University rankings: What do they really show?

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Abstract

University rankings as developed by the media are used by many stakeholders in higher education: students looking for university places; academics looking for university jobs; university managers who need to maintain standing in the competitive arena of student recruitment; and governments who want to know that public funds spent on universities are delivering a world class higher education system. Media rankings deliberately draw attention to the performance of each university relative to all others, and as such they are undeniably simple to use and interpret. But one danger is that they are potentially open to manipulation and gaming because many of the measures underlying the rankings are under the control of the institutions themselves. This paper examines media rankings (constructed from an amalgamation of variables representing performance across numerous dimensions) to reveal the problems with using a composite index to reflect overall performance. It ends with a proposal for an alternative methodology which leads to groupings rather than point estimates.

Keywords: Higher education; Rankings; Performance; Principal components analysis

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1. Introduction

University rankings are often constructed by commercial publishers and are lists of higher education institutions (HEIs), presented in the format of a league table based on performance, which in turn is derived from a set of underlying quantitative data (Usher and Medow 2009). Rankings draw attention to relative performance, and are often aimed at the general public, for example, prospective students (and their parents) to help them choose a university. In recent years, however, rankings of HEIs have increased and their usage has expanded: it is now common for (prospective) students, staff and HEI managers to resort to these when making important decisions or managerial policies.[1]

In the international arena, although many rankings exist, three popular ones are:

- The Academic Ranking of World Universities (ARWU) compiled annually by the Shanghai Jiao Tong University since 2003;
- The QS World University Rankings of the world's top universities produced by Quacquarelli Symonds published annually since 2004;
- The *Times Higher Education (THE)* World University Rankings, produced and published annually since 2004, and in partnership with Thomson Reuters since 2010.

Two additional ones are also worthy of note as they differ slightly from those listed above. Universitas 21 provides a ranking of *countries'* higher education systems (rather than the individual universities), and U-Multirank allows users to produce their own rankings based on their own preferences (rather than fixed weightings imposed by the publication); the theme of preferences will be picked up again later.

[1] Note that there is some evidence that they might be instrumental in determining VC pay, for example Allcock *et al.* (2017).

Within countries, national media also provide rankings of their domestic HEIs. Although there were some early attempts to rank US universities or disciplines within them using, for example, the biographical dictionary of academics (Cattell 1906) and ratings of graduate programs in the USA as evaluated by faculty (Hughes 1925), the first serious media rankings of universities and colleges (at the institution level) appeared in the USA in *US News and World Report* in 1983 (Dill 2009).[2] Since 1994, the publication of university rankings based on various individual measures of performance has become commonplace in the UK, USA and elsewhere (Yorke 1997). In the UK, for example, *The Times*, *Sunday Times* and *The Guardian* all publish their own university rankings, while *The Independent* produces *The Complete University Guide.*

While rankings have generally been aimed at external stakeholders such as prospective students, interest in and usage of media rankings has broadened to institutions themselves (possibly as an internal auditing tool) and to governments, especially with the regular publication of global rankings of universities. So important have rankings become to all higher education stakeholders that 'Rankings – both national and international – have not just captured the imagination of higher education but in some ways have captured higher education itself.' (Bekhradnia 2016, p3).

The possibility that universities are altering behaviour in order to climb the league tables is potentially worrying. HEIs should be developing their behaviour around social priorities. If these do not align with the priorities encouraged by media rankings, this suggests a deviation from what is socially optimal (Muller 2017). It is therefore important to understand the principles underlying the compilation of university rankings.

[2] One could argue that the tables of performance produced in the *Financial Times* in the UK were also forerunners to the media rankings we see today. These covered distinct aspects such as: achievement rates (Dixon 1976); labour market destinations (Dixon 1985); and completion rates (Dixon 1989).

The purpose of this paper is to examine and critically evaluate the methodological approach underpinning the construction of university rankings which essentially involves calculating a composite index from an array of data. Of particular interest is whether a single measure can truly reflect overall performance across a variety of production activities (relating to teaching and research). Further attention is directed at just how precisely rankings illustrate performance, and also how the methodology underpinning the construction of media rankings can incentivise certain behaviours of HEIs. This leads to the proposal of an alternative approach to assessing universities. The analysis and review presented here are of interest to (prospective) students, managers and policy-makers in higher education sectors internationally.

