NATIONAL RESEARCH UNIVERSITY
HIGHER SCHOOL OF ECONOMICS

Fuad T. Aleskerov, Vladimir V. Pislyakov, Andrey N. Subochev

RANKING JOURNALS IN ECONOMICS, MANAGEMENT AND POLITICAL SCIENCE BY SOCIAL CHOICE THEORY METHODS

BASIC RESEARCH PROGRAM

WORKING PAPERS

SERIES: SCIENCE, TECHNOLOGY AND INNOVATION

WP BRP 27/STI/2014

Fuad T. Aleskerov[1], *Vladimir V. Pislyakov*[2], *Andrey N. Subochev*[3]

RANKING JOURNALS IN ECONOMICS, MANAGEMENT AND POLITICAL SCIENCE BY SOCIAL CHOICE THEORY METHODS[4]

Data on economic, management and political science journals are used to produce quantitative estimates of (in)consistency of evaluations based on seven popular bibliometric indicators. This paper proposes a new approach to the construction of aggregate journal rankings: aggregation is considered to be a multicriteria decision problem and ordinal ranking methods from social choice theory are employed to solve it. We apply either a direct ranking method based on majority rule (e.g. the Copeland rule, the Markovian method) or a multistage procedure of selection and exclusion of the best journals, as determined by a majority rule-based social choice solution concept (tournament solution), such as the uncovered set and the minimal externally stable set. We use the same method to analyze correlations of rankings and demonstrate that aggregate rankings reduce the number of contradictions and represent the set of single-indicator-based rankings better than any of the seven rankings themselves.

JEL Classification: C65

Keywords: journal ranking, citedness, bibliometric indicators, rank aggregation, multicriteria choice, social choice rules

[1] DeCAn Lab and Department of Mathematics for Economics, National Research University Higher School of Economics, Moscow, Russia; Institute of Control Sciences, Russian Academy of Sciences, Moscow, Russia; alesk@hse.ru

[2] Library, National Research University Higher School of Economics, Moscow, pislyakov@hse.ru

[3] DeCAn Lab and Department of Mathematics for Economics, National Research University Higher School of Economics, Moscow, asubochev@hse.ru

[4] This study comprises research findings from the «Constructing Rankings by Social Choice methods» project (grant № 12-05-0036, years 2012-2013) carried out as a part of The National Research University Higher School of Economics' Academic Fund Program. The work was partially financed by the International Laboratory of Decision Choice and Analysis (DeCAn Lab) as a part of projects 32.0 (2010), 53.0 (2011) and 93.0 (2013) within the Program for Fundamental Research of the National Research University Higher School of Economics.

We thank O. Perederina and T. Vitkup, HSE students, for their help with data collection.

1 Introduction

At present, various bibliometric indicators, such as the impact factor, the immediacy index, SNIP, SJR and others, are used as objective measures of the quality of ever growing number of academic journals. Rankings based on these indicators reflect comparative significance of a particular journal as a means of intra-scientific communication. But since there are several indicators, rankings based on different measures are different, and that poses a problem.

The aims of the paper are the following. First, we use data on 212 economic journals, 93 management journals and 99 political science journals to produce quantitative estimates of (in)consistency of evaluations based on seven common bibliometric indicators (2- and 5-year impact factors, immediacy index, SNIP, SJR, Hirsch index, article influence). Then we calculate aggregate journal rankings, which may replace the set of initial rankings. New rankings sum up information about journals' comparative values contained in single-indicator-based rankings and resolve their observed contradictions. Finally, we employ rank correlation analysis in order to determine if there is any advantage in replacing single-indicator-based rankings by aggregate rankings.

A new approach is proposed – we consider an aggregation of rankings as a multi-criteria decision problem and employ ordinal ranking methods from social choice theory. Different bibliometric indicators are regarded as criteria. Single-indicator-based rankings are aggregated by simple majority rule. The result of an aggregation is a binary relation reflecting which journal from a given pair is better than the other one with respect to the majority of indicators. This majority relation is generally nontransitive. Therefore, in order to obtain a ranking we need to apply either a direct ranking method based on majority rule (e.g. the Copeland rule, the Markovian method) or a multistage procedure of selection and exclusion of the best journals, as determined by a majority rule-based social choice solution concept (tournament solution), such as the uncovered set and the minimal externally stable set.

The study also revisits our previous work on aggregate rankings of management science journals, where older bibliometric data were used (Aleskerov et al., 2011). The new results are compared with the previous ones.

The text is organized as follows. In Section 2, definitions are provided for the main bibliometric indicators related to journals' citedness, and their meaning is explained. This section also contains a description of the empirical data. In Section 3, two majority rule-based ranking methods (the Copeland rule and the Markovian method) are defined, as well as three social choice solution concepts, known as tournament solutions (the uncovered set, the minimal externally stable set, the weak top cycle). The sorting procedure based on a tournament solution is formally described in this section. The values of correlation measures for both aggregate rankings and single-indicator-based rankings are presented in Section 4. Section 5 contains a formal comparative analysis of ranking methods based on the correlation of rankings these methods produce. Also in Section 5 these new results are compared with findings of our previous study (Aleskerov et al., 2011). Interpretations of the results and suggestions for further research are given in the Conclusion.

2 Bibliometric indicators

Here we give only brief definitions of several journal citation-based indicators. Detailed descriptions of these indicators could be found in Rousseau (2002), Glänzel, Moed, (2002), Pislyakov (2007), and many others.

2.1 Impact factor

Journal impact factor is probably the most known and widely used journal citation indicator. It was first introduced in Garfield, Sher (1963). The value of this indicator is a function of the mean number of citations per paper over a certain fixed period of time for a given journal. The definition in its general form is as follows (Egghe, 1988; Rousseau, 1988). Let $PUB(t)$ denote the number of all papers published in a particular journal in the year t, and let $CIT(T, t)$ denote the number of all citations received in the year T by all papers in the journal published in the year t. Then the value of the n-year journal impact factor IF for the year T is given by the formula

$$IF=\frac{\sum_{i=1}^{n} CIT(T, T-i)}{\sum_{i=1}^{n} PUB(T-i)}\,. \tag{1}$$

How to choose the “publication window” (the value of n) to ensure efficiency of journals’ evaluation is still a matter of academic debates. At present only 2-year and 5-year impact factors are used in practice. Their values are published annually in the Journal Citation Reports (JCR), a database supported by Thomson Reuters Corporation. This product uses another Thomson database called Web of Science (WoS). WoS contains citation data on an individual paper level while JCR aggregates citation indicators for journals as a whole.

The most popular version of the impact factor is the 2-year indicator[5], n=2. This is the "classic" version: every time the impact factor is mentioned without a reference to its time frame, it is understood as the 2-year indicator due to the popularity of this version. However, scientific communities in several disciplines, especially in social sciences, do not fully absorb new knowledge in such a short period of time as two years. Therefore, it was proposed to use another version of this indicator, one with a wider publication window. As of 2007, Thomson Reuters publishes the values of the 5-year journal impact factor.

A 5-year impact factor is obtained if one puts n=5 in (1). A journal ranking based on the 5-year impact factor will differ from the one based on the 2-year indicator: journals, in which papers become obsolete more slowly, will be at advantage. The obsolesce rate of a journal depends, first and foremost, on the journal's scientific field.

2.2 Immediacy index

The impact factor does not take into account citations received by a paper in the year of publication. Nevertheless, such citations do occur and their number is increasing due to the practice of online publication of papers' preprints and general acceleration of the publishing process. The indicator based on citations "of the same year" is also published by Thomson Reuters in the JCR database and is called the "immediacy index". The immediacy index II is calculated according to the following formula

$$II=\frac{\square\square\square(\square,\square)}{\square\square\square(\square)}\,. \qquad (2)$$

The immediacy index demonstrates how fast an academic community reacts to publications in a journal. Since economics is a "slow" discipline with respect to the knowledge absorption (in comparison, for instance, to biomedical sciences), the values of the immediacy index for economic journals are not very high: for 2011 its median value for 212 journals selected for the present study is 0.196 (to compare, for the same year the 2-year impact factor's median is 0.929, the 5-year impact factor's median is 1.229). Median values of the immediacy index, the 2-year and the 5-year impact-factors for 93 management science journals are 0.211, 1.492 and 2.146, correspondingly. Median values of the immediacy index, the 2-year and the 5-year impact-factors for 99 political science journals are 0.118, 0.718 and 0.963, correspondingly.

[5] We omit some technical details related to the calculation of the impact factor, e.g. a method of selection of citable items. They can be found, for instance, in Pislyakov (2007).

2.3 SNIP (source normalized impact per paper)

Other indicators are more complex. Their authors tried to find a better measure for journal influence and to get rid of some deficiencies, which the classic impact factor possesses. Without going into technicalities, we describe their main concept and characteristic features.

SNIP indicator ("source normalized impact per paper", Moed, 2010) was introduced in 2009. Like the impact factor, this indicator measures average citedness of a paper in a journal but (unlike the former) normalizes it by the value of the journal's "citation potential". To calculate this potential:

- An "individual subject field" of a journal is determined: it comprises all papers published in the current year that cite (at least once) any issue of the journal published within the last ten years; this is done to dispense with standard subject categories of the WoS/JCR database, which are often rough and inflexible;
- Average number of references in the publications from the "individual subject field" of the journal is calculated – the longer these lists of references, the greater the "citation potential" of the journal's field. When one takes into account this factor, it becomes possible to make interdisciplinary comparison, which is one of the most complex problems in bibliometrics since average citedness differs significantly across academic fields (so will differ impact factors of those journals, which are comparable in their influence but belong to different fields).
- However, in calculating "citation potential" (average number of references) only those references are taken into account that cite documents (a) indexed in the database (Scopus); (b) published within the "publication window" of SNIP, which is three preceding years. Thus, one equalizes a field relatively well represented in the database and a field where there are many references to sources outside the database (for instance, a discipline where books are cited more frequently than journal articles). Moreover, this procedure makes equal those fields where most recent literature is cited with those where older documents also receive a great number of citations.

The SNIP indicator is a ratio of the average number of citations per article received by a journal to the citation potential of the journal's individual disciplinary field. This normalization of citation frequencies by the average length of reference lists is called "source normalization" (i.e. normalization by sources of citations).

The main difference between SNIP and the impact factor is that the former takes into account characteristics of the individual "citation context" of each journal. Also, SNIP is based on a longer publication window – 3 years. Currently, the values of SNIP are calculated and published for all journals indexed in the Scopus database (publisher – Elsevier). Data on SNIP are refreshed periodically. Here we use data downloaded from the Scopus website[6] in October 2012.

2.4 Hirsch index (h-index)

The Hirsch index or "h-index" (Hirsch, 2005) evaluates both the number of papers and their citedness. By definition, the h-index for a set of publications equals *h*, if exactly *h* papers from the set have received no less than *h* citations, while the others have received no more than *h* citations. This indicator does not involve calculation of the averages, thus the h-index is robust with respect to outliers (e.g. when there is only one paper with enormously large number of citations which significantly affects their average number). To have a high value of h-index, a journal has to publish many frequently cited papers.

Initially, h-index was introduced to assess the output of a scientist, but it can also be applied to journals. For instance, Braun et al. (2006) consider the set of papers published in a journal in a certain year and calculate their citedness at present (in their case, four years after publication). In this paper, we adopted a more balanced approach: we take into account papers published in a journal over five years (from 2007 to 2011) and citations received over the same period of time. The values of the h-index depend upon the database one uses. We use the Web of Science database to calculate h-index.

It should also be noted that h-index has certain disadvantages. The most evident one is the following: the papers with low citedness (below and, in certain cases, equal to *h*) are completely ignored. Indeed, let there be two journals with 50 papers published in each of them. Let each paper in the first journal receives 10 citations, while 10 papers in the second one receive 10 citations each, but the other 40 papers are not cited at all. The journals are clearly unequal by their "influence", but their h-index values are the same – 10.

2.5 SJR (SCImago Journal Rank)

Two following indicators are called "weighted" because they give citations different weights based upon how influential the source of a citation is. The level of influence is measured by the citedness of the source itself. The same algorithm is used by some web-page ranking methods, for instance PageRank by Google.

---

6 http://www.journalmetrics.com/values.php. In 2012, "optimized" values of SNIP (so called SNIP2: Waltman et al., 2013) were published. We use a previous version of SNIP intentionally, since it has already been tested for a while by the academic community. The latest published data are the values for the first half of 2011. The same is to be said about SJR (see below).

One of these indicators was proposed by SCImago, a Spanish research group, and is called SCImago Journal Rank (SJR). Like SNIP, this indicator is calculated for journals indexed by Scopus. The value of SJR is obtained as a result of the following iterative procedure. First, each journal is assigned the same value of "prestige". Then these values are recalculated several times. At each iteration, the value of the journal's prestige is updated depending on the current values of prestige of those journals that cite the given one. The process of recalculation stops when the changes become smaller than a certain value set *a priory*. A detailed description of the method can be found in Gonzalez-Pereira et al. (2010). It should be noted that this procedure is equivalent to counting how often a reader would take a certain journal, if she randomly moved from journal to journal following citation links.

Only citations made to papers published within the last three years are taken into account in SJR. If the number of journal self-citations is large, then it is artificially reduced and is set to 33% of all citations made to this journal. Finally, the SJR of a journal is normalized by the number of its articles, therefore the value of this indicator is independent of journal volume.

In 2012, a new "optimized" SJR2 indicator was introduced (Guerrero-Bote, Moya-Anegón, 2012), however, we still use the previous version of this indicator.

2.6 Eigenfactor and Article influence

Eigenfactor was proposed in 2007 by researchers from Bergstrom Laboratory (University of Washington). Its authors interpret this indicator using a model of random movement of readers from journal to journal, similar to the model mentioned above. To calculate eigenfactor, one needs to find the eigenvector corresponding to the maximal eigenvalue of the citation matrix (the entry in the cell *ij* of this matrix is the number of citations received by the journal *i* from the journal *j*).[7] The eigenfactor of a journal is proportional to the weighted sum of received citations, where the weights of citations from each journal are the components of the eigenvector corresponding to these journals. But the eigenfactor depends not only on the citedness of a journal but also on its volume. Therefore, it is more convenient to use an indicator normalized by the number of articles in a journal. The term "article influence" is used to denote a thus normalized eigenfactor.

The article influence is in many respects similar to SJR. It differs from the latter not in principal but rather on technical grounds. For example, while calculating article influence:

[7] In practice eigenvector is found iteratively, thus it bears some similarity to SJR. See http://octavia.zoology.washington.edu/people/jevin/Documents/JournalPseudocode_EF.pdf.

