Economics Bulletin

Volume 37, Issue 4

An Elo ranking for economics journals

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Abstract

Rankings for sports such as chess or table tennis are based on the so called Elo rating system. In this paper, we apply this rating system to rank economics journals. One main advantage of the Elo ranking compared to existing ones is its explicit consideration of a journal's performance path. Another advantage is the easy application of the system to any journal metric that is published on a regular basis. Our application is based on data from Web of Science that comprises the impact factors of 382 economics journals for the period from 1997 to 2016. The most recent Elo ranking is quite different for rather 'middle-class' journals compared to other existing rankings. However, also some differences for the top 30 emerge.

We are grateful to one anonymous referee for very helpful comments. We also thank Justus Meyer for his excellent research assistance.
Citation: Robert Lehmann and Klaus Wohlrabe, (2017) "An Elo ranking for economics journals", *Economics Bulletin*, Volume 37, Issue 4, pages 2282-2291
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Submitted: August 01, 2017. **Published:** October 26, 2017.

1 Introduction

Ranking scientific journals has a long tradition and is intensively monitored by several interest groups such as researchers and academic institutions. From a publisher's point of view, it is straightforward to accumulate high-quality journals in its portfolio. Modern tenure tracks and job market positions, however, require researchers to frequently publish articles in these high-quality outlets. Crucial for the definition of the quality is always the underlying ranking scheme. Since it is by no means obvious how such a scheme should look like, a heated debate is going on that is especially pronounced in the scientific field of economics (Butz *et al.*, 2017). This article does not want to form a meta-statement on how to rank economics journals, but to present a promising alternative that is commonly applied in sports: the Elo rating system.

Citations, the impact factor or the source normalized impact per paper (SNIP) indicator are three possible journal metrics for setting up a ranking. As it was brought forward by Lehmann and Wohlrabe (2017) for a data set containing more than 20 000 journals from a number of scientific sub-disciplines, the main disadvantage from rankings based on these metrics is the predominant time invariance of the classification scheme. Many metrics more or less refer to a specific year, thus, a journal's prestige significantly drops if the chosen metric falls. However, one would agree that this drop is not equal to a loss of reputation. This shortcoming of rather standard classification schemes is attenuated by the Elo rating system, since the latest Elo ranking is based on the complete trajectory of a journal's performance. This is one main result of Lehmann and Wohlrabe (2017), who find that the ranking for rather 'middle-class' journals can tremendously change on the basis of the Elo rating system compared to standard classification schemes. Since economics is a field with a very special ranking discussion, we adopt the Elo rating system to this scientific sub-discipline in this paper.

The underlying idea of the Elo system is the following. Each journal has an Elo score which is basically derived from its impact. At the end of a given year t, the journals 'compete' with each other such as in sports and earn Elo points that are based on the journal's expected value for a 'win' or a 'loss'. After all competitions, the journal's Elo score is adjusted accordingly. Based on these new scores, the journals compete with each other in $t + 1$. Thus, the expected values as well as the resulting Elo points vary over time, thus, the ranking approach becomes more dynamic. This procedure causes the latest ranking to depend on the complete time path of a journal's performance.

Our analysis is based on data from the Web of Science Journal Citation Reports. We rely on 382 economics journals from 1997 to 2016. As expected before, the time path of a journal's performance clearly matters for the most recent ranking. Thus, a rather 'bad' year in a journal's performance is no reason for a large drop in the ranking position. Compared to rankings based on average impact factors, data from Research Papers in Economics (RePEc) or the Scimago Journal Rank (SJR) by Scopus, it turns out that the Elo ranking is by no means identical to those resulting from the alternatives. Especially the rankings for 'middle-class' journals are quite different. We, however, also find differences for the top 30 ranked journals. The Elo rating system makes its point and can be an alternative to existing ranking approaches.

The paper is organized as follows. Section 2 introduces the data and the Elo rating system. In Section 3 we present and discuss the new ranking. The last section concludes.