The paper is in 5 sections of which this introduction is the first. Section 2 looks at how university rankings are developed and explores, in particular, the challenges of amalgamating information across multiple dimensions into a single composite measure from which rankings are then derived. The potential effects of these rankings on institutional behaviour and national policy are then reviewed in section 3, while proposals for an alternative way forward are presented and discussed in section 4. The paper ends with section 5 which draws some final conclusions. While the ideas and methodological approaches are of general application and interest, illustrative examples and analysis are based on a recent ranking of UK universities.

2. Developing university rankings

Dimensions

Higher education and its institutions can be seen to represent a classic principal-agent problem (Johnes 1992) whereby the principals or stakeholders who are interested in the performance of universities rely on the agents who run universities to deliver the desired outcomes.[3]

[3] It should be noted that the principal-agent model may be overly simplistic for a complex organisation such as a university which produces multiple outputs and may operate cross subsidisation across these outputs.

Universities' multiple stakeholders are interested in numerous and varying desired outcomes;[4] hence multiple dimensions are needed to produce university rankings in an effort to ensure that the performance dimensions of interest to all stakeholders are represented. Thus, in identifying the dimensions, we need to recognise the principals.

Higher education in the UK and elsewhere often receives funding from the government which naturally has an interest in how the HEIs perform. Dimensions in this context should reflect the outcomes most valued by society (Dill 2009). Research and teaching are generally agreed to be the main areas of activity in HEIs. In England, the Higher Education Funding Council for England (HEFCE) undertakes a regular review of UK universities' research on behalf of all the funding councils, the most recent one being the Research Excellence Framework (REF) in 2014,[5] and much of the resources allocated by funding councils to universities for research purposes relate to performance as reflected by such reviews (Harman 2011). Similar performance-based funding mechanisms for research abound (Dill 2009), for example, in Australia,[6] Spain, Hong Kong, Poland, Portugal, Italy, New Zealand, Norway, Sweden, Denmark, Finland (Hicks 2012). Funding incentives are therefore used to steer the behaviour of universities in the direction desired by the government, which oversees society's needs. However, the relationship between research assessment and research output in the UK, which has a highly competitive environment, is unclear: while there are some observed increases in output just prior to evaluation, these seem to be somewhat transitory, and performance-based funding may not actually provide an incentive for constant improvement (Himanen *et al*. 2009).

[4] The difficulties for managers of dealing with multiple stakeholders who may have conflicting objectives is discussed in Weimer and Vining (1996).
[5] The results of the REF 2014 can be found here: http://www.ref.ac.uk/. Note that REF 2014 was preceded by various Research Assessment Exercises (RAEs) undertaken in 1986, 1989, 1992, 1996, 2001 and 2008.
[6] See https://education.gov.au/research-block-grants.

Student numbers have traditionally determined teaching resources to UK universities in two ways: through the university tuition fee; and through HEFCE resourcing which is currently linked to student numbers by subject.[7] The latter is clearly not performance-related and the former is only to the extent that students might choose their university and programme on the basis of perceived teaching reputation. In practice, of course, this requires reliable indicators to inform potential students.

A Teaching Excellence Framework (TEF) to mirror the REF has recently been introduced in the UK as a means of linking funding to teaching performance (analogous to the principles underlying REF in the research context) with the explicit aim of improving teaching quality and ensuring students and taxpayers of efficient use of resources.[8] The results of the TEF, based on various measures of the student experience and teaching outcomes, were published in June 2017,[9] and their link to fee-setting in the future has yet to be fully determined. Media rankings do not as yet incorporate these measures into their analysis and so alternative measures to reflect teaching performance are used.

The government is not the only potential stakeholder wishing to know about university performance; prospective students (both national and international) wishing to find a university place also want to know how well universities perform in order to inform their choice. Their interests are likely to focus on, for example, the student experience in university, spending on areas of primary interest to them such as academic resources or facilities, and student outcomes. It is not difficult to find data on all aspects of university activities: in the UK, for example, the Higher Education Statistics Agency (HESA) provides data on, for example:[10] widening participation rates; non-continuation rates; research output; and graduate employment.