- Citations received by papers published over the last 5 (instead of 3) years are taken into account;
- All self-citations are ignored.

The most important difference between SJR and the article influence is that different databases are used: SJR is based on Scopus, whereas the article influence is based on WoS. As of 2007, data on the eigenfactor and the article influence were published in JCR[8]. Here we use their values for 2011.

Finally, it should be noted that both SJR and the article influence smooth differences in citation activity between different disciplines since the "prestige" of a journal is equally distributed among its citations.

2.7 Data

In the present analysis, we compare rankings of journals based on seven main bibliometric indicators: 2- and 5-year impact factors, the immediacy index, SNIP, SJR, the Hirsch index, and the article influence. We consider three sets of journals, representing three academic disciplines: economics, management and political science. Rankings are computed for each set separately. For the year 2011, the JCR database lists 319, 168 and 147 journals under the categories Economics, Management and Political science, respectively. At that time, the values of the 5-year impact factor had not been published for all of them (usually that happens when a journal has been included in the database quite recently), therefore journals with missing values have been excluded. Also, we exclude journals missing values for the immediacy index, SNIP, or SJR. As a result, we selected 212 economic journals, 93 management science journals and 99 political science journals with known values of the impact-factor (2011), the 5-year impact factor (2011), the immediacy index (2011), the Hirsch index (2007–2011), SNIP (2011), SJR (2011) and the article influence (2011). The data sources are summarized in Table 1.

[8] These indicators are also published with a 1-year embargo in open access at http://eigenfactor.org/, but see Jacsó (2010) on the differences in data obtained from the two different systems.

Tab. 1. Data sources

Indicator	Database	Year(s)
2-year impact factor	JCR/WoS	2011
5-year impact factor	JCR/WoS	2011
immediacy index	JCR/WoS	2011
SNIP	Scopus	2011
h-index	WoS	2007–2011 (papers and citations)
SJR	Scopus	2011
article influence	JCR/WoS	2011

The values of these bibliometric indicators are used to rank journals. A journal ranking is an ordered set of positions occupied by journals. These positions are denoted by natural numbers called ranks. A position in an ordering can be occupied by several journals. Such journals have coinciding ranks. Positions are ordered from the best to the worst with their ranks increasing. The ranks of journals in seven initial single-indicator-based rankings are given in Tables 9–11 in the Appendix.

3 Aggregated rankings constructed by ordinal methods borrowed from social choice

Different bibliometric indicators generate similar but not identical rankings. We see no sufficient reason to presume that any indicator is somehow inferior to others. Rather, their disparity seems to results from the complexity and multidimensionality of the object they are designed to measure – the quality and significance of an academic journal. Therefore, rather than trying to choose “the best” indicator, we believe it is worth exploring ways to aggregate contradictory information contained in the set of rankings based on all indicators. Ranking of journals then becomes a multicriteria evaluation problem.

A classical solution to a multicriteria evaluation problem is to calculate a weighted sum of the criteria’s values for each alternative and then rank alternatives by the value of the sum. However, this method has two fundamental deficiencies related to its *cardinal* nature. First, to obtain meaningful results one has to be sure that it is theoretically possible to perform the operation of summation on the values of criteria in a given case since it is not possible generally. Second, the choice of weights needs to be justified. We have no such justification for the problem under consideration, therefore we cannot be sure that the weighted summation of bibliometric indicators is a correct procedure yielding meaningful results. As a way out of this difficulty, we propose to apply *ordinal* ranking methods. We borrowed them from social choice theory since it is possible to frame any multicriteria decision problem as a social choice problem (Arrow, Raynaud, 1986).

3.1 Basic notions

One of the main objectives of social choice theory is to determine what alternatives *will* be or *should* be chosen from all feasible alternatives on the basis of preferences that voters (i.e. individual participants in a collective decision-making process) have concerning these alternatives. It is possible to transfer social choice methods to a multi-criteria setting if one treats a ranking based on a certain criterion as a representation of preferences of a certain voter (or an expert). In our case, the set of rankings based on corresponding bibliometric indicators is treated as a profile of preferences of seven virtual voters/experts.

Let A, $|A|=m$, $m\geq 3$, denote the general set of feasible alternatives; let N, $|N|=n$, $n\geq 2$, denote a group of experts making a collective decision by vote. A decision is a choice of certain alternatives from A. Preferences of a voter i, $i\in N$, with regard to alternatives from A are revealed through pairwise comparisons of alternatives and thus are modelled by a binary relation P_i on A, $P_i \subseteq A\times A$: if comparing an alternative x with an alternative y a voter i prefers x to y, then the ordered pair (x, y) belongs to the relation P_i, $(x, y)\in P_i$; it is also said that x dominates y with respect to P_i, xP_iy. If a voter is unable to compare two alternatives or thinks they are of equal value, we will presume that he is indifferent regarding the choice between them, i.e. $(x, y)\notin P_i$ & $(y, x)\notin P_i$.

If chooser's preferences are known and a choice rule (a mapping of the set of binary relations on A onto the set of nonempty subsets of A) is given, then it is possible to determine what alternatives should be the result of his choice. Thus the social choice problem can be solved if one 1) knows individual preferences, 2) defines a binary relation μ, $\mu\subseteq A\times A$ that models collective preferences (i.e. collective opinion with regard to alternatives from A), and 3) determines a choice rule $S(\mu, A)$: $\{\mu\}\to 2^A\backslash\varnothing$, also called a solution. Probably the most popular method to construct μ from individual preferences is to apply the majority rule. In this case, μ is called a majority (preference) relation: x dominates y via μ if the number of voters who prefer x to y is greater than the number of those who prefer y to x, $x\mu y\Leftrightarrow|N_1|>|N_2|$, where $N_1=\{i\in N|\ xP_iy\}$, $N_2=\{i\in N|\ yP_ix\}$.

The choice of this particular rule of aggregation is prescribed by the social choice theory since the majority rule, and this rule only, satisfies several important normative conditions (see Aizerman, Aleskerov, 1983), such as independence of irrelevant alternatives, Pareto-efficiency, neutrality (equal treatment of alternatives), and anonymity (equal treatment of voters), which hold in our case as well. Moreover, in a multi-criteria setting the application of this rule allows one to obtain aggregated evaluations of alternatives without recourse to arithmetic operations on criteria, and consequently removes the problem of their theoretical justification.

It follows from the definition that any μ is asymmetric, $(x, y)\in\mu \Rightarrow (y, x)\notin\mu$. If the following holds $x\neq y \wedge (x, y)\notin\mu \wedge (y, x)\notin\mu$, then alternatives x and y are tied, and both ordered pairs belong to a set of ties τ, $\tau\subseteq A\times A$, $(x, y)\in\tau$ & $(y, x)\in\tau$. It is evident that a set of ties τ is an irreflexive and symmetric binary relation.

For computational purposes a majority relation μ is represented by a majority matrix $\mathbf{M}=[m_{xy}]$, defined in the following way:

$m_{xy}=1 \Leftrightarrow (x, y)\in\mu$, or $m_{xy}=0 \Leftrightarrow (x, y)\notin\mu$.

A matrix $\mathbf{T}=[t_{ij}]$ representing a set of ties τ is defined in the same way.

To define several choice rules we will also need the notions of the lower section, the upper section and the horizon of the alternative x. The lower section of an alternative x is the set $L(x)$ of all alternatives dominated by x via μ, $L(\mathrm{x})=\{y|\ x\mu y\}$, the upper section of x is the set $D(x)$

of all alternatives that dominate x via μ, $D(x)=\{y|\ y\mu x\}$, the horizon of x is the set $H(x)$ of all alternatives that tie x, $H(x)=\{y|\ y\tau x\}$.

3.2 The Copeland rule

A majority relation quite often happens not to be a ranking itself since it is generally nontransitive. That is, a majority relation often contains cycles. For instance, there are often alternatives x, y and z such that $x\mu y$ and $y\mu z$ and $z\mu x$ (a 3-step μ-cycle: x is majority preferred to y, which is majority preferred to z, which is majority preferred to x). This result is known as the "Condorcet paradox". In order to check if majority relations in our case are transitive or not and to evaluate how nontransitive they are, we calculate the number of 3-step μ-cycles, 4-step μ-cycles and 5-step μ-cycles for three sets of journals. This can be done by raising a majority matrix **M** to the power of 3, 4 and 5, correspondingly. When k equals 3, 4 or 5, the number of k-step μ-cycles q_k is equal to the trace (the sum of all diagonal entries) of the matrix $\mathbf{M}^k$ divided by k: $q_k = \frac{\mathrm{tr}(\mathbf{M}^k)}{k}$ (Cartwright, Gleason, 1966). Numbers of cycles for each majority relation are given in Table 2.

Table 2. Numbers of 3-, 4- and 5-step μ-cycles for three sets of journals

	3-step cycles	4-step cycles	5-step cycles
Economics	2446	22427	226103
Management	203	787	3254
Political Science	149	430	1344

As we see, the Condorcet paradox occurs in all three cases. In order to bypass the nontransitivity problem, several ranking methods have been proposed. Probably the simplest one is the Copeland rule (Copeland, 1951). The idea of this method is the following: the greater the number of alternatives that are worse than a given one, the better this alternative is; and it is determined through pairwise comparisons (based on a majority relation) whether a given alternative is either better or worse than another one. Alternatively, it could be put that an alternative is good if the number of alternatives that are better is small. Finally, one can combine these two principles.

Formally, the Copeland aggregate ranking is an ordering of the alternatives by their score $s(x)$ (called the Copeland score), as given by one of the following formulae:

Version 1. $s_1(x)=|L(x)|-|D(x)|$

Version 2. $s_2(x)=|L(x)|$

Version 3. $s_3(x)=|A|-|D(x)|$

All three versions yield the same result when there are no ties. In this study, we use the second and the third versions of the Copeland rule. Vectors $\mathbf{s}_2$ и $\mathbf{s}_3$ of Copeland scores (the 2nd and the 3rd versions) are computed by the formulae $\mathbf{s}_2=\mathbf{M}\cdot\mathbf{a}$, $\mathbf{s}_3=(\mathbf{I}-\mathbf{M}^{tr})\cdot\mathbf{a}$, where $\mathbf{I}$ and $\mathbf{a}$ denote, correspondingly, the matrix and the vector, whose entries and components are all equal to 1.

Let us consider how the second version of the Copeland rule ranks journals in the following example. Let us assume that there are m=5 journals, $A=\{x_1, x_2, x_3, x_4, x_5\}$, and n=3 indicators generating three journal rankings. The journals are ordered as $x_1>x_2>x_3>x_4>x_5$ by the 1st indicator, $x_4>x_5>x_2>x_3>x_1$ by the 2nd indicator, $x_5>x_3>x_1>x_2>x_4$ by the 3rd indicator. The majority matrix $\mathbf{M}$ is the following:

Majority matrix **M**						Cardinality of the lower section $\|L(x)\|$
	x_1	x_2	x_3	x_4	x_5	
x_1	0	1	0	1	0	2
x_2	0	0	1	1	0	2
x_3	1	0	0	1	0	2
x_4	0	0	0	0	1	1
x_5	1	1	1	0	0	3

According to the second version of the Copeland rule, the aggregate ranking contains three ranks: 1) x_5; 2) x_1 - x_2 - x_3; 3) x_4 .

3.3 A sorting procedure based on tournament solutions

In order to construct a ranking, we can also use solutions to the problem of optimal social choice. Let us consider the following iterative procedure. A solution concept $S(\mu, A)$ is a choice correspondence that determines a set $B_{(1)}$ of those alternatives from a set A that are considered to be the best with respect to collective preferences expressed in a form of a majority relation μ: $B_{(1)}=S(\mu, A)$. Alternatives from $B_{(1)}$ are of "prime quality" choices comparing with all other alternatives. Let us exclude them and repeat the sorting procedure for the set $A\backslash B_{(1)}$. Then a set $B_{(2)}=S(\mu, A\backslash B_{(1)})=S(\mu, A\backslash S(\mu, A))$ will be determined. This set contains second best choices – they are worse than alternatives from $B_{(1)}$ and better than options from $A\backslash(B_{(1)}\cup B_{(2)})$. After a finite number of selections and exclusions, all alternatives from A will be separated by classes $B_{(k)}=S(\mu, A\backslash(B_{(k-1)}\cup B_{(k-2)}\cup...\cup B_{(2)}\cup B_{(1)}))$ according to their "quality", and these classes define the ranking we are looking for.

In this study, we use two tournament solutions: the uncovered set and the externally stable set. The first solution is based on the following idea: let us make the notion of majority preferences stronger, so it becomes always possible to choose undominated alternatives.[9] That is, when the set of undominated alternatives of μ is empty, let us select undominated alternatives of a special subset α of μ, $\alpha \subseteq \mu$. The subrelation α is defined in the following way. It is said that an alternative x covers y, $x\alpha y$, if x μ-dominates both y and all alternatives, which are μ-dominated by y: $x\alpha y \Leftrightarrow (x\mu y \wedge \forall z \in A\ (y\mu z \Rightarrow x\mu z))$ (Miller, 1980). That is, the majority of voters strongly prefer x to y when 1) they prefer x to y, and 2) there is no alternative z, such that it is strictly less preferable than y and at least as preferable as x. The best alternatives are those not covered (not dominated with respect to α) by any other alternatives. Their set is called the uncovered set[10] *UC*. The uncovered set is always nonempty due to the transitivity of the covering relation α.

Instead of choosing "strong" candidates as is the case with the uncovered set, it is possible to choose candidates from a "strong" group. The second solution is based on this idea of choosing from a set endowed with some "good" properties. A set *ES* is externally stable if for any alternative x outside *ES* there exists an alternative y in *ES* that is more preferable for the majority of voters than x: $\forall x \notin ES\ \exists y$: $y \in ES \wedge y\mu x$ (von Neumann, Morgenstern, 1944). An externally stable set is minimal if none of its proper subsets is externally stable. An alternative is optimal if it belongs to at least one minimal externally stable set *MES*, therefore the tournament solution is the union of all such sets, which is likewise denoted as *MES* (Subochev, 2008; see also, Aleskerov, Subochev, 2013).[11] *MES* is always nonempty.

When *UC* (or *MES*) is determined for the initial set of journals, the journals comprised by this set receive the first (best) rank. After that, these journals are excluded from the general set *A* and the procedure repeats iteratively, as it was explained in the beginning of this section.

The uncovered set and the union of minimal externally stable sets can be calculated through their matrix-vector representations given in Aleskerov, Subochev (2009; 2013). These representations use the matrices **M** and **T** defined in Subsection 3.1.

