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Another brick in the wall: a new ranking of academic journals in Economics using FDH

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Abstract The academic journals rankings are widely used for academic purposes, especially in the field of Economics. There are many procedures to construct academic journals rankings. Some of them are based on citation analysis while other are based on expert opinion. In this study, we introduced a methodological innovation to aggregate different performance measures to build an alternative ranking of journals in Economics. Our approach is based on a pure output oriented Free Disposal Hull (FDH). We analyzed four indicators—Journal Impact Factor, Discounted Impact Factor, h-index, and Article Influence—for a set of 232 journals in Economics. The results allow us to reach two main conclusions. First, the ranking based on the FDH method seems to be consistent with other well-known reference rankings (i.e.: KMS, Invariant, Ambitious and Area Score). Second, the additional information that provides the FDH model may be used by the Editorial Board to formulate strategies to achieve goals. For instance, to improve a journal score by comparing it with the scores of similar journals.

Keywords Citation analysis · Free Disposal Hull · Academic journals rankings

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Introduction

Academic journals rankings (henceforth AJR) are widely used for different purposes (Harvey et al. 2015). For instance, scientists can use them to find the most appropriate journal to publish their manuscripts. Likewise, academic departments, faculties or universities use the AJRs increasingly for hiring or tenure processes, for conducting research evaluation or for projects' funding decisions. Furthermore, Economics is one of the fields where journals rankings are nowadays more commonly used.

The aim of this paper is to propose a novel aggregation approach to building up an AJR in the field of Economics. For this purpose, we used the Free Disposal Hull (henceforth FDH) which, to the best of our knowledge, has not been used for this purpose so far. We believe that this approach, which is increasingly used in other fields such as efficiency analysis in Economics (De Borger and Kerstens 1996; Gupta and Verhoeven 2001), can be extended successfully to the field of Bibliometrics and the so-called Science of Science Policy (Husbands Fealing et al., 2011).

One of the main advantages of the FDH model is that it provides more than a single score for each journal. It also yields some additional information that can be used for journal's potential improvements. For example, the FDH model allows to identify the benchmark set of journals and carry out the so-called "yardstick competitions" among pairs of journals.

For these reasons, we consider this approach provides an added value for Journals' editors, hiring committees, or researchers since an FDH-based ranking could be more informative than a list of academic journals ordered according to a single index.

The academic journal rankings are relatively straightforward to use and are readily understandable as their main assumption is that the higher is the position of a journal; the better is its prestige and reputation. However, there are many variables involved in the elaboration of an AJR, and therefore, both the variables included, and the way these variables are combined could generate entirely different orders. For that reason, the AJRs should be "handled with care" (Wall, 2009) if we take into account that the "correct AJR" does not exist, which implies that all the published rankings could be criticized to some extent. In fact, any AJR is the result of a set of subjective decisions taken by its authors (journals included, indicators selected, etc.). Essentially, every new AJR represents just "another brick in the wall", and consequently the selection of an AJR should be based on its methodology and the benefits that it provides regarding fairness in the comparison, usefulness and general agreement about its validity and not on how closely it represents one's preconceptions.

The AJRs in Economics usually are based on two types of indicators. On the one hand, citations and other bibliometric indicators such as h-indexes, average citations (Harvey et al. 2010). On the other, the journals' reputation measured through surveys or polls among experts. In some cases, the scores are computed as a combination of both type of inputs (Haddow and Genoni 2010). Additionally, it is also frequent that academic departments have their rankings for hiring decisions or promotions. Most of these AJRs remain unpublished; therefore, the number of other AJRs could be significantly high.

The sources of subjectivity are important in all ARJs. For example, the citation-based rankings depend on which database is used (i.e. Scopus, Web of Science, Google Scholar Citations), and also which indexes are selected (2 or 5 years IF, h-index, SJR, eigenfactor, etc.). When the AJR are based on surveys among experts, some aspects such as the sample size and selection or the validity and reliability of the questionnaire could affect the results.

Finally, the methodology used to obtain the aggregated scores is an essential element that determines the result. There is an extensive set of statistical methods used in literature from fuzzing clustering (Benati and Stefani 2011) to nested regression (Currie and Pandher 2011), or machine learning (Ennas et al., 2015).