[7] See http://www.hefce.ac.uk/lt/howfund/.
[8] See https://www.gov.uk/government/speeches/teaching-at-the-heart-of-the-system.
[9] See http://www.hefce.ac.uk/lt/tef/.
[10] Source: https://www.hesa.ac.uk/data-and-analysis/performance-indicators accessed 17th July 2017.

Additional data can also be derived (from both HESA and other sources) to reflect feedback from current students, or the reputation of the institution.

University rankings published by the media are typically based on data from a variety of sources and covering various dimensions. *The Complete University Guide*, for example, bases its rankings on the following 10 dimensions:[11] entry standards; student satisfaction; research assessment; research intensity; graduate prospects; student-staff ratio; academic services spend; facilities spend; good honours; and degree completion. *The Times* (and *Sunday Times*) and *The Guardian* use similar (but not identical) measures, with *The Guardian* focussing only on teaching-related activity (see table 1 for more detail). These national rankings with their attention to teaching (as well as, or rather than, research) contrast with international rankings where the focus is predominantly on research (see table 1). The latter may therefore be seen more as reflecting reputation or prestige, while the rankings which include teaching-related indicators might provide an indication of more general performance.

Table 1 here

The performance of individual HEIs might well vary across different measures, and so numerous dimensions lead to problems of evaluation and interpretation (Johnes 1996). The measures used in creating rankings are themselves open to critique (Dill and Soo 2005), and have been challenged on the basis that their choice is determined more by their availability than by reasons of reflecting excellence in performance (Locke *et al.* 2008). Moreover, many national-level rankings incorporate both teaching- and research-related measures; yet if teaching and research are not closely related (Marginson and Wende 2007), the construction of a single index based on measures reflecting both is questionable.

[11] Source: http://www.thecompleteuniversityguide.co.uk/league-tables/methodology/ accessed 17th July 2017. Note that this particular university guide is chosen purely for illustrative purposes; conclusions from any analysis presented here can be generalised across all university guides.

A simple rank correlation of the 10 measures underpinning *The Complete University Guide* (2018) illustrates the difficulties of deriving a consistent picture of performance from 10 potentially disparate measures (see table 2). Although the majority of indicators are highly correlated, 12 pairs have a correlation coefficient which is not significantly different from zero at conventional significance levels. Thus a university's position in the ranking can change radically depending on which indicator is used: one HEI (ranked 54 overall), for example, is ranked in the top 5 on academic services, but near to the bottom on facilities. In contrast, the HEI ranked 53 overall is top on graduate prospects but near the bottom on student satisfaction. In fact, the student satisfaction indicator appears to provide a noticeably different representation of performance compared to the other measures. This is not particularly surprising since, unlike the other variables, it is based on individuals' perceptions and opinions. Moreover, there is evidence that student evaluations of teaching do not, in fact, measure the effectiveness of teaching (Stark and Freishtat 2014), and are beset by bias, most notably against female instructors, and this bias itself varies by student gender and discipline (Boring *et al.* 2016).

Table 2 here

Such differences between small numbers of HEIs can be revealed by plotting the data across dimensions in a radar plot. Figure 1 presents a radar plot of these data[12] for the HEIs discussed above (ranked 53 and 54 overall). Given the definitions of the indicators, performance at the outer edge is better than performance nearer the centre of the plot. We can see that both HEIs perform well on academic services spend, for example, but there are considerable discrepancies in performance between the two HEIs in terms of graduate prospects and student satisfaction. Thus differences in performance across the dimensions are clearly visible from the plot, yet

[12] Note that the original data have been standardised data to have mean zero; a higher value represents more favourable performance on every dimension.

looking only at the overall ranking conceals these. However, radar plots, whilst useful for pairwise comparisons, do not lend themselves to application across the wider set of universities.

Figure 1 here

Weightings

The complexities of interpreting performance measures are therefore clear. If the objective is to produce a single index of overall performance across various dimensions then these disparate measures need to be combined into a meaningful aggregate index. This requires an appropriate set of weights with which to aggregate the separate measures. The simplest approach is to apply an equal weighting across all indicators;[13] alternatively different weightings can be assigned based on an underlying value set. *The Complete University Guide* assigns weightings of between 0.5 and 1.5 (from around 6% to 11%) to the 10 individual measures (see table 3). Weightings are typically arbitrary (Kehm 2014); different publications use different weightings (and underlying indicators), yet satisfactory reasons for choice of weightings are not typically provided; nor is the fact that other weightings could be equally valid but possibly lead to different rankings (Usher and Medow 2009).