3.4 The Markovian method

Finally, we would like to apply a version of a ranking called the Markovian method, since it is based on an analysis of Markov chains that model stochastic moves from vertex to vertex via arcs of a digraph representing a binary relation μ. The earliest versions of this method were

9 Due to the Condorcet paradox the set of alternatives undominated via the majority relation itself (the so-called core) may (and almost always will) be empty.

10 There exist alternative definitions of the covering relation and, consequently, of the uncovered set. They are listed in Aleskerov, Subochev (2013).

11 Minimal externally stable set was introduced by Subochev (2008) as a version of another tournament solution – minimal weakly stable set (MWS) introduced by Aleskerov and Kurbanov (1999). Therefore in Subochev (2008) and in Aleskerov, Subochev (2009) this solution concept is called the second version of the minimal weakly stable set and is denoted as MWS^{II}. The version of the uncovered set we use here is denoted as UC^{II} in the aforementioned texts.

proposed by Daniels (1969) and Ushakov (1971). References to other papers can be found in Chebotarev, Shamis (1999).

To explain the method let us consider its application in the following situation. Suppose alternatives from *A* are chess-players. Only two persons can sit at a chess-board, therefore in making judgments about players' relative strength, we are compelled to rely upon results of binary comparisons, i.e. separate games. Our aim is to rank players according to their strength. Since it is not possible with a single game, we organize a tournament.

Before the tournament starts we separate patently stronger players from the weaker ones by assigning each player to a certain league, a subgroup of players who are relatively equal in their strength. To make the assignments, we use the sorting procedure described in the previous subsection. The tournament solution that is used for the selection of the strongest players is the weak top cycle *WTC* (Ward, 1961; Schwartz, 1970, 1972, 1977; Good, 1971; Smith, 1973). It is defined in the following way. A set *WTC* is called the weak top cycle if 1) any alternative in *WTC* μ-dominates any alternative outside *WTC*: $\forall\ x \notin WTC,\ y \in WTC \Rightarrow y\mu x$, and 2) none of its proper subsets satisfies this property.

The relative strength of players assigned to different leagues is determined by a binary relation μ, therefore in order to rank all players all we need to know is how to rank players of the same league. Each league receives a chess-board. Since there is only one chess-board per league, the games of a league form a sequence in time.

Players who participate in a game are chosen in the following way: a player who has been declared a (current) winner in the previous game remains at the board, her rival is randomly chosen from the rest of the players, among whom the loser of the previous game is also present. In a given league, all probabilities of being chosen are equal. If a game ends in a draw, the previous winner, nevertheless, loses her title and it passes to her rival. Therefore, despite ties being allowed, there is a single winner in each game. It is evident that the strength of a player can be measured by counting a relative number of games where he has been declared a winner (i.e. the number of his wins divided by the total number of games in a tournament).

In order to start a tournament, we need to decide who is declared a winner in a fictitious "zero-game". However, the longer the tournament goes (i.e. the greater the number of tournament games there are), the smaller the influence of this decision on the relative number of wins of any player is. In the limit when the number of games tends to infinity, relative numbers of wins are completely independent of who had been given "the crown" before the tournament started.

Instead of calculating the limit of the relative number of wins, one can find the limit of the probability a player will be declared a winner in the last game of the tournament since these values are equal. We can count the probability and its limit using matrices **M** and **T** defined above.

Suppose we somehow know the relative strength of players in each pair of them. Also, suppose this strength is constant over time and is represented by binary relations μ and τ. Therefore, if we know μ and the names of the players who are sitting at the chess-board, we can predict the result of the game: the victory of x (if $x\mu y$), the victory of y (if $y\mu x$) or a draw (if $x\tau y$).

Let $\mathbf{p}^{(k)}$ denote a vector, i-th component $p_i^{(k)}$ of which is the probability a player number i is declared the winner of a game number k. Two mutually exclusive situations are possible. The first case - the player number i is declared the winner in both the previous game (game number k-1) and the current game. She can be declared the winner in the game number k, if and only if her rival (who has been chosen by lot) belongs to the lower section of i. The probability that the i-th player was declared the winner in the game number k-1 is $p_i^{(k-1)}$, the probability of her rival being in $L(i)$ equals $\frac{s_2(i)}{m-1}$, where $s_2(i)$ is the Copeland score (the 2nd version), $s_2(x)=|L(x)|$. Thus, the probability of the i-th player being declared the winner in game number k is $p_i^{(k-1)} \cdot \frac{s_2(i)}{m-1}$.

The second case - the player number i is declared the winner in the current game, but not in the previous one. He can be declared the winner in game number k, if and only if 1) he has been chosen by lot as a rival to the winner in the game number k-1, the probability of which equals $\frac{1}{m-1}$; and 2) if the (k-1)-th winner is in the lower section or in the horizon of the i-th player, a probability of which equals $\sum_{j=1}^{m}(m_{ij}+t_{ij}) \cdot p_j^{(k-1)}$.[12] Thus the probability $p_i^{(k)}$ can be determined from the following equation

$$p_i^{(k)} = p_i^{(k-1)} \cdot \frac{s_2(i)}{m-1} + \frac{1}{m-1} \cdot \sum_{j=1}^{m}(m_{ij}+t_{ij}) \cdot p_j^{(k-1)} \tag{3}$$

Formula (3) can be rewritten in a matrix-vector form as

$$\mathbf{p}^{(k)} = \mathbf{W} \cdot \mathbf{p}^{(k-1)} = \frac{1}{m-1} \cdot (\mathbf{M} + \mathbf{T} + \mathbf{S}) \cdot \mathbf{p}^{(k-1)} \tag{4}$$

The matrix $\mathbf{S}=[s_{ij}]$ is defined as $s_{ii}=s_2(i)$ and $s_{ij}=0$ when $i \neq j$.

Consequently, passing the title of the current winner from player to player is a Markovian process with the transition matrix **W**.

We are interested in vector $\mathbf{p}=\lim_{k\to\infty} \mathbf{p}^{(k)}$. It is not hard to prove that no matter what the initial conditions are (i.e. what the value of $\mathbf{p}^{(0)}$ is), the limit vector is an eigenvector of the matrix **W** corresponding to the eigenvalue $\lambda=1$ (see, for instance, Laslier (1997)). Therefore **p** is determined by solving the system of linear equations $\mathbf{W} \cdot \mathbf{p} = \mathbf{p}$. To rank players in a league, one needs to order them by decreasing values of p_i. Since we have pre-sorted players using *WTC*, none of the components p_i is equal to zero (Laslier, 1997).

[12] Here notations m, m_{ij}, t_{ij} are those introduced in Subsection 3.1.

The ranks of journals in five aggregate rankings are given in Tables 9-11 in the Appendix.

4 Correlations

The number of the alternative's position in a ranking is a rank variable. Therefore, to evaluate the (in)consistency of two rankings, one needs to apply ranking measures of correlation. In this paper, we use two related but not identical measures based on the Kendall distance: the Kendall rank correlation index τ_b (Kendall, 1938) and the share of coinciding pairs *r*.

To remind the reader what the Kendall distance is, let us consider a pair of journals and compare their positions in two rankings. If a journal is placed above the second one in the first ranking, but at the same time it is placed below the other one in the second ranking, then this pair of journals counts as an inversion. The Kendall distance between two rankings is the number of inversions N_- (a number of unordered pairs of objects ranked inversely in two ranking). Correspondingly, the greater the number of inversions is, the farther apart (i.e. the more disparate) the rankings are. The Kendall rank correlation coefficient τ_b depends on the Kendall distance in the following way:

$$\tau_b = \frac{N_+ - N_-}{\sqrt{(N - n_1)\cdot(N - n_2)}} \quad (5)$$

Here N_+ is the number of coinciding pairs, which are not ties, i.e. such journal pairs, where one journal is placed above the second one in both rankings; n_1 is the number of pairs, where both journals have the same rank in the first ranking; n_2, correspondingly, is the number of pairs, where both journals have the same rank in the second ranking. Obviously, $N_+ + N_- = N - n_1 - n_2 + N_0$, where N_0 is the number of pairs tied in both rankings.

The share of coinciding pairs *r* is a percentage of pairs ranked in the same way in both rankings, $r = 100 \cdot \frac{N_+ + N_0}{N}$. This measure has a simple probabilistic interpretation. If someone knows that alternative *x* is ranked above alternative *y* in ranking R_1 and guesses that in ranking R_2 they are placed in the same order, then *r* is the probability of her being correct. When *r*=50% probability of being right equals probability of being wrong, which means two rankings do not correlate.

The main difference between τ_b and *r* is that the latter "punishes" rankings containing too many ties, while the former does not. Values of τ_b and *r* are given in Tables 3 and 4, correspondingly.

Tab 3. Kendall τ_b

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	Copeland (2)	Copeland (3)	*UC*	*MES*	Markovian
Economics												
impact factor	1,000	0,830	0,503	0,637	0,654	0,698	0,700	0,834	0,831	0,834	0,835	0,819
5-year impact factor	0,830	1,000	0,510	0,725	0,702	0,726	0,741	0,903	0,904	0,906	0,896	0,891
immediacy index	0,503	0,510	1,000	0,475	0,442	0,454	0,472	0,550	0,551	0,556	0,578	0,560
article influence	0,637	0,725	0,475	1,000	0,620	0,673	0,674	0,766	0,769	0,777	0,785	0,769
Hirsch index	0,654	0,702	0,442	0,620	1,000	0,592	0,650	0,738	0,737	0,737	0,747	0,729
SNIP	0,698	0,726	0,454	0,673	0,592	1,000	0,638	0,759	0,759	0,767	0,775	0,750
SJR	0,700	0,741	0,472	0,674	0,650	0,638	1,000	0,792	0,790	0,800	0,797	0,775
Copeland rule (2 v.)	0,834	0,903	0,550	0,766	0,738	0,759	0,792	1,000	0,990	0,970	0,950	0,956
Copeland rule (3 v.)	0,831	0,904	0,551	0,769	0,737	0,759	0,790	0,990	1,000	0,969	0,950	0,959
sorting by *UC*	0,834	0,906	0,556	0,777	0,737	0,767	0,800	0,970	0,969	1,000	0,955	0,954
sorting by *MES*	0,835	0,896	0,578	0,785	0,747	0,775	0,797	0,950	0,950	0,955	1,000	0,949
Markovian method	0,819	0,891	0,560	0,769	0,729	0,750	0,775	0,956	0,959	0,954	0,949	1,000
Management												
impact factor	1,000	0,790	0,520	0,641	0,663	0,679	0,626	0,787	0,787	0,789	0,780	0,775
5-year impact factor	0,790	1,000	0,475	0,743	0,749	0,798	0,702	0,894	0,895	0,901	0,888	0,872
immediacy index	0,520	0,475	1,000	0,456	0,418	0,399	0,391	0,500	0,500	0,499	0,497	0,497
article influence	0,641	0,743	0,456	1,000	0,668	0,695	0,728	0,801	0,801	0,804	0,808	0,788
Hirsch index	0,663	0,749	0,418	0,668	1,000	0,756	0,710	0,797	0,797	0,804	0,822	0,797
SNIP	0,679	0,798	0,399	0,695	0,756	1,000	0,719	0,846	0,842	0,848	0,853	0,822
SJR	0,626	0,702	0,391	0,728	0,710	0,719	1,000	0,778	0,779	0,780	0,792	0,773
Copeland rule (2 v.)	0,787	0,894	0,500	0,801	0,797	0,846	0,778	1,000	0,993	0,974	0,964	0,956
Copeland rule (3 v.)	0,787	0,895	0,500	0,801	0,797	0,842	0,779	0,993	1,000	0,973	0,964	0,957
sorting by *UC*	0,789	0,901	0,499	0,804	0,804	0,848	0,780	0,974	0,973	1,000	0,965	0,956
sorting by *MES*	0,780	0,888	0,497	0,808	0,822	0,853	0,792	0,964	0,964	0,965	1,000	0,953
Markovian method	0,775	0,872	0,497	0,788	0,797	0,822	0,773	0,956	0,957	0,956	0,953	1,000
Political Science												
impact factor	1,000	0,773	0,422	0,671	0,682	0,653	0,673	0,801	0,803	0,798	0,802	0,803
5-year impact factor	0,773	1,000	0,374	0,835	0,757	0,705	0,717	0,894	0,905	0,902	0,909	0,889
immediacy index	0,422	0,374	1,000	0,356	0,425	0,372	0,398	0,450	0,441	0,448	0,453	0,425
article influence	0,671	0,835	0,356	1,000	0,688	0,671	0,653	0,806	0,816	0,819	0,829	0,794
Hirsch index	0,682	0,757	0,425	0,688	1,000	0,623	0,696	0,800	0,798	0,807	0,814	0,801
SNIP	0,653	0,705	0,372	0,671	0,623	1,000	0,662	0,747	0,749	0,751	0,753	0,741
SJR	0,673	0,717	0,398	0,653	0,696	0,662	1,000	0,793	0,783	0,794	0,789	0,768
Copeland rule (2 v.)	0,801	0,894	0,450	0,806	0,800	0,747	0,793	1,000	0,977	0,974	0,968	0,951
Copeland rule (3 v.)	0,803	0,905	0,441	0,816	0,798	0,749	0,783	0,977	1,000	0,969	0,968	0,960
sorting by *UC*	0,798	0,902	0,448	0,819	0,807	0,751	0,794	0,974	0,969	1,000	0,982	0,946
sorting by *MES*	0,802	0,909	0,453	0,829	0,814	0,753	0,789	0,968	0,968	0,982	1,000	0,951
Markovian method	0,803	0,889	0,425	0,794	0,801	0,741	0,768	0,951	0,960	0,946	0,951	1,000

Tab. 4. Percentage of coinciding pairs with respect to total number of journal pairs *r*

