Normalization of citation impact in economics

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26 July 2017

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Abstract

This study is intended to facilitate fair research evaluations in economics. Field- and time-normalization of citation impact is the standard method in bibliometrics. Since citation rates for journal papers differ substantially across publication years and Journal of Economic Literature (JEL) classification codes, citation rates should be normalized for the comparison of papers across different time periods and economic subfields. Without normalization, both factors that are independent of research quality bias the results of citation analyses. We introduce two normalized indicators in economics, which are the most important indicators in bibliometrics: (1) the mean normalized citation score (MNCS) compares the citation impact of a focal paper with the mean impact of similar papers published in the same economic subfield and publication year. (2) $PP_{top\ 50\%}$ is the share of papers that belong to the above-average half in a certain subfield and time period. Since the MNCS is based on arithmetic averages despite skewed citation distributions, we recommend using $PP_{top\ 50\%}$ for fair comparisons of entities in economics (e.g. researchers, institutions, or countries). In this study, we apply the method to 294 journals (including normalized scores for 192,524 papers) by assigning them to four citation impact classes and identifying 33 outstandingly cited economics journals.

Key words

Bibliometrics, citations, JEL codes, journal ranking, mean normalized citation score (MNCS), citation percentile, $PP_{top\ 50\%}$

1 Introduction

Research evaluation is the backbone of economic research; common standards in research and high-quality work cannot be achieved without such evaluations (Bornmann, 2011; Moed & Halevi, 2015). It is a sign of post-academic science – with its focus on accountability – that quantitative methods of research evaluation complement qualitative assessments of research (i.e. peer review). Today, the most important quantitative method is bibliometrics with its measurements of research output and citation impact. Whereas in the early 1960s, only a small group of specialists was interested in bibliometrics (e.g. Eugene Garfield, the inventor of Clarivate Analytics' Journal Impact Factor, JIF), research activities in this area have substantially increased over the past two decades (Wouters et al., 2015). Today various bibliometric studies are being conducted based on data from individual researchers, scientific journals, universities, research organizations, and countries (Gevers, 2014). According to the Panel for Review of Best Practices in Assessment of Research et al. (2012) bibliometrics is the most important part of the field of scientometrics and is "accepted by the general scientific community" (p. 34).

Since citation impact is seen as a proxy of research quality, which measures one part of quality, namely impact (other parts are accuracy and importance, Martin & Irvine, 1983), while impact measurements are increasingly used as a basis for funding or tenure decisions in science, citation impact indicators are the focus of bibliometric studies. In these studies it is often necessary to analyse citation impact across papers published in different fields and years. However, comparing counts of citations across fields and publication years leads to biased results (Council of Canadian Academies, 2012). Since the average citation rates for papers published in different fields and years differ significantly (independently of the quality of the papers) (Kreiman & Maunsell, 2011; Opthof, 2011), it is standard in bibliometrics to normalize citations. According to Abramo, Cicero, and D'Angelo (2011) and Waltman and

van Eck (2013b), field-specific differences in citation patterns arise for the following reasons: (i) different numbers of journals indexed for the fields in bibliometric databases (Marx & Bornmann, 2015); (ii) different citation and authorship practices, as well as cultures among fields; (iii) different production functions across fields (McAllister, Narin, & Corrigan, 1983); and (iv) numbers of researchers vary strongly by field (Kostoff, 2002). The law of the constant ratios (Podlubny, 2005) claims that the ratio of the numbers of citations in any two fields remains close to constant.

It is the aim of normalized bibliometric indicators "to correct as much as possible for the effect of variables that one does not want to influence the outcomes of a citation analysis" (Waltman, 2016, p. 375). In principle, normalized indicators compare the citation impact of a focal paper with a citation impact baseline defined by papers published in the same field and publication year. The recommendation to use normalized bibliometric indicators instead of bare citation counts is one of the ten guiding principles for research metrics listed in the Leiden manifesto (Hicks, Wouters, Waltman, de Rijcke, & Rafols, 2015; Wilsdon et al., 2015).

This study is intended to introduce the approach of citation normalizing in economics, which corresponds to the current state of the art in bibliometrics. Section 3 presents two normalized citation indicators (see also Appendix B): the mean normalized citation score (MNCS), which was the standard approach in bibliometrics over many years, and the current preferred alternative $PP_{top\ 50\%}$. The MNCS normalizes the citation count of a paper with respect to a certain economic subfield. $PP_{top\ 50\%}$ further corrects for skewness in subfields' citation rates; the metric is based on percentiles. It determines whether a paper belongs to the 50% most frequently cited papers in a subfield. The subfield definition used in this study relies on the Journal of Economic Literature (JEL) classification system. It is well-established in economics and most of the papers published in economics journals have JEL codes attached.

In section 2 we describe our dataset and provide several descriptive statistics. We extracted all of the papers from the Web of Science (WoS, Clarivate Analytics) economics subject category published between 1991 and 2013. We matched these papers with the corresponding JEL codes listed in EconLit. Using citation data from WoS, we realized that the citation rates substantially differ across economic subfields. As in many other disciplines, citation impact analyses can significantly inspire or hamper the career paths of researchers in economics, their salaries and reputation (Ellison, 2013; Gibson, Anderson, & Tressler, 2014). In a literature overview Hamermesh (2015) demonstrates that citations are related to the salaries earned by economists. Fair research evaluations in economics should therefore consider subfield-specific differences in citation rates, because the differences are not related to research quality.

In section 4 we introduce a new economics journal ranking based on normalized citation scores. We calculated these scores for 192,524 papers published in 294 journals (see also Appendix A). Although several top journals are similarly positioned to other established journal rankings in economics, we found large differences for many journals. In section 6, we discuss our results and give some direction for future research. The subfield-normalization approach can be applied to other entities than journals, such as researchers, research groups, institutions and countries.

2 Methods

2.1 The Journal of Econometric Literature (JEL) Codes

A key issue in the calculation of normalized citation scores is the definition of fields and subfields, which are used to compile the reference sets (Wilsdon et al., 2015; Wouters et al., 2015): "In comparative studies, inappropriate reference standards obtained from questionable subject assignment might result in misleading conclusions" (Glänzel & Schubert, 2003, p. 357). The most common approach in bibliometrics is to use subject

categories that are defined by Clarivate Analytics for WoS or Elsevier for Scopus. These subject categories are sets of journals publishing papers in similar research areas, such as biochemistry, condensed matter physics and economics. They shape a multidisciplinary classification system covering a broad range of research areas (Wang & Waltman, 2016). However, this approach has been criticised in recent years because it is stretched to its limits with multi-disciplinary journals, e.g. *Nature* and *Science*, and field-specific journals with a broad scope, e.g. *Physical Review Letters* and *The Lancet*. "These journals do not fit neatly into a field classification system" (Waltman & van Eck, 2013a, p. 700), because they cannot be assigned to a single field or publish research from a broad set of subfields (Haddow & Noyons, 2013).

It is not only specific for fields, but also for subfields that they have different patterns of productivity and thus different numbers of citations (Crespo, Herranz, Li, & Ruiz-Castillo, 2014; National Research Council, 2010). Thus, it is an obvious alternative for field-specific bibliometrics to use a mono-disciplinary classification system (Waltman, 2016). It is an advantage of these systems that they are specially designed to represent the subfield patterns in a single field (Boyack, 2004) and are assigned to papers on the paper-level (and not journal-level). The assignment of subfields at the paper level protects the systems from problems with multi-disciplinary journals. In recent years, various bibliometric studies have used mono-disciplinary systems. Chemical Abstracts (CA) sections are used in chemistry and related areas (Bornmann & Daniel, 2008; Bornmann, Schier, Marx, & Daniel, 2011), MeSH (Medical Subject Headings) terms in biomedicine (Bornmann, Mutz, Neuhaus, & Daniel, 2008; Leydesdorff & Opthof, 2013; Strotmann & Zhao, 2010), PACS (Physics and Astronomy Classification Scheme) codes in physics and related areas (Radicchi & Castellano, 2011), and the MathSciNet's MSC (Mathematics subject classification) system in mathematics (Smolinsky & Lercher, 2012).

Table 1. Main Journal of Economic Literature (JEL) codes

Code letter	Category
A	General Economics and Teaching
B	History of Economic Thought, Methodology, and Heterodox Approaches
C	Mathematical and Quantitative Methods
D	Microeconomics
E	Macroeconomics and Monetary Economics
F	International Economics
G	Financial Economics
H	Public Economics
I	Health, Education, and Welfare
J	Labour and Demographic Economics
K	Law and Economics
L	Industrial Organization
M	Business Administration and Business Economics; Marketing; Accounting; Personnel Economics
N	Economic History
O	Economic Development, Innovation, Technological Change, and Growth
P	Economic Systems
Q	Agricultural and Natural Resource Economics; Environmental and Ecological Economics
R	Urban, Rural, Regional, Real Estate, and Transportation Economics
Y	Miscellaneous Categories
Z	Other Special Topics

In economics, the assignment of publications to subfields has a long history. Early classification attempts by the American Economic Association go back to the beginning of the 20th century when ten major categories were defined in the *American Economic Review*. These categories have been subsequently revised several times and transferred to the EconLit system, including JEL codes. The majority of economics journals ask authors to provide JEL codes for their papers. A detailed overview of the history and meaning of JEL codes is provided by Cherrier (2017). In its current form (since 1991) all JEL codes – the main categories – are designed as "Exx", i.e. a letter plus two stages of subcategories indicated by numbers (see https://www.aeaweb.org/jel/guide/jel.php). There are 20 categories at the main level, which are listed in Table 1. The main levels form the basis for the computation of the

normalized scores in this study. The 133 categories at the first sub-level (e.g. E1) are used for robustness checks (see section 5; further disaggregated levels are not considered here).

2.2 Publication and citation data

WoS is the most important bibliographic database in bibliometrics. Most of the studies in this area are based on its publication and citation data. We downloaded all meta-data of the papers and the corresponding citations from the subject category "economics", which were published between 1991 and 2013. We used 1991 as the first year, since JEL codes were established in its current form in 1991. We obtained data for 224,867 papers with the document type "article" or "review", which were published in 386 journals. With the exclusion of other document types (e.g. editorial material, notes, and comments), we focus in this study on substantial and citable items.

We have made four adjustments to this dataset:

(1) We excluded publications of the *Papers and Proceedings* issues from the *American Economic Review* and the *European Economic Review*. These papers are usually very short due to space considerations from the journal (usually five to six pages). They often represent an extension only that has been left out in full-length papers published elsewhere.

(2) We only kept those papers published in journals that were listed in 2013 for at least four years. Thus, we excluded papers from journals that have stopped being listed (or reclassified) in WoS or deceased.

(3) The journals in which the papers have appeared had to be listed in EconLit, since the JEL codes were obtained from the Econlit database. If we were not able to match a paper via EconLit (because the publishing journal was not listed), we used JEL codes data from RePEc (see Zimmermann, 2013). For these papers we applied a similar matching procedure as described by Angrist, Azoulay, Ellison, Hill, and Lu (2017).

(4) Papers without JEL codes, missing JEL codes, or with JEL codes "Y" and "Z" were excluded from the study. The codes "Y" and "Z" are not related to a specific content.

The four adjustments ended up with 192,524 papers, which appeared in 294 journals. The citations of these papers refer to the time period between publication and the end of 2016. Thus, the citation counts of the papers are based on different citation windows (ranging between 4 and 26 years). The longer the citation window, the more the "true" impact of a paper can be determined (Research Evaluation and Policy Project, 2005; Wang, 2013). Glänzel (2008) and Glänzel, Thijs, Schubert, and Debackere (2009) recommend using a citation window of at least three years. Johnston, Piatti, and Torgler (2013) show for papers published in the *American Economic Review* that the mean citation rate peaks in the fourth year after publication. Since the citations in our in-house database are counted until the end of 2016, we included no years prior to 2013 in this study.

2.3 Descriptive statistics and differences in citation rates

Table 2 reports descriptive statistics for all papers in the dataset and for the papers from selected years in a five year time interval. The development over time shows that the number of economics journals increased. Correspondingly, the number of papers and assigned JEL codes also increased. Due to the diminishing citation window from 26 to 4 years, citation counts decrease and shares of non-cited papers increase over time. In Table 9 (see Appendix A), we further report the number of papers, the time period covered in WoS, and descriptive citation statistics for each journal in our dataset. For 108 of all 294 journals in the set (37%), papers appeared across the complete time period from 1991 to 2013. For the other journals, the WoS coverage started later than 1991 (such as for the four American Economic journals). The results in Table 9 demonstrate that almost all journals publish papers with zero citations. With an average of 145 citations, the highest citation rate was reached by the *Quarterly*

Journal of Economics by way of comparison. Arellano and Bond (1991) is the most frequently cited paper in our set (with 4,627 citations).

Table 2. Descriptive statistics

Year	Journals	Papers	Citations	Share of papers with zero citations	JEL codes
1991	108	4,181	120,856	12.1%	7,748
1995	134	5,145	149,439	10.1%	9,076
2000	165	6548	174,807	8.2%	1,5140
2005	192	8,013	181,045	7.3%	22,497
2010	293	13,474	139,462	13.2%	43,649
2013	294	15,901	69,641	22.4%	58,228
1991-2013	294	192,425	3,506,995	11.8%	534,911

Table 3 shows average citation rates for papers assigned to different JEL codes. The results are presented for selected years in a five year time interval. It is clearly visible over all publication years that the average values differ substantially between the economics subfields. For example, papers published in 1991 in "General Economics and Teaching" (A) received on average 15.2 citations; with 49.5 citations this figure is more than three times larger in "Mathematical and Quantitative Methods" (C). Similar results for differences in citation rates of economic subfields have been published by van Leeuwen and Calero Medina (2012), Ellison (2013), Hamermesh (2015), and Perry and Reny (2016).