2 Data and Methodology

2.1 Data

Our analysis is based on the Journal Citation Reports (JCR) from the Web of Science platform by Clarivate Analytics at `http://clarivate.com`.[1] We rely on all JCRs from the *Economics* category, comprising the years from 1997 to 2016. The journal sample is unbalanced since a large number of entries and exits take place over time. In 1997, 166 journals were listed in the JCR, whereas the number increased to 347 in 2016. If we count the total number, 382 journals have appeared in the data, with 130 listed permanently over the observation period. In contrast, nine journals were listed only once.

As the bibliometric measure for journal quality we employ the standard two year Journal Impact Factor (JIF), since it is stated in every report and for each year. Thus, the JIF is the only impact measure that is available for the full sample period.[2] The definition of the two year JIF is the following (see Thomson Reuters Web of Science, 2015): *Total citations in a year to papers published in a journal in the previous 2 years* divided by *Total papers published in a journal in the previous 2 years*. The number of citations are not exclusively limited to economics journals but are counted across the whole Web of Science data base, thus, citations coming in from other scientific disciplines are included. Self-citations of a journal are, however, not excluded in the calculation of the JIF.[3] Furthermore, the JIF does not account for different citation styles across scientific fields like the SNIP does.[4] Although often criticized in the bibliometric literature, the JIF is still one of the cornerstones to evaluate journals.[5] For details and further references see Archambault and Larivière (2009) and Vanclay (2012).

2.2 The Elo Rating System

Fundamentals. The origin of the Elo rating system is chess. Arpad Emrick Elo, an American physicist born in Hungary and eponym for the rating, wanted to develop a system to rate chess players of the United States Chess Federation (USCF) that is based on well defined statistical properties. Nowadays, the rating is also adopted by the Fédération Internationale des Échecs (FIDE), the world chess federation, or transferred to many other sports such as table tennis (see, for example, Glickman, 1995). Next to the sports application, the Elo rating system was also used by Večeк *et al.* (2014) to rank evalutionary algorithms. Lehmann and Wohlrabe (2017) recently applied the system to rank more than 20 000 journals from all possible scientific disciplines.

The Elo rating system comprises two steps (see here and henceforth Glickman and Jones, 1999). First, the expected score is calculated. And second, the player's rating is

[1] The use of the Web of Science platform for bibliometric analyses has a long tradition in the corresponding literature. The characteristics of the database have been studied in detail by, for example, Michels and Schmoch (2012) or Moed (2005).

[2] Other possible impact measures are the five year JIF, the total number of citations and the Eigenfactor score. A newer measure that also accounts for citation practices between disciplines is the SNIP.

[3] In some years the JCRs provided impact factors corrected for self-citations. These metrics are, unfortunately, not available for the whole observation period.

[4] Field-normalization by the SNIP indicator is done for a very broad journal classification. The measure does, however, not account for different citation patterns *within* economics (e.g., macroeconomics vs. microeconomics). For a normalization approach using the Journal of Economic Literature (JEL) codes, see Bornmann and Wohlrabe (2017).

[5] One visible evidence for this fact is that almost every journal posts its IF on the journal web page.

adjusted according to the match outcome. For a very detailed description we refer to Elo (1978). The true strength of two players A and B is basically unknown, thus, the hypothetical match outcome between both is approximated with the following formula:

$$E_A = \frac{1}{1 + 10^{(R_B - R_A)/400}} \,. \tag{1}$$

The probability or the expected score for player A to win against player B is definded as E_A. This score is based on the unknown strengths of both players (R_A and R_B). We assume that a match between two players with strengths $R_A = 1\,400$ and $R_B = 1\,500$ takes place. The expected long-run score of player A to win the match is $E_A = 0.36$, thus, in 36 out of 100 cases player A will beat his opponent B or gain a draw. With $E_B = 0.64$, the opposite holds true for player B. However, a match can only end in three outcomes: 0/1 if player A loses/wins and 0.5 in the case of a draw. As the strengths are unknown, they are replaced by estimates called Elo scores or Elo ratings (R_A or R_B).