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	Copeland (2)	Copeland (3)	*UC*	*MES*	Markovian
Economics												
impact factor	100,00	91,46	74,70	81,77	79,07	84,80	83,38	91,34	91,25	89,73	86,72	90,91
5-year impact factor	91,46	100,00	75,08	86,22	81,40	86,26	85,45	94,81	94,91	93,32	89,67	94,52
immediacy index	74,70	75,08	100,00	73,31	68,48	72,28	71,79	76,81	76,92	75,68	74,01	77,56

article influence	81,77	86,22	73,31	100,00	77,39	83,60	82,12	87,99	88,15	86,92	84,32	88,44
Hirsch index	79,07	81,40	68,48	77,39	100,00	76,06	77,94	83,02	82,91	81,76	80,06	82,71
SNIP	84,80	86,26	72,28	83,60	76,06	100,00	80,32	87,60	87,63	86,41	83,85	87,48
SJR	83,38	85,45	71,79	82,12	77,94	80,32	100,00	87,74	87,62	86,69	83,89	87,11
Copeland rule (2 v.)	91,34	94,81	76,81	87,99	83,02	87,60	87,74	100,00	98,98	96,48	92,37	97,49
Copeland rule (3 v.)	91,25	94,91	76,92	88,15	82,91	87,63	87,62	98,98	100,00	96,40	92,39	97,66
sorting by *UC*	89,73	93,32	75,68	86,92	81,76	86,41	86,69	96,48	96,40	100,00	93,14	95,70
sorting by *MES*	86,72	89,67	74,01	84,32	80,06	83,85	83,89	92,37	92,39	93,14	100,00	92,27
Markovian method	90,91	94,52	77,56	88,44	82,71	87,48	87,11	97,49	97,66	95,70	92,27	100,00
Management												
impact factor	100,00	89,43	75,83	81,95	80,50	83,87	79,64	88,80	88,83	87,70	86,00	88,71
5-year impact factor	89,43	100,00	73,59	87,10	84,69	89,86	83,43	94,16	94,25	93,22	91,30	93,60
immediacy index	75,83	73,59	100,00	72,63	68,42	69,78	68,00	74,40	74,43	73,28	72,04	74,71
article influence	81,95	87,10	72,63	100,00	80,74	84,69	84,71	89,50	89,57	88,38	87,38	89,39
Hirsch index	80,50	84,69	68,42	80,74	100,00	85,04	81,39	86,72	86,70	86,07	85,90	87,10
SNIP	83,87	89,86	69,78	84,69	85,04	100,00	84,27	91,75	91,61	90,60	89,57	91,09
SJR	79,64	83,43	68,00	84,71	81,39	84,27	100,00	86,77	86,93	85,76	85,25	86,96
Copeland rule (2 v.)	88,80	94,16	74,40	89,50	86,72	91,75	86,77	100,00	99,04	96,82	95,21	97,29
Copeland rule (3 v.)	88,83	94,25	74,43	89,57	86,70	91,61	86,93	99,04	100,00	96,80	95,09	97,38
sorting by *UC*	87,70	93,22	73,28	88,38	86,07	90,60	85,76	96,82	96,80	100,00	95,11	95,91
sorting by *MES*	86,00	91,30	72,04	87,38	85,90	89,57	85,25	95,21	95,09	95,11	100,00	94,48
Markovian method	88,71	93,60	74,71	89,39	87,10	91,09	86,96	97,29	97,38	95,91	94,48	100,00
Political Science												
impact factor	100,00	88,56	69,53	83,45	79,14	82,58	80,09	89,49	89,42	87,90	86,68	90,08
5-year impact factor	88,56	100,00	67,20	91,67	82,81	85,20	82,25	94,15	94,58	93,07	91,94	94,41
immediacy index	69,53	67,20	100,00	66,27	65,62	67,12	65,70	70,52	69,99	69,22	68,44	69,74
article influence	83,45	91,67	66,27	100,00	79,41	83,47	79,12	89,75	90,06	88,93	88,02	89,59
Hirsch index	79,14	82,81	65,62	79,41	100,00	76,33	77,51	84,52	84,29	84,02	83,69	84,89
SNIP	82,58	85,20	67,12	83,47	76,33	100,00	79,57	86,81	86,79	85,61	84,33	87,01
SJR	80,09	82,25	65,70	79,12	77,51	79,57	100,00	85,63	84,97	84,56	83,34	84,75
Copeland rule (2 v.)	89,49	94,15	70,52	89,75	84,52	86,81	85,63	100,00	97,94	96,68	95,07	97,05
Copeland rule (3 v.)	89,42	94,58	69,99	90,06	84,29	86,79	84,97	97,94	100,00	96,33	95,24	97,34
sorting by *UC*	87,90	93,07	69,22	88,93	84,02	85,61	84,56	96,68	96,33	100,00	96,76	95,30
sorting by *MES*	86,68	91,94	68,44	88,02	83,69	84,33	83,34	95,07	95,24	96,76	100,00	94,04
Markovian method	90,08	94,41	69,74	89,59	84,89	87,01	84,75	97,05	97,34	95,30	94,04	100,00

Direct observations of values in Tables 3 and 4 confirm our previous results (Aleskerov et al., 2011): for each of the three sets of journals almost all aggregate rankings (except *MES*-based ones) correlate with any single-indicator-based ranking better than most of the other single-indicator-based rankings do. Therefore replacing the set of seven single-indicator-based rankings by aggregate rankings is justified.

5 Formal comparison of ranking methods

Let us employ the same method of binary multicriteria comparisons to evaluate ranking methods more formally. The problem of aggregation can be reformulated as a choice of a single object representing a given group of objects. In our case, we need to choose a ranking method that produces a ranking that serves as the best representative for the set of rankings based on seven bibliometric indicators. We have twelve candidates: five rank aggregation methods and seven initial indicators themselves. Let us use the same idea of binary multi-criteria comparisons and majority relations in order to determine the best representations. For a given set of journals, each of the twelve ranking methods produces a ranking. Let us say that ranking R_1 represents a given set of rankings better than ranking R_2 if R_1 is better correlated with (is closer to) the majority of rankings from this set than R_2. In our case, each ranking is characterized by 7-component vector, its *i*-th component being the value of a given correlation measure for this ranking and a corresponding single-indicator-based ranking. We compare these vectors and define a majority relation on the set of twelve ranking methods compared.

Tables 5 and 6 contain the results of binary comparisons for each of the three sets of journals based on measures τ_b and r, correspondingly. The first number in a cell equals 1 if the ranking of the row correlates with seven single-indicator-based rankings better than the ranking of the column (with respect to a given measure of correlation). It equals 0 otherwise, i.e. the first numbers are majority matrices' entries. The second number (in brackets) is a number of those initial rankings that are closer to the ranking of a row than to the ranking of a column (with respect to a given measure of correlation). The last column contains the Copeland score (the 2nd version) of the ranking, i.e. sums of numbers outside the brackets across the corresponding row.

The bottom sections of Tables 5 and 6 contain the results of our previous study, when we ranked 82 management science journals using bibliometric data for the years 2008-2010 (Aleskerov et al., 2011).[13]

Let us also unite the results of all binary comparisons of rankings produced by the twelve methods. For each pair of methods we have 3×7=21 comparisons based on the proximity of two rankings to a single-indicator-based ranking with respect to a given correlation measure: either τ_b or r. For all three cases (sets of journals) and all seven bibliometric indicators, let us count how often method M_a "wins" over method M_b, a=1÷12, b=1÷12, that is, how often a ranking produced by method M_a happens to be closer to a single-indicator-based ranking than a ranking produced by method M_b. In a given case (i.e. for a given set of journals), the number of wins is the bracketed value in the cell corresponding to row a and column b of either Table 5 or Table 6. This number varies between 0 and 7.The numbers in brackets in the two sections of Table 7 are the sums of all wins, that is, sums of corresponding (bracketed) entries in the three first sections of Table 5 and Table 6. They vary from 0 to 21. Let us say that method M_a performs generally better than method M_b[14] if M_a "wins" over M_b more often than M_b "wins" over M_a. Thus, the first

[13] The values of both impact factors, the immediacy index and the article influence were taken for 2008, the values of SNIP and SJR - for 2010; the h-index was calculated for 2004–2008.
[14] That is, M_a produces better representations of sets of rankings based on seven selected bibliometric indicators than M_b does.

number (outside brackets) in a cell of Table 7 equals 1 if the corresponding bracketed entry is higher than 10=[21/2]. It equals 0 otherwise.[15]

Tab. 5. Majority matrices (and numbers of "wins") when rankings are compared by τ_b

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	Copeland (2)	Copeland (3)	*UC*	*MES*	Markovian	**Copeland score s_2**
Economics													
impact factor		0(1)	1(6)	1(6)	1(6)	1(5)	1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	5
5-year impact factor	1(6)		1(6)	1(6)	1(6)	1(6)	1(6)	0(1)	0(1)	0(1)	0(1)	0(2)	6
immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	0(1)	0(1)	1(6)		1(5)	1(4)	0(3)	0(1)	0(1)	0(1)	0(1)	0(1)	3
Hirsch index	0(1)	0(1)	1(6)	0(2)		0(2)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	1
SNIP	0(2)	0(1)	1(6)	0(3)	1(5)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	2
SJR	0(2)	0(1)	1(6)	1(4)	1(6)	1(6)		0(1)	0(1)	0(1)	0(1)	0(1)	4
Copeland rule (2 v.)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)		0(3)	0(1)	0(1)	1(5)	8
Copeland rule (3 v.)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(4)		0(0)	0(1)	1(5)	9
sorting by *UC*	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(7)		0(2)	1(6)	10
sorting by *MES*	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(5)		1(7)	11
Markovian method	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(2)	0(2)	0(1)	0(0)		7
Management													
impact factor		0(2)	1(6)	0(3)	0(3)	0(2)	0(3)	0(2)	0(2)	0(2)	0(2)	0(2)	1
5-year impact factor	1(5)		1(6)	1(5)	1(5)	1(4)	1(6)	0(2)	0(2)	0(2)	0(2)	0(2)	6
immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	1(4)	0(2)	1(6)		0(3)	0(3)	1(4)	0(1)	0(1)	0(1)	0(1)	0(1)	3
Hirsch index	1(4)	0(2)	1(6)	1(4)		0(2)	1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	4
SNIP	1(5)	0(3)	1(6)	1(4)	1(5)		1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	5
SJR	1(4)	0(1)	1(6)	0(3)	0(2)	0(2)		0(1)	0(1)	0(1)	0(1)	0(1)	2
Copeland rule (2 v.)	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)		1(4)	0(1)	0(3)	1(6)	9
Copeland rule (3 v.)	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(3)		0(1)	0(3)	1(6)	8
sorting by *UC*	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)		0(3)	1(7)	10
sorting by *MES*	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(4)	1(4)	1(4)		1(7)	11
Markovian method	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(1)	0(1)	0(0)	0(0)		7
Political Science													
impact factor		0(2)	1(6)	0(3)	0(3)	1(6)	1(4)	0(1)	0(1)	0(1)	0(1)	0(1)	3
5-year impact factor	1(5)		1(6)	1(6)	1(5)	1(6)	1(5)	0(2)	0(2)	0(2)	0(2)	0(2)	6
immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	1(4)	0(1)	1(6)		0(3)	1(4)	0(3)	0(1)	0(1)	0(1)	0(1)	0(1)	3
Hirsch index	1(4)	0(2)	1(6)	1(4)		1(6)	1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	5
SNIP	0(1)	0(1)	1(6)	0(3)	0(1)		0(2)	0(1)	0(1)	0(1)	0(1)	0(1)	1
SJR	0(3)	0(2)	1(6)	1(4)	0(2)	1(5)		0(1)	0(1)	0(1)	0(1)	0(1)	3
Copeland rule (2 v.)	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)		0(3)	0(2)	0(1)	1(5)	8
Copeland rule (3 v.)	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(4)		0(2)	0(1)	1(5)	9
sorting by *UC*	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(5)	1(5)		0(1)	1(6)	10
sorting by *MES*	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)		1(6)	11
Markovian method	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(2)	0(2)	0(1)	0(1)		7
Management 2008-2010[16]													
impact factor		1(4)	1(6)	1(6)	1(6)	1(4)	1(4)	0(1)	0(1)	0(1)	0(1)	0(1)	6
5-year impact factor	0(3)		1(6)	1(5)	1(5)	1(5)	1(4)	0(1)	0(1)	0(1)	0(1)	0(1)	5

[15] The overall scheme is very much like the competition of nations during the Olympic games. Methods are like nations. Rankings produced by methods are like sportsmen representing nations. Cases are like different sports (say, tennis, soccer and ping pong). "Wins" are points that sportsmen add to their national collection.

[16] Aleskerov et al. (2011)

immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	0(1)	0(2)	1(6)		1(4)	0(3)	0(2)	0(1)	0(1)	0(1)	0(1)	0(1)	2
Hirsch index	0(1)	0(2)	1(6)	0(3)		1(4)	0(2)	0(1)	0(1)	0(1)	0(1)	0(1)	2
SNIP	0(3)	0(2)	1(6)	1(4)	0(3)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	2
SJR	0(3)	0(3)	1(6)	1(5)	1(5)	1(6)		0(1)	0(1)	0(1)	0(1)	0(1)	4
Copeland rule (2 v.)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)		0(3)	0(2)	0(2)	1(7)	8
Copeland rule (3 v.)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(4)		0(2)	0(2)	1(7)	9
sorting by *UC*	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(5)	1(5)		1(5)	1(7)	11
sorting by *MES*	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(5)	1(5)	0(2)		1(7)	10
Markovian method	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	0(0)	0(0)	0(0)	0(0)		7

Tab. 6. Majority matrices (and numbers of "wins") when rankings are compared by *r*