Table 3 here

The validity of combining multiple indicators into one ranking is therefore questionable (Marginson 2014). It is easy to see that the correlation between the ranking derived by *The Complete University Guide* and the original variables varies considerably. While entry standards, research assessment, graduate prospects, good honours achieved and degree completion correlate well with the overall ranking (see table 3), student satisfaction and facilities spend definitely do not.

[13] Each performance measure is usually standardised to produce a z-score before calculating an overall ranking. This ensures that the composite index is not affected by the units of measurement of the components underlying it.

Thus the weightings matter and should ideally reflect the preferences of the stakeholders, but deriving preferences for a group from the preferences of the individuals who comprise the group is known to be problematic, and a consensus on the relative importance of the different dimensions is unlikely to be achieved. It might be possible to reduce numerous indicators to a manageable number of dimensions, even without any information on an appropriate weighting system, using such techniques as principal components analysis, data envelopment analysis (in particular the 'benefit of the doubt' approach introduced by Cherchye *et al.* (2007)), the analytic hierarchy process, or co-plot (Johnes 2015).[14]

The danger of a composite index (and hence media rankings) is that it is typically not based on any justifiable model of university performance (Locke *et al.* 2008). The representation of performance which it purportedly provides is therefore likely to be confusing, particularly if it poorly represents some of the dimensions that it supposedly covers, or if inappropriate weightings are used. This in turn can lead, for example, to inappropriate policy development, poor managerial decisions, or to potential students choosing the wrong university for their needs.

Illustration

Data from *The Complete University Guide* can illustrate these points since rankings from the overall indicator are strongly correlated with those from all the separate indicators *with the exception of* those relating to student satisfaction and facilities spend (table 3). The overall ranking is therefore an apparently poor representation of performance to stakeholders for whom these dimensions are of particular interest.

We will investigate further the validity of reducing a large data set to a single index by examining the measures of *The Complete University Guide* data using principal components

[14] The interested reader can find more details on all the techniques elsewhere (Saltelli *et al.* 2005; Johnes 2015).

analysis. A principal components analysis aims to explain as much of the variation in the original data (the 10 dimensions in this case) with as few variables as possible (see Saltelli *et al.* 2005 for more details).

The weightings for each of the 10 principal components calculated from *The Complete University Guide* data for 2018 are displayed in table 4 which also displays the percentage variation accounted for by each principal component. The Kaiser criterion (Saltelli *et al.* 2005) indicates that two principal components adequately represent the information in the data set. The first principal component is mainly a combination of all dimensions *apart from* those reflecting student satisfaction and facilities spend (as indicated by the weights in table 4), while the second principal component largely represents the combined dimensions of student satisfaction and facilities spend. This aligns with the findings from the rank correlations of table 2.

Table 4 here

Figure 2 displays a plot of the first two principal components. Universities in the top right of the plot score highly on both principal components and so they are performing well across all 10 dimensions. The converse is true of universities located to the bottom and left of the plot. Those universities located in the leading diagonal quadrants display mixed performance. Numbers next to the plotted points in figure 2 are the rankings obtained from the overall score of *The Complete University Guide*, with 1 representing top performance. While the top-ranked university is in the top right quadrant of the principal components plot, in fact there are many examples where the ranking and the plot do not align. For example, the university ranked 127th in *The Complete University Guide* appears in the bottom right hand quadrant of the scatter plot: while it performs badly on 8 of the indicators, its performance measured against the second principal component (reflecting student satisfaction and facility spend) is well in the top half.

At the other end of the performance spectrum, the university ranked 4th is in the top left hand quadrant and is ranked second from bottom on the basis of the second principal component (reflecting student satisfaction and facility spend).

Figure 2 here

The rank correlations between the first two principal components and the overall ranking (see table 5) confirm that *neither* the first principal component *nor* the composite ranking satisfactorily capture university performance consistently across all 10 dimensions. Thus a single indicator is insufficient to capture all the information contained in these 10 measures. This finding is in line with results of a similar analysis of university rankings from *The Guardian* and the *Times Higher Education Supplement* (see HEFCE 2008, Appendix C) and an analysis of earlier university rankings from *The Complete University Guide* (Johnes 2016). The general message is that, in trying to give a simple overview of performance, composite indicators can be misleading.