The results in Table 3 also reveal that the average citation rates decline over time in most cases, as the citation window gets smaller.

The dependency of the average citations in economics on time and subfield, which is independent of research quality, necessitates the consideration of subfield and publication year in bibliometric studies. Without consideration of these differences, research evaluations are expected to be biased and disadvantage economists newly publishing in the field or working in subfields with systematically low average citations (e.g. in "History of Economic Thought, Methodology, and Heterodox Approaches", B).

Table 3. Average citation rates per JEL code and publication year

JEL-Code	1991	1995	2000	2005	2010	2013
A	15.2	8.7	16.3	15.7	5.3	2.9
B	4.7	7.9	11.6	7.4	5.4	1.9
C	49.5	54.6	28.0	25.3	10.8	4.3
D	35.4	28.3	26.5	21.1	9.4	4.0
E	23.9	19.9	23.8	18.9	7.3	3.7
F	17.2	25.8	18.8	18.6	8.3	3.5
G	46.4	36.7	43.1	27.8	12.8	4.9
H	18.8	19.0	21.4	17.2	8.6	4.0
I	35.1	37.3	32.4	28.6	12.1	4.7
J	31.9	26.2	25.3	21.8	9.6	4.0
K	37.7	22.1	29.3	16.4	6.5	3.2
L	18.8	30.6	22.6	22.5	10.1	4.5
M	25.6	38.7	41.4	35.7	14.0	5.4
N	13.0	12.2	15.0	17.1	8.3	3.7
O	37.3	38.0	32.2	22.5	10.5	4.1
P	11.2	15.4	16.4	20.1	9.1	3.9
Q	20.4	26.0	26.0	26.4	14.7	6.6
R	35.5	24.9	22.4	24.8	13.3	5.6

3 Standard approaches in bibliometrics to normalize citation impact

Economics was already part of bibliometric studies, which considered field-specific differences (e.g. Ruiz-Castillo, 2012). Palacios-Huerta and Volij (2004) generalized an idea for citation normalization that goes back to Liebowitz and Palmer (1984), where citations are weighted with respect to the citing journal. However, this approach does not correspond to the current standards in bibliometrics and has not yet become established in economics. Angrist et al. (2017) constructed their own classification scheme featuring ten subfields in the spirit of Ellison (2002). The classification builds upon JEL codes, keywords, and abstracts. Using about 135,000 papers published in 80 journals the authors construct time varying importance weights for journals that account for the subfield where a paper was published. However, this

approach also normalizes on the citing side, similar to Palacios-Huerta and Volij (2004). Combes and Linnemer (2010) calculated normalized journal rankings for all EconLit journals. Although they considered JEL codes for the normalization procedure, they calculated the normalization at the journal, and not at the paper level. Linnemer and Visser (2016) document the most cited papers from the so called top-5 economics journals (Card & DellaVigna, 2013), where they also account for time and JEL codes. With the focus on the top 5 journals, however, they considered only a small sample of journals and did not calculate indicators.

3.1 Mean Normalized Citation Score (MNCS)

The definition and use of normalized indicators in bibliometrics started in the mid-1980s with the papers by Schubert and Braun (1986) and Vinkler (1986). Here normalized citation scores (NCSs) result from the division of the citation count of focal papers by the average citations of comparable papers in the same field or subfield. The denominator is the expected number of citations and constitutes the reference set of the focal papers (Mingers & Leydesdorff, 2015; Waltman, 2016). Resulting impact scores larger than 1 indicate papers cited above-average in the field or subfield and scores below 1 denote papers with below-average impact.

Several variants of this basic approach have been introduced since the mid-1980s (Vinkler, 2010) and different names have been used for the metrics, e.g. relative citation rate, relative subfield citedness, and field-weighted citation score. In the most recent past, the metric has been mostly used in bibliometrics under the label “MNCS”. Here the NCS for each paper in a publication set (of a researcher, institution, or country) are added up and divided by the number of papers in the set, which results in the mean NCS (MNCS). Since citation counts depend on the length of time between the publication year of the cited papers and the time point of the impact analysis (see Table 3), the NCS is separately calculated for single publication years.

van Raan (2005) published the following rules of thumb for interpreting the MNCS: "This indicator enables us to observe immediately whether the performance of a research group or institute is significantly far below (indicator value <0.5), below (indicator value 0.5–0.8), about (0.8–1.2), above (1.2–1.5), or far above (>1.5) the international impact standard of the field" (p. 7). Thus, excellent research has been published by an entity (e.g. journal or researcher), if the MNCS exceeds 1.5. 17.4% of the papers in our dataset belong to the excellent category, while 4.7% are classified as above average; 11.8% and 43.5% of the papers are in the far below and below categories, respectively.

The MNCS has two important properties, which are required by established normalized indicators (Moed, 2015; Waltman, van Eck, van Leeuwen, Visser, & van Raan, 2011): (1) The MNCS value of 1 has a specific statistical meaning: it represents average performance and below-average and above-average performance can be easily identified. (2) If the paper of an entity (e.g. journal or researcher) receives an additional citation, the MNCS increases in each case.

A detailed explanation of how the MNCS is calculated in this study can be found in Appendix B.

3.2 $PP_{top\ 50\%}$ – a percentile based indicator as the better alternative to the MNCS

Although the MNSC has been frequently used as indicator in bibliometrics, it has an important disadvantage: it uses the arithmetic average as a measure of central tendency, although distributions of citation counts are skewed (Seglen, 1992). As a rule, field-specific paper sets contain many lowly or non-cited papers and only a few highly-cited papers (Bornmann & Leydesdorff, 2017). Therefore, percentile-based indicators have become popular in bibliometrics, which are robust against outliers. According to Hicks et al. (2015) in the Leiden Manifesto, "the most robust normalization method is based on percentiles: each paper is weighted on the basis of the percentile to which it belongs in the citation distribution

of its field (the top 1%, 10% or 20%, for example)" (p. 430). The recommendation to use percentile-based indicators can also be found in the Metric Tide (Wilsdon et al., 2015).

Against the backdrop of these developments in bibliometrics, and resulting recommendations in the Leiden Manifesto and the Metric Tide, we use the $PP_{top\ 50\%}$ indicator in this study as the better alternative to the MNCS. Basically, the indicator is calculated on the basis of the citation distribution in a specific subfield whereby the papers are sorted in decreasing order of citations. Papers belonging to the 50% of most frequently cited papers are assigned the score 1 and the others the score 0 in a binary variable. The binary variables for all subfields can then be used to calculate the $P_{top\ 50\%}$ or $PP_{top\ 50\%}$ indicators. $P_{top\ 50\%}$ is the absolute number of papers published by an entity (e.g. journal or institution) belonging to the 50% most frequently cited papers and $PP_{top\ 50\%}$ the relative number. Here, $P_{top\ 50\%}$ is divided by the total number of papers in the set. Thus, it is the percentage of papers by an entity that are cited above-average in the corresponding subfields.

The detailed explanation of how the $PP_{top\ 50\%}$ indicator is calculated in this study can be found in Appendix B.

4 Results

4.1 Comparison of citation counts, normalized citation scores (NCSs) and $P_{top\ 50\%}$

The normalization of citations only makes sense in economics if the normalization leads to meaningful differences between normalized scores and citations. However, one cannot expect complete independence, because both metrics measure impact based on the same data source.

Table 4. The most frequently cited paper in every subfield of economics based on normalized citation score (NCS). The citation counts are also given for comparison.

JEL code	NCS	Citation count	Paper
A	37.6	344	Stefano DellaVigna (2009): "Psychology and Economics: Evidence from the Field", *Journal of Economic Literature*, 47(2), 315-72.
B	39.4	526	John Sutton (1997): "Gibrat's Legacy", *Journal of Economic Literature*, 35(1), 40-59.
C	119.2	4627	Manuel Arellano, Manuel & Stephen Bond (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, 58(2), 277-297.
D	82.1	2985	Amos Tversky & Daniel Kahneman (1992): "Advances in Prospect Theory: Cumulative Representation of Uncertainty", *Journal of Risk and Uncertainty*, 5(4), 297-323.
E	61.0	1584	Robert E. Hall and Jones, Charles I., (1999): "Why do Some Countries Produce So Much More Output Per Worker than Others?", *The Quarterly Journal of Economics*, 114(1), 83-116.
F	75.1	1917	Marc J. Melitz (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, 71(6), 1695-1725.
G	90.8	1644	Mitchell A. Petersen (2009): "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches", *Review of Financial Studies*, 22(1), 435-480.
H	48.7	1041	Simon Gachter & Ernst Fehr (2000): "Cooperation and Punishment in Public Goods Experiments", *American Economic Review*, 90(4), 980-994.
I	77.6	1838	Daron Acemoglu, Simon Johnson, & James A. Robinson (2001): "The Colonial Origins of Comparative Development: An Empirical Investigation2, *American Economic Review*, 91(5), 1369-1401.
J	119.2	4627	Manuel Arellano, Manuel & Stephen Bond (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", *Review of Economic Studies*, 58(2), 277-297.
K	66.7	3300	Andrei Shleifer, Florencio Lopez-de-Silanes, & Rafael La Porta (2008): "The Economic Consequences of Legal Origins", *Journal of Economic Literature*, 46(2), 285-332.
L	75.1	1917	Marc J. Melitz (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, 71(6), 1695-1725.
M	29.3	568	Israel M. Kirzner (1997): "Entrepreneurial Discovery and the Competitive Market Process: An Austrian Approach", *Journal of Economic Literature*, 35(1), 60-85.
N	77.6	1838	Daron Acemoglu, Simon Johnson, & James A. Robinson (2001): "The Colonial Origins of Comparative Development: An Empirical Investigation", *American Economic Review*, 91(5), 1369-1401.
O	77.6	1838	Daron Acemoglu, Simon Johnson, & James A. Robinson (2001): "The Colonial Origins of Comparative Development: An Empirical Investigation", *American Economic Review*, 91(5), 1369-1401.
P	77.6	1838	Daron Acemoglu, Simon Johnson, & James A. Robinson (2001): "The Colonial Origins of Comparative Development: An Empirical Investigation", *American Economic Review*, 91(5), 1369-1401.
Q	53.8	1418	David Pimentel, Rodolfo Zuniga, & Doug Morrison (2005): "Update on the environmental and economic costs associated with alien-invasive species in the United States", *Ecological Economics*, 52(3), 273-288.
R	58.4	2071	Paul Krugman (1991): "Increasing Returns and Economic Geography", *Journal of Political Economy*, 99(3), 483-499.

Table 4 shows the papers with the largest NCSs in each subfield of economics. The listed papers include survey papers and methodological papers that are frequently used within and across subfields. We also find landmark papers in the table that have been continuously cited in the respective subfields. Linnemer and Visser (2016) published a similar list of most frequently cited papers in each subfield. For the JEL codes C, F, H, and R the same papers have been identified in agreement; differences are visible for the codes E, G, I, J, L. and O. Since Linnemer and Visser (2016) based their analyses on a different set of journals which is significantly smaller than our set, the differences are expectable.

The impact scores in Table 4 reveal that the papers are most frequently cited in the subfields with very different citation counts – between n=344 in "General Economics and Teaching" (A) and n=4627 in "Mathematical and Quantitative Methods" (C). Correspondingly, similar NCSs in the subfields reflect different citation counts. The list of papers also demonstrate that papers are assigned to more than one economic subfield. The paper by Acemoglu, Johnson, and Robinson (2001) is the most cited paper in four subfields. Since many other papers in the dataset are also assigned to more than one subfield, we considered a fractional counting approach of citation impact. The detailed explanation of how the fractional counting has been implemented in the normalization can be found in Appendix B.

Table 4 provides initial indications that normalization is necessary in economics. However, the analysis could not include $P_{top\ 50\%}$, because this indicator is primarily a binary variable. To reveal the extent of agreement and disagreement between all metrics (citation counts, NCS, and $P_{top\ 50\%}$), we group the papers according to the Characteristics Scores and Scales (CSS) method, which is proposed by Glänzel, Debackere, and Thijs (2016). For each metric (citation counts and NCS), CSS scores are obtained by truncating the publication set at their metric mean and recalculating the mean of the truncated part of the set until the procedure is stopped or no new scores are generated. We defined four classes which we

labeled with “poorly cited”, “fairly cited”, “remarkably cited”, and “outstandingly cited” (Bornmann & Glänzel, 2017). Whereas poorly cited papers fall below the average impact of all papers in the set, the other classes are above this average and further differentiate the high impact area.

Table 5. Agreement and disagreement in measuring citation impact by using citations, Normalized Citation Score (NCS), and $P_{top\ 50\%}$

		NCS				$P_{top\ 50\%}$		
		poorly cited (1)	fairly cited (2)	remarkably cited (3)	outstandingly cited (4)	<=0.5	>0.5	Sum
Citations	(1)	**134,564**	13,843	705	2	98666	50,448	149,114
	(2)	7,226	**206,16**	4,182	557	5	32,576	32,581
	(3)	0	2139	**4,586**	1,108	0	7,833	7,833
	(4)	0	0	546	**2,352**	0	2,898	2,898
	Sum	141,790	36,598	10,019	4,019	98,671	937,55	192,426
	Agreement = 84.25%, Kappa = 0.601 [0.597, 0.604]							

Table 5 (left side) shows how the papers in our set are classified according to CSS with respect to citations and NCS. 84% of the papers are positioned on the diagonal (printed in bold), i.e. the papers are equally classified. The Kappa coefficient – a more robust measure than the share of agreement, since the possibility of agreement occurring by chance is taken into account – highlights that the agreement is not perfect (which is the case with Kappa=1). According to the guidelines by Landis and Koch (1977), the agreement between citations and NCS is only moderate.