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	Copeland (2)	Copeland (3)	*UC*	*MES*	Markovian	**Copeland score s_2**
						Economics							
impact factor		0(1)	1(6)	1(6)	1(6)	1(5)	1(5)	0(1)	0(1)	0(1)	1(4)	0(1)	6
5-year impact factor	1(6)		1(6)	1(6)	1(6)	1(6)	1(6)	0(2)	0(2)	0(2)	1(7)	0(2)	7
immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	0(1)	0(1)	1(6)		1(6)	1(4)	1(4)	0(1)	0(1)	0(1)	0(1)	0(1)	4
Hirsch index	0(1)	0(1)	1(6)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	1
SNIP	0(2)	0(1)	1(6)	0(3)	1(6)		1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	3
SJR	0(2)	0(1)	1(6)	0(3)	1(6)	0(2)		0(1)	0(1)	0(1)	0(1)	0(1)	2
Copeland rule (2 v.)	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)		0(3)	1(7)	1(7)	1(5)	10
Copeland rule (3 v.)	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(4)		1(7)	1(7)	1(5)	11
sorting by *UC*	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(0)	0(0)		1(7)	0(0)	8
sorting by *MES*	0(3)	0(0)	1(6)	1(6)	1(6)	1(6)	1(6)	0(0)	0(0)	0(0)		0(0)	5
Markovian method	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(2)	0(2)	1(7)	1(7)		9
						Management							
impact factor		0(2)	1(6)	0(3)	1(4)	0(2)	0(3)	0(2)	0(2)	0(2)	0(2)	0(2)	2
5-year impact factor	1(5)		1(6)	1(5)	1(6)	1(4)	1(6)	0(2)	0(2)	0(3)	1(4)	0(2)	7
immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	1(4)	0(2)	1(6)		1(5)	0(3)	1(5)	0(1)	0(1)	0(1)	0(2)	0(1)	4
Hirsch index	0(3)	0(1)	1(6)	0(2)		0(1)	1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	2
SNIP	1(5)	0(3)	1(6)	1(4)	1(6)		1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	5
SJR	1(4)	0(1)	1(6)	0(2)	0(2)	0(2)		0(1)	0(1)	0(1)	0(1)	0(1)	2
Copeland rule (2 v.)	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)		0(2)	1(7)	1(7)	1(4)	10
Copeland rule (3 v.)	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(5)		1(7)	1(7)	1(4)	11
sorting by *UC*	1(5)	1(4)	1(6)	1(6)	1(6)	1(6)	1(6)	0(0)	0(0)		1(7)	0(0)	8
sorting by *MES*	1(5)	0(3)	1(6)	1(5)	1(6)	1(6)	1(6)	0(0)	0(0)	0(0)		0(0)	6
Markovian method	1(5)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(3)	0(3)	1(7)	1(7)		9
						Political Science							
impact factor		0(2)	1(6)	0(3)	1(6)	1(5)	1(6)	0(1)	0(1)	0(2)	0(2)	0(1)	4
5-year impact factor	1(5)		1(6)	1(6)	1(6)	1(6)	1(6)	0(2)	0(2)	0(3)	1(4)	0(2)	7
immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	1(4)	0(1)	1(6)		1(6)	1(4)	1(6)	0(1)	0(1)	0(1)	0(1)	0(1)	5
Hirsch index	0(1)	0(1)	1(6)	0(1)		0(1)	0(3)	0(1)	0(1)	0(1)	0(1)	0(1)	1
SNIP	0(2)	0(1)	1(6)	0(3)	1(6)		1(5)	0(1)	0(1)	0(1)	0(1)	0(1)	3
SJR	0(1)	0(1)	1(6)	0(1)	1(4)	0(2)		0(1)	0(1)	0(1)	0(1)	0(1)	2
Copeland rule (2 v.)	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)		1(5)	1(7)	1(7)	0(3)	10
Copeland rule (3 v.)	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	0(2)		1(7)	1(7)	1(4)	10
sorting by *UC*	1(5)	1(4)	1(6)	1(6)	1(6)	1(6)	1(6)	0(0)	0(0)		1(7)	0(0)	8
sorting by *MES*	1(5)	0(3)	1(6)	1(6)	1(6)	1(6)	1(6)	0(0)	0(0)	0(0)		0(0)	6
Markovian method	1(6)	1(5)	1(6)	1(6)	1(6)	1(6)	1(6)	1(4)	0(3)	1(7)	1(7)		10

Management 2008-2010												
impact factor		1(4)	1(6)	1(6)	1(6)	1(4)	1(4)	0(1)	0(1)	0(1)	0(3)	0(1)	6
5-year impact factor	0(3)		1(6)	1(5)	1(6)	1(5)	1(4)	0(1)	0(1)	0(1)	0(3)	0(1)	5
immediacy index	0(1)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0
article influence	0(1)	0(2)	1(6)		1(6)	0(3)	0(2)	0(1)	0(1)	0(1)	0(1)	0(1)	2
Hirsch index	0(1)	0(1)	1(6)	0(1)		0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	1
SNIP	0(3)	0(2)	1(6)	1(4)	1(6)		0(3)	0(1)	0(1)	0(1)	0(1)	0(1)	3
SJR	0(3)	0(3)	1(6)	1(5)	1(6)	1(4)		0(1)	0(1)	0(1)	0(2)	0(1)	4
Copeland rule (2 v.)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)		0(2)	1(7)	1(7)	1(4)	10
Copeland rule (3 v.)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(5)		1(7)	1(7)	1(5)	11
sorting by *UC*	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	0(0)	0(0)		1(7)	0(1)	8
sorting by *MES*	1(4)	1(4)	1(6)	1(6)	1(6)	1(6)	1(5)	0(0)	0(0)	0(0)		0(0)	7
Markovian method	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	1(6)	0(3)	0(2)	1(6)	1(7)		9

Tab. 7. Majority matrices for the unions of three sets of correlation coefficients

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	Copeland (2)	Copeland (3)	*UC*	*MES*	Markovian	**Copeland score s_2**
Rankings are compared by Kendall's τ_b													
impact factor		0(5)	1(18)	1(12)	1(12)	1(13)	1(12)	0(4)	0(4)	0(4)	0(4)	0(4)	5
5-year impact factor	1(16)		1(18)	1(17)	1(16)	1(16)	1(17)	0(5)	0(5)	0(5)	0(5)	0(6)	6
immediacy index	0(3)	0(3)		0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0
article influence	0(9)	0(4)	1(18)		1(11)	1(11)	0(10)	0(3)	0(3)	0(3)	0(3)	0(3)	3
Hirsch index	0(9)	0(5)	1(18)	0(10)		0(10)	1(11)	0(3)	0(3)	0(3)	0(3)	0(3)	2
SNIP	0(8)	0(5)	1(18)	0(10)	1(11)		0(8)	0(3)	0(3)	0(3)	0(3)	0(3)	2
SJR	0(9)	0(4)	1(18)	1(11)	0(10)	1(13)		0(3)	0(3)	0(3)	0(3)	0(3)	3
Copeland rule (2 v.)	1(17)	1(16)	1(18)	1(18)	1(18)	1(18)	1(18)		0(10)	0(4)	0(5)	1(16)	8
Copeland rule (3 v.)	1(17)	1(16)	1(18)	1(18)	1(18)	1(18)	1(18)	1(11)		0(3)	0(5)	1(16)	9
sorting by *UC*	1(17)	1(16)	1(18)	1(18)	1(18)	1(18)	1(18)	1(17)	1(18)		0(6)	1(19)	10
sorting by *MES*	1(17)	1(16)	1(18)	1(18)	1(18)	1(18)	1(18)	1(16)	1(16)	1(15)		1(20)	11
Markovian method	1(17)	1(15)	1(18)	1(18)	1(18)	1(18)	1(18)	0(5)	0(5)	0(2)	0(1)		7
Rankings are compared by *r*													
impact factor		0(5)	1(18)	1(12)	1(16)	1(12)	1(14)	0(4)	0(4)	0(5)	0(8)	0(4)	5
5-year impact factor	1(16)		1(18)	1(17)	1(18)	1(16)	1(18)	0(6)	0(6)	0(8)	1(15)	0(6)	7
immediacy index	0(3)	0(3)		0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0(3)	0
article influence	0(9)	0(4)	1(18)		1(17)	1(11)	1(15)	0(3)	0(3)	0(3)	0(4)	0(3)	4
Hirsch index	0(5)	0(3)	1(18)	0(4)		0(3)	0(9)	0(3)	0(3)	0(3)	0(3)	0(3)	1
SNIP	0(9)	0(5)	1(18)	0(10)	1(18)		1(15)	0(3)	0(3)	0(3)	0(3)	0(3)	3
SJR	0(7)	0(3)	1(18)	0(6)	1(12)	0(6)		0(3)	0(3)	0(3)	0(3)	0(3)	2
Copeland rule (2 v.)	1(17)	1(15)	1(18)	1(18)	1(18)	1(18)	1(18)		0(10)	1(21)	1(21)	1(12)	10
Copeland rule (3 v.)	1(17)	1(15)	1(18)	1(18)	1(18)	1(18)	1(18)	1(11)		1(21)	1(21)	1(13)	11
sorting by *UC*	1(16)	1(13)	1(18)	1(18)	1(18)	1(18)	1(18)	0(0)	0(0)		1(21)	0(0)	8
sorting by *MES*	1(13)	0(6)	1(18)	1(17)	1(18)	1(18)	1(18)	0(0)	0(0)	0(0)		0(0)	6
Markovian method	1(17)	1(15)	1(18)	1(18)	1(18)	1(18)	1(18)	0(9)	0(8)	1(21)	1(21)		9

If we apply the Copeland rule to majority matrices in Tables 5-7, we will obtain ten rankings of ranking methods. These rankings are presented in Table 8.

Tab. 8. The Copeland rankings of ranking methods

compared by Kendall's τ_b					
rank	**Economics**	**Man. Sc.**	**Pol. Sc.**	**All 3 sets combined**	**Previous results (2008)**
	***R*₁**				
1	*MES*	*MES*	*MES*	*MES*	*UC*
2	*UC*	*UC*	*UC*	*UC*	*MES*
3	Copeland 3	Copeland 2	Copeland 3	Copeland 3	Copeland 3
4	Copeland 2	Copeland 3	Copeland 2	Copeland 2	Copeland 2
5	Markovian	Markovian	Markovian	Markovian	Markovian
6	5-y.impact	5-y.impact	5-y.impact	5-y.impact	impact
7	impact	SNIP	Hirsch	impact	5-y.impact
8	SJR	Hirsch	AI/	AI/	SJR
9	AI	AI	impact/	SJR	AI/
10	SNIP	SJR	SJR	Hirsch/	Hirsch/
11	Hirsch	impact	SNIP	SNIP	SNIP
12	immediacy	immediacy	immediacy	immediacy	immediacy

compared by r					
rank	**Economics**	**Man. Sc.**	**Pol. Sc.**	**All 3 sets combined**	**Previous results (2008)**
	R_6	R_7	R_8	R_9	R_{10}
1	Copeland 3	Copeland 3	Copeland 3/	Copeland 3	Copeland 3
2	Copeland 2	Copeland 2	Copeland 2/	Copeland 2	Copeland 2
3	Markovian	Markovian	Markovian	Markovian	Markovian
4	*UC*	*UC*	*UC*	*UC*	*UC*
5	5-y.impact	5-y.impact	5-y.impact	5-y.impact	*MES*
6	impact	*MES*	*MES*	*MES*	impact
7	*MES*	SNIP	AI	impact	5-y.impact
8	AI	AI	impact	AI	SJR
9	SNIP	impact/	SNIP	SNIP	SNIP
10	SJR	Hirsch/	SJR	SJR	AI
11	Hirsch	SJR	Hirsch	Hirsch	Hirsch
12	immediacy	immediacy	immediacy	immediacy	immediacy

Table 8 ranks methods by their ability to produce comparatively good representations of sets of rankings based on the seven selected bibliometric indicators. Methods that produce better representations are ranked higher.

The following observations can be made concerning the robustness of rankings with respect to the choice of the aggregation method. Rankings R_1, R_2, R_6, R_9, R_{10} coincide with their majority relations. Triplets {AI, impact, SJR} (in R_3), {AI, Hirsch, SNIP} (in R_5), {impact, Hirsch, SJR} (in R_7) and {Copeland3, Copeland2, Markovian} (in R_8) are Condorcet cycles. Therefore, in all ten cases, any neutral (treating all alternatives equally) and Condorcet-consistent (producing majority relation when the latter is complete and transitive) ranking method based on majority relation will place twelve compared rankings in the same order as they are placed in Table 8, quadruplet {AI, SJR, Hirsch, SNIP} in R_4 being the only exception.[17]

[17] There is a cycle containing these four alternatives, and it can be broken differently by different methods. But it is important to note that if we apply other aggregation methods (the 1st or the 3d versions of the Copeland rule, the Markovian ranking, sorting by *UC*, by *MES* or by *WTC*), then other versions of R_4 will differ from that of Table 8 only with respect to pairs of alternatives from this quadruplet, and there will be no inversions. This fact confirms our conclusion concerning robustness.

Thus, we may conclude that the results of our comparisons of ranking methods are robust with respect to the choice of the aggregation method.

In all ten cases, ranking by values of the immediacy index demonstrates the lowest level of correlation with single-indicator-based rankings. This is possibly due to a very narrow publication window that this indicator is based on. When rankings are compared by r, the second worst ranking is one based on the Hirsch index. The scale of this index contains too few grades as compared to scales of other indicators, consequently rankings based on h-index contain significantly more ties than rankings based on other indicators. As a result, the values of r are lower, since this measure (unlike τ_b) "punishes" rankings containing too many ties. Indeed, being a tie in a ranking based on h-index, a pair most probably will not be a tie in another ranking. Thus, this pair will not contribute to the numerator of r, while r's denominator remains constant across all pairs.

In all cases except ones related to the older data (i.e. except R_5 and R_{10}) rankings based on the 5-year impact factor demonstrate the highest level of correlation among single-indicator-based rankings. In the previous study, the most correlated ranking was one based on the classic impact factor, the 5-year impact being the second best.

Systematic differences between rankings based on other indicators are not observed.

Formal comparisons confirm direct observations. In all ten cases, almost all aggregate ranking methods produce rankings that represent the set of single-indicator-based rankings better than any of these seven. Therefore replacing the set of seven single-indicator-based rankings with aggregate rankings is justified. The only exception is sorting by *MES* when it is compared with impact factors by r. Again, this happens because measure r punishes rankings with a lot of ties while τ_b does not.[18] This difference between two correlation measures also explains why sorting by *MES* and sorting by *UC* are placed above the Markovian method and both versions of the Copeland rule in R_1, R_2, R_3, R_4 and R_5, while their order is reversed in R_6, R_7, R_8, R_9 and R_{10}. Thus, if we suppose that higher values of τ_b for rankings based on sorting by *MES* or by *UC* are probably caused by their lack of discrimination rather than by their proximity to seven initial rankings, then the best method producing the most representative rankings will be the third version of the Copeland rule.

[18] See Tables 9–11 in Appendix. The less the number of positions in a ranking is, the more ties the ranking contains.

6 Conclusion

The influence of a journal is a notion that is hard to define. Measuring journal influence is a problem that has no clear-cut solution. Different approaches lead to different measures and different indicators, each possessing its own theoretical justification. We took the values of seven popular bibliometric indicators as our data. The analysis of correlations has shown that the 5-year impact factor is the best choice if one tries to represent seven single-indicator-based journal rankings by one of them. The least correlated are rankings based on the immediacy index. This is possibly due to a very narrow publication window that this indicator is based on. Rankings based on the Hirsch index contain too many ties. Other indicators are of more or less equal representativeness.