In this study, we propose an AJR based on the aggregation of four citation-based indicators that represent the most influential trends in Bibliometrics. The indicators are (1) the Journal Impact Factor (JIF); (2) the Discounted Impact Factor (DIF); (3) the h-index, and (4) the Article Influence (AI). Since any single indicator has some caveats, we bring them together by using a novel aggregation method that offers a sounder result that could be broadly accepted by academics, editors, and decision makers (i.e. hiring committees, funding bodies, etc.). Last, to check the validity and the robustness of our results, we report the correlation coefficients with four well-known different rankings.

We collected data on these four indicators for 232 journals in Economics in 2010. We initially selected the journals from IDEAS/RePEc rankings (https://ideas.repec.org/top/). This page provides links to various rankings of 1325 journals in Economics and related fields. First, we collected two indicators from this web: the DIF and the h-index. Then we gathered the JIF from the Journal Citation Reports (Thomson-Reuters), and the AI from eigenfactor.org. The inclusion of the last two indicators reduced the number of journals down to 232.

Our results confirm that the FDH ranking based on four bibliometric indicators is highly correlated with previously published rankings, which supports its validity. Moreover, this approach also provides useful complementary information to academics, journals editors, and decision makers. For instance, journal editors may use the FDH output for improving their scores or identifying which other journals compete with them. To sum up, we consider that the FDH approach is a promising method for its use in Bibliometrics, and particularly for building up academic journal rankings.

The paper is organized as follows. In "The FDH method" section, we introduce the FDH methodology. "Methodology" section is devoted to describing data and variables. "Results" section presents the results and finally, the paper ends with some conclusions and explores directions for further research.

The FDH method

The FDH is a non-parametric multivariate method which it is usually employed to determine the efficiency of a set of the so-called decision making units (DMU) based on their inputs and outputs.

The FDH model is used in the field of production economics and efficiency measurement where most of research focuses on studying the performance of producers taking into account their ability to manage the resources they can control in order to produce the maximum output feasible. Defining a vector of inputs $x = (x_1,\ldots, x_m) \in \mathbb{R}^{+}_{m}$ and a vector of outputs $y = (y_1,\ldots, y_s) \in \mathbb{R}^{+}_{s}$, the feasible multi-input multi-output production technology can be defined using the output possibility set $P(x)$, which can be produced using the input vector x: $P(x) = \{y\text{: } x \textit{ can produce } y\}$. The two most well-known non-parametric techniques for estimating $P(x)$ are Data Envelopment Analysis (Charnes et al. 1978, Banker et al. 1984) and Free Disposal Hull (Deprins, et al. 1984). Both techniques assume some general microeconomic properties for production functions (Shephard, 1970; Daraio and Simar 2007) and draw the production frontier connecting efficient units assuming free disposability in inputs and outputs for $P(x)$.[1] However, while DEA builds up the production frontier through a convex piecewise linear combination of best performers, the FDH technique is more flexible than DEA because it relaxes the convexity assumption and efficiency performance can be evaluated on existing best practice units. For that reason, FDH provides more straightforward comparisons than DEA for the 2002 AJR users. For example, an FDH model makes possible to benchmark inefficient journals against other fully efficient real journals instead of providing as target hypothetical linear combinations of journals that do not exist.

In this study, we use a pure output oriented FDH model for aggregating four journal performance indicators. We assume that the selected journals are trying to maximize their contribution to the growth of the science that we could call "impact in the science community." We consider that there is not an index comprising all possible dimensions to rank a list of journals. Otherwise, what it is usually available, is a set of output indicators for measuring different dimensions of the relevance of a group of journals of a scientific discipline.

The idea of comparing a set of one equal input decision making units producing multiple outputs—i.e. journals of Economics—is not new. It was originally proposed by Thompson et al. (1986), Adolphson et al. (1991), and Lovell and Pastor (1997). Further, Lovell and Pastor (1999) formalized the concept under a DEA framework. They defined the 'pure output model' as an output-oriented DEA model with a single constant input equal to 1.