Table 5 here

3. Potential effects of rankings

We consider in this section the potential effects of using media rankings in stakeholders' decision making. University rankings are generally very transparent: stakeholders are normally able to see exactly what data underpin the rankings and the method used to combine these data into a single composite index. This should be an attractive and desirable feature of rankings, but it is also, in fact, at the root of the potential problems. While transparency means that a HEI can easily identify its strengths and weaknesses and alter behaviour accordingly, it also means that rankings are open to manipulation by those whose performance is being measured (Johnes 1992; Pollard *et al.* 2013) and hence the possibility of gaming.

Media rankings are becoming increasingly important to individual institutions: national and global rankings can be used by other institutions to identify suitable collaborative partners; they can be used by students to inform their choice of university; by prospective academic employees seeking new posts; and by employers in the context of graduate recruitment (Saisana *et al.* 2011; Hazelkorn 2015). This means that a university has an incentive to change its behaviour in response to the rankings; but the altered behaviour may not actually be of benefit to performance – only to its ranking.

Many of the measures of performance are under the control of the HEI, and there has been concern from senior managers of universities that some measures in league tables are susceptible to 'cheating' behaviour (Rolfe 2003), and suggestion that universities are influencing data in order to raise their rankings (Hazelkorn 2015). Graduation or achievement rates, for example, can be improved by introducing better teaching (a positive effect of rankings) or by lowering standards which leads to 'grade inflation' (Johnes 2004; Popov and Bernhardt 2013; Bachan 2015; Johnes and Soo 2015). There have also been claims that students have been pressured to provide favourable responses to the National Student Survey in the UK in order to boost performance in media rankings (Newman 2008).

Gaming behaviour is dangerous because it can mean that people using rankings are misled. A government, for example, might adopt a policy of merging HEIs on the basis that greater size leads to greater visibility in the world rankings as well as greater efficiency (Jump 2014). Indeed, just such a policy is being rolled out in France, Russia and China in the belief that global rankings of domestic HEIs can be favourably affected (Shin and Toutkoushian 2011). It would be unwise, however, to base any policy solely on rankings.

Gaming aside, focus by universities on improving performance as measured by the components underpinning rankings leads to HEIs becoming much more homogeneous. Rankings,

particularly the international ones, are biased towards research activity (Dill 2009), and this could lead to HEIs altering mission from teaching to research excellence (Shin and Toutkoushian 2011). Elite, research-intensive universities are often the ones which are highly-ranked, and so they become the benchmarks for the lower-ranked HEIs. Indeed, performance-based funding of research (using, for example, the REF in the UK) combined with efforts to climb the media rankings can lead to universities cross-subsidising their research using teaching funds (see Ehrenberg (2012) for some evidence on this in the context of Economics in American higher education).[15] The consequence of this is that there is then a reduction in diversity between universities (Morphew and Swanson 2011). But diversity in higher education permits more choice for students (HEFCE 2012), and so its removal or reduction might have a negative impact on student access caused by imperfect geographical mobility (Kelchtermans and Verboven 2010; De Fraja and Valbonesi 2012).

Finally university rankings suggest a precision which may not in fact be supported by close scrutiny of the data. Rankings are derived from scores which in turn are weighted aggregates of the components. Sometimes universities can have very similar scores (and hence performance) but the separate rankings suggest a greater difference in performance than there really is (Longden 2011). This is clearly illustrated in figure 3 which looks at ranking versus overall score for universities based on data from *The Complete University Guide 2018*. The universities ranked first and second, for example, are distinct from those ranked third and fourth which are, in turn, distinct form those ranked fifth to eleventh, and the HEIs ranked twelfth to fifteenth are almost indistinct in terms of their overall score. Such observations can be made throughout the rankings.

[15] This cross-subsidisation actually has more disadvantages than simply reducing diversity, one of which os a sub-optimal allocation of resources to university activities – see (Muller 2017) for a discussion of distortions created by rent-seeing behaviour in higher education.