After the match, the Elo scores have to be updated. This is done by the following formula from the perspective of player A:

$$R_{A,t+1} = R_{A,t} + k(S_A - E_A) \,. \tag{2}$$

The new rating for player A in $t+1$ ($R_{A,t+1}$) is the old rating ($R_{A,t}$) plus the difference between the match outcome and the expected long-run score ($S_A - E_A$), weighted by the factor k to allow how fast a player can catch up. For weaker chess players, k equals 32. Three match outcomes and thus resulting ratings can now emerge, again from player A's perspective:

- A **wins** ($S_{A,t} = 1$)**:** $R_{A,t+1} = 1\,420$, $R_{B,t+1} = 1\,480$,
- **Draw** ($S_{A,t} = 0.5$)**:** $R_{A,t+1} = 1\,404$, $R_{B,t+1} = 1\,496$,
- A **loses** ($S_{A,t} = 0$)**:** $R_{A,t+1} = 1\,388$, $R_{B,t+1} = 1\,512$.

Player A's rating increases either winning the match or gaining a draw since the expected long-run score is lower than the draw's point value ($0.36 < 0.50$). The expected values in $t+1$ are then based on the updated Elo ratings. For the mathematics of such pairwise comparisons – the Elo rating system is a special case – we refer to Joe (1991).

Journal ranking. After the discussion of the fundamentals, we have to set parameter values for the application of the system to rank economics journals. We follow Lehmann and Wohlrabe (2017) and apply their procedure. The match outcomes are defined as 0/1 if journal A has a lower/higher JIF compared to journal B and 0.5 if the JIFs are equal. Since we only look at economics journals, we set $k = 1$ in order to allow for the same 'catch-up speed'. However, we will elaborate more on the variation of k in Section 3. If the journals have no impact at all ($JIF_{A,t} = JIF_{B,t} = 0$), they will not play against each other. As an impact factor of zero would result in an inflationary number of draws, we want to avoid Elo ratings for journals to increase that have no impact. If a journal's JIF is missing in t, it will not play against the other competitors and we put its old Elo rating forward to $t+1$. We also restrict the absolute maximum of the rating difference to $|R_{B,t} - R_{A,t}| \leq 400$ which is also recommended by FIDE.[6] By not setting this maximum,

[6]The official statement can be found in the handbook on FIDE Rating Regulations effective from July 1, 2014 at: `https://www.fide.com/fide/handbook.html?id=172&view=article`.

the ranking would become very volatile as stated by Lehmann and Wohlrabe (2017). As the initial Elo score, we set $R_{A,0} = 10\,000$ since we cannot estimate those figures from the data. However, the final ranking of 2016 is not affected by this value as we treat the journals as non-existing before 1997. The Elo scores develop onwards from this starting point. For 'newcomer' in the data set we cannot proceed as before. We rather place the new journal in the distribution of Elo scores in the following way. If a journal enters in year t, it will play a 'pre-tournament' against all journals from $t-1$ beforehand, based on all rules mentioned before. Afterwards, the fictive number of wins and draws serve as the measure to calculate the position of the new journal in the whole distribution in $t-1$. The resulting Elo score is then used for the new journal in t. For each year, the Elo scores are only adjusted ones, thus, the journals first play against each other. At the end of all pairwise comparisons, the new Elo rating is calculated. Taking the year 2016 as an example, the data set comprises 347 journals that end up in 346 pairwise comparisons each. The overall journal ranking of 2016 is based on the latest Elo scores ($R_{A,2016}$). As one can see from the equations before, the latest ranking incorporates the complete trajectory or history of a journal's performance.