The results in Table 5 show that 16% of the papers in the set have different classifications based on citations and NCS. For example, 13,843 papers are cited below average according to citations (classified as poorly cited), but above average cited according to NCS (classified as fairly cited). Two papers clearly stand out by being classified as poorly cited with respect to citations, but outstandingly cited with respect to the NCS. These are Lawson (2013) with 15 citations and an NCS of 7.8, and Wilson and Gowdy (2013) with 13 citations and an NCS of 6.8. There are also numerous papers in the set that are upgraded in

impact measurement by normalized citations: 7,226 papers are cited above average (fairly cited) according to citations, but score below average according to NCR (poorly cited). 546 papers are outstandingly cited if citations are used; but they are remarkably cited on the base of the NCR, i.e. if the subfield is considered in impact measurement.

Table 5 (right side) also includes the comparison of citations and $P_{top\ 50\%}$. Several papers in this study are fractionally assigned to the 50% most-frequently cited papers in the corresponding subfields and publication years (see the explanation in Appendix B). Since $P_{top\ 50\%}$ is not completely a binary variable (with the values 0 or 1), we categorized the papers in our set into two groups: $P_{top\ 50\%}<=0.5$ and $P_{top\ 50\%}>0.5$ for the statistical analysis. Nearly all of the papers classified as poorly cited on the basis of citations are also cited below average on the basis of $P_{top\ 50\%}$. Thus, both indicators are more or less in agreement in this area. The results also show that many papers that are above average cited by $P_{top\ 50\%}$ are classified differently by citations. On the one hand, these results are an indication that the indicator is able to level the skewness of citations in the above average area. On the other hand, 50,448 (26%) papers are classified as poorly cited on the basis of citations, but are above average cited on the basis of $P_{top\ 50\%}$.

Taken together, the results in Table 5 demonstrate that normalization leads to similar results as citations for many papers; however, there is also a high level of disagreement, which may bias the results of impact analyses in economics based on citations.

4.2 New field- and time-normalized journal ranking

The first economics journal ranking was published by Coats (1971) who used readings from members of the American Economic Association as ranking criterion. With the emerging dominance of bibliometrics in research evaluation in recent decades, citations have become the most important source for ranking journals – in economics and beyond. The most popular current rankings in economics – besides conducting surveys among economists – are

the relative rankings that are based on the approach of Liebowitz and Palmer (1984). Bornmann, Butz, and Wohlrabe (in press) provide a comprehensive overview of existing journal rankings in economics.

Since funding decisions and the offer of professorships in economics are mainly based on publications in reputable journals, journal rankings should not be biased by different citation rates in economics subfields. Based on the NCS and the $P_{top\ 50\%}$ for each paper in our set, we therefore calculated journal rankings by averaging the normalized paper impact across years. Figure 1 visualizes the MNCSs and confidence intervals (CIs) of the 294 journals in our publication set, which are rank-ordered by the MNCS. The CIs are generated by adding and subtracting $1.96 * \sigma_{MNCS}$ from the MNCS, where σ_{MNCS} denotes the corresponding standard deviation (Stern, 2013). If the CIs of two journals do not overlap, they differ "statistically significantly" (α = 1%) in their mean citation impact (Bornmann, Stefaner, de Moya Anegón, & Mutz, 2014; Cumming, 2012).

The results should be interpreted against the backdrop of α = 1% (and not α = 5%), because the publication numbers are generally high in this study. The chance of receiving statistically significant results grows with increasing sample sizes. There are two groups including two journals each in Figure 1, which are clearly separated from the other journals: *Journal of Economic Literature* and *Quarterly Journal of Economics* in the first group – confirming the result by Stern (2013) – and *Journal of Political Economy* and *American Economic Review* in the second group. The very high impact of the journals in the first group is especially triggered by a few very frequently cited papers appearing in these journals: 26 papers in these journals are among the 100 papers with the highest NCSs. Excluding this small group of papers, the CIs of the journals would overlap with many other journals. All other economic journals in the figure are characterised by overlaps of CIs (more or less clearly pronounced). Most of the journals in Figure 1 do not differ statistically significantly from similarly ranked journals.

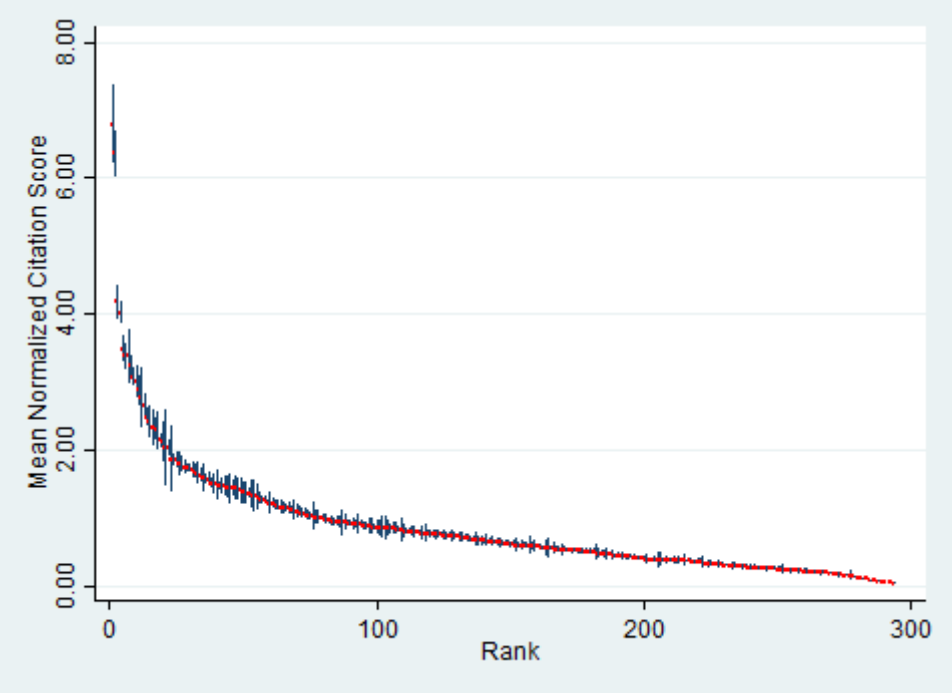

Figure 1. Rank-distribution of 294 economics journals by MNCSs with confidence intervals (CIs)

The alternative $PP_{top\ 50\%}$ journal ranking is based on the premise that the impact results for scientific entities (here: journals) should not be biased by a few outliers, i.e. the few very highly-cited papers. Figure 2 shows the rank distribution of the journals on the basis of $PP_{top\ 50\%}$ and the corresponding CIs. In contrast to the MNCS, we do not find any group of journals that is statistically significantly different from the others. Furthermore, the shape of the curve is less convex, and the curve slopes down almost linearly.

These results highlight that the $PP_{top\ 50\%}$ journal ranking is less affected by outliers and reflects the majority of papers published in the journals more accurately than the MNCS ranking. The CIs for the journals in Figure 2 demonstrate that the accuracy of impact measurement is the lowest for journals in the middle rank positions (the CIs are comparably wide) and the highest for journals with the highest or lowest rank positions (the CIs are comparably small).

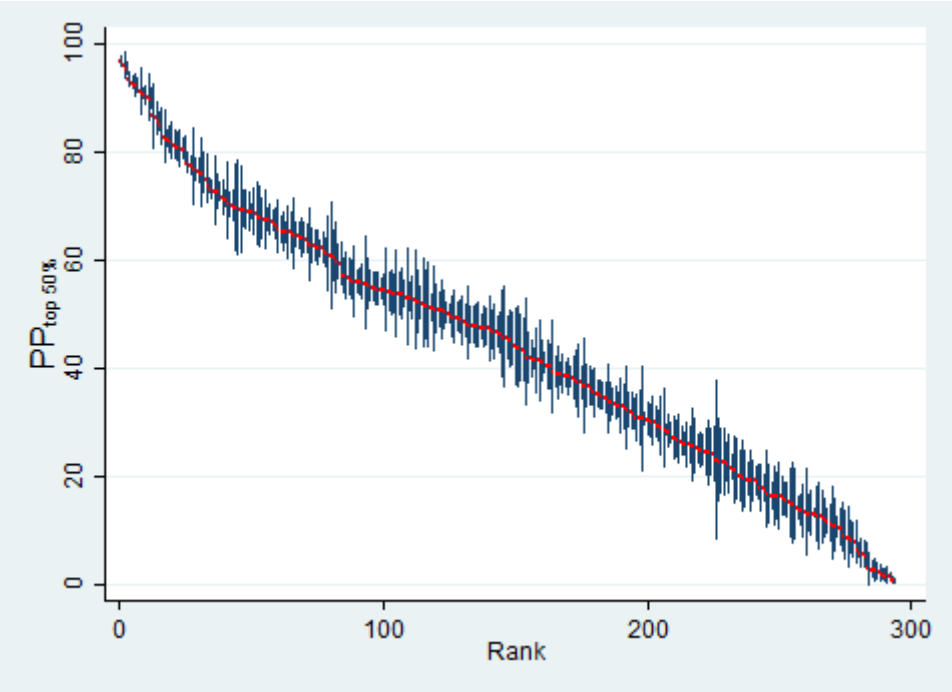

Figure 2. Rank-distribution of 294 journals by $PP_{top\ 50\%}$ with confidence intervals (CIs)

The overlaps of the CIs in Figure 2 make it impossible to identify a group of top journals among the economics journals. To be (statistically) significantly different from the rest of journals, their CIs should not overlap. This does not apply to any journal in the figure. We therefore used another (robust) method to classify the journals into certain impact groups and separate an outstandingly cited group. In section 4.1 we applied the CSS method to assign the papers in our set to four impact classes. Since the method can also be used with aggregated scores (Bornmann & Glänzel, 2017), we assigned the journals in our set to four impact classes based on $PP_{top\ 50\%}$. Table 9 in Appendix A shows all journals (n=294) with their assignments to the four groups: 145 journals are poorly cited, 79 journals are fairly cited, 40 journals are remarkably cited, and 30 journals are outstandingly cited.

Table 6 shows the 30 economics journals in the outstandingly cited group. Additionally, three further journals are considered in the table. Their CIs include the threshold that separates the outstandingly cited journal group from remarkably cited journals. Thus, one cannot exclude the possibility that these journals also belong to the outstandingly cited group.

Table 6. Outstandingly cited economics journals (according to $PP_{top\ 50\%}$) with confidence intervals (CIs). The so called top-5 economics journals are printed in bold.

Rank	Journal	$PP_{top\ 50\%}$	CI	
1	***Quarterly Journal of Economics***	96.57	95.45	97.68
2	*American Economic Journal-Applied Economics*	95.82	93.31	98.32
3	***Journal of Political Economy***	95.19	93.90	96.49
4	*Journal of Finance*	93.24	91.86	94.62
5	*Journal of Financial Economics*	92.56	91.32	93.80
6	*Transportation Research Part B-Methodological*	92.15	89.94	94.36
7	***Econometrica***	92.10	90.66	93.54
8	*American Economic Journal-Macroeconomics*	90.92	86.43	95.42
9	***American Economic Review***	90.67	89.53	91.81
10	***Review of Economic Studies***	90.23	88.45	92.02
11	*American Economic Journal-Economic Policy*	89.79	85.45	94.14
12	*Review of Financial Studies*	89.62	87.60	91.64
13	*Annual Review of Economics*	86.38	80.30	92.46
14	*Journal of Economic Literature*	86.07	82.88	89.26
15	*Journal of Economic Perspectives*	85.43	83.43	87.43
16	*Journal of Economic Geography*	84.51	81.11	87.91
17	*Journal of Economic Growth*	82.57	77.53	87.61
18	*Review of Economics and Statistics*	82.25	80.46	84.05
19	*Journal of Human Resources*	82.04	79.49	84.59
20	*Transportation Research Part A-Policy and Practice*	81.88	78.42	85.34
21	*Journal of Accounting & Economics*	81.12	78.26	83.99
22	*Journal of Labor Economics*	80.76	77.85	83.67
23	*Transportation Research Part E-Logistics and Transportation Review*	80.59	77.05	84.13
24	*Journal of International Economics*	80.43	78.44	82.42
25	*Rand Journal of Economics*	80.37	77.93	82.81
26	*Journal of Monetary Economics*	77.70	75.63	79.76
27	*Economic Journal*	77.25	75.43	79.08
28	*Review of Environmental Economics and Policy*	77.23	70.02	84.43
29	*Journal of Health Economics*	76.50	74.26	78.73
30	*Journal of Environmental Economics and Management*	76.32	73.92	78.71
31	*American Economic Journal-Microeconomics*	75.91	69.47	82.34
32	*Economic Geography*	75.88	71.99	79.76
33	*Economics & Human Biology*	74.73	70.06	79.40

The two top journals in Table 6 are *Quarterly Journal of Economics* and *American Economic Journal-Applied Economics*. With $PP_{top\ 50\%} = 96.57$ and $PP_{top\ 50\%} = 95.82$, nearly

100% of the papers published in these journals are $P_{top\ 50\%}$. Thus the journals are able to publish papers that almost all belong to the above average cited papers in the corresponding subject categories and publication years.

In order to investigate the stability of journals in the outstandingly cited group, we annually assigned each economics journal in our set to the four citation impact classes (following the CSS approach). Seven out of the 33 journals in Table 6 fall into the outstandingly cited group every year: *AEJ-Macroeconomics, AEJ-Applied Economics, AEJ-Economic Policy, Econometrica, Journal of Financial Economics, Journal of Political Economy*, and the *Quarterly Journal of Economics*. The *American Economic Review* is classified as fairly cited in 2011 and as outstandingly cited in all other years. *The Review of Economic Studies* was also always in the outstandingly cited group – with the exception of two years in the 1990s. The majority of all other journals in Table 6 are either classified as outstandingly or remarkably cited over the years.