Previous works have used DEA with a similar purpose in Bibliometrics (Halkos and Tzeremes 2011; Tüselmann et al. 2015) but as it was said, FDH allows to relax the convexity assumption comparing only real journals performance. In this paper, we propose to slightly adapt the conventional FDH technique to obtain a Bibliometrics index based on efficiency analysis to construct a ranking for scientific journals. This idea of using FDH employing one fixed—equal to 1—input (in our case the Editorial Board) to produce different dimensions of outputs was first applied by Lovell (1995) to construct a macroeconomic performance frontier for ten Asian economies.

Our primary assumption in the Bibliometrics framework is that a set of journals of the same field are directly comparable because all of them have the same aim that is to maximize their 'impact in the science community' through the publication of high-quality papers. As Lovell and Pastor (1999) suggest, we could interpret this model from a production perspective arguing that each scientific journal is the input by itself, and, therefore, all of them employ a single constant equal to one input to produce different outputs.

In this approach, the FDH model is a tool for aggregating performance indicators for building up a new AJR without explicit reference to the inputs, and not as a traditional efficiency analysis that would require the inputs that are being used for achieving such performance. Under this framework, we could regard the Editorial Board of each journal as a decision-making unit that can pursue different performance goals[2] as, for example, to increase the number of published articles and their average quality, to optimize its specialization degree and other relevant indicators according to different criteria.

[1] Free disposability in inputs and outputs for $P(x)$ means that if $(x, y) \in P(x)$ then $(x', y') \in P(x)$ for any $x' \geq x$ and $y' \leq y$.

[2] It could be always possible to make an efficiency analysis including journal inputs as to having a stronger back office, more budget or others. In this paper, as well as in traditional AJR, we focus our attention in measuring the effectiveness dimension regardless the input side.

This means that we have to adapt the standard FDH model for a case where a set of one equal input decision making units produce multiple outputs. The pure output oriented FDH model is,

$$\text{Max} \quad \theta_0 + \varepsilon\left(\sum_{r=1}^{s} s_r^+\right) \tag{1}$$

$$\sum_{j=1}^{N} \lambda_j y_{rj} - s_r^+ = \theta y_{r0} \quad r = 1, 2, \ldots, s$$

$$\sum_{j=1}^{N} \lambda_j = 1$$

$$\lambda_j \in \{0, 1\};\ s_r^+ \geq 0 \quad j = 1, 2, \ldots, N$$

where r denotes output and j production unit, θ_0 is the efficiency score for unit 0, λ_j are the weights one and zero to identify the benchmark for producer 0, s_r^+ is the outputs slacks (Tofallis 2001) and ε is a non-Archimedean small positive number. If $\theta_0 = 1$, the producer is relatively efficient compared to other units. If $\theta_0 > 1$, the unit evaluated is inefficient as the sample contains other units that perform better and θ_0 shows the amount by which all s outputs of the inefficient producer can be equi-proportionately increased.

An aggregated index with these characteristics has some advantages. Firstly, it allows to use a flexible 'benefit of doubt' set of weights that maximizes the result for each evaluated unit instead of a rigid set of weights to aggregate the performance indicators (Cherchye et al. 2007)[3]. Secondly, the FDH approach is easier to interpret, easier to compute it, and invariant to the indicators' measurement units. Lastly, the pure output oriented FDH method considers that a DMU with the highest value in one indicator will always be found fully efficient 'by default' just because any other DMU can not dominate it. This one is not a surprising result since the FDH can be interpreted as the Pareto optimality concept.

Methodology

We collected data on four indicators for 232 academic journals in Economics in 2010. We selected the journals from IDEAS/RePEc (https://ideas.repec.org/top/). Moreover, we used the program EMS to estimate the FDH models. This software is freely available at http://www.holger-scheel.de/ems/.

The IDEAS/RePEc repository is a collaborative project in which publishers self-index their publications. The citation analysis is carried out by the CitEc project (http://citec.repec.org/). This project provides citation analysis for documents distributed on the RePEc digital library. For each document made available in electronic format, CitEC extracts its list of references. To do so, CitEc use CiteSeer (http://citeseer.csail.mit.edu) and ParsCit (http://aye.comp.nus.edu.sg/parsCit) algorithms in the process of identification and parsing of references.