Figure 3

Thus, rankings not only leave the higher education sector susceptible to unwanted behaviour and its consequences, but these may actually be based on rankings that have little meaning. It is therefore important to know whether or not the differences in rankings between HEIs are 'real' or significant in a statistical sense, yet little work has focused on this aspect in the context of individual measures or composite indexes.

4. An alternative to rankings: Groupings rather than point estimates

The use of rankings based on composite indicators constructed from arbitrary weightings applied to all HEIs is therefore controversial. An alternative method of aggregation based on data envelopment analysis (DEA) can overcome many of the shortcomings of conventional composite indicators (CIs) identified in the previous section. This benefit of the doubt (BOD) approach evaluated using DEA produces a CI derived by solving the following linear programming problem for each observation (university) k being assessed on the basis of i indicators x_i (Saltelli *et al.* 2005; Cherchye *et al.* 2007):

$$I_k = \max_{w_{ki}} \sum_i w_{ki} x_{ki}$$

Subject to

$\sum_i w_{ki} x_{ji} \leq 1$

$w_{ki} \geq 0$ for $k = 1 \ldots n$

Essentially it is the original DEA model (Charnes *et al.* 1978) with all the variables in the indicator (x_i) treated as outputs, and a dummy input equal to one for all HEIs (Cherchye *et al.* 2007). The resulting index will vary between the values of 0 and 1. Since it is based on DEA, the CI derived in this way has various advantages. First, DEA is unaffected by the units of measurement of the dimensions. Second, the weights used in the aggregation are decided by

the data, and differ by unit (HEI in this case). Thus the weights are sensitive to the observed priorities of the HEIs and the weights derived will provide the best possible composite score which can be achieved for each HEI. In practice this means that each university is measured against universities with similar mission or objectives, and hence diversity in the sector is preserved. What is more, the incentive for game-playing is reduced because no HEI is disadvantaged by their chosen priorities, and so HEIs are encouraged simply to act in line with their mission.

A possible drawback of the approach is that many HEIs will have a score of 1 and therefore there is an apparent lack of discrimination amongst the best-performing HEIs; indeed the precision of any ranking is open to doubt. An extension of DEA using bootstrapping techniques allows us to estimate confidence intervals around the composite scores for each HEI, and these are plotted along with the composite scores in figure 4. It emerges that in fact there is no significant difference between the composite scores for this set of universities based on the 10 indicators in the *The Complete University Guide*.

Figure 4 here

One way in which we can gain some idea of the performance of universities whilst avoiding these problems is to derive performance *groupings*, rather than point estimates (Bougnol and Dula 2006). One way of constructing groups is to use DEA to produce tiers of universities – known as 'peeling the DEA onion' (Barr *et al.* 2000): the first application of DEA to the data produces a set of perfectly performing universities which are removed to form the top tier. DEA is then applied to the reduced data set, and the perfectly performing universities removed to form the second tier. This process, or 'peeling', continues until all universities have been allocated to a tier (this is illustrated in figure 5).

Figure 5 here

The peeling method is illustarted using the data from *The Complete University Guide 2018* and applying the DEA BOD model to the data.[16] The peeling approach yields 6 groupings of universities (shown in table 6; universities are ordered alphabetically within group).

Table 6 here

It is worth examining the characteristics of these groups in terms of the 10 initial indicators which underpin the university rankings, and the overall scores and rankings (see table 7). In terms of average ranking, the first two tiers are very similar, while there are clear differences (the average rankings rise) for each tier thereafter. The overall scores are typically highest for the first tier and fall for each subsequent tier, although the first two tiers exhibit similar performance across many of the other indicators including: student satisfaction; research quality; research intensity; graduate prospects; staff-student ratio; good honours; and degree completion. In fact, the distinguishing features of the universities in tiers 1 and 2 are the average facilities spend and the average academic services spend – tier 1 scores considerably higher on both indicators than tier 2.

Table 7 here

Although no other pair of tiers is so alike as tiers 1 and 2 across so many indicators, there is no doubt that tiers 5 and 6 also share some similar features. In the case of these two tiers it is the research measures (particularly intensity) where there are clear differences, while both the spending indicators (academic services and facilities) show lesser distinctions.