4.3 Comparisons with other journal rankings

How is the $PP_{top\ 50\%}$ journal ranking related to the results of other rankings in economics? The most simple form of ranking the journals is by their mean citation rate. The JIF is one of the most popular journal metric, which is based on the mean citation rate of papers within one year received by papers in the two previous years (Garfield, 2006). In the comparison with $PP_{top\ 50\%}$ we use the mean citation rate for each journal. Since the citation window is not restricted to certain years in the calculation of $PP_{top\ 50\%}$, we consider all citations from publication year until the end of 2016 in the calculation of the mean citation rate.

The RePEc website (see www.repec.org) has become an essential source for various rankings in economics. Based on a large and still expanding bibliometric database, RePEc publishes numerous rankings for journals, authors, economics departments and institutions.

RePEc covers more journals and additional working papers, chapters and books compared to WoS (further details can be found in Zimmermann, 2013). For the comparison with the $PP_{top\ 50\%}$ journal ranking, we consider two popular journal metrics from RePEc: the simple and the recursive Impact Factor (IF). The simple IF is the ratio of all citations to a specific journal and the number of listed papers in RePEc. The recursive IF also takes the prestige of the citing journal into account (Liebowitz & Palmer, 1984). Whereas the simple and recursive IFs are based on citations from the RePEc database, the citations for calculating the mean citation rates (see above) are from WoS.

Table 7. Comparison of the $PP_{top\ 50\%}$ journal ranking with rankings based on the mean citation rate, simple IF, and recursive IF

		$PP_{top\ 50\%}$			
		Journal classification			
Other rankings		Outstandingly cited (1)	Remarkably cited (2)	Fairly cited (3)	Poorly cited (4)
Mean citation rate (WoS)	(1)	**10**	0	0	0
	(2)	12	**4**	0	0
	(3)	6	27	**26**	0
	(4)	1	8	48	**129**
	Agreement = 62.36%, Kappa = 0.374 [0.294, 0.450]				
RePEC simple IF	(1)	**9**	0	0	0
	(2)	10	**5**	0	1
	(3)	8	17	**21**	5
	(4)	2	17	53	**123**
	Agreement = 58.30%, Kappa = 0.298 [0.218, 0.374]				
RePEc recursive IF	(1)	**5**	0	0	0
	(2)	13	**2**	1	0
	(3)	7	16	**11**	7
	(4)	4	21	62	**122**
	Agreement = 51.66%, Kappa = 0.168 [0.101, 0.246]				

The results of the comparisons are reported in Table 7. 23 journals in our sample are not listed in RePEc, thus, we excluded these journals from all comparisons. We used the CSS

method to classify all journals on the basis of the mean citation rate, $PP_{top\ 50\%}$, as well as simple and recursive IFs, as outstandingly, remarkably, fairly, and poorly cited (see section 4.1). The Kappa coefficients in the table highlight a slight agreement between the recursive IF and $PP_{top\ 50\%}$ and a fair agreement between $PP_{top\ 50\%}$ and mean citation rate and simple IF, respectively (Landis & Koch, 1977). Thus, the results reveal that there is considerable agreement, but also disagreement between the rankings. The results in Table 7 also show that almost in all cases when the journal classifications differ between two indicators, the journal is better ranked if the ranking is based on $PP_{top\ 50\%}$. In other words, many journals are worse classified either based on the mean citation rate, simple IF, or recursive IFs than based on $PP_{top\ 50\%}$. The main reason for this result might be the convexity of the rankings based on the mean citation rate, simple IF, and recursive IFs, which results in top groups with fewer journals.

5 Robustness

JEL codes are available on different levels. We used the main level with 18 categories in this study to normalise the data (see section 2.1). The first sub-level includes 122 categories. In a first robustness check of our new journal ranking in section 4.2 we calculated $PP_{top\ 50\%}$ for all journals by using the 122 sub-levels, instead of the 18 main levels for normalization. Again, we used the CSS method to classify the journals as outstandingly, remarkably, fairly, and poorly cited on the basis of $PP_{top\ 50\%}$ (see section 4.1). Table 8 (see the part with the first robustness check) shows the comparison of two different $PP_{top\ 50\%}$ journal rankings, whereby one ranking was calculated on the basis of the JEL codes main level and the other on the basis of the JEL codes first sub-field level. The Kappa coefficient and the percent agreement highlight a very high level of agreement between the rankings based on the two different subfield definitions. Thus, the journal results are robust to the use of the JEL code level for normalization.

Table 8. Robustness checks with respect to JEL codes, as well as top-cited and lowly-cited papers in the set

		$PP_{top\ 50\%}$ – all papers			
		Journal classification			
$PP_{top\ 50\%}$		Outstandingly cited (1)	Remarkably cited (2)	Fairly cited (3)	Poorly cited (4)
First robustness check					
JEL codes first sub-field level	(1)	**30**	0	0	0
	(2)	0	**40**	0	0
	(3)	0	0	**76**	2
	(4)	0	0	3	**143**
	% Agreement = 98.30% , Kappa = 0.974 [0.945, 0.9909]				
Second robustness check					
Excluding top-cited papers	(1)	**29**	1	0	0
	(2)	1	**38**	1	0
	(3)	0	1	**77**	2
	(4)	0	0	1	**143**
	% Agreement = 97.62% , Kappa = 0.964 [0.935, 0.989]				
Third robustness check					
Excluding lowly-cited papers	(1)	**25**	0	0	0
	(2)	5	**29**	0	0
	(3)	0	11	**70**	2
	(4)	0	0	9	**143**
	% Agreement = 90.82% , Kappa = 0.858 [0.800, 0.903]				

In two further robustness checks, we tested the results against the influence of extreme values: are the journals similarly classified as outstandingly, remarkably, fairly, and poorly cited, if the most-cited and lowly-cited papers in the journals are removed? The most-cited papers refer in the check to the most-cited papers of each journal in each year, which reduce the publication numbers by 4,863 papers. The lowly-cited papers are defined as papers with zero citations or one citation (this reduced the publication numbers by almost one fourth). The results of the further robustness checks are presented in Table 8 (see the parts with the second and third robustness checks). If the top-cited papers are excluded, all journals besides two are equally classified; the Kappa coefficient is correspondingly close to 1. The exclusion of lowly-cited papers leads to more journals, which are assigned to different classes; however,

the Kappa coefficient is still very high at 0.86. According to the guidelines of Landis and Koch (1977) the agreement is almost perfect. The results in Table 8 also show that 20 journals are downgraded by one class, if lowly-cited papers are excluded. These journals suffer from the fact that the median is higher than in the complete set of papers. In the calculation of $PP_{top\ 50\%}$ with the complete set, many papers only marginally passed the median.

6 Discussion

Field- and time-normalization of citation impact is the standard method in bibliometrics (Hicks et al., 2015), which should be applied in citation impact analyses across different time periods and subfields in economics. The most important reason is that there are different publication and citation cultures, which lead to subfield- and time-specific citation rates: for example, the mean citation rate in "General Economics and Teaching" decreases from 12 citations in 2000 to 5 citations in 2009. There is a low rate of only 7 citations in "History of Economic Thought, Methodology, and Heterodox Approaches", but a high rate of 31 citations in "Financial Economics" (for papers published in 2001). Anauati, Galliani, and Galvez (2016) and other studies have confirmed the evidence that citation rates in subfields of economics differs. Without consideration of time- and subfield-specific differences in citation impact analysis, fair comparisons between scientific entities (e.g. single researchers, research groups, and institutions) are impossible and entities with publication sets from recent time periods and in specific subfields are at a disadvantage.

In this study, we introduced two normalized indicators in economics, which are the most important indicators in bibliometrics. The MNCS compares the citation impact of a focal paper with the mean impact of similar papers published in the same subfield and publication year. Thomson Reuters (2015) published a list of recommendations, which should be considered in the use of the indicator: for example, "use larger sets of publications when possible, for example, by extending the time period or expanding the number of subjects to be

covered" (p. 15). We strongly encourage the consideration of the listed points in bibliometric studies in economic using the MNCS. However, Thomson Reuters (2015) and many bibliometricians view the influence of very highly cited papers on the mean as a measure of central tendency as a serious problem of the MNCS: "In our view, the sensitivity of the MNCS indicator to a single very highly cited publication is an undesirable property" (Waltman et al., 2012, p. 10).

In recent years, percentiles have become popular as a better alternative to mean-based normalized indicators. The share of papers belonging to the X% most cited papers is regarded as the most important citation impact indicator in the Leiden Ranking (Waltman et al., 2012). According to Li and Ruiz-Castillo (2014), the percentile rank indicator is robust to extreme observations. In this study, we used the $PP_{top\ 50\%}$ indicator to identify those papers belonging to the above-average half in a certain subfield and time period. Besides focusing on the above-average half, it is also possible to focus on the 10% or 20% most frequently cited papers ($PP_{top\ 10\%}$ or $PP_{top\ 20\%}$). As the results of Waltman et al. (2012) show, however, the focus on another percentile rank is expected to lead to similar results. Besides percentiles, the use of log-transformed citations instead of citations in the MNCS formula has also been proposed as an alternative (Thelwall, 2017). However, this alternative has not reached the status of a standard in bibliometrics yet.

In this study, we calculated normalized scores for each paper. The normalization leads to similar impact assignment for many papers; however, there is also a high level of disagreement, which may lead to biased results of impact analyses in economics-based on citations. There are several cases in the data that demonstrate unreasonable advantages or disadvantages for the papers if the impact is measured by citation counts without consideration of subfield- and time-specific baselines. For example, we can expect that papers published in "History of Economic Thought, Methodology, and Heterodox Approaches" and papers published recently are systematically disadvantaged in research evaluations across

different subfields and time (because of their low mean citation rates). By contrast, papers from "Financial Economics" and papers published several years ago are systematically advantaged, since more citations can be expected. Thus, we attach importance to the consideration of normalization in economic impact studies, which is strongly recommended by experts in bibliometrics (Hicks et al., 2015).

In this study, we introduce a new journal ranking, which is based on the state of the art in bibliometrics. According to Hicks et al. (2015) and others in bibliometrics (e.g. Waltman et al., 2012; Wilsdon et al., 2015), citation analysis based on percentiles ($PP_{top\ 50\%}$) should be preferred to the other, the mean-based ranking (MNCS). Since all journals of the so called top-5 journals in economics are among the outstandingly cited journals (in terms of $PP_{top\ 50\%}$), we propose that the list of the economic top journals is extended by the other outstandingly cited journals in the $PP_{top\ 50\%}$ list. The proposed extension may lead to a selection of about 30 top journals by only one indicator, but field- and time-normalized citations are the best available indicator for the quality assessment of journals. According to Bornmann and Marx (2014b), the benefit of citation analysis is based on what Galton (1907) called the "wisdom of crowds".

The ideal way of assessing entities in science, such as journals, is to combine quantitative (metrics) and qualitative (peer review) assessments to overcome the disadvantages of both approaches each. For example, the most-reputable journals that are used for calculating the Nature Index (NI, see https://www.natureindex.com) are identified by two expert panels (Bornmann & Haunschild, 2017; Haunschild & Bornmann, 2015). The NI counts the publications in these most-reputable journals; the index is used by the Nature Publishing Group (NPG) to rank institutions and countries. To apply the ideal method of research evaluation in economics, peer review and metrics should be combined to produce a list of top-journals in economics: a panel of economists uses the list from our study with about 30 outstandingly cited journals and rates them according to their importance in economics.

Ferrara and Bonaccorsi (2016) offer advice on how a journal ranking can be produced by using expert panels.

In this study we produced a comprehensive dataset with normalized scores on the paper level. We used the dataset to identify the most frequently cited papers and journals. The dataset can be further used for various other entities in economics. The most frequently cited researchers, research groups, institutions, and countries can be determined subfield- and time-normalized. On the level of single researchers, we recommend that the normalized scores should be used instead of the popular h index proposed by Hirsch (2005). Like citation counts, the h index is not time- and subfield normalized. It is also dependent on the academic age of the researcher. Thus, Bornmann and Marx (2014a) recommended calculating the sum of $P_{top\ 50\%}$ for a researcher and dividing it by the number of his or her academic years. This results in a subfield-, time-, and age-normalized impact score. In future studies, we will apply citation impact normalization on different entities in economics. It would be helpful for these studies if normalized impact scores were to be regularly included in RePec, although it is a sophisticated task to produce these scores.

Acknowledgements

The bibliometric data used in this paper are from an in-house database developed and maintained by the Max Planck Digital Library (MPDL, Munich) and derived from the Science Citation Index Expanded (SCI-E), Social Sciences Citation Index (SSCI), Arts and Humanities Citation Index (AHCI) prepared by Thomson Reuters (Philadelphia, Pennsylvania, USA). We would like to thank Ludo Waltman at the Centre for Science and Technology Studies (CWTS) of the Leiden University for his support in calculating the field-normalized indicators. We would also like to thank David Card, Daniel Hamermesh, Stefano DellaVigna and participants at the workshop "Economics of Science and Innovation" at the Summer Forum in Barcelona 2017 for their valuable feedback on previous versions of the manuscript.

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Appendix A

Table 9. Descriptive statistics for the journals included in this study and journal rankings based on the mean normalized citation scores (MNCS) and the share of the 50% most frequently cited papers ($PP_{top\ 50\%}$). The table is sorted in decreasing order by $PP_{top\ 50\%}$.

