
479	Gazi University	1991.2	0.64	1.37	63.8	23.4	12.8	21.8	33.1	45.1	0.58
480	Lomonosov Moscow State University	2841.3	0.64	1.54	66.9	22.2	10.9	19.8	32.8	47.4	0.66
481	King Saud University	878.9	0.64	1.47	65.2	23.3	11.5	19.7	33.0	47.3	0.61
482	Istanbul University	2740.1	0.63	1.38	63.6	24.6	11.9	21.1	34.6	44.3	0.63
483	Kyungpook National University	2122.8	0.63	1.35	61.4	25.7	12.8	18.1	33.8	48.1	0.69
484	Saint Petersburg State University	889.8	0.63	1.46	65.6	23.0	11.5	19.9	33.2	46.9	0.63
485	Pusan National University	2181.5	0.63	1.39	64.3	22.9	12.8	20.6	32.9	46.5	0.61
486	Tehran University of Medical Sciences	1076.2	0.62	1.26	62.6	25.1	12.4	24.2	34.1	41.8	0.6
487	Hacettepe University	2745.6	0.62	1.32	63.3	24.6	12.1	22.0	34.2	43.8	0.58
488	Catholic University of Korea	1223.5	0.62	1.16	58.8	27.0	14.2	22.9	34.2	42.9	0.58
489	University of Zagreb	2038.6	0.61	1.4	65.2	22.4	12.4	20.8	32.7	46.4	0.61
490	Federal University of São Paulo	1806.4	0.61	1.24	62.7	24.4	12.9	24.9	33.0	42.1	0.59
491	National University of La Plata	1402.8	0.61	1.31	63.2	23.2	13.6	20.5	33.0	46.5	0.58
492	Huazhong University of Science and Technology	3841.1	0.6	1.47	67.2	22.2	10.6	19.7	34.5	45.8	0.63
493	Federal University of Paraná	920.9	0.59	1.27	63.7	23.1	13.2	22.4	31.8	45.8	0.59
494	Inha University	2063.4	0.59	1.43	66.6	21.6	11.8	19.3	33.6	47.1	0.63
495	Nihon University	2115	0.58	1.25	63.3	24.0	12.7	21.3	32.7	46.0	0.63
496	Federal University of Viçosa	506.2	0.58	1.31	65.0	22.1	12.9	20.3	33.5	46.2	0.61
497	University of Belgrade	2231.6	0.57	1.39	67.3	21.8	11.0	20.3	32.6	47.1	0.65
498	Ankara University	2035.1	0.57	1.23	64.3	23.4	12.3	22.1	32.5	45.4	0.62
499	Konkuk University	1238.7	0.56	1.26	64.5	22.5	13.0	20.7	33.8	45.5	0.59
500	University of Malaya	1115.8	0.5	1.32	68.2	21.2	10.7	15.9	33.9	50.2	0.73
	Average	3772.2	1.01	2.1	62.9	24.6	12.5	22.9	32.7	44.4	0.63
	SD	2777.4	0.24	0.48	1.9	1.2	1.2	1.7	0.8	1.6	0.03
	CV	0.7	0.23	0.23	0.0	0.1	0.1	0.1	0.0	0.0	0.04