3 Results

In this section, we present our economics journals ranking based on the Elo rating system. Table 1 shows the result.[7] The table has five columns: the resulting ranking (i) from the Elo system with $k = 1$, (ii) based on the Elo system with $k = 10$, (iii) from the average JIF for the years 1997 to 2016, (iv) on the basis of data from Research Papers in Economics (RePEc) and (v) the 2016 SJR score by Scopus. Before we compare the Elo ranking with those based on other approaches or data, we take a closer look on the Elo outcome.

The top three journals in Economics based on the Elo ranking are the *Journal of Economic Literature*, followed by the *Quarterly Journal of Economics* and the *Journal of Finance*. Almost all well-known journals are listed in the top 30. Also journals that are more or less classified as 'field-journals' are ranked, for example, in the top 20 (*Economic Geography* – 11, *Journal of Economic Geography* – 14 or *PharmacoEconomics* – 17). Based on rather subjective weights one might ask, however, how other well-known journals are ranked. Let us take a closer look at the complete ranking. The *Journal of the European Economic Association* (JEEA) is ranked on the 36th place. The JEEA started with a low JIF but improved its performance over the last years. However, the Elo system smooths the performance since it considers the complete trajectory of a journal. The same holds for the *American Economic Journal: Macroeconomics* which is placed 58. There might also be an error in the data since the AEJ: Macro has on average a ten-times lower JIF at its launch compared to the other AEJ-Journals. This causes the journal to be ranked as it is by the Elo system.

In the next step, we compare our Elo results to rankings based on other approaches or different data. First, we start by modifying the adjustment parameter k and recalculate the ranking (column 3 in Table 1). The changes are negligible as also the rank correlation of 0.994 in Table 2 points to. This high rank correlation is also confirmed by plotting both rankings against each other (see panel A in Figure 1). The scatter shows an almost 45° line with some few differences.

[7] The complete Elo ranking containing all journals can be found in an earlier version of this paper (MPRA Paper No. 80539) at: `https://ideas.repec.org/p/pra/mprapa/80539.html`.

Table 1: Top 30 ranked economics journals in 2016

Journal	**Elo 2016 (k = 1)**	**Elo 2016 (k = 10)**	**Average IF (1997-2016)**	**RePEc**	**SJR 2016**
Journal of Economic Literature	1	1	1	2	11
Quarterly Journal of Economics	2	2	3	1	1
Journal of Finance	3	3	2	8	2
Journal of Economic Perspectives	4	4	5	9	17
Journal of Financial Economics	5	5	11	6	6
Journal of Political Economy	6	6	9	3	5
Review of Financial Studies	7	8	4	10	7
Econometrica	8	7	15	4	4
Review of Economic Studies	9	9	25	7	3
Review of Environmental Economics and Policy	10	13	7	66	37
American Economic Review	11	10	24	11	9
Economic Geography	12	12	18	178	47
Transportation Research Part B: Methodological	13	11	6	171	44
Journal of Economic Geography	14	16	8	61	33
Value in Health	15	15	13	–	–
Journal of Accounting & Economics	16	14	26	38	14
PharmacoEconomics	17	17	14	292	73
Journal of Economic Growth	18	19	21	5	28
Review of Economics and Statistics	19	20	37	22	18
Technological and Economic Development of Economy	20	30	12	–	–
Ecological Economics	21	21	42	110	72
Transportation Research Part A: Policy and Practice	22	26	20	175	79
American Economic Journal: Applied Economics	23	18	10	26	10
American Economic Journal: Economic Policy	24	24	23	39	12
Brookings Papers on Economic Activity	25	33	28	14	41
Economic Journal	26	32	46	19	30
Energy Economics	27	22	58	71	54
Economic Policy	28	28	34	12	46
Transportation Research Part E: Logistics and Transportation Review	29	27	22	181	74
Economic Systems Research	30	23	16	145	40

Note: The journals are ordered according to the Elo ranking. *Source:* Data taken from Web of Science, RePEc, and Scopus.