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
CSS: outstandingly cited journals														
Quarterly Journal of Economics	1991	966	140461	145.4	0	2369	**1**	96.57	95.45	97.68	2	6.35	6.01	6.70
American Economic Journal-Applied Economics	2009	188	4618	24.6	1	95	**2**	95.82	93.31	98.32	10	2.99	2.76	3.22
Journal of Political Economy	1991	966	96697	100.1	0	3300	**3**	95.19	93.90	96.49	3	4.17	3.91	4.42
Journal of Finance	1991	1151	92389	80.3	0	2089	**4**	93.24	91.86	94.62	8	3.24	3.07	3.40
Journal of Financial Economics	1991	1596	108964	68.3	0	3707	**5**	92.56	91.32	93.80	9	3.07	2.93	3.21
Transportation Research Part B-Methodological	2001	487	12381	25.4	0	288	**6**	92.15	89.94	94.36	14	2.48	2.35	2.62
Econometrica	1991	1296	111278	85.9	0	2306	**7**	92.10	90.66	93.54	5	3.49	3.28	3.69
American Economic Journal-Macroeconomics	2009	146	3681	25.2	0	137	**8**	90.92	86.43	95.42	7	3.37	2.98	3.76
American Economic Review	1991	2274	177182	77.9	0	1838	**9**	90.67	89.53	91.81	4	4.02	3.86	4.18
Review of Economic Studies	1991	984	60027	61.0	0	4627	**10**	90.23	88.45	92.02	11	2.87	2.64	3.10
American Economic Journal-Economic Policy	2009	157	2658	16.9	0	134	**11**	89.79	85.45	94.14	16	2.32	2.06	2.59
Review of Financial Studies	1991	827	32980	39.9	0	1644	**12**	89.62	87.60	91.64	13	2.64	2.45	2.83
Annual Review of Economics	2009	113	1973	17.5	0	107	**13**	86.38	80.30	92.46	18	2.29	2.01	2.57
Journal of Economic Literature	1991	422	54936	130.2	0	1242	**14**	86.07	82.88	89.26	1	6.79	6.21	7.36
Journal of Economic Perspectives	1991	1078	71984	66.8	0	1273	**15**	85.43	83.43	87.43	6	3.38	3.19	3.57
Journal of Economic Geography	2002	386	13648	35.4	0	627	**16**	84.51	81.11	87.91	15	2.42	2.18	2.66

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Journal of Economic Growth	1999	194	10491	54.1	0	937	**17**	82.57	77.53	87.61	12	2.76	2.31	3.21
Review of Economics and Statistics	1991	1593	65089	40.9	0	978	**18**	82.25	80.46	84.05	19	2.13	2.03	2.23
Journal of Human Resources	1991	809	27617	34.1	0	420	**19**	82.04	79.49	84.59	38	1.51	1.42	1.59
Transportation Research Part A-Policy and Practice	2005	410	6207	15.1	0	142	**20**	81.88	78.42	85.34	27	1.79	1.67	1.90
Journal of Accounting & Economics	1991	664	37842	57.0	0	718	**21**	81.12	78.26	83.99	17	2.31	2.14	2.48
Journal of Labor Economics	1991	655	25143	38.4	0	511	**22**	80.76	77.85	83.67	31	1.70	1.59	1.80
Transportation Research Part E-Logistics and Transportation Review	1997	416	7070	17.0	0	93	**23**	80.59	77.05	84.13	25	1.84	1.72	1.96
Journal of International Economics	1991	1337	43370	32.4	0	749	**24**	80.43	78.44	82.42	22	2.02	1.91	2.14
Rand Journal of Economics	1991	928	34587	37.3	0	634	**25**	80.37	77.93	82.81	34	1.63	1.53	1.72
Journal of Monetary Economics	1991	1410	48025	34.1	0	700	**26**	77.70	75.63	79.76	24	1.85	1.75	1.95
Economic Journal	1991	1850	56975	30.8	0	615	**27**	77.25	75.43	79.08	36	1.57	1.50	1.64
Review of Environmental Economics and Policy	2007	112	2672	23.9	0	166	**28**	77.23	70.02	84.43	20	2.11	1.81	2.41
Journal of Health Economics	1991	1258	44976	35.8	0	1515	**29**	76.50	74.26	78.73	28	1.74	1.63	1.86
Journal of Environmental Economics and Management	1991	1088	37856	34.8	0	650	**30**	76.32	73.92	78.71	32	1.69	1.60	1.78
CSS: remarkably cited journals														
American Economic Journal-Microeconomics	2009	153	1642	10.7	0	145	**31**	75.91	69.47	82.34	45	1.43	1.21	1.65
Economic Geography	1991	412	13070	31.7	0	570	**32**	75.88	71.99	79.76	33	1.65	1.50	1.81
Economics & Human Biology	2006	292	4536	15.5	0	166	**33**	74.73	70.06	79.40	46	1.43	1.31	1.55
Ecological Economics	1993	3125	93398	29.9	0	1418	**34**	73.66	72.21	75.12	29	1.73	1.66	1.79
Journal of Public Economics	1991	2115	55282	26.1	0	688	**35**	72.71	70.91	74.52	41	1.47	1.41	1.53
Review of Finance	2008	172	2151	12.5	0	124	**36**	72.56	66.13	78.99	47	1.43	1.25	1.60
Journal of Law & Economics	1991	614	16119	26.3	0	588	**37**	72.50	69.16	75.83	56	1.29	1.19	1.39
Energy Economics	1991	1766	40225	22.8	0	289	**38**	72.48	70.51	74.44	30	1.72	1.66	1.79

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Journal of The European Economic Association	2003	661	15007	22.7	0	754	**39**	71.26	67.98	74.54	26	1.79	1.62	1.97
Journal of Econometrics	1991	2332	89458	38.4	0	3168	**40**	71.11	69.33	72.89	37	1.56	1.45	1.67
Socio-Economic Review	2009	128	1446	11.3	0	124	**41**	70.82	63.65	77.98	40	1.49	1.26	1.71
Journal of Urban Economics	1991	1125	27772	24.7	0	447	**42**	70.10	67.58	72.63	58	1.25	1.19	1.32
Journal of Financial and Quantitative Analysis	1991	846	22764	26.9	0	392	**43**	69.99	67.00	72.98	62	1.19	1.12	1.26
Review of International Organizations	2008	104	827	8.0	0	50	**44**	69.55	61.49	77.60	69	1.10	0.95	1.25
Asian Economic Policy Review	2007	81	560	6.9	0	29	**45**	69.34	60.44	78.25	113	0.79	0.71	0.86
Theoretical Economics	2007	117	957	8.2	0	44	**46**	69.25	61.15	77.35	77	1.00	0.90	1.11
Journal of Risk and Uncertainty	1991	599	19528	32.6	0	2985	**47**	69.22	65.63	72.80	53	1.35	1.13	1.56
Industrial and Corporate Change	2002	543	12620	23.2	0	527	**48**	69.13	65.41	72.85	42	1.47	1.34	1.59
Journal of Law Economics & Organization	1991	537	16575	30.9	0	1318	**49**	68.93	65.22	72.64	49	1.40	1.21	1.58
World Development	1991	3180	74997	23.6	0	694	**50**	68.74	67.23	70.25	59	1.22	1.18	1.26
Journal of Economic Surveys	2000	400	9609	24.0	0	687	**51**	68.70	64.36	73.05	35	1.58	1.38	1.78
Economic Policy	1997	217	3860	17.8	0	265	**52**	68.36	62.38	74.35	51	1.36	1.20	1.52
World Bank Research Observer	1993	233	6774	29.1	0	614	**53**	67.74	62.07	73.41	55	1.31	1.12	1.50
World Bank Economic Review	1991	487	15524	31.9	0	783	**54**	67.59	63.65	71.53	44	1.45	1.29	1.61
Experimental Economics	2000	273	6925	25.4	0	1848	**55**	67.28	61.89	72.66	23	1.85	1.37	2.34
Health Economics	1996	1446	35343	24.4	0	502	**56**	67.26	64.98	69.54	57	1.26	1.19	1.32
Journal of Applied Econometrics	1991	914	27414	30.0	0	1235	**57**	67.17	64.27	70.06	43	1.46	1.30	1.61
Journal of Development Economics	1991	1583	37002	23.4	0	329	**58**	67.06	64.88	69.24	52	1.35	1.29	1.42
Journal of Business & Economic Statistics	1991	943	33586	35.6	0	1613	**59**	66.53	63.61	69.45	39	1.49	1.34	1.63
European Journal of Political Economy	2008	325	2927	9.0	0	73	**60**	66.03	61.12	70.94	67	1.13	1.04	1.22
Journal of Money Credit and Banking	1991	1246	22364	17.9	0	281	**61**	65.49	63.01	67.96	68	1.10	1.04	1.16
Jcms-Journal of Common Market Studies	2005	534	4933	9.2	0	85	**62**	65.06	61.24	68.87	73	1.06	0.98	1.13

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Journal of Economic Theory	1991	2144	42260	19.7	0	609	**63**	64.96	63.00	66.93	82	0.95	0.91	0.99
Brookings Papers On Economic Activity	1991	309	7708	24.9	0	413	**64**	64.95	59.87	70.04	48	1.42	1.26	1.59
Journal of Policy Analysis and Management	1993	539	10362	19.2	0	175	**65**	64.88	61.07	68.70	71	1.09	1.02	1.17
Journal of Financial Stability	2008	175	1627	9.3	0	93	**66**	64.81	58.17	71.45	60	1.21	1.05	1.37
European Economic Review	1991	1369	30462	22.3	0	1003	**67**	64.49	62.07	66.91	61	1.21	1.13	1.28
Small Business Economics	1992	1142	22570	19.8	0	273	**68**	64.21	61.56	66.85	66	1.13	1.07	1.19
Journal of Industrial Economics	1991	622	15427	24.8	0	447	**69**	64.04	60.41	67.66	65	1.15	1.06	1.24
Food Policy	1996	880	15280	17.4	0	301	**70**	64.00	61.08	66.92	63	1.18	1.11	1.24
CSS: fairly cited journals														
Journal of Economic Psychology	1991	1100	18075	16.4	0	474	**71**	63.77	61.08	66.45	75	1.02	0.96	1.08
Cambridge Journal of Regions Economy and Society	2008	153	1869	12.2	0	146	**72**	62.71	55.76	69.66	54	1.32	1.08	1.55
China Economic Review	1995	631	7997	12.7	0	152	**73**	62.47	58.99	65.95	84	0.94	0.88	1.00
Land Economics	1991	910	20863	22.9	0	459	**74**	62.44	59.43	65.45	72	1.06	1.00	1.13
International Journal of Forecasting	1992	780	14921	19.1	0	1038	**75**	62.19	58.94	65.43	70	1.09	1.00	1.19
Journal of Banking & Finance	1991	3161	54633	17.3	0	787	**76**	62.05	60.43	63.68	79	0.99	0.96	1.02
Journal of Comparative Economics	1991	847	13302	15.7	0	208	**77**	62.00	58.96	65.03	80	0.98	0.93	1.04
International Economic Review	1991	1164	25146	21.6	0	658	**78**	61.22	58.54	63.91	74	1.03	0.95	1.10
Emerging Markets Review	2009	155	1020	6.6	0	38	**79**	60.96	53.79	68.13	88	0.93	0.81	1.04
Annual Review of Financial Economics	2009	83	646	7.8	0	52	**80**	60.60	50.65	70.56	102	0.85	0.69	1.01
Economy and Society	1991	380	8243	21.7	0	307	**81**	60.58	55.91	65.25	50	1.36	1.21	1.52
Industry and Innovation	2008	192	1535	8.0	0	68	**82**	60.20	53.66	66.74	106	0.84	0.76	0.92
Oxford Review of Economic Policy	1991	740	11768	15.9	0	246	**83**	59.35	56.03	62.66	96	0.88	0.82	0.94
Review of Economic Dynamics	2001	502	6643	13.2	0	296	**84**	59.01	54.99	63.04	78	1.00	0.90	1.10
Journal of Economic History	1991	750	8922	11.9	0	155	**85**	56.93	53.64	60.22	112	0.79	0.75	0.84