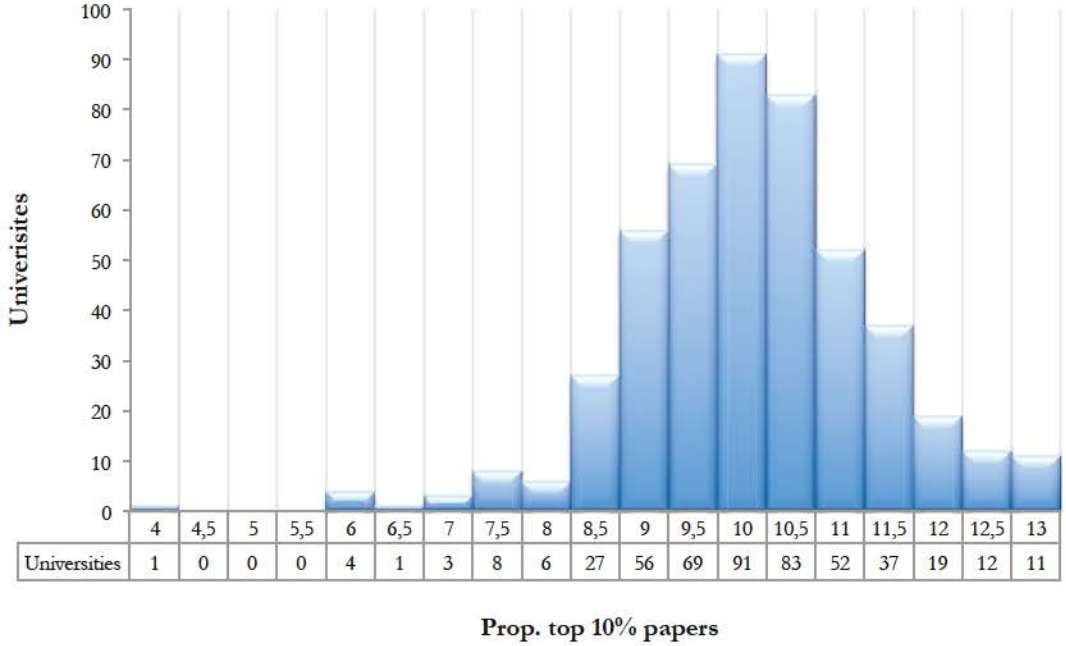
Table 1. Percentage of articles in each university that appear in the top τ% of the global rank, together with the standard deviation, σ_τ, and the coefficient of variation, σ_τ/τ

			Empirical values in:					
Theoretical values			Normalized distribution C^*			Un-normalized distr. C		
τ%	σ_τ	σ_τ/τ	τ%	σ_τ	σ_τ/τ	τ%	σ_τ	σ_τ/τ
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	0.20	0.20	0.96	0.29	0.30	0.82	0.52	0.63
5	0.43	0.09	4.95	0.90	0.18	4.33	1.93	0.45
10	0.59	0.06	10.00	1.46	0.15	8.91	3.22	0.36
20	0.79	0.04	20.03	2.41	0.12	18.30	5.10	0.28
30	0.91	0.03	30.04	3.11	0.10	27.90	6.44	0.23
40	0.97	0.02	40.00	3.49	0.09	37.67	7.25	0.19
50	0.99	0.02	49.88	3.76	0.08	47.59	7.63	0.16
75	0.86	0.01	74.73	4.08	0.05	73.08	6.57	0.09
90	0.59	0.01	88.94	4.08	0.05	88.93	4.07	0.05



	4	4,5	5	5,5	6	6,5	7	7,5	8	8,5	9	9,5	10	10,5	11	11,5	12	12,5	13
Universities	23	15	25	14	13	24	23	29	39	34	33	39	31	33	28	10	15	15	10

Figure 1.A. Distribution over the 500 universities of the top 10% articles in the un-normalized citation distribution *C*. Histogram of the percentage that these articles represent with respect to the total number of articles in each university.



	4	4,5	5	5,5	6	6,5	7	7,5	8	8,5	9	9,5	10	10,5	11	11,5	12	12,5	13
Universities	1	0	0	0	4	1	3	8	6	27	56	69	91	83	52	37	19	12	11

Figure 1.B. Distribution over the 500 universities of top 10% articles in the overall normalized citation distribution *C. Histogram of the percentage that these articles represent with respect to the total number of articles in each university.**

Table 2. The skewness of citation distributions according to the CSS approach. Percentages of articles and citations by category. Average, standard deviation, and coefficient of variation over the 500 LR universities, and results for the union of the LR universities, and the overall citation distribution