Despite the correlation of single-indicator-based rankings being high, there is a significant number of contradictions. We propose to minimize their number by replacing the set of single-indicator-based rankings with an aggregate ranking. Aggregation of rankings can be performed in many different ways. This paper demonstrates the power of ordinal ranking methods borrowed from social choice theory. This is a novel approach in bibliometrics. Ordinal methods relieve a researcher from the burden of finding appropriate weights and theoretical justifications for arithmetic operations with aggregated variables. Correlation analysis has also shown that aggregate rankings reduce the number of contradictions and represent the set of single-indicator-based rankings better than any of the seven rankings themselves. Thus, aggregate rankings are more efficient instruments for the evaluation of journal influence.

Some of the aggregate rankings (produced by the Copeland rule and the Markovian method) are characterized by a high level of discrimination, that is their shares of tied pairs are very small (less than 1%). For instance, the Markovian method allows to discriminate almost all journals. Other rankings (those based on tournament solutions) are rough orderings, which could also be of value. One may even argue that these rough orderings, when many journals are regarded as equal to each other, better represent our intuitive judgments concerning journal influence.

Not all social choice ranking methods have been employed in this study. There are also tournament solutions other than the top cycle, the uncovered and minimal externally stable sets. The next logical step would be to widen both the arsenal of aggregation techniques and the set of empirical data.

Appendix

Tab. 9. Ranks of economic journals in single-indicator-based and aggregate rankings
(journals are ordered by their impact-factor)

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	the Copeland rule (2 version)	the Copeland rule (3 version)	sorting by *UC*	sorting by *MES*	Markovian method
Number of positions in a ranking	**200**	**207**	**159**	**204**	**30**	**201**	**65**	**135**	**139**	**59**	**37**	**211**
Journal of Economic Literature	1	1	4	2	10	1	1	1	1	1	1	1
Quarterly Journal of Economics	2	2	5	1	3	2	3	2	2	2	2	2
Review of Financial Studies	3	7	9	7	5	7	11	5	5	5	5	5
Journal of Finance	4	3	3	5	4	3	12	3	3	3	3	3
Journal of Economic Perspectives	5	4	21	6	7	6	6	4	4	4	4	4
Economic Geography	6	10	28	49	17	28	36	17	15	9	7	23
Journal of Financial Economics	7	5	12	8	3	4	17	5	6	5	5	7
Brookings Papers On Economic Activity	8	16	44	12	23	31	24	13	13	9	7	13
Journal of Accounting and Economics	9	9	72	24	13	8	35	9	9	9	7	12
Journal of Economic Geography	10	8	2	35	10	12	32	7	7	7	6	8
Journal of Political Economy	11	6	55	3	9	5	11	6	6	6	5	6
Review of Economic Studies	12	11	24	4	12	9	15	7	7	7	6	10
Economics Human Biology	13	35	20	87	18	107	8	23	23	14	7	31
Ecological Economics	14	19	43	69	1	45	13	10	10	9	7	17
American Economic Review	15	12	8	9	2	13	13	8	8	8	6	11
Review of Economics and Statistics	16	14	23	11	9	10	18	8	8	7	6	9
PharmacoEconomics	17	23	7	72	11	80	2	11	12	10	7	21
Journal of Banking & Finance	18	42	22	96	12	14	37	21	19	15	7	29
Journal of Economic Growth	19	13	126	10	20	16	33	12	12	9	7	16
Journal of Human Resources	20	21	22	17	18	17	14	11	11	9	7	15
Energy Economics	21	25	31	62	6	26	18	13	13	9	7	19
Journal of Health Economics	22	20	78	37	10	62	5	16	15	10	8	28
Economic Policy	23	24	13	26	23	25	29	18	16	9	7	25
Value in Health	24	26	49	76	9	104	4	19	18	11	8	30
Journal of Environmental Economics and Management	25	22	36	34	13	22	19	15	14	9	7	24
Review of Environmental Economics and Policy	26	15	1	33	17	60	20	13	12	9	7	18
Journal of Development of Economics	27	29	17	29	11	24	25	19	18	12	7	32
Health Economics	28	33	27	55	12	72	7	21	20	14	8	37
Food Policy	29	38	44	90	16	47	9	24	25	17	8	38
Journal of Regional Science	30	53	68	79	20	77	44	37	39	22	12	58
Economic Journal	31	28	18	25	11	19	20	14	13	9	7	20
Journal of Urban Economics	32	30	22	42	14	20	16	19	17	9	7	22
Journal of Monetary Economics	32	31	75	15	11	27	33	20	20	13	7	33
Journal of Business and Economic Statistics	33	37	16	18	19	26	34	22	22	14	7	35
Journal of Financial and Quantitative Analysis	34	47	76	31	19	35	40	29	29	19	11	48
Journal of Applied Econometrics	35	46	34	28	19	42	36	27	28	18	11	45
Journal of International Economics	36	27	61	22	13	11	39	23	24	16	9	36
Economy and Society	37	39	128	53	16	86	51	37	37	20	12	57
Post-Soviet Affairs	38	119	132	133	25	89	58	87	85	32	16	122
Cambridge Journal of Regions Economy and Society	39	56	6	101	23	152	53	59	56	23	13	71
Journal of Labor Economics	40	17	53	13	20	23	34	22	21	10	8	34
International Economic Review	41	63	137	23	19	43	41	33	33	20	12	54
Applied Economic Perspectives and Policy	42	77	85	118	28	33	50	53	52	24	13	80
Journal of Agricultural Economics	43	59	93	108	21	118	28	49	45	23	13	61

Small Business Economics	44	41	46	98	13	34	47	27	28	18	11	40
World Development	45	45	64	70	13	44	23	27	28	18	11	41
Journal of Risk and Uncertainty	46	43	57	39	21	53	30	32	31	20	12	51
European Economic Review	47	54	77	43	17	51	37	32	32	20	11	46
Environmental & Resource Economics	48	66	26	91	16	121	31	34	35	21	11	47
Quantitative Marketing and Economics	49	64	22	36	23	86	50	38	38	21	12	59
RAND Journal of Economics	50	40	91	16	18	37	43	30	29	18	11	42
International Journal of Forecasting	50	36	14	51	17	52	38	28	28	18	11	44
Inžinerinė ekonomika - Engineering Economics	51	106	107	197	17	73	45	55	56	25	13	93
Journal of Public Economics	52	44	81	32	12	30	21	25	26	17	10	39
Bulletin of Indonesian Economic Studies	53	120	7	154	25	29	59	77	75	28	14	110
Cambridge Journal of Economics	54	88	100	112	18	58	49	51	48	24	13	90
Papers in Regional Science	55	69	65	117	20	67	49	45	44	23	13	85
World Bank Research Observer	56	55	87	54	24	91	35	40	40	22	13	69
Journal of Risk and Insurance	57	87	44	88	21	82	10	43	41	22	13	72
European Review of Agricultural Economics	58	61	59	94	24	98	40	47	46	22	13	83
Industrial and Corporate Change	59	48	32	71	16	63	28	31	30	20	12	50
Experimental Economics	60	18	45	14	20	15	26	20	19	10	7	26
Review of Economic Dynamics	61	70	30	19	21	48	39	35	35	20	12	62
Journal of the European Economic Association	62	50	13	20	15	59	22	26	26	18	7	27
Journal of Econometrics	63	32	15	21	8	21	32	17	16	9	7	14
Journal of Agrarian Change	64	74	11	95	21	39	37	39	39	22	12	64
Journal of Economic Surveys	65	49	42	59	19	36	32	33	33	21	12	53
JCMS - Journal of Common Market Studies	66	57	92	80	16	61	54	41	41	22	13	60
Land Economics	67	58	94	83	18	111	43	44	43	23	13	74
Insurance Mathematics & Economics	68	85	104	93	18	32	42	46	44	23	13	89
Futures	69	91	88	171	19	146	53	68	68	28	14	108
Mathematical Finance	70	68	63	46	20	18	42	36	38	22	12	63
Resource and Energy Economics	71	76	33	85	21	96	37	45	43	23	13	65
Work Employment and Society	72	73	156	119	19	54	53	56	55	26	13	91
Journal of Economic Theory	73	78	38	27	14	66	43	35	37	20	12	49
Regional Studies	74	62	51	115	13	49	51	43	42	23	12	66
American Journal of Agricultural Economics	75	75	92	102	15	87	41	45	45	23	13	79
Economica	76	95	52	68	21	85	47	52	50	24	13	81
World Bank Economic Review	77	34	29	30	17	38	43	27	27	17	11	43
Oxford Economic Papers	78	92	54	82	22	117	51	62	61	27	13	101
Journal of Policy Analysis and Management	79	60	90	58	18	88	52	48	45	23	13	76
Journal of Money Credit and Banking	80	65	40	38	16	50	49	34	36	20	12	52
Journal of Economics and Management Strategy	80	80	60	48	19	68	49	43	40	23	12	67
Journal of Real Estate Research	81	112	141	149	26	93	53	83	82	30	15	129
Journal of Economic Psychology	82	72	97	81	17	74	34	41	42	23	13	70
Economics of Education Review	82	83	41	98	18	46	51	46	44	23	13	77
Australian Journal of Agricultural and Resource Economics	83	102	159	130	21	118	39	68	68	27	14	107
Journal of Industrial Economics	84	97	131	47	22	65	51	60	60	25	13	96
Review of International Political Economy	85	124	66	107	20	140	57	74	73	30	15	118
New Political Economy	86	123	121	137	23	132	60	90	86	32	16	136
Journal of Comparative Economics	87	71	138	73	20	56	50	54	52	25	13	88
Journal of Law Economics & Organization	88	67	62	41	21	78	53	51	47	24	13	75
Real Estate Economics	89	94	101	77	24	41	49	62	60	25	14	104
Canadian Journal of Agricultural Economics - La Revue canadienne d'agroéconomie	90	116	98	151	24	162	53	86	82	31	16	127
Journal of Economic History	91	114	58	67	24	40	57	64	64	27	14	102
Regional Science and Urban Economics	92	86	80	78	20	100	51	61	59	27	13	86
Journal of Economic Behavior and Organization	93	85	89	61	15	113	48	50	49	24	13	73
Oxford Bulletin of Economics and Statistics	94	84	140	63	22	70	44	57	58	25	13	94
Journal of Evolutionary Economics	94	82	126	129	21	150	56	80	76	30	15	112
Transformations in Business and Economics	95	125	118	194	21	164	54	88	85	31	16	135
Economic Inquiry	96	101	83	60	20	131	35	58	57	24	13	92
Economic Development and Cultural Change	97	81	117	74	23	92	49	64	63	27	14	100

Journal of Transport Economics and Policy	98	108	79	120	24	83	43	66	67	25	14	105
Information Economics and Policy	99	113	129	113	22	79	46	72	70	28	15	111
China Economic Review	100	93	95	146	22	64	49	67	65	25	15	106
Explorations in Economic History	101	133	19	99	24	75	54	73	70	29	15	113
Journal of Population Economics	102	96	80	89	20	112	53	68	66	28	13	87
Labour Economics	103	99	119	65	19	97	49	63	62	25	13	97
Public Choice	104	103	99	97	18	124	54	70	69	29	15	116
Journal of Law and Economics	105	52	28	40	20	81	35	34	37	20	12	56
Journal of Real Estate Finance and Economics	106	118	112	124	24	55	53	79	75	30	15	121
KYKLOS	107	79	67	100	22	88	51	65	63	27	13	95
Journal of Productivity Analysis	108	90	142	121	22	101	52	72	72	28	14	119
Econometrics Journal	109	129	73	64	24	109	54	78	74	30	15	123
Journal of Economic Dynamics and Control	110	107	80	66	16	57	36	42	42	22	13	68
Econometric Theory	110	121	35	50	21	95	42	55	54	25	13	82
International Journal of Industrial Organization	111	100	102	57	20	71	51	64	62	25	13	98
Journal of Regulatory Economics	112	122	96	105	24	137	51	78	75	30	15	126
Journal of Competition Law and Economics	113	142	135	151	25	102	59	97	97	33	16	148
Games and Economic Behavior	114	98	82	45	18	108	45	55	53	23	13	84
Journal of Forest Economics	115	105	69	152	25	123	58	89	84	30	16	132
Review of Income and Wealth	116	115	86	92	22	76	56	75	71	30	15	114
Journal of Development Studies	117	110	70	116	20	129	56	76	74	30	15	120
Oxford Review of Economic Policy	118	51	10	56	19	69	16	34	34	21	12	55
Economic History Review	118	127	48	103	24	86	60	82	77	31	16	115
Econometric Reviews	119	89	128	44	20	90	27	53	51	23	13	78
Review of World Economics	120	117	152	123	23	126	55	87	84	31	16	131
Agricultural Economics	121	104	122	131	27	114	41	82	80	31	16	128
Quantitative Finance	122	132	111	118	23	149	48	84	82	31	15	134
Economics and Philosophy	123	131	37	111	27	103	43	79	77	28	13	109
Journal of Agricultural and Resource Economics	124	145	153	164	26	118	39	94	95	32	17	156
Economic Modelling	125	148	128	159	22	135	55	92	92	33	17	151
Review of Development Economics	126	141	146	132	23	147	56	93	91	32	17	150
World Economy	127	111	108	109	20	133	58	80	78	30	15	124
Tijdschrift voor Economische en Sociale Geografie	128	147	74	161	23	142	58	95	94	34	18	155
Economics of Transition	129	134	39	148	24	145	58	94	89	33	16	142
Economic Theory	130	139	25	75	20	134	56	80	77	28	15	117
Journal of Policy Modeling	131	146	114	162	22	114	52	89	86	31	16	144
Southern Economic Journal	132	140	89	106	22	136	53	84	81	31	15	133
Economic Development Quarterly	133	126	115	167	22	121	55	90	87	32	16	145
Geneva Risk and Insurance Review	134	154	159	135	28	84	55	98	98	33	18	157
CESifo Economic Studies	135	128	69	127	24	162	57	91	88	32	17	138
Feminist Economics	136	109	113	111	22	110	55	81	79	30	15	125
Canadian Journal of Economics – La Revue canadienne d'économique	137	127	50	86	22	94	50	69	68	28	13	99
Empirical Economics	138	137	125	141	23	130	55	91	89	32	17	152
Contemporary Economic Policy	139	144	155	139	23	163	54	95	95	33	18	154
Journal of Economics / Zeitschrift f	140	152	93	155	26	161	60	106	106	37	18	160
Europe-Asia Studies	141	157	158	163	23	128	61	105	104	35	18	158
Journal of African Economies	142	130	71	136	25	115	50	85	83	31	14	130
Federal Reserve Bank of St Louis Review	143	158	126	84	25	171	52	97	96	34	18	139
Pacific Economic Review	144	170	109	173	25	169	60	111	110	40	20	174
Journal of Housing Economics	145	135	62	142	24	106	57	92	90	33	16	141
International Tax and Public Finance	146	138	159	126	23	141	57	98	93	33	18	153
China & World Economy	147	167	105	170	25	172	58	108	107	38	20	170
Scandinavian Journal of Economics	148	118	103	52	23	99	47	71	71	29	15	103
Journal of Media Economics	149	165	76	173	27	160	59	110	110	40	20	173
Journal of Macroeconomics	150	160	126	143	23	119	58	96	97	34	18	146
ASTIN Bulletin	151	151	101	122	24	105	57	93	91	31	16	137
Fiscal Studies	151	167	47	147	25	116	58	99	99	35	18	149
Theory and Decision	152	166	121	128	24	158	57	101	101	35	18	143