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Mathematical Finance	1997	450	11525	25.6	0	1828	**86**	56.90	52.38	61.42	76	1.02	0.80	1.24
Regional Studies	1994	667	9867	14.8	0	892	**87**	56.66	53.16	60.17	64	1.15	1.04	1.27
Journal of Economics & Management Strategy	1992	630	11219	17.8	0	234	**88**	56.18	52.48	59.88	92	0.90	0.83	0.97
North American Journal of Economics and Finance	2008	178	914	5.1	0	46	**89**	55.91	49.18	62.64	107	0.84	0.74	0.93
Games and Economic Behavior	1991	1829	34829	19.0	0	1200	**90**	55.87	53.66	58.08	94	0.89	0.84	0.95
International Journal of Industrial Organization	1991	1291	19921	15.4	0	477	**91**	55.81	53.20	58.42	115	0.78	0.74	0.82
Economic Development and Cultural Change	1991	740	11588	15.7	0	407	**92**	55.66	52.32	59.00	123	0.75	0.70	0.80
Qme-Quantitative Marketing and Economics	2006	119	1244	10.5	0	62	**93**	55.54	46.88	64.21	104	0.84	0.72	0.96
European Journal of Health Economics	2007	359	3072	8.6	0	155	**94**	55.48	50.65	60.30	91	0.91	0.83	1.00
Econometric Theory	1991	999	19172	19.2	0	842	**95**	55.13	52.12	58.14	120	0.76	0.70	0.82
Cambridge Journal of Economics	1991	1040	13129	12.6	0	577	**96**	54.71	51.93	57.49	95	0.88	0.82	0.94
Journal of Population Economics	1992	809	10419	12.9	0	126	**97**	54.59	51.36	57.82	119	0.76	0.72	0.81
Labour Economics	2000	793	9288	11.7	0	190	**98**	54.49	51.21	57.78	108	0.82	0.77	0.87
Journal of Economic Behavior & Organization	1991	2431	36138	14.9	0	685	**99**	54.48	52.59	56.37	90	0.92	0.88	0.96
Regional Science and Urban Economics	1991	971	15480	15.9	0	422	**100**	54.36	51.39	57.32	99	0.86	0.81	0.91
Journal of Financial Econometrics	2007	142	1415	10.0	0	225	**101**	54.35	46.55	62.15	103	0.85	0.68	1.03
Energy Journal	1991	605	9487	15.7	0	226	**102**	53.86	50.08	57.64	85	0.94	0.87	1.02
Journal of Evolutionary Economics	1996	491	6471	13.2	0	180	**103**	53.80	49.62	57.97	86	0.94	0.86	1.03
Review of International Political Economy	1994	608	8003	13.2	0	915	**104**	53.72	50.04	57.41	98	0.87	0.75	0.99
Economic Systems Research	2008	127	1940	15.3	0	124	**105**	53.64	45.40	61.88	21	2.03	1.46	2.60
Resource and Energy Economics	1993	509	8903	17.5	0	187	**106**	53.56	49.49	57.64	81	0.98	0.89	1.06
Real Estate Economics	1996	396	5624	14.2	0	85	**107**	53.56	48.89	58.22	147	0.62	0.58	0.67
Environmental & Resource Economics	1995	1219	20523	16.8	0	363	**108**	53.45	50.83	56.08	89	0.92	0.87	0.97

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Annual Review of Resource Economics	2009	101	908	9.0	0	73	**109**	52.97	43.87	62.07	101	0.86	0.73	0.98
Economics of Education Review	1995	1111	14708	13.2	0	221	**110**	52.95	50.19	55.70	111	0.80	0.76	0.84
Journal of Regional Science	1991	524	8170	15.6	0	169	**111**	52.80	48.76	56.85	83	0.95	0.87	1.03
American Law and Economics Review	2008	97	626	6.5	0	65	**112**	52.56	43.29	61.83	110	0.80	0.69	0.92
Post-Soviet Affairs	1992	245	1998	8.2	0	63	**113**	51.96	46.06	57.86	145	0.63	0.57	0.69
Oxford Bulletin of Economics and Statistics	1991	842	16283	19.3	0	1254	**114**	51.94	48.72	55.16	97	0.87	0.76	0.98
Journal of Consumer Affairs	1998	121	869	7.2	0	66	**115**	51.88	43.49	60.26	138	0.66	0.58	0.74
Journal of Business Economics and Management	2009	206	1402	6.8	0	69	**116**	51.53	45.11	57.94	117	0.77	0.67	0.87
Journal of Economic Inequality	2008	139	1001	7.2	0	59	**117**	51.47	43.60	59.34	87	0.93	0.74	1.12
Economic Inquiry	1991	1324	16900	12.8	0	288	**118**	50.91	48.35	53.46	127	0.73	0.69	0.77
European Review of Economic History	2007	126	723	5.7	0	47	**119**	50.82	42.80	58.85	139	0.66	0.58	0.73
International Review of Economics & Finance	2008	410	2208	5.4	0	64	**120**	50.75	46.19	55.30	126	0.73	0.67	0.80
Economica	1991	778	10438	13.4	0	412	**121**	50.64	47.30	53.97	129	0.73	0.67	0.78
Papers In Regional Science	2000	282	3050	10.8	0	158	**122**	50.60	45.13	56.08	100	0.86	0.76	0.95
Journal of Productivity Analysis	1995	575	9142	15.9	0	325	**123**	50.59	46.76	54.42	105	0.84	0.77	0.91
Journal of Economic Dynamics & Control	1991	2148	28401	13.2	0	468	**124**	50.21	48.20	52.23	130	0.72	0.69	0.75
American Journal of Agricultural Economics	1991	2724	44923	16.5	0	402	**125**	49.97	48.18	51.75	116	0.78	0.75	0.81
European Review of Agricultural Economics	1993	530	7555	14.3	0	286	**126**	49.38	45.37	53.39	121	0.76	0.70	0.82
Journal of Empirical Finance	2008	342	2750	8.0	0	99	**127**	49.32	44.29	54.35	125	0.74	0.67	0.81
Journal of Development Studies	1991	1043	12565	12.0	0	396	**128**	49.24	46.42	52.05	124	0.74	0.70	0.79
Scandinavian Journal of Economics	1991	846	10853	12.8	0	410	**129**	49.22	46.05	52.39	134	0.70	0.65	0.75
Feminist Economics	1998	363	4066	11.2	0	281	**130**	48.62	43.88	53.35	122	0.75	0.68	0.82
Oxford Economic Papers-New Series	1991	857	13843	16.2	0	840	**131**	48.49	45.32	51.66	114	0.79	0.70	0.87

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Journal of Forest Economics	2005	180	1602	8.9	0	61	**132**	48.19	41.32	55.06	131	0.71	0.64	0.78
Economic History Review	1991	678	6013	8.9	0	142	**133**	47.80	44.32	51.29	135	0.68	0.64	0.73
Review of World Economics	1991	732	6699	9.2	0	100	**134**	47.78	44.38	51.19	150	0.60	0.55	0.65
Economics of Transition	1997	465	4702	10.1	0	151	**135**	47.71	43.52	51.91	149	0.62	0.57	0.67
Journal of Transport Economics and Policy	1991	480	6589	13.7	0	159	**136**	47.67	43.41	51.94	133	0.71	0.65	0.76
Insurance Mathematics & Economics	1991	1461	17754	12.2	0	310	**137**	47.45	44.93	49.96	144	0.64	0.60	0.67
Journal of Risk and Insurance	1995	594	7085	11.9	0	141	**138**	47.42	43.54	51.30	155	0.59	0.55	0.63
Journal of Agricultural Economics	1991	692	8391	12.1	0	131	**139**	47.40	43.88	50.93	140	0.65	0.61	0.70
Econometric Reviews	2005	225	2555	11.4	0	248	**140**	47.12	40.86	53.38	93	0.90	0.74	1.06
Kyklos	1991	605	7277	12.0	0	317	**141**	46.90	43.09	50.72	132	0.71	0.64	0.78
New Political Economy	2003	311	2499	8.0	0	67	**142**	46.42	41.23	51.61	128	0.73	0.65	0.81
Agricultural Economics	2000	914	10827	11.8	0	330	**143**	46.38	43.40	49.35	136	0.68	0.64	0.72
Explorations In Economic History	1991	556	4952	8.9	0	194	**144**	46.35	42.52	50.17	142	0.65	0.60	0.71
Spatial Economic Analysis	2008	118	982	8.3	0	124	**145**	46.06	37.95	54.17	109	0.82	0.64	1.00
Journal of Cultural Economics	2007	96	518	5.4	0	39	**146**	45.49	36.01	54.97	154	0.59	0.51	0.67
Emerging Markets Finance and Trade	2003	459	2436	5.3	0	32	**147**	45.42	41.32	49.53	171	0.52	0.49	0.55
Economics and Philosophy	1991	310	2862	9.2	0	179	**148**	45.25	40.02	50.48	141	0.65	0.56	0.74
Information Economics and Policy	2000	361	3532	9.8	0	125	**149**	45.15	40.21	50.09	143	0.65	0.58	0.72
CSS: poorly cited journals														
Journal of Real Estate Research	2006	162	1138	7.0	0	51	**150**	43.78	36.63	50.93	151	0.60	0.54	0.66
Review of Economics of The Household	2008	144	809	5.6	0	47	**151**	43.74	36.20	51.29	146	0.63	0.55	0.70
Econometrics Journal	2005	230	2038	8.9	0	202	**152**	43.57	37.36	49.78	137	0.67	0.57	0.77
Journal of Sports Economics	2007	237	1292	5.5	0	34	**153**	43.19	37.24	49.15	173	0.52	0.47	0.56
Economics & Politics	2009	90	392	4.4	0	40	**154**	42.82	32.90	52.74	152	0.59	0.49	0.69
Journal of Housing Economics	1995	379	4252	11.2	0	120	**155**	41.66	36.97	46.36	161	0.57	0.52	0.62

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Journal of Regulatory Economics	1991	663	7457	11.2	0	337	**156**	41.59	38.00	45.19	158	0.58	0.53	0.63
World Economy	1992	1860	13491	7.3	0	293	**157**	41.51	39.43	43.60	162	0.56	0.53	0.59
Journal of Forecasting	2002	214	1392	6.5	0	205	**158**	41.32	35.24	47.40	159	0.58	0.49	0.67
Journal of Institutional Economics	2009	128	613	4.8	0	53	**159**	41.22	33.63	48.81	118	0.77	0.63	0.91
International Tax and Public Finance	1998	564	5111	9.1	0	136	**160**	41.17	37.36	44.98	148	0.62	0.56	0.68
Public Choice	1991	2158	20660	9.6	0	355	**161**	40.93	38.93	42.93	156	0.59	0.55	0.62
World Trade Review	2008	355	1286	3.6	0	34	**162**	40.41	35.91	44.91	170	0.52	0.48	0.57
Australian Journal of Agricultural and Resource Economics	1997	457	4806	10.5	0	184	**163**	40.18	35.93	44.44	153	0.59	0.54	0.65
International Journal of Health Care Finance & Economics	2008	107	528	4.9	0	26	**164**	40.13	31.46	48.80	166	0.55	0.47	0.63
National Tax Journal	1991	959	9806	10.2	0	425	**165**	39.16	36.23	42.10	165	0.55	0.51	0.59
Tourism Economics	2008	305	1248	4.1	0	32	**166**	38.95	33.78	44.12	178	0.50	0.46	0.55
Economic Theory	1995	1682	14915	8.9	0	420	**167**	38.72	36.48	40.96	172	0.52	0.49	0.55
Journal of The Japanese and International Economies	1991	551	4758	8.6	0	225	**168**	38.70	34.88	42.51	184	0.47	0.42	0.52
Canadian Journal of Economics-Revue Canadienne D Economique	1991	1428	13028	9.1	0	189	**169**	38.54	36.13	40.95	179	0.50	0.47	0.53
Review of Income and Wealth	1991	675	5608	8.3	0	128	**170**	38.29	34.83	41.74	181	0.49	0.45	0.54
Economic Modelling	1991	2099	11007	5.2	0	280	**171**	38.28	36.34	40.22	160	0.57	0.54	0.59
Review of International Economics	2007	480	2228	4.6	0	58	**172**	38.03	33.98	42.07	167	0.53	0.48	0.57
Fiscal Studies	2001	256	1791	7.0	0	77	**173**	37.83	32.28	43.38	177	0.51	0.45	0.56
Econ Journal Watch	2004	157	663	4.2	0	49	**174**	37.38	30.55	44.20	183	0.47	0.40	0.55
Journal of Real Estate Finance and Economics	1993	866	9429	10.9	0	462	**175**	37.16	34.09	40.24	174	0.51	0.48	0.55
Cliometrica	2007	88	436	5.0	0	51	**176**	36.63	27.65	45.61	157	0.59	0.46	0.72
Review of Development Economics	2005	444	2758	6.2	0	138	**177**	36.61	32.52	40.69	176	0.51	0.46	0.56
Macroeconomic Dynamics	1998	576	4215	7.3	0	354	**178**	36.60	32.92	40.27	180	0.50	0.46	0.55

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Empirical Economics	2002	691	3909	5.7	0	171	**179**	36.30	32.96	39.65	168	0.53	0.48	0.57
Bulletin of Indonesian Economic Studies	1991	354	2290	6.5	0	36	**180**	35.35	30.76	39.94	219	0.35	0.33	0.38
Journal of Policy Modeling	1991	1170	8056	6.9	0	196	**181**	34.98	32.42	37.55	187	0.45	0.42	0.48
History of Political Economy	1991	859	2442	2.8	0	22	**182**	34.94	32.11	37.76	207	0.38	0.35	0.40
Social Choice and Welfare	1991	1191	9076	7.6	0	106	**183**	34.68	32.06	37.30	191	0.43	0.41	0.45
Journal of Economic Education	1991	773	4110	5.3	0	202	**184**	34.30	31.22	37.38	193	0.42	0.38	0.46
German Economic Review	2007	176	854	4.9	0	43	**185**	34.23	27.74	40.73	169	0.53	0.44	0.61
Journal of African Economies	1997	515	3653	7.1	0	257	**186**	33.47	29.70	37.23	196	0.42	0.38	0.45
Journal of Macroeconomics	1991	1117	5966	5.3	0	121	**187**	33.45	30.85	36.04	199	0.39	0.37	0.42
Review of Industrial Organization	1994	795	6718	8.5	0	169	**188**	33.32	30.18	36.46	195	0.42	0.39	0.45
Southern Economic Journal	1991	1411	10860	7.7	0	127	**189**	32.93	30.61	35.26	197	0.41	0.38	0.43
Journal of Competition Law & Economics	2005	269	1179	4.4	0	35	**190**	32.90	27.64	38.16	190	0.44	0.40	0.48
Economic Development Quarterly	1996	394	3892	9.9	0	713	**191**	32.77	28.46	37.07	163	0.55	0.43	0.67
International Finance	2007	118	489	4.1	0	31	**192**	32.46	24.52	40.41	186	0.46	0.37	0.54
Journal of Agricultural and Resource Economics	1992	699	6557	9.4	0	93	**193**	31.98	28.69	35.27	189	0.44	0.42	0.47
International Review of Law and Economics	1995	578	4003	6.9	0	89	**194**	31.87	28.32	35.42	200	0.39	0.36	0.42
Quantitative Finance	2001	890	7274	8.2	0	556	**195**	31.41	28.45	34.36	175	0.51	0.47	0.56
China & World Economy	2006	310	1429	4.6	0	104	**196**	30.65	26.08	35.23	194	0.42	0.38	0.47
International Labour Review	1991	270	1732	6.4	0	75	**197**	30.56	25.38	35.73	188	0.45	0.39	0.52
Journal of Economic Interaction and Coordination	2008	78	349	4.5	0	37	**198**	30.47	20.74	40.20	164	0.55	0.41	0.69
Applied Economics	1991	5121	33649	6.6	0	423	**199**	30.44	29.25	31.64	203	0.38	0.37	0.40
International Journal of Game Theory	1991	713	5103	7.2	0	143	**200**	30.42	27.10	33.75	214	0.36	0.33	0.39
Scottish Journal of Political Economy	1991	721	5129	7.1	0	122	**201**	30.17	27.01	33.34	209	0.37	0.34	0.40
European Journal of The History of	2005	245	422	1.7	0	23	**202**	30.02	25.36	34.69	226	0.31	0.28	0.34