The average of the rankings of the universities in each tier are very broadly in line with the ranking of the tiers in that the average for the first tier is the lowest, and so on. But there are

[16] Note that two HEIs ranked 78th and 126th have been excluded because they have no observations on the research indicators.

some big differences between ranking and tier for some universities. This might arise because of the calculation of the weightings in DEA.

The examination of averages, however, conceals the heterogeneity within each group. Thus also displayed in table 7 are the minimum and maximum values on each indicator. By examining tables 6 and 7 together, we can see that the consequence of using DEA BOD is that the HEIs contained in each tier can vary considerably in their missions. In tier 1, we have Cambridge, Oxford and Durham, for example, alongside lower 'ranked' institutions such as Middlesex University: the former group might be seen as research-intensive, whilst the latter prides itself on its student focus and teaching informed by research. Thus the universities within tier 1 can have quite different objectives; what they share is that they are the most efficient at achieving their chosen objectives as evaluated by DEA BOD. In other words, tier 1 represents the best-performing HEIs on the 10 indicators used by *The Complete University Guide*, whilst preserving each HEI's mission. There is clearly a variety of ways to perform well – both research-intensive and teaching-intensive, and tier 1 encompasses a range of such HEIs. We can find similar contrasts between HEIs in the other tiers. In contrast to traditionally produced rankings, this methodology therefore preserves diversity amongst institutions in a HE sector.

This analysis is offered purely as an example of how a tiered approach to performance assessment might work in practice. While there are alternative approaches which should be explored and evaluated, DEA BOD does have certain advantages. First, the DEA BOD approach uses weightings (calculated by the method) which show each HEI in their best light, whilst a lack of prior knowledge regarding those weightings means that the rankings are not susceptible to gaming behaviour. The presentation by tiers rather than points is more satisfactory in terms of illustrating clearer distinctions: those HEIs within a group have close performance, whilst performance of HEIs across groups are more distinctive.

5. Conclusions

This paper examines the construction of media rankings of universities, using the results of one set of rankings in the UK to demonstrate issues which arise with all rankings based on a similar methodology – whether from the UK or elsewhere. Various problems with university rankings are highlighted. In particular, a principal components analysis of the indicators which underpin the rankings suggests that in fact one composite index does not adequately reflect the information contained in the data set. In addition, the differences between universities in the table might actually be very slight, yet the rankings suggest to the laypeople who use them that distinctions in performance are potentially large. Furthermore, as rankings become more high profile, there is the potential for HEIs to engage in undesirable gaming behaviour.

Many of these disadvantages could be reduced by adopting a tiered performance approach, using frontier estimation, to produce groupings rather than specific rankings. An illustrative application of this approach produces 6 university groupings with clear distinctions between the groups in terms of their typical performance on the data underpinning the performance evaluation. The approach, however, preserves heterogeneity within groups, and thereby permits universities to pursue their own missions. This has the advantage that the diversity of any higher education sector is retained. Moreover, the frontier estimation method is less prone to gaming behaviour by the HEIs whose relative performance is being assessed.

The methodology illustrated here is just one approach to producing rankings which might reduce the undesirable consequences of rankings, and alternatives should also be examined. What is abundantly clear, however, is that users of the current rankings should be very wary of the apparent messages they give.

Table 1: Dimensions of selected media rankings a) for the UK and b) internationally

Ranking source	Dimensions	Weighting (%)
a) UK media rankings		
The Guardian	National Student Survey - Teaching	10
	National Student Survey - Assessment and feedback	10
	National Student Survey - Overall satisfaction	5
	Value added	16.25
	Student-staff ratio	16.25
	Expenditure per student	10
	Entry scores	16.25
	Career prospects	16.25
The Times	Entry standards	9.52
	Student-staff ratios	9.52
	Services and facilities spend	9.52
	completion rates	9.52
	Firsts and 2:1s	9.52
	Graduate prospects	9.52
	Research Excellence Framework	14.29
	Teaching quality (National Student Survey)	14.29
	Student experience (National Student Survey)	14.29
The Complete University Guide	Entry standards	11.11
	Student satisfaction (National Student Survey)	16.67
	Research quality (Research Excellence Framework)	11.11
	Research intensity (Research Excellence Framework)	5.56
	Graduate prospects	11.11
	Staff-student ratio	11.11
	Academic services spend	5.56
	Facilities spend	5.56
	Good honours	11.11
	Degree completion	11.11