	Percentage of articles in category			Percentage of articles in category		
	1	2	3	1	2	3
A. Field-normalized citation distributions. Assignment of articles to universities according to the fractional method						
I. Average (Std. deviation)	62.9 (1.9)	24.6 (1.2)	12.5 (1.2)	22.9 (1.7)	32.7 (0.8)	44.4 (1.5)
Coefficient of variation	0.03	0.05	0.10	0.08	0.02	0.03
II.1. LR union						
(1.9 million articles)	62.8	24.8	12.4	23.4	32.6	44.0
II. 2. Overall citation distribution						
(3.6 million articles)	69.2	21.7	9.1	23.7	33.7	42.6
B. Field-normalized citation distributions. Assignment of articles to universities according to the multiplicative method						
III. Average (Std. deviation)	66.3 (2.3)	22.7 (1.0)	10.9 (1.6)	24.4 (1.8)	32.7 (1.0)	42.9 (1.5)
Coefficient of variation	0.03	0.04	0.14	0.08	0.03	0.03
IV.1. LR union						
(4.3 million articles)	65.9	23.0	11.1	25.1	32.3	42.6
IV. 2. Extended count						
(8.3 million articles)	62.3	24.4	13.3	22.1	32.2	45.7
C. Raw citation distributions. Assignment of articles to universities according to the fractional method						
V. Average (Std. deviation)	65.9 (2.4)	23.3 (1.5)	10.8 (1.3)	22.7 (1.8)	32.3 (1.1)	45.0 (1.8)
Coefficient of variation	0.04	0.07	0.12	0.08	0.03	0.04
VI.1. LR union						
(1.8 million articles)	70.9	20.7	8.4	26.3	31.6	42.1
VI.2. Overall citation distribution						
(3.6 million articles)	72.0	20.2	7.8	22.6	32.2	45.2
D. Previous results for citation distributions in a comparable case. Articles published in 1998-2002 in 219 sub-fields with a fixed, five-year citation window. Panel A in Table 1, in Albarrán *et al.* (2011):						
VII. Average (Std. deviation)	68.6 (3.7)	-	10.0 (1.7)	21.1 (5.0)	-	44.9 (4.6)
Coefficient of variation	0.05		0.17	0.24		0.10

Table 3. The skewness of citation distributions according to the *GM* index. Average, standard deviation, and coefficient of variation over the 500 LR universities, and results for the union of the LR universities, and the overall citation distribution

A. Field-normalized citation distributions. Fractional method	
I. Average (Std. deviation)	0.63 (0.03)
Coefficient of variation	0.04
II.1. LR union (1.9 million articles)	0.56
II.2. Overall citation distribution (3.6 million articles)	0.58
B. Field-normalized citation distributions. Multiplicative method	
III. Average (Std. deviation)	0.62 (0.03)
Coefficient of variation	0.05
IV.1. LR union (4.3 million articles)	0.53
IV. 2. Extended count (8.3 million articles)	0.72
C. Raw citation distributions. Fractional method	
V. Average (Std. deviation)	0.68 (0.5)
Coefficient of variation	0.07
VI.1. LR union (1.9 million articles)	0.75
VI.2. Overall citation distribution(3.6 million articles)	0.79