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Economic Thought														
Contemporary Economic Policy	1994	858	6608	7.7	0	110	**203**	29.82	26.94	32.71	198	0.39	0.37	0.42
Economic Record	1991	799	5092	6.4	0	163	**204**	29.22	26.21	32.22	204	0.38	0.33	0.43
Cesifo Economic Studies	2005	235	1177	5.0	0	44	**205**	29.08	23.61	34.55	185	0.46	0.41	0.52
Journal of Pension Economics & Finance	2008	126	520	4.1	0	67	**206**	28.80	21.50	36.11	182	0.49	0.38	0.60
Economics Letters	1991	6379	44076	6.9	0	1401	**207**	28.37	27.31	29.43	202	0.39	0.37	0.40
Theory and Decision	1995	673	3645	5.4	0	111	**208**	28.20	24.88	31.52	210	0.37	0.34	0.40
Journal of Economic Issues	1991	1507	6614	4.4	0	252	**209**	27.93	25.89	29.98	216	0.36	0.34	0.38
Annals of Regional Science	1993	380	1797	4.7	0	117	**210**	26.96	22.85	31.07	192	0.43	0.38	0.48
Open Economies Review	1995	557	2195	3.9	0	93	**211**	26.79	23.32	30.25	223	0.32	0.29	0.35
Journal of Public Economic Theory	2007	308	1119	3.6	0	93	**212**	26.70	22.04	31.37	212	0.37	0.32	0.41
Journal of Post Keynesian Economics	1991	794	3490	4.4	0	70	**213**	26.33	23.48	29.18	235	0.29	0.27	0.31
Journal of Mathematical Economics	1991	1233	7485	6.1	0	183	**214**	25.81	23.45	28.16	231	0.30	0.28	0.31
Amfiteatru Economic	2008	339	1039	3.1	0	49	**215**	25.74	21.44	30.04	217	0.36	0.32	0.40
Defence and Peace Economics	1994	545	2839	5.2	0	76	**216**	25.67	22.19	29.15	218	0.35	0.32	0.39
Prague Economic Papers	2008	140	352	2.5	0	18	**217**	25.56	18.77	32.34	211	0.37	0.30	0.44
Computational Economics	2008	247	672	2.7	0	16	**218**	25.43	20.32	30.54	227	0.31	0.28	0.34
Journal of Institutional and Theoretical Economics-Zeitschrift Fur Die Gesamte Staatswissenschaft	1991	828	5000	6.0	0	207	**219**	25.02	22.23	27.80	208	0.37	0.32	0.42
Canadian Journal of Agricultural Economics-Revue Canadienne D Agroeconomie	1991	533	2637	4.9	0	43	**220**	24.66	21.22	28.10	232	0.30	0.27	0.32
Manchester School	1998	705	3531	5.0	0	87	**221**	24.60	21.63	27.58	229	0.31	0.28	0.33
Pacific Economic Review	2005	332	1248	3.8	0	51	**222**	24.35	20.00	28.70	221	0.35	0.31	0.39
Review of Radical Political Economics	2009	147	377	2.6	0	50	**223**	24.27	18.15	30.39	201	0.39	0.31	0.46
Mathematical Social Sciences	1998	335	1377	4.1	0	181	**224**	24.22	19.80	28.64	220	0.35	0.31	0.39

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Metroeconomica	2008	198	480	2.4	0	33	**225**	23.95	18.58	29.31	213	0.36	0.30	0.43
Socio-economic Planning Sciences	2013	24	42	1.8	0	9	**226**	23.02	8.20	37.83	205	0.38	0.27	0.49
Asian Economic Papers	2008	97	266	2.7	0	26	**227**	22.83	15.17	30.49	215	0.36	0.27	0.45
Journal of Economic Policy Reform	2007	159	419	2.6	0	31	**228**	22.64	16.59	28.69	224	0.32	0.26	0.38
Asian Economic Journal	2007	133	370	2.8	0	18	**229**	22.44	16.08	28.79	234	0.29	0.25	0.33
Transformations In Business & Economics	2005	403	1374	3.4	0	43	**230**	22.37	18.62	26.12	230	0.30	0.27	0.33
Panoeconomicus	2008	183	394	2.2	0	20	**231**	22.16	16.58	27.74	225	0.32	0.27	0.37
American Journal of Economics and Sociology	1991	915	3542	3.9	0	60	**232**	21.42	19.00	23.84	242	0.26	0.24	0.28
Journal of Applied Economics	2005	153	579	3.8	0	47	**233**	21.10	14.83	27.38	228	0.31	0.25	0.36
China Agricultural Economic Review	2009	151	435	2.9	0	43	**234**	21.07	15.31	26.84	206	0.38	0.28	0.48
Journal of International Trade & Economic Development	2007	218	457	2.1	0	18	**235**	19.83	14.97	24.69	237	0.27	0.23	0.31
International Journal of Economic Theory	2008	118	245	2.1	0	13	**236**	19.83	13.08	26.58	240	0.27	0.23	0.30
Finanzarchiv	2005	177	504	2.8	0	59	**237**	19.33	13.93	24.74	241	0.27	0.22	0.31
Economist-Netherlands	1991	490	2145	4.4	0	183	**238**	19.27	16.01	22.52	244	0.26	0.23	0.29
Bulletin of Economic Research	2008	154	286	1.9	0	12	**239**	19.06	13.32	24.80	246	0.25	0.21	0.28
Studies in Nonlinear Dynamics and Econometrics	1997	358	2011	5.6	0	188	**240**	19.01	15.13	22.88	238	0.27	0.23	0.31
Japan and The World Economy	1993	644	2626	4.1	0	142	**241**	18.97	16.11	21.83	248	0.24	0.22	0.27
Post-Communist Economies	1999	427	1480	3.5	0	31	**242**	18.75	15.46	22.03	239	0.27	0.24	0.29
European Journal of Law and Economics	2008	231	455	2.0	0	20	**243**	17.78	13.32	22.24	236	0.28	0.24	0.32
Journal of Economics	1991	756	3375	4.5	0	101	**244**	17.74	15.15	20.33	243	0.26	0.24	0.28
Review of Economic Design	2008	102	189	1.9	0	13	**245**	17.41	10.29	24.53	251	0.24	0.19	0.29
Economia Politica	2007	132	235	1.8	0	23	**246**	16.55	10.86	22.25	250	0.24	0.20	0.28
Politicka Ekonomie	1994	649	1434	2.2	0	33	**247**	16.21	13.54	18.88	249	0.24	0.21	0.27
Journal of Behavioral Finance	2008	130	311	2.4	0	15	**248**	16.16	10.50	21.82	245	0.25	0.22	0.29

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Journal of The Asia Pacific Economy	2007	215	487	2.3	0	21	**249**	16.09	11.61	20.56	247	0.25	0.22	0.27
Review of Network Economics	2008	120	363	3.0	0	29	**250**	16.07	9.69	22.45	233	0.29	0.23	0.35
Economic and Social Review	1991	307	1002	3.3	0	34	**251**	16.05	12.30	19.81	253	0.22	0.20	0.24
Japanese Economic Review	1999	440	1465	3.3	0	60	**252**	15.66	12.44	18.89	259	0.21	0.19	0.23
Developing Economies	1991	424	1440	3.4	0	40	**253**	15.44	12.25	18.63	269	0.18	0.16	0.20
Asian-Pacific Economic Literature	2007	97	170	1.8	0	12	**254**	14.97	8.41	21.53	258	0.21	0.17	0.26
Geneva Risk and Insurance Review	2005	76	330	4.3	0	90	**255**	14.78	7.20	22.37	222	0.34	0.25	0.43
Portuguese Economic Journal	2005	95	280	2.9	0	48	**256**	14.69	8.01	21.38	252	0.24	0.17	0.31
Journal of World Trade	1992	679	1962	2.9	0	70	**257**	13.91	11.57	16.24	263	0.20	0.18	0.21
B E Journal of Economic Analysis & Policy	2007	471	1189	2.5	0	64	**258**	13.61	10.69	16.53	257	0.22	0.19	0.24
Global Economic Review	2008	145	233	1.6	0	14	**259**	13.53	8.57	18.50	264	0.19	0.16	0.23
Review of Derivatives Research	2008	65	151	2.3	0	14	**260**	13.20	5.16	21.24	255	0.22	0.18	0.26
Australian Economic Review	2006	315	695	2.2	0	28	**261**	12.99	9.53	16.46	254	0.22	0.19	0.25
Australian Economic History Review	1991	208	534	2.6	0	15	**262**	12.94	8.75	17.13	256	0.22	0.19	0.25
Applied Economics Letters	1995	4189	12663	3.0	0	110	**263**	12.91	11.97	13.86	265	0.19	0.18	0.19
Australian Economic Papers	2007	137	267	1.9	0	16	**264**	12.91	7.63	18.19	267	0.19	0.15	0.22
Revista de Historia Economica	2008	89	137	1.5	0	13	**265**	12.49	6.26	18.72	266	0.19	0.15	0.22
International Journal of Transport Economics	2005	149	326	2.2	0	16	**266**	12.30	7.43	17.16	262	0.20	0.16	0.24
B E Journal of Macroeconomics	2007	266	510	1.9	0	27	**267**	12.22	8.49	15.95	268	0.18	0.16	0.21
Eastern European Economics	1991	533	1116	2.1	0	24	**268**	11.57	9.10	14.04	271	0.16	0.14	0.17
Romanian Journal of Economic Forecasting	2008	277	398	1.4	0	15	**269**	11.24	7.77	14.70	270	0.17	0.15	0.20
Baltic Journal of Economics	2007	60	69	1.2	0	7	**270**	11.16	4.23	18.09	273	0.15	0.11	0.19
History of Economic Ideas	2009	98	72	0.7	0	30	**271**	10.72	5.72	15.73	277	0.15	0.08	0.21
South African Journal of Economics	1991	778	1977	2.5	0	38	**272**	10.44	8.51	12.37	275	0.15	0.14	0.16

	Descriptive statistics						$PP_{Top50\%}$				MNCS			
					Paper citations				Confidence interval				Confidence interval	
Journal	Start	Papers	Citations (total)	Citations/ paper	Min	Max	Rank	Score	Lower	Upper	Rank	Mean	Lower	Upper
Ekonomska Istrazivanja-Economic Research	2007	266	383	1.4	0	23	**273**	10.41	7.05	13.77	261	0.20	0.16	0.24
Annals of Economics and Finance	2007	141	259	1.8	0	40	**274**	10.37	5.66	15.07	260	0.21	0.15	0.26
Asia-Pacific Journal of Accounting & Economics	2008	114	131	1.1	0	21	**275**	8.94	4.32	13.55	278	0.13	0.10	0.16
Estudios De Economia	2007	76	116	1.5	0	9	**276**	8.57	2.95	14.20	272	0.15	0.12	0.19
Independent Review	2005	220	346	1.6	0	19	**277**	8.57	5.31	11.83	276	0.15	0.13	0.17
Acta Oeconomica	1991	202	253	1.3	0	25	**278**	8.08	4.72	11.44	279	0.12	0.10	0.15
Journal of Australian Political Economy	2007	112	160	1.4	0	13	**279**	7.73	3.69	11.78	274	0.15	0.13	0.17
Jahrbucher Fur Nationalokonomie Und Statistik	1991	887	1372	1.5	0	39	**280**	6.21	4.78	7.63	283	0.10	0.10	0.11
B E Journal of Theoretical Economics	2007	237	301	1.3	0	15	**281**	5.62	2.80	8.43	282	0.11	0.09	0.12
Singapore Economic Review	2007	212	224	1.1	0	14	**282**	5.39	2.66	8.12	281	0.11	0.09	0.12
Iktisat Isletme Ve Finans	2009	249	219	0.9	0	8	**283**	5.14	2.60	7.67	280	0.11	0.09	0.12
Revista de Historia Industrial	2009	67	28	0.4	0	6	**284**	2.78	-0.35	5.91	288	0.06	0.03	0.08
Hitotsubashi Journal of Economics	1991	262	305	1.2	0	18	**285**	2.52	0.91	4.14	286	0.07	0.06	0.08
Economics-The Open Access Open-Assessment E-Journal	2009	182	74	0.4	0	15	**286**	2.46	0.35	4.58	290	0.05	0.03	0.08
South African Journal of Economic and Management Sciences	2006	267	257	1.0	0	11	**287**	2.41	0.80	4.03	284	0.09	0.08	0.10
Investigacion Economica	2006	163	84	0.5	0	16	**288**	1.95	0.18	3.72	287	0.06	0.04	0.09
Revue d Economie Politique	2005	304	203	0.7	0	19	**289**	1.72	0.49	2.95	289	0.05	0.04	0.06
Revista de Economia Mundial	1999	309	74	0.2	0	12	**290**	1.54	0.24	2.83	294	0.03	0.02	0.04
Economia Mexicana-Nueva Epoca	2009	58	14	0.2	0	3	**291**	1.39	-0.25	3.04	293	0.04	0.02	0.05
Trimestre Economico	1993	486	318	0.7	0	36	**292**	1.25	0.44	2.05	292	0.04	0.03	0.04
Cepal Review	2007	144	64	0.4	0	4	**293**	0.62	-0.06	1.29	291	0.05	0.03	0.06
Recherches Economiques De Louvain-Louvain Economic Review	2008	95	56	0.6	0	4	**294**	0.44	-0.19	1.07	285	0.07	0.05	0.08

Appendix B

Calculation of the Mean Normalized Citation Score (MNCS)

For the calculation of the MNCS, each paper's citations in a paper set (of a journal, researcher, institution, or country) are divided by the mean citation impact in a corresponding reference set; the received NCSs are averaged to the MNCS. Table 10 shows how the MNCs are calculated for two fictitious journals. For example, the NCS for paper number 2 is 3/10.67=0.28; the MNCS for journal B is (0.28+1.00)/2=0.64. The MNCS is formally defined as (Waltman et al., 2011)

$$MNCS = \frac{1}{n}\sum_{i=1}^{n}\frac{c_i}{e_i}$$

where c_i is the citation count of a focal paper and e_i is the corresponding expected number of citations in the economic subfield (JEL code). The MNCS is defined similar to the item-oriented field-normalized citation score average indicator (Lundberg, 2007; Rehn, Kronman, & Wadskog, 2007). Since citation counts depend on the length of time between the publication year of the cited papers and the time point of the impact analysis (see Table 3), the MNCS is separately calculated for single publication years.