[3] The FDH could be extended for dealing with large random noise or measurement errors through the robust order-m estimator proposed by Cazals et al. (2002). This approach isrelated to the FDH estimator, but instead of constructing a full frontier, it creates a number of partial frontiers that envelops only m (≥1) observations randomly drawn from theoriginal sample to build confident intervals for the evaluated journals.

Table 1 Definition of indicators

Indicator	Definition	Source	Journals
IF	Impact Factor (2-years)	JCR–Thompson Reuters	574
AI	Article Influence (score)	Eigenfactor.org	387
h-index	h-index	IDEAS/RepEc	1055
DIF	Discounted IF	IDEAS/RepEc	1044
Total			232

Source: Author' own elaboration

Table 2 Descriptive statistics

Indicator	Mean	St. dev.	Min.	Max.	N
h-index	23.25	24.20	1	148	232
IF	1.295	1.056	0.061	7.432	232
AI	1.332	1.690	0.027	11.688	232
DIF	0.832	1.061	0.006	6.564	232

Source: Author' own elaboration

Although IDEAS/RePEc comprises information regarding 1325 journals, we have worked with a shorter list of journals ($n = 232$) due to the inclusion of two additional indexes from other sources (i.e. Journal Impact Factor from the Journal Citation Reports, and Article Influence from eigenfactor.org). We realize that citation-based indicators that have some caveats and frequently generate criticism. For that reason, we selected four indicators that represent the main current trends in citation analysis. Table 1 summarizes these indicators.

First, we included the Journal Impact Factor (JIF) provided by the Journal Citation Reports. This index is widely known by scientists and commonly used by decision makers worldwide. Second, we also included the journals' h-indexes. While the JIF is an indicator of the average citations per document, the h-index represents the number of highly influential papers published by each journal (i.e. seminal papers). Third, we also have used the Discounted Impact Factor (DIF) that takes into account the age of citations. Thus, if an article is cited in a paper dated in 2012 and we are in 2015, these citations would count for 0.25. As a consequence, it allows identifying the publications that are more cited nowadays (Zimmermann 2012). We gathered the last two indicators from IDEAS/RePEc. Finally, we included the Article Influence (AI) provided by eigenfactor.org, which weights citations by the reputation of the citing journal. Table 2 shows the descriptive statistics for the four indicators.

Although the four selected indicators represent the main current trends in citation analysis, there is a limitation due to the similarities between them. For this reason, to contrast the robustness of our aggregated score, we selected four previous rankings that have been widely recognized by the scientific community. In the paragraphs below, we describe the main characteristics of the four selected rankings.

Firstly, we used as a reference to compare our results the KMS ranking. Since its publication in 2003, this classification was widely adopted by Economics Departments around the World, and it was updated in 2011 (Kalaitzidakis et al. 2011). In fact, many institutions' rankings are based on this AJR. This citation-based ranking uses data from the Thomson-Reuters Web of Science. The indicator used for each journal is essentially the iterative citations-based impact factor (eigenfactor) introduced by (Liebowitz and Palmer 1984). It provides a list of 209 journals for the period 2003–2008.

Secondly, we compared our results with the so-called Invariant ranking proposed by Palacios-Huerta and Volij (2004), supported by a theoretical approach. The authors established four properties that ideally should be fulfilled by an AJR and conclude that there is a unique ranking method that attains the four properties simultaneously. The properties are (1) invariance on reference intensity; (2) homogeneity; (3) consistency; and (4) invariance to the splitting of journals. According to these properties, the "right" approach for building up a ranking is the one developed in the seminal work of Pinski and Narin (1976). This approach is at the core of the PageRank algorithm used by Google to rank web pages. After this conclusion, they provide an AJR of 37 journals based on citations using Thomson Reuters Web of Science for the year 2000.

Thirdly, we took into account the self-named Ambitious ranking stated by Engemann and Wall (2009). This one is also a citation-based ranking which uses Thomson Reuters Web of Science citation data for 2 years 2002 and 2008. The authors base their approach on the assumption that the economists prefer to be cited by the top academic journals to increase their reputation. Therefore, it considers citations received only from seven of top general interest journals in Economics. Besides, the authors correct the possible biases due to journal size, the age of the articles and citations, citation source and reference intensity. The result is an "ambition-adjusted" AJR that comprises 69 journals. They also provide an alternative version computed by excluding self-citations.