Second, we compare our basic Elo results with a ranking that is based on the average JIF for each journal over the period 1997 to 2016. Panel B of Figure 1 reveals a higher dispersion in the rankings compared to the variation of parameter k; this result is also confirmed by looking at the corresponding rank correlation in Table 2 (0.932). The dispersion is especially pronounced for rather 'middle-class' journals, which points to one main result by Lehmann and Wohlrabe (2017). We can observe, however, some huge outliers which underpins our main contribution. Whereas the average JIF suggests that a journal is ranked bad, the Elo system corrects these outliers over time and rather smooths the ranking.

Table 2: Spearman rank correlation between different rankings

	Elo 2016 (k = 1)	**Elo 2016 (k = 10)**	**Average IF (1997-2016)**	**RePEc**	**SJR 2016**
Elo 2016 (k = 1)	1.000				
Elo 2016 (k = 10)	0.994	1.000			
Average IF (1997-2016)	0.932	0.915	1.000		
RePEc	0.614	0.597	0.593	1.000	
SJR 2016	0.889	0.889	0.847	0.616	1.000

Note: The correlations with the RePEc and the SJR ranking are based on a reduced sample with $N = 303$ and $N = 345$ observations respectivly, while the other correlations are based on the full sample ($N = 382$ observations). *Source:* Data taken from Web of Science, RePEc, and Scopus.

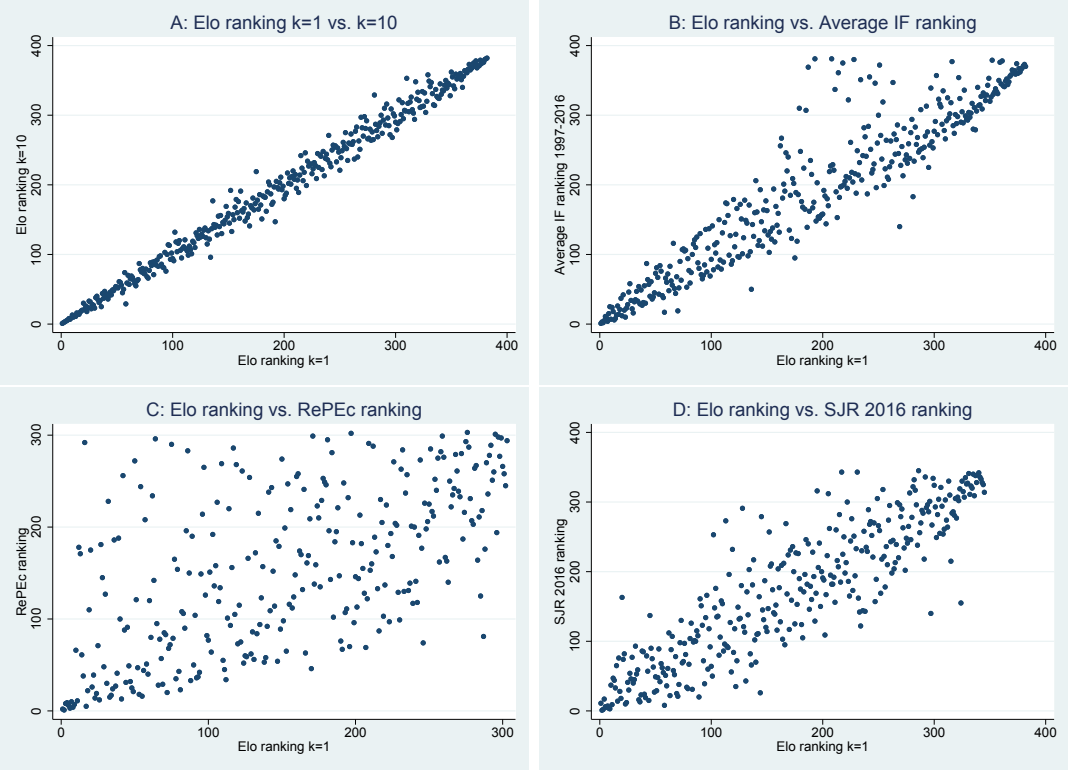
For our third comparison we make usage of another data source for impact factors: Research Papers in Economics (RePEc, `http://www.repec.org`). RePEc has become a very important source for various rankings in economics. Based on a large but still expanding bibliometric database, RePEc publishes numerous rankings for journals, authors, economic departments, and institutions. RePEc covers more journals and working paper series compared to Web of Science. In addition, RePEc also includes chapters and books (further details can be found in Zimmermann, 2013). For our comparison, we use the Simple Impact Factor (SIF), which is defined as the ratio between *cumulative citations of a journal* and its *total number of articles*. In this sense, and in the spirit of our Elo system, the SIF more or less covers the complete history of a journal. We base our comparison on a subset of journals since not all that are included in Web of Science are also listed in RePEc. Thus, we recalculate our 2016 Elo ranking accordingly.