It is a nice property of the MNCS that it leads to an average value of 1. However, this is only valid in a paper set (with papers from one year) if each paper is assigned to one field. However, many of the field classification systems (e.g. JEL codes) assign papers to more than one field. Table 10 shows a simple example that illustrates the problem with the multi-assignment of papers. Paper number 5 is assigned to two fields. The obvious solution for the calculation of the NCS would be to calculate an average of two ratios for this paper: ((9/10.67)+(9/8.5)/2)=0.95. However, this solution leads to an average value of greater than 1 (1.01) across the five papers in Table 10.

Table 10. Case study demonstrating the calculation of the MNCS and the problems with the normalization of citation counts if papers are assigned to more than one field

Paper number	Number of papers	Field	Citations	Number of fields	Normalized citation score	Journal A	Journal B
1	1	X	20	1	1.88	1	
2	1	X	3	1	0.28		1
3	1	Y	8	1	0.94	1	
4	1	Z	6	1	1.00		1
5	1	X and Y	9	2	0.95	1	
Total					1.01	3	2
Expected number of citations		X	10.67				
		Y	8.50				
		Z	6.00				
MNCS Journal A						1.26	0.64
MNCS Journal B							0.64

In order to solve this problem, Waltman et al. (2011) propose the following two calculations, which ensure a mean value of 1 (see Table 11): (1) The expected number of citations for field X is calculated as follows: (20+3+(9*0.5))/(1+1+0.5)=11. Thus, the citations of paper 5 are fractionally counted; the calculation for field Y is correspondingly: (8+(9*0.5))/(1+0.5). (2) The NCS for paper 5 also considers its fractional assignment to two fields and is calculated as follows: (9/11*0.5)+(9/8.33*0.5). Both calculations lead to the desired property of the indicator that it results in a mean value of 1 across all papers in a field – although the papers might be assigned to more than one field.

Table 11. Example to demonstrate the solution of the problems illustrated in Table 10

Paper	Number of papers	Field	Citations	Field fraction	Normalized impact (NCS)	Journal A	Journal B
1	1	X	20	1	1.82	1	
2	1	X	3	1	0.27		1
3	1	Y	8	1	0.96	1	
4	1	Z	6	1	1.00		1
5	1	X and Y	9	0.5	0.95	1	
					1.00	3	2
Expected number of citations		X	11.00				
		Y	8.33				
		Z	6.00				
MNCS Journal A						1.24	
MNCS Journal B							0.64

Calculation of the percentile based indicator: $PP_{top\ 50\%}$

Table 12 uses an example dataset to demonstrate how the $PP_{top\ 50\%}$ indicator is calculated. Basically, the indicator is generated on the basis of the citation distribution in a field (here: field A) whereby the papers are sorted in decreasing order of citations. Papers belonging to the 50% most frequently cited papers are assigned the score 1 and the others the score 0 in a binary variable. The binary variable can then be used to calculate the $P_{top\ 50\%}$ or $PP_{top\ 50\%}$ indicators. $P_{top\ 50\%}$ is the absolute number of papers published in field A belonging to the 50% most frequently cited papers (here: 5) and $PP_{top\ 50\%}$ the relative number whereas $P_{top\ 50\%}$ is divided by the total number of papers (5/10*100=50). If a journal (here: journal X) had published 5 papers from field A (and no further papers in other fields), $P_{top\ 50\%} = 3$ and $PP_{top\ 50\%} = 60\%$ (3/5).

Table 12. Fictitious example with 10 papers in field A to demonstrate the calculation of $PP_{top\ 50\%}$

Citations	Paper	$P_{top\ 50\%}$	Journal X
25	1	1	
21	1	1	1
19	1	1	1
17	1	1	1
16	1	1	
14	1	0	1
12	1	0	1
9	1	0	
1	1	0	
0	1	0	
Number	10	10	5
$P_{top\ 50\%}$		5	3
$P_{top\ 50\%}$		50	60

The $PP_{top\ 50\%}$ indicator is concerned by two problems, whereby the solution for the first problem is outlined in Table 13. Citation distributions are characterized by ties, i.e. papers having the same number of citations. The ties lead to problems in identifying the 50% most frequently cited papers, if the ties concern papers around the threshold of 50% in a citation distribution. In Table 13, the 7 papers with 20 citations can be clearly assigned to the 50% most frequently cited papers and the 5 papers with 0 citations to the rest. However, this is not possible for the 6 papers with 10 citations; they cannot be clearly assigned to one of both groups.

Waltman and Schreiber (2013) propose a solution for this problem, which leads to exactly 50% most frequently cited papers in a field despite the existence of papers with the same number of citations (around the threshold). We explain their solution using the example data in Table 13.

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Table 13. Fictitious example with 18 papers in field B to demonstrate the calculation of $PP_{top\ 50\%}$ following the approach of Waltman and Schreiber (2013)

Citations	Paper	$P_{top\ 50\%}$
20	1	1
20	1	1
20	1	1
20	1	1
20	1	1
20	1	1
20	1	1
10	1	0.33
10	1	0.33
10	1	0.33
10	1	0.33
10	1	0.33
10	1	0.33
0	1	0
0	1	0
0	1	0
0	1	0
0	1	0
Sum	18	9

Each of the 18 papers in field B represents 1/18=5.56% of the field-specific citation distribution. Hence, together the 7 papers with 20 citations represent 7*5.56%=38.92% of the citation distribution, the 6 papers with 10 citations represent 6*5.56%=33.36% of the citation distribution, and the 5 papers with 0 citations represent 5*5.56%=27.8%. We would like to identify the 50% most frequently cited papers, whereby the 10 papers with 10 citations are still unclear. Waltman and Schreiber (2013) fractionally assign these papers to the 50% most frequently cited papers, so that we end up with 50% 50% most frequently cited papers.

The 7 papers with 20 citations cover 38.92% of the 50% most frequently cited papers. The rest (50%-38.92%=11.08%) needs to be covered by the 10 papers with 10 citations. In order to reach this goal, the segment of the citation distribution covered by the papers with 10 citations must be split into two parts, one part covering 11.08% of the distribution, the other part covering the remaining 33.36%-11.08%=22.28%. This other part (22.28%) belongs to the

bottom 50% of the citation distribution. Splitting the segment of the distribution covered by papers with 10 citations is done by assigning each of the 6 papers to the 50% most frequently cited papers with a fraction of 11.08%/33.36%=0.33. The value 11.08% represents the share of the papers with 10 citations, which belong to the 50% most frequently cited papers; 33.36% is the percentage of papers in the field with 10 citations.

In this way, we obtain 50% 50% most frequently cited papers, since ((0.33*6)+7)/18 equals 50%. There are 6 papers in the field with 10 citations, which are fractionally assigned to the 50% most frequently cited papers, and 7 papers with 20 citations that clearly belong to the 50% most frequently cited papers.

Fehler! Ungültiger Eigenverweis auf Textmarke. shows an example that reveals the second problem with the $PP_{top\ 50\%}$ indicator: papers are assigned not only to one, but to two or more fields. The example in Table 14 consists of 26 papers whereby 1 paper (see the grey shaded lines in the table) belongs to two fields. In these cases, the papers in multiple fields are fractionally counted for the calculation of $PP_{top\ 50\%}$ following the approach of Waltman et al. (2011).

We explain the approach using the example in Table 14. Since 1 paper in the table belongs to two fields (B and C), it is weighted by 0.5 instead of 1 (the other papers in the sets which belong to one field each are weighted with 1). This leads to 15.5 papers in field B and 10.5 papers in field C.

In field B, the papers with 20 citations represent 29.03% of the citation distribution (4.5/15.5), the papers with 10 citations 38.71% (6/15.5), and the papers with 0 citations 32.26% (5/15.5). Thus, the papers with 20 citations cover 29.03% of the 50% most frequently cited papers. The rest with 20.97% (50%-29.03%) should be covered by the 6 papers with 10 citations. Splitting the segment of the distribution covered by papers with 10 citations is done by assigning each of the 6 papers to the 50% most frequently cited papers with a fraction of

20.97%/38.71%=0.54. Thus, we obtain 50% 50% most frequently cited papers since ((0.54*6)+4.5)/15.5 equals 50%.

Table 14. Fictitious example for field B with 18 papers and field C with 11 papers to demonstrate the calculation of $PP_{top\ 50\%}$ if papers are fractionally counted following the approach of Waltman and Schreiber (2013) and Waltman et al. (2011)

Field B	Citations	Paper	Number of fields	Paper fraction	$P_{top\ 50\%}$
	20	1	2	0.5	1
	20	1	1	1	1
	20	1	1	1	1
	20	1	1	1	1
	20	1	1	1	1
	10	1	1	1	0.54
	10	1	1	1	0.54
	10	1	1	1	0.54
	10	1	1	1	0.54
	10	1	1	1	0.54
	10	1	1	1	0.54
	0	1	1	1	0
	0	1	1	1	0
	0	1	1	1	0
	0	1	1	1	0
	0	1	1	1	0
Sum		16		15.5	7.75
Field C	Citations	Paper	Number of fields	Paper fraction	$P_{top\ 50\%}$
	50	1	1	1	1
	50	1	1	1	1
	50	1	1	1	1
	20	1	2	0.5	0.5
	20	1	1	1	0.5
	20	1	1	1	0.5
	20	1	1	1	0.5
	20	1	1	1	0.5
	10	1	1	1	0
	10	1	1	1	0
	10	1	1	1	0
Sum		11		10.5	5.25

In field C with a total of 10.5 papers, we have 3 papers with 50 citations (28.57% of the citation distribution), 4.5 papers with 20 citations (42.86% of the distribution), and 3

papers with 10 citations (28.57%). 21.43% of the citation distribution (50%-28.57%) should be covered by the papers with 20 citations: 21.43%/42.86%=0.5. We receive the value of 50% with ((0.5*4.5)+3)/10.5.

Table 15. Fictitious example including two journals (Y and Z) using data from Table 14

Field	$P_{top\ 50\%}$	Journal Y	Journal Z
B/C	0.75	1	
B	1		1
B	1	1	
B	1	1	
B	1		1
B	0.54	1	
B	0.54		1
B	0.54	1	
B	0.54		1
B	0.54	1	
B	0.54	1	
B	0		1
B	0		1
B	0	1	
B	0		1
B	0	1	
C	1		1
C	1	1	
C	1	1	
C	0.5	1	
C	0.5		1
C	0.5	1	
C	0.5	1	
C	0	1	
C	0	1	
C	0		1
Sum	13	16	10
$P_{top\ 50\%}$		8.42	4.58
$PP_{top\ 50\%}$		52.6	45.83

In Table 15, the data from Table 14 are used to transfer the calculations for two different fields (B and C) towards a small world example in which only two journals exist (Y and Z) publishing all the papers in fields B and C. Journal Y has published 16 papers and

journal Z 10 (the small world consists of 26 papers). Whereas 25 papers belong to one field (B or C), 1 paper belongs to two fields (B and C). If papers belong to multiple fields, $P_{top\ 50\%}$ from both fields is added up by considering the paper fractions. For the paper belonging to both fields in Table 15, $P_{top\ 50\%}$ is calculated as follows: (0.5*1)+(0.5*0.5)=0.75.

If the $P_{top\ 50\%}$ scores for the papers belonging to journals Y and Z are added up each, this gives the $P_{top\ 50\%}$ scores for the journals. It equals 8.42 for journal Y. Thus, 8.42 papers published by the journal belong to the 50% most frequently cited papers. This results in $PP_{top\ 50\%}$ = 52.6% (8.42/16). The results in Table 15 show that journal Y has published more above-average papers than journal Z with 45.83%. Together, both journals have published 50% 50% most frequently cited papers: ((52.6%*16)+(45.83%*10))/(16+10).