Lastly, we used the Area Score (http://diamscience.org/collections/show/54) published by diamScience that is based on pairwise comparisons between journals (Stigler et al. 1995). The Area Score uses the Direct Influence Aggregation Model proposed by Cornillier and Charles (2015) to build an AJR from all the citations in articles published in 2013 in 333 Journals for papers published between 2004 and 2013. In this model, the attractiveness (i.e. the average article's influence) of a journal is defined as the weighted average of its direct influence on all other journals under consideration, to each of which is accorded a weight proportional to its attractiveness.

To test the robustness of our results and to check to what extent these findings are consistent with previously published rankings, we calculate the Spearman's correlation coefficients between our findings and the four rankings (KMS, Ambitious, Invariant and Area Score).

Results

The top-20 journals of the FDH ranking using four bibliometric indicators are shown in the first column in Table 3. The rest of columns of Table 3 reflect the position that each top-20 journal has according to the alternative criteria.

To test the validity of our score, we computed the Spearman's correlation coefficients between our ranking with the four rankings described in the previous section. The results are shown in Table 4.

Spearman's coefficients show that the FDH ranking is highly correlated to KMS, Invariant, Ambitious and Score Area. This result suggests that FDH is a straightforward procedure to obtain a valid ranking similar to other methods widely accepted by the economic research stakeholders.

Table 3 Top 20 journals using FDH

Journal	Ranking method					
	FDH	KMS	Invariant	Ambitious	Area Score	FDH Efficiency index
QJE	1	2	2	1	2	1
JEL	2	13	3	–	5	1
JPE	3	4	5	2	1	1
Econometrica	4	3	1	3	4	1
AER	5	1	4	4	3	1.037
J. Econ. Growth	6	26	–	7	26	1.048
Rev Fin. Stud.	7	–	–	23	14	1.291
J. Mon. Econ.	8	6	7	11	9	1.392
J. Finance	9	–	–	19	8	1.424
Rev. Econ. Stud.	10	7	6	5	6	1.541
J. Fin. Econ.	11	15	21	25	20	1.559
Econ. Pol.	12	42	–	–	32	1.582
J. Econ. Per.	13	11	10	–	7	1.605
Brook. Pap. Econ.	14	33	–	–	21	1.618
J. Econometrics	15	14	11	21	11	1.667
Econ. Jour.	16	10	28	9	10	1.747
J. Int. Bus. Stud.	17	–	–	–	–	1.776
Rev. Econ. &Stat.	18	–	17	8	12	1.795
J. Int. Econ.	19	12	29	12	24	1.899
Eur Ec Rev	20	16	23	22	23	1.944

Source: Author' own elaboration

Table 4 Spearman correlation coefficients among rankings

	FDH	KMS	Invariant	Ambitious	Area score
FDH	1				
KMS	0.807*	1			
Invariant	0.671*	0.691*	1		
Ambitious	0.737*	0.824*	0.730*	1	
Area Score	0.806*	0.909*	0.778*	0.832*	1

Source: Authors' own elaboration. * Significant at 99 % confidence level

Finally, as we discussed in the methodology section, the FDH provides a plus with respect these other methods including the DEA, as it is possible to make vis-à-vis comparisons and yardsticks competitions thought the identification of the dominated journals (see Table 5).