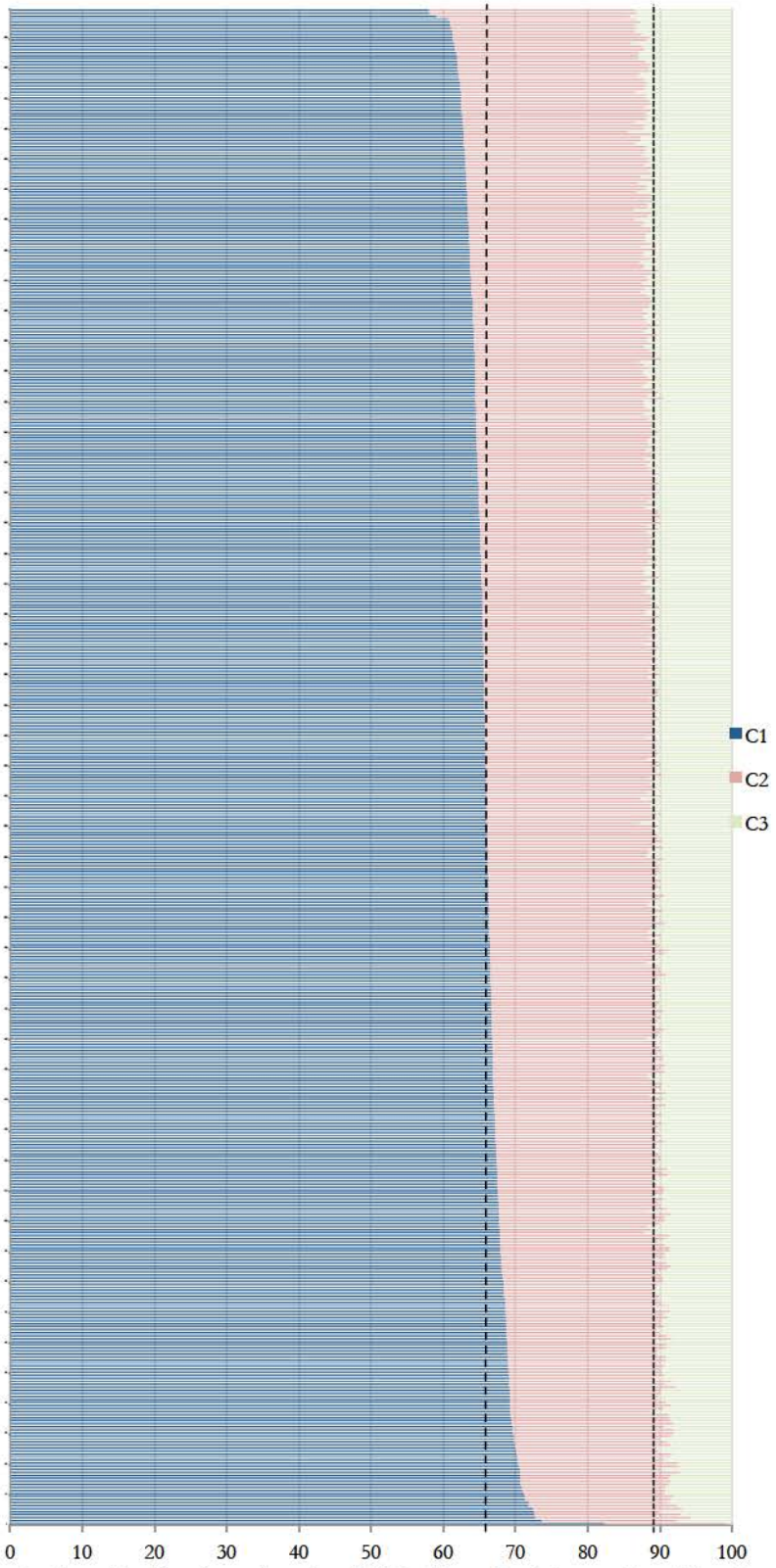


Figure 2. Partition of the citation distributions for the 500 Leiden Ranking universities into three categories according to the CSS technique

Table 4.A. The effect on overall citation inequality, $I(C)$, of the differences in citation impact between universities before and after MNCS normalization, and the impact of normalization on this effect

	$IDPD$	Normalization impact $=100\,[IDPD - IDCP^*/IDCP]$
Before MNCS normalization, $100\,[IDPU/I(C)]$	3.85 %	-
After MNCS normalization, $100\,[IDPU^*/I(C)]$	0.72 %	81.3 %

Table 4.B.[a] The effect on overall citation inequality, $I(C)$, of the differences in citation impact between countries before and after MNCS normalization, and the impact of normalization on this effect

	$IDPD$	Normalization impact $=100\,[IDPD - IDCP^*/IDCP]$
Before MNCS normalization, $100\,[IDPU/I(C)]$	5.6 %	-
After MNCS normalization, $100\,[IDPU^*/I(C)]$	0.9%	83.8 %

Table 4.C.[b] The effect on overall citation inequality, $I(C)$, of the differences in citation impact between sub-fields before and after mean normalization, and the impact of normalization on this effect

	$IDPD$	Normalization impact $=100\,[IDPD - IDCP^*/IDCP]$
Before MNCS normalization, $100\,[IDPU/I(C)]$	17.9%	-
After MNCS normalization, $100\,[IDPU^*/I(C)]$	3.45%	87.1 %

[a] Table 3 in Crespo, J. A., Li, Y., & Ruiz-Castillo, J. (2014).

[b] Table 3 in Albarrán, P., Perianes-Rodriguez, A., & Ruiz-Castillo, J. (2015).