The rank correlation in Table 2 and panel C in Figure 1 reveal large differences between the two rankings. A huge dispersion becomes obvious by scattering both rankings. We also find prominent examples in the top 30 (see again Table 1), for example, the journals *Economic Geography*, *Transportation Research Part B: Methodological* and *PharmacoEconomics*. The according ranking differences are 166, 158 and 275 places. At this point we could conclude that the RePEc ranking is quite different from the Elo one. But this conclusion should be formulated with caution, since the RePEc data base does not comprise all articles of all journals. The journals can decide on their own whether to upload all of its publications or not, thus, the Web of Science data are not fully comparable to those by RePEc. Furthermore, the citation coverage in RePEc is quite incomplete.

Fourth, we compare our Elo ranking with one resulting from the 2016 Scimago Journal Rank (SJR) as proposed by González-Pereira *et al.* (2010). The SJR is a field-normalized indicator that accounts for the prestige of the citing journal.[8] Its calculation is based on bibliometric data from Scopus that cover citations from more than 20 000 journals. The field-normalization takes place at the level of the so called *All Science Journal Classification* that allows to distinguish between the main fields of science (e.g., economics or physics), but is not suitable to account for the different areas within economics. As in the case of RePEc, we recalculate our 2016 Elo scores since not all journals are available in Scopus.

[8]A detailed description can be found at: `http://www.scimagojr.com/SCImagoJournalRank.pdf`.

Figure 1: Scatter plots between rankings based on different approaches or data



The dispersion between the Elo ranking and the one resulting from the SJRs of 2016 is not as pronounced as in the case of RePEc (see panel D in Figure 1). Also the rank correlation of 0.889 points to this result. However, some differences emerge for the top 30. Three journals are no longer ranked top 10 by applying the SJR: the *Journal of Economic Literature*, the *Journal of Economic Perspectives* and the *Review of Environmental Economics and Policy*.

In order to reveal the extent of agreement and disagreement between all rankings in a different way, we finally group the journals according to the Characteristics Scores and Scales (CSS) method proposed by Glänzel *et al.* (2016). For each metric (Elo with $k = 1$ or $k = 10$, the average Impact Factor, RePEc, and the SJR), CSS scores are obtained by truncating the journal set at their metric mean, recalculating the new mean of the remaining journals and proceed as such until a stopping criteria is fulfilled or no new scores are generated (see, for a more detailed presentation, Bornmann and Glänzel, 2017). We define four classes that are labeled **A**, **B**, **C**, and **D**. Whereas 'poorly-cited' journals in category D fall below the average impact of all journals in the set, the remaining classes are by definition above this average and can be used to further differentiate an area of journals with higher impact.