The FDH method provides for each journal not just its position in the ranking "FDH rank". Besides, the method assigns a score "FDH Score" that is the main criterion used to sort the evaluated journals. If the score (θ_0 in model 1) is equal to 1 it means that the journal is efficient. Therefore, the journals *QJE*, *JEL*, *JPE* and Econometrica are all fully efficient, and they will be the benchmarks for the remaining journals. In this case, to break ties in FDH scores, a secondary criterion is used: the number of benchmarked journals "N. Bench". This number indicates the number of inefficient evaluated units that takes this journal as a

Table 5 Full output of FDH method

Journal ID		FDH rank	FDH Score	N. bench.	Benchmark journal ID	Dominated journals No.	Dominated journals ID. Journal	Dominating
194	QJE	1	1.000	110	–	0		227
119	JEL	2	1.000	89	–	0		225
154	JPE	3	1.000	17	–	0		219
33	Econ.	4	1.000	12	–	0		215
3	AER	5	1.037	–	154	1	154	212
116	JEG	6	1.048	–	119	2	119 194	186
205	RFS	7	1.291	–	194	2	119 194	205
150	JME	8	1.392	–	33	4	3 33 154 194	171
129	J. Fin.	9	1.424	–	194	1	194	209
202	RES	10	1.541	–	194	3	33 119 194	212

Source: Authors' own elaboration

reference benchmark. As QJE is the benchmark for 110 journals, it is placed at the top position of the ranking in the "FDH rank" column, followed by JEL, JEP, and *Econometrica*. Also, three other journals—JPE, QJE, and JEL—are 'efficient by default' because they have the highest values in the h-index (JPE), Journal Impact Factor (JEL), Article Influence (QJE) and Discounted Impact Factor (JEL). However, *Econometrica* is also at the top of the ranking because it cannot be dominated in all dimensions by the other three top journals.

For those journals that are inefficient, the score is >1 and each one has a benchmark journal (represented in the column "Benchmark Journal ID" of Table 5). For example, the American Economic Review (AER) shows a FDH score equivalent to 1.037 indicating that in order to be fully efficient this journal should raise its four indicators (h-index, IF, AI and DIF) in a 3.7 % in order to became as efficient as its "Benchmark Journal" that in this case is JPE. Moreover, the FDH method identifies the number of journals that are dominated for each journal in the column "Dominating" together with the number of journals that dominate the journal evaluated in the column "Dominated Journals". A journal dominates (is dominated by) another journal when it has better (worse) performance in all the indicators considered. In this sense, for example, the Review of Economics and Statistics (RES), which ranks 10th, dominates 212 journals and is dominated by three journals (*Econometrica*, JEL, and QJE).

An interesting way to use this information is to formulate strategies for improving the score by comparing each journal with those that dominate it but, at the same time, they are close to it. For instance, although JME's benchmark is Econometrica, it is also dominated by three other journals (QJE, JPE, AER). These journals represent the set of similar and dominating journals for the JME. Its goal should be to improve its scores in the short term by following a path that allows the journal to catch up other dominating journals close to its current performance.

Conclusions

The academic journals rankings are widely used for academic purposes, especially in the field of Economics. There are many procedures to construct academic journals rankings. Some of them are based on citation analysis while other are based on expert opinion. There is also a fair amount of methods used to compute the aggregated scores for each journal within a ranking.

In this study, we have used the Free Disposal Hull (FDH) model to build a ranking for 232 journals in Economics from four performance indicators. The pure output oriented FDH method developed in this research provides for each journal, not just its position in a ranking list but also its relative efficiency level compared with competing journals. Moreover, for each item (i.e. journal) the FDH model identifies a set of dominated journals.

The results allow us to reach two main conclusions. First, the ranking based on the FDH method seems to be consistent with other well-known reference rankings (i.e.: KMS, Invariant, Ambitious and Area Score). Second, the additional information that provides the FDH model may be used by the Editorial Board to formulate strategies to achieve goals. For instance, to improve a journal score by comparing it with the scores of similar journals.

Although the primary goal of this piece of research was to introduce a new approach for computing aggregated scores for ranking a set of academic journals in Economics, we consider this study has some caveats that should be addressed in further research. Particularly, the set of indicators used for computing the aggregated score should be more eclectic. For that purpose, we are planning to introduce different performance indicators in other models. For instance, the pairwise comparisons between journals (Cornillier and Charles 2015), or the Source Normalized Impact per Publication (Ennas et al. 2015). Moreover, we would like to incorporate usage and altmetric indicators such as the number of downloads.

To sum up, we think that the conceptual framework presented in this paper, based on building a journal ranking through the aggregation of accepted bibliometric indicators by using FDH provides an appealing methodology for obtaining fairer journals comparisons.

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