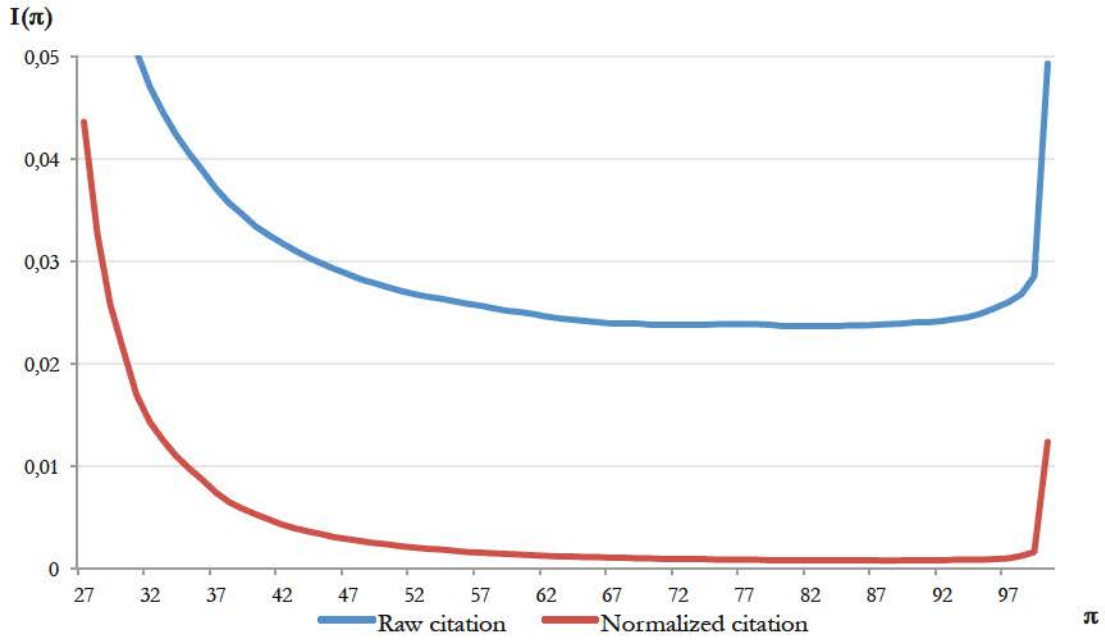


Figure 3. Citation inequality due to differences in citation impact between universities, I(π), as a function of π. Results for the [27, 100] quantile interval.

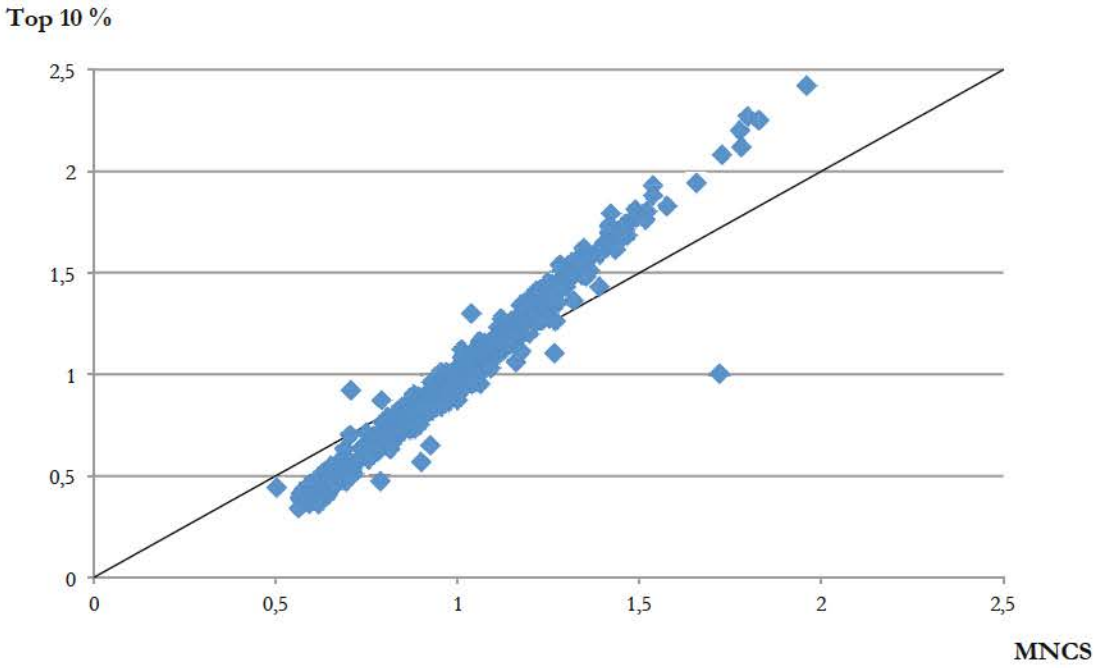


Figure 4. Scatterplot of the relation between the *MNCS* indicator and the *PPtop 10%* indicator for the 500 Leiden Ranking universities