Cliometrica	153	155	128	168	26	139	62	108	108	38	20	167
Review of Industrial Organization	154	143	103	125	25	159	59	100	99	35	18	159
Applied Economics	155	149	144	166	21	155	58	103	103	35	19	166
Post-Communist Economies	155	174	159	187	27	168	61	118	120	45	21	187
Macroeconomic Dynamics	156	163	109	110	24	120	57	95	96	32	16	140
Economics Letters	157	169	143	138	19	165	52	103	103	35	18	165
Social Choice and Welfare	158	162	134	104	22	166	55	100	100	35	17	147
International Review of Law and Economics	158	168	149	158	25	183	59	114	113	41	21	178
Open Economies Review	158	164	133	157	26	153	59	110	111	39	20	180
South African Journal of Economics	159	183	148	189	27	179	58	118	124	45	21	193
Studies in Nonlinear Dynamics and Econometrics	160	153	159	150	26	127	56	107	105	37	19	169
Journal of the Japanese and International Economies	161	150	106	134	25	154	59	104	102	36	18	161
Defence and Peace Economics	162	171	56	172	25	180	63	114	114	42	20	177
Economic Record	163	136	127	140	23	138	59	102	99	36	18	164
Politická ekonomie	164	187	80	195	26	170	62	119	121	45	21	188
National Tax Journal	165	162	55	144	26	156	55	106	105	35	19	163
Journal of World Trade	166	185	43	181	26	178	63	118	123	45	23	194
International Journal of Transport Economics	167	179	130	177	28	167	59	115	116	43	20	181
International Labour Review	168	156	145	165	24	176	61	112	112	38	20	176
Japan and the World Economy	169	181	150	175	26	151	61	116	119	44	21	185
Eastern European Economics	170	188	120	190	27	185	62	123	127	48	26	196
Journal of Economic Issues	171	176	127	184	23	173	62	116	119	43	21	184
Australian Economic History Review	172	189	159	186	27	187	54	124	128	49	27	197
American Journal of Economics and Sociology	173	177	84	174	25	186	61	116	117	43	21	183
International Journal of Game Theory	174	172	154	114	25	133	57	109	106	37	19	168
La Revista de Economía Mundial	174	202	85	199	30	197	64	130	134	54	32	205
Journal of Institutional and Theoretical Economics	175	182	56	160	25	189	61	117	117	44	20	175
Journal of Post Keynesian Economics	176	175	130	178	24	144	57	113	111	38	20	172
Journal of Mathematical Economics	177	180	120	145	24	148	56	107	105	37	19	162
Ekonomický časopis - Journal of Economics	178	197	116	202	26	188	62	125	129	50	28	198
Independent Review	179	194	147	176	27	193	63	125	130	50	28	199
Australian Economic Review	180	191	109	185	26	182	61	121	126	47	25	191
Jahrbücher für Nationalökonomie und Statistik	181	184	153	179	26	177	61	118	122	45	22	189
Japanese Economic Review	182	173	151	156	26	174	61	117	118	44	21	182
Manchester School	183	178	136	173	25	175	60	117	119	44	21	186
Journal of Economic Education	184	186	159	191	28	125	62	126	128	50	28	195
History of Political Economy	185	195	137	183	26	143	62	122	126	45	26	192
Applied Economics Letters	186	190	157	182	23	181	61	120	125	46	24	190
Scottish Journal of Political Economy	187	161	159	153	25	157	58	109	109	38	20	171
Hacienda Pública Española	188	193	159	186	30	192	61	127	131	51	29	202
European Journal of the History of Economic Thought	189	199	159	188	27	122	64	128	131	52	30	200
FinanzArchiv - Public Finance Analysis	190	192	159	180	27	184	62	126	130	50	28	201
Investigación Económica	191	204	120	200	29	196	64	131	135	55	33	207
South African Journal of Economic and Management Sciences	192	201	150	198	28	200	64	132	134	54	32	206
Developing Economies	193	159	110	169	27	177	57	115	115	40	21	179
Portuguese Economic Journal	194	196	123	194	27	191	63	128	132	52	30	203
Journal of Economic Policy Reform	195	200	124	193	28	195	64	129	133	53	31	204
La Revista de economía aplicada	196	198	139	192	29	190	64	129	133	53	31	204
La Revue d'Economie Politique	197	203	147	196	28	198	65	132	136	56	34	208
El Trimestre Económico	198	205	159	201	29	194	64	133	137	57	35	209
Hitotsubashi Journal of Economics	199	207	159	204	30	199	64	134	138	58	36	210
La Revue d'études comparatives Est-Ouest	200	206	159	203	30	201	65	135	139	59	37	211

Tab. 10. Ranks of management science journals in single-indicator-based and aggregate rankings
(journals are ordered by their impact-factor)

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	the Copeland rule (2 version)	the Copeland rule (3 version)	sorting by *UC*	sorting by *MES*	Markovian method
Number of positions in a ranking	**90**	**92**	**84**	**91**	**30**	**92**	**41**	**68**	**69**	**42**	**33**	**93**
Academy of Management Review	1	1	2	2	2	2	4	1	1	1	1	1
Academy of Management Journal	2	2	14	1	3	4	7	2	2	2	2	2
Academy of Management Learning and Education	3	18	11	28	19	31	22	18	18	10	9	20
Journal of Management	4	5	3	4	7	7	6	3	3	3	3	5
MIS Quarterly	5	3	12	7	9	1	6	3	3	3	3	4
Journal of Operations Management	6	9	29	16	5	3	3	5	5	5	5	7
Organization Science	7	10	4	8	6	15	14	7	7	6	6	9
Journal of Applied Psychology	8	4	24	5	1	5	2	3	3	3	3	3
Journal of Management Studies	9	12	1	14	10	18	15	8	9	7	7	12
Administrative Science Quarterly	10	6	71	3	15	9	14	6	6	6	6	8
Journal of Organizational Behavior	11	15	7	17	15	29	16	12	12	9	9	15
Strategic Management Journal	12	7	19	9	4	6	13	4	4	4	4	6
Academy of Management Perspectives	13	34	5	27	16	52	14	19	19	12	11	23
International Journal of Management Reviews	14	14	47	20	20	22	12	16	17	10	10	22
Journal of International Business Studies	15	13	12	19	5	14	16	11	11	8	8	13
Omega - International Journal of Management Science	16	24	6	29	8	13	1	9	10	8	8	11
Technovation	17	33	18	60	14	20	19	20	20	12	10	29
Organizational Research Methods	18	11	8	10	15	23	5	10	11	8	8	14
Organizational Behavior and Human Decision Processes	19	20	34	11	12	36	9	13	13	10	9	17
Personnel Psychology	20	8	25	6	10	10	11	7	8	6	6	10
Leadership Quarterly	21	16	30	25	13	17	20	14	15	10	9	21
Tourism Management	22	22	26	48	11	8	17	15	16	9	9	19
Service Industries Journal	23	52	65	74	20	75	33	44	46	23	19	57
Research Policy	24	19	39	23	6	19	10	13	14	9	9	18
R and D Management	25	27	53	44	21	34	18	25	25	13	12	36
Group and Organization Management	26	31	13	40	21	28	25	24	24	13	12	31
Organization Studies	27	25	40	22	13	27	25	21	21	12	11	28
Journal of Information Technology	28	29	9	36	23	41	31	27	28	14	12	38
Information and Management	29	21	64	41	12	11	11	17	18	11	10	27
Long Range Planning	30	41	16	42	20	48	24	31	32	15	14	44
Information Systems Research	31	17	41	13	16	12	21	18	18	10	10	24
Journal of Product Innovation Management	32	23	38	34	18	25	24	22	22	12	11	30
European Journal of Work and Organizational Psychology	33	32	17	30	22	44	19	27	27	13	12	34
Journal of Occupational and Organizational Psychology	34	43	5	38	21	50	25	32	33	17	15	45
Corporate Governance - An International Review	35	61	53	71	20	57	28	41	44	22	19	60
Management Science	36	26	27	12	9	21	9	13	13	9	9	16
Human Relations	37	40	31	37	17	42	24	29	30	15	12	32
Management Learning	38	54	49	61	22	53	29	40	41	20	18	58
Organization	39	51	21	39	22	51	31	37	38	19	17	53
California Management Review	40	38	43	35	20	33	23	28	29	13	12	39
Operations Research	41	45	40	18	14	24	5	19	19	10	10	25
Small Business Economics	42	44	32	45	15	37	25	31	32	15	12	43
Supply Chain Management	43	39	72	52	18	39	23	33	33	16	13	46
Industrial Marketing Management	44	35	22	67	14	38	29	30	31	15	12	33
British Journal of Management	45	36	20	43	21	55	28	34	35	18	16	47
Human Resource Management	45	48	52	47	21	45	26	35	36	18	16	49
International Small Business Journal	46	50	42	66	22	40	31	39	40	20	18	55

International Journal of Forecasting	47	37	15	24	20	43	19	26	27	13	12	41
M&SOM - Manufacturing and Service Operations Management	48	42	35	15	19	30	8	23	23	13	10	26
Journal of Management Information Systems	49	30	78	31	15	16	23	25	26	13	11	35
Journal of Small Business Management	50	47	75	49	22	32	25	36	37	19	16	50
Industrial and Corporate Change	51	49	23	33	18	47	11	30	29	16	12	40
Decision Sciences	52	28	62	26	19	26	22	25	26	13	12	37
Small Group Research	53	59	73	48	23	58	20	41	43	20	19	54
International Journal of Selection and Assessment	54	63	45	59	22	64	32	43	46	23	20	61
Harvard Business Review	55	46	33	32	16	56	22	33	34	16	11	42
Journal of Organizational Behavior Management	56	79	44	81	27	86	38	59	60	30	25	80
Journal of Service Management	57	72	60	80	29	81	35	58	59	33	24	81
Gender, Work and Organization	58	60	69	54	24	60	30	43	46	23	20	66
Journal of Management Inquiry	59	64	10	53	25	80	36	47	50	25	22	70
Leadership	60	68	63	69	25	77	34	52	52	28	23	73
International Journal of Operations and Production Management	61	53	83	58	18	35	26	38	39	20	16	51
Journal of Economics and Management Strategy	62	62	36	21	21	49	27	38	38	19	16	48
International Journal of Human Resource Management	63	58	70	68	17	59	34	44	47	24	20	62
Journal of Engineering and Technology Management (JET-M)	64	55	76	56	23	66	29	45	48	24	21	67
Group Decision and Negotiation	65	73	77	63	25	65	29	50	51	25	22	69
Service Business	66	77	28	86	26	78	34	56	57	30	24	82
Journal of the Operational Research Society	67	65	56	51	19	62	23	42	45	21	20	56
MIT Sloan Management Review	67	57	48	46	23	61	27	41	43	21	19	59
IEEE Transactions on Engineering Management	68	56	74	55	20	49	26	41	42	21	18	52
Journal of Forecasting	69	78	57	50	25	68	26	48	49	26	22	64
Public Management Review	70	69	59	65	22	63	35	49	51	27	22	72
New Technology, Work and Employment	71	70	50	70	27	69	33	51	53	28	23	65
Research Technology Management	72	75	58	79	25	89	39	59	60	30	25	79
Cornell Hospitality Quarterly	73	81	66	87	28	87	35	62	63	36	27	87
System Dynamics Review	74	71	67	62	26	54	29	49	52	24	20	68
Interfaces	75	76	67	57	25	71	29	53	53	29	23	74
Journal of Sport Management	76	67	37	77	25	46	35	51	51	26	23	71
Organizational Dynamics	77	74	61	72	24	76	35	55	55	29	24	77
Systems Research and Behavioral Science	78	87	79	78	26	85	34	60	61	34	25	85
Journal of Organizational Change Management	79	80	75	75	24	70	33	55	56	29	24	78
Technology Analysis and Strategic Management	80	62	46	64	23	67	30	46	50	25	22	63
Personnel Review	81	66	68	73	24	72	34	54	54	26	23	75
Total Quality Management and Business Excellence	82	82	58	85	25	73	32	57	57	30	24	76
Chinese Management Studies	83	88	58	89	29	88	38	65	66	39	30	90
International Journal of Manpower	84	83	51	76	25	74	35	57	58	31	24	83
Canadian Journal of Administrative Sciences - Revue Canadienne des Sciences de L'Administration	84	84	55	82	27	82	37	61	62	35	26	86
International Journal of Technology Management	85	86	82	83	25	83	36	63	64	37	28	88
Systemic Practice and Action Research	86	89	80	88	27	84	35	64	65	38	29	89
Review of Industrial Organization	87	85	54	58	27	79	36	58	59	32	24	84
Negotiation Journal	88	90	84	84	28	90	33	66	67	40	31	91
Zeitschrift für Personalforschung	89	91	84	90	30	91	40	67	68	41	32	92
South African Journal of Economic and Management Sciences	90	92	81	91	30	92	41	68	69	42	33	93

Tab. 11. Ranks of political science journals in single-indicator-based and aggregate rankings