Table 3 presents the results of the CSS approach. The number of journals that are equally classified by two different rankings can be found on the respective diagonal. If the number of off-diagonal elements increases, the more do the rankings disagree. Nevertheless, Table 3 confirms our previous interpretations. The highest dispersion in journal classifications can be found by comparing the Elo ranking 2016 ($k = 1$) either with the RePEc or the SJR ranking. In the case of SJR, however, the numbers of journals located on the off-diagonal are rather small. For the RePEc ranking, the numbers are much higher. This finding can again be explained by data differences.

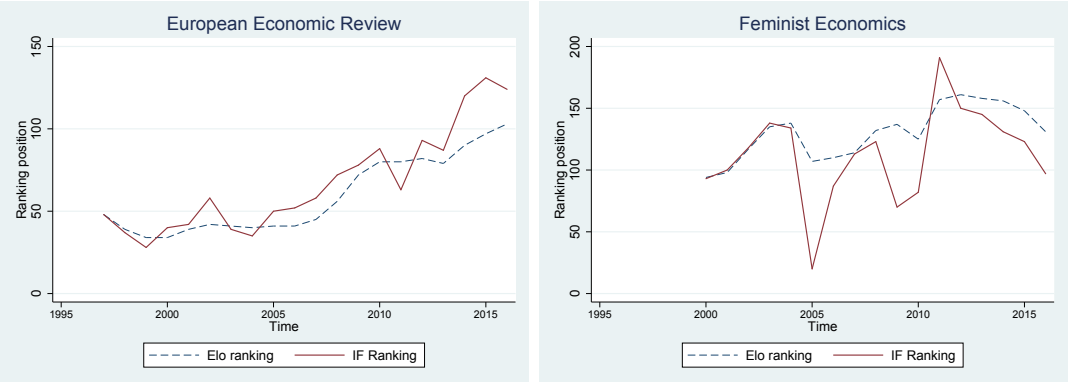
In the end, and to underpin our argumentation on the trajectory, we introduce Figure 2 that plots the evolution of the rankings either based on the latest Elo score or the 2016 JIF for the journals *European Economic Review* (EER) and *Feminist Economics* (FE). For the EER we observe a worsening JIF ranking over time. The corresponding Elo ranking lies in almost all cases below the JIF ranking. This finding points to the issue that the EER profits in the short-run from its past prestige. However, in the long-run its early success vanishes. For FE we observe two large position gains: 2005 and 2009. Figure 2 clearly shows that the Elo rating system almost perfectly smooths out these outliers, thus, it takes care of the performance of the journal over time.

Table 3: Journal classification according to the CSS approach

		Elo 2016 (k = 1)			
	Journal Classification	**A**	**B**	**C**	**D**
Elo 2016 (k = 10)	**A**	36	2	0	0
	B	2	38	5	0
	C	0	1	90	8
	D	0	0	4	196
Average IF (1997-2016)	**A**	16	19	3	0
	B	1	11	33	0
	C	0	0	49	50
	D	0	0	0	200
RePEc	**A**	9	7	7	8
	B	0	10	9	16
	C	0	2	27	50
	D	0	0	10	148
SJR 2016	**A**	8	8	18	2
	B	1	4	26	11
	C	0	1	17	70
	D	0	0	0	179

Source: Data taken from Web of Science, RePEc, and Scopus.

Figure 2: Ranking comparison over time for two specific journals



4 Conclusion

One criticism to be raised when it comes to rank economics journals is the negligence of a journal's performance over time. In this paper, a prominent ranking system in sports, namely the Elo system, is transferred to scientific publishing in economics. Our analysis is based on 382 journals from Web of Science that are listed in the Journal Citation Reports for the period from 1997 to 2016. It turns out that the performance time line of a journal is crucial for its latest ranking. Thus, the new Elo system makes a point since the resulting ranking is by no means identical to those resulting from different alternatives (average impact factors, data from Research Papers in Economics – RePEc or the latest SJR score). A huge difference occurs especially for rather 'middle-class' journals. In the end, the Elo rating system seems to be a promising alternative to already existing and prominent approaches.

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