(journals are ordered by their impact-factor)

	impact factor	5-year impact factor	immediacy index	article influence	Hirsch index	SNIP	SJR	the Copeland rule (2 version)	the Copeland rule (3 version)	sorting by *UC*	sorting by *MES*	Markovian method
Number of positions in a ranking	**95**	**98**	**72**	**95**	**19**	**97**	**28**	**69**	**66**	**42**	**36**	**97**
American Political Science Review	1	4	14	2	2	2	4	1	1	1	1	2
American Journal of Political Science	2	3	24	3	1	3	1	1	1	1	1	1
Public Opinion Quarterly	3	2	25	8	3	9	2	2	2	2	2	4
Journal of Conflict Resolution	4	7	12	6	5	7	8	4	4	4	4	6
Political Analysis	5	1	8	1	7	5	3	1	1	1	1	3
Global Environmental Politics	6	20	42	44	8	23	11	13	13	11	11	17
Politics and Society	7	12	39	12	8	27	19	11	12	9	8	13
Political Geography	8	6	15	17	3	20	11	5	5	5	5	7
Journal of Peace Research	9	15	4	14	5	11	10	6	6	5	5	8
Policy Studies Journal	10	33	2	54	9	17	10	11	13	9	9	22
Annual Review of Political Science	11	5	17	4	6	1	6	3	3	3	3	5
Political Psychology	11	9	13	15	8	26	7	7	7	6	6	10
Post-Soviet Affairs	12	45	58	50	14	32	21	30	29	19	18	42
Political Behavior	13	17	58	13	12	25	14	11	13	9	9	21
Comparative Political Studies	14	10	5	9	4	10	12	6	5	5	5	9
African Affairs	15	24	7	25	8	8	10	9	9	8	8	12
Governance	15	21	46	28	9	24	16	15	16	12	12	23
New Left Review	16	27	37	20	10	13	19	16	17	13	13	24
British Journal of Political Science	17	16	19	11	6	4	11	8	8	7	7	11
Journal of Politics	18	8	33	7	4	21	9	6	5	5	5	9
European Journal of Political Research	18	14	11	16	8	54	20	13	13	10	9	19
Environmental Politics	19	28	35	51	8	46	15	17	18	14	14	27
International Political Sociology	20	25	52	37	8	55	24	24	22	15	15	30
JCMS - Journal of Common Market Studies	21	22	28	27	5	22	18	12	14	9	8	16
International Studies Quarterly	22	11	44	10	5	14	18	9	10	8	8	14
European Union Politics	23	13	16	19	8	12	17	10	11	9	9	15
Political Communication	24	18	9	18	10	15	16	12	14	10	10	20
Human Rights Quarterly	25	51	66	56	12	37	23	34	33	20	20	33
Journal of Political Philosophy	26	32	53	26	12	20	20	21	20	15	15	29
Quarterly Journal of Political Science	27	19	72	5	12	64	18	22	19	14	14	25
International Journal of Press/Politics	28	26	3	31	12	28	19	18	18	14	14	34
Review of International Political Economy	29	48	21	46	9	61	20	27	26	16	16	41
New Political Economy	30	47	51	52	11	57	23	32	31	20	18	47
West European Politics	31	29	1	30	7	19	18	14	15	9	8	18
Journal of Democracy	32	40	23	38	10	16	21	27	25	16	17	39
Annals of the American Academy of Political and Social Science	33	31	30	33	6	59	13	17	18	14	14	26
Social Science Quarterly	34	36	45	43	9	49	13	23	24	16	15	31
Party Politics	35	39	13	34	10	34	20	23	23	15	15	37
Journal of Strategic Studies	36	62	6	58	14	31	26	38	36	22	21	57
Political Research Quarterly	37	34	63	29	8	40	21	26	22	16	15	36
Terrorism and Political Violence	38	42	57	40	13	42	23	31	27	18	18	45
Public Choice	39	37	32	36	7	52	18	24	24	15	15	32
Cooperation and Conflict	40	57	48	71	14	41	23	39	36	23	21	53
Political Studies	41	35	70	23	8	18	17	19	18	14	14	28
Legislative Studies Quarterly	42	38	13	21	13	33	21	25	23	17	15	38
Armed Forces and Society	43	52	54	68	14	39	20	34	34	19	18	52
Ethics and Global Politics	44	58	72	63	16	80	26	55	52	30	25	80

Comparative Politics	45	44	56	32	13	44	21	29	28	19	18	44
Publius - The Journal of Federalism	46	43	26	48	12	43	19	28	27	18	18	43
Scandinavian Political Studies	47	23	59	24	14	6	24	31	28	16	15	40
Electoral Studies	48	30	10	22	9	48	23	20	21	14	14	35
American Politics Research	49	50	36	43	12	62	23	32	32	19	18	49
Policy and Politics	50	54	43	61	12	65	23	36	36	22	21	56
Historical Materialism - Research in Critical Marxist Theory	51	73	64	70	14	69	24	48	46	27	24	69
Studies in Comparative International Development	52	46	72	45	14	56	22	35	34	20	18	54
Acta Politica	53	41	59	39	12	53	22	30	30	18	18	46
Parliamentary Affairs	54	65	27	62	13	51	24	40	38	24	21	59
New Republic	55	87	22	79	18	93	27	59	57	34	29	86
Political Theory	56	59	49	47	14	30	18	33	32	19	18	50
International Political Science Review	57	55	41	53	12	36	23	34	34	21	19	51
Survival	58	70	20	57	14	45	24	41	39	24	22	64
Europe-Asia Studies	59	63	71	67	12	53	24	43	40	22	21	60
Communist and Post-Communist Studies	60	68	72	64	13	66	19	46	42	26	23	67
Politikon: South African Journal of Political Studies	61	69	72	68	15	50	25	50	49	27	24	79
Government and Opposition	62	56	40	52	13	35	5	32	30	19	18	48
Studies in Conflict and Terrorism	63	60	43	59	12	63	25	42	41	25	21	65
PS - Political Science and Politics	64	74	55	66	11	68	24	45	43	26	23	66
Monthly Review - An Independent Socialist Magazine	65	79	18	72	15	73	23	49	47	27	24	70
Dissent	66	85	41	75	17	95	28	60	57	35	30	84
Canadian Journal of Political Science - Revue Canadienne de Science Politique	67	75	72	69	14	76	25	54	51	28	25	76
Political Science Quarterly	68	66	61	55	13	70	25	46	44	26	23	68
Local Government Studies	69	71	66	81	13	47	24	48	45	26	24	61
Journal of Theoretical Politics	69	61	34	41	13	71	24	44	39	22	21	62
Latin American Politics and Society	70	49	72	35	13	58	22	37	35	22	21	55
Swiss Political Science Review	71	72	45	57	15	78	25	52	50	27	24	74
East European Politics and Societies	72	64	50	65	13	74	26	51	46	27	24	71
Politická ekonomie	73	82	27	87	15	77	25	54	53	29	25	77
Latin American Perspectives	74	76	47	78	13	72	23	51	48	27	24	72
State Politics and Policy Quarterly	75	56	72	49	13	38	23	39	37	22	21	58
Political Quarterly	76	78	63	73	13	75	25	53	52	28	24	75
Australian Journal of Political Science	77	77	38	80	13	60	24	50	47	27	24	73
Nation	78	86	29	85	19	94	28	62	59	37	32	88
Journal of Women, Politics and Policy	79	80	72	77	17	81	26	58	55	32	27	83
Independent Review	80	83	64	76	15	84	26	57	55	32	27	82
Problems of Post-Communism	81	81	72	74	16	79	25	56	54	31	26	81
Internasjonal Politikk	82	89	67	95	17	91	28	66	62	39	33	92
Studies in American Political Development	83	53	72	42	15	29	26	53	46	29	24	63
Scottish Journal of Political Economy	84	67	72	60	14	67	21	47	47	26	24	78
Current History	85	88	69	82	17	85	27	61	58	36	31	87
Issues and Studies	86	92	72	90	17	82	26	64	60	37	32	90
Policy Review	87	90	65	84	19	86	27	63	60	37	32	89
SWS-Rundschau	88	94	60	91	19	87	27	65	62	38	33	93
Political Science	89	84	31	83	17	83	18	58	56	33	28	85
Política y gobierno	90	93	72	86	18	97	26	66	63	38	33	94
Russian Politics and Law	91	96	68	92	19	90	27	67	64	40	34	95
Pensée	92	97	72	94	19	88	28	69	66	42	36	97
Revue d'Économie Politique	93	91	64	88	17	89	28	65	61	38	33	91
Commentary	94	95	71	89	18	92	28	68	65	41	35	96
Internationale Politik	95	98	62	93	18	96	28	69	66	42	36	97

Literature

1. Aizerman M.A., Aleskerov F.T. (1983). Arrow's problem in group choice theory // Automation and Remote Control - Vol. 9, P. 127-151.
2. Aizerman M., Aleskerov F. (1995). Theory of Choice. Amsterdam: North-Holland/Elsevier.
3. Aleskerov F., Kurbanov E. (1999). A Degree of Manipulability of Known Social Choice Procedures // Current Trends in Economics: Theory and Applications / Eds. Alkan A., Aliprantis Ch., Yannelis N. N.Y.: Springer-Verlag. P. 13-27.
4. Aleskerov F.T., Pislyakov V.V., Subochev A.N. (2013). Rankings of economic journals constructed by methods from Social Choice Theory: Working paper WP7/2013/03. Moscow: National Research University Higher School of Economics. (in Russian)
5. Aleskerov F.T., Pislyakov V.V., Subochev A.N., Chistyakov A.G. (2011). Rankings of management science journals constructed by methods from Social Choice Theory: Working paper WP7/2011/04. Moscow: National Research University Higher School of Economics. (in Russian)
6. Aleskerov F., Subochev A. (2009). Matrix-vector representation of various solution concepts. Working paper WP7/2009/03. Moscow: SU - Higher School of Economics.
7. Aleskerov F., Subochev A. (2013). Modeling optimal social choice: matrix-vector representation of various solution concepts based on majority rule // Journal of Global Optimization - Vol. 56, Iss. 2, P. 737-756.
8. Arrow K.J., Raynaud H. (1986). Social Choice and Multicriterion Decision-Making. Cambridge (Mass.): MIT Press.
9. Braun T., Glänzel W., Schubert A. (2006). A Hirsch-type index for journals // Scientometrics - Vol. 69, No. 1, P. 169–173.
10. Cartwright D., Gleason T.C. (1966). The number of paths and cycles in a digraph // Psychometrika – Vol. 31, No. 2, P. 179-199.
11. Chebotarev P., Shamis E. (1999). Preference fusion when the number of alternatives exceeds two: indirect scoring procedures // Journal of the Franklin Institute - Vol. 336, P. 205-226.
12. Copeland A.H. (1951). A reasonable social welfare function (mimeo). University of Michigan, Ann Arbor (Seminar on Application of Mathematics to the Social Sciences).
13. Daniels H.E. (1969). Round-robin tournament scores // Biometrica - Vol. 56, P. 295-299.
14. Eigenfactor Score and Article Influence Score: Detailed Methods // http://www.eigenfactor.org/methods.pdf
15. Egghe L. (1988). Mathematical relations between impact factors and average number of citations // Information Processing and Management - Vol. 24., P. 567–576.
16. Garfield E., Sher I. H. (1963). New factors in the evaluation of scientific literature through citation indexing // American Documentation - Vol. 14, No. 3, P. 195–201.
17. Glänzel W., Moed H. F. (2002). Journal impact measures in bibliometric research // Scientometrics - Vol. 53, No. 2, P. 171–193.
18. Good I.J. (1971). A note on Condorcet sets // Public Choice - Vol. 10, P. 97-101.

19. Gonzalez-Pereira B., Guerrero-Bote V., Moya-Anegon F. (2010). A new approach to the metric of journals scientific prestige: The SJR indicator // Journal of Informetrics - Vol. 4, Iss. 3, P. 379 – 391.

20. Guerrero-Bote V. P., Moya-Anegón F. (2012). A further step forward in measuring journals' scientific prestige: The SJR2 indicator // Journal of Informetrics - Vol. 6, Iss. 4, P. 674-688.

21. Hirsch J. E. (2005). An index to quantify an individual's scientific research output // Proceedings of the National Academy of Sciences - Vol. 102, No. 46, P. 16569-16572.

22. Jacsó P. (2010). Differences in the rank position of journals by Eigenfactor metrics and the five-year impact factor in the Journal Citation Reports and the Eigenfactor Project web site // Online Information Review - Vol. 34, No. 3, P. 496–508.

23. Kendall M.G. (1938). A New Measure of Rank Correlation // Biometrika - Vol. 30, P. 81-89.

24. Laslier J.F. (1997). Tournament Solutions and Majority Voting. Berlin: Springer.

25. Miller N.R. (1980). A new solution set for tournaments and majority voting: Further graph-theoretical approaches to the theory of voting // American Journal of Political Science - Vol. 24, P. 68-96.

26. Moed H. F. (2010) Measuring contextual citation impact of scientific journals // Journal of Informetrics - Vol. 4, Iss. 3, P. 265–277.

27. von Neumann J., Morgenstern O. (1944). Theory of Games and Economic Behavior. Princeton: Princeton University Press.

28. Pislyakov V.V. (2007). Citation-based methods for evaluation of scientific information // Sotsiologicheskij Zhurnal - Vol. 1, P. 128–140. (in Russian)

29. Rousseau R. (1988). Citation distribution of pure mathematics journals // Informetrics 87/88 / Ed. L. Egghe, R. Rousseau. Amsterdam: Elsevier. P. 249–262.

30. Rousseau R. (2002). Journal evaluation: Technical and practical issues // Library Trends - Vol. 50, Iss. 3, P. 418–439.

31. Schwartz T. (1970). On the Possibility of Rational Policy Evaluation // Theory and Decision - Vol. 1, P. 89-106.

32. Schwartz T. (1972). Rationality and the Myth of the Maximum // Noûs - Vol. 6, P. 97-117.

33. Schwartz T. (1977). Collective choice, separation of issues and vote trading // The American Political Science Review - Vol. 71, No. 3, P. 999-1010.

34. Smith J. (1973). Aggregation of Preferences with Variable Electorates // Econometrica - Vol. 41, Iss. 6, P. 1027-1041.

35. Subochev A. (2008). Dominant, Weakly Stable, Uncovered Sets: Properties and Extensions: Working paper WP7/2008/03. Moscow: SU - Higher School of Economics.

36. Ushakov I.A. (1971). The problem of choosing the preferable object // Izvestiya Akademii Nauk SSSR. Tekhnicheskaya Kibernetika - Vol. 4, P. 3-7. (in Russian)

37. Waltman L., van Eck N. J., van Leeuwen T. N., Visser M. S. (2013). Some modifications to the SNIP journal impact indicator // Journal of Informetrics - Vol. 7, Iss. 2, P. 272–285.

38. Ward B. (1961). Majority Rule and Allocation // Journal of Conflict Resolution - Vol. 5, P. 379-389.

Fuad T. Aleskerov
DeCAn Lab and Department of Mathematics for Economics, National Research University Higher School of Economics, Moscow, Russia; Institute of Control Sciences, Russian Academy of Sciences, Moscow, Russia; alesk@hse.ru

Vladimir V. Pislyakov
Library, National Research University Higher School of Economics, Moscow, pislyakov@hse.ru

Andrey N. Subochev
DeCAn Lab and Department of Mathematics for Economics, National Research University Higher School of Economics, Moscow, asubochev@hse.ru