Table 1 (continued): Dimensions of selected media rankings a) for the UK and b) internationally

b) International media rankings		
Academic Ranking of World Universities (*ARWU*)	Quality of education: Alumni of an institution winning Nobel Prizes and Fields Medals	10
	Quality of faculty: Staff of an institution winning Nobel Prizes and Fields Medals	20
	Quality of faculty: Highly cited researchers in 21 broad subject categories	20
	Research output: Papers published in Nature and Science	20
	Research output: Papers indexed in Science Citation Index-expanded and Social Science Citation Index	20
	Per capita performance: Per capita academic performance of an institution	10
QS World Rankings	Academic peer review	40
	Faculty: student ratio	20
	Citations per faculty	20
	Employer reputation (Based on a survey on graduate employers)	10
	International faculty ratio	5
	International student ratio	5
THE World Rankings	Teaching: the learning environment	30
	Reputation survey	15
	Student: staff ratio	4.50
	Doctorate: bachelors ratio	2.25
	Doctorates awarded to academic staff ratio	6.00
	Institutional income	2.25
	Research: volume, income and reputation	30
	Reputation survey	18
	Research income	6
	Research productivity	6
	Citations: research influence	30
	International outlook	7.5
	International: domestic student ratio	2.5
	International;: domestic staff ratio	2.5
	International collaboration	2.5
	Industry income	2.5

Sources: https://www.theguardian.com/education/2016/may/23/methodology-behind-the-guardian-university-guide-2017; https://www.thetimes.co.uk/article/methodology-for-the-sunday-times-and-the-times-good-university-guide-2017-fl6r5vq0l; https://www.thecompleteuniversityguide.co.uk/league-tables/methodology/; https://www.topuniversities.com/university-rankings-articles/world-university-rankings/world-university-ranking-methodologies-compared, all accessed 25th July 2017

Table 2: Rank correlations of 10 indicators from *The Complete University Guide 2018*

	1	2	3	4	5	6	7	8	9
1. Entry standards									
2. Student satisfaction	0.08								
3. Research quality	0.78*	0.02							
4. Research intensity	0.67*	0.14	0.72*						
5. Graduate prospects	0.74*	0.14	0.67*	0.64*					
6. Staff-student ratio	0.55*	0.11	0.60*	0.55*	0.46*				
7. Academic services spend	0.49*	-0.01	0.58*	0.47*	0.49*	0.53*			
8. Facilities spend	0.12	0.18*	0.14	0.18*	0.26*	0.15	0.22*		
9. Good honours	0.81*	0.06	0.75*	0.70*	0.66*	0.50*	0.49*	0.08	
10. Degree completion	0.74*	0.13	0.70*	0.65*	0.76*	0.54*	0.46*	0.19*	0.75*

Source: *The Complete University Guide 2018* and own calculations (https://www.thecompleteuniversityguide.co.uk/league-tables/rankings accessed 17th July 2017)

Notes: * = significant at the 5% significance level. Note that *The Complete University Guide* uses student-staff ratio (indictor 6) and this has been reversed for the purposes of the correlation table to ensure that a higher value is consistent with more favourable performance.

Table 3: Weightings used to produce an overall performance indicator in *The Complete University Guide 2018* and rank correlation between the overall ranking and its components

	Weight	Correlation
1. Entry standards	1.0	0.88*
2. Student satisfaction	1.5	0.23*
3. Research quality	1.0	0.85*
4. Research intensity	0.5	0.77*
5. Graduate prospects	1.0	0.82*
6. Staff-student ratio	1.0	0.69*
7. Academic services spend	0.5	0.61*
8. Facilities spend	0.5	0.27*
9. Good honours	1.0	0.84*
10. Degree completion	1.0	0.82*

Source: http://www.thecompleteuniversityguide.co.uk/league-tables/methodology/ accessed 27th May 2017

Table 4: Weightings for the 10 principal components (PC) associated with *The Complete University Guide 2018* data

	Principal components									
***The Complete University Guide* dimensions**	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
1. Entry standards	0.39	-0.05	-0.04	-0.05	0.11	-0.18	0.17	-0.18	0.60	-0.61
2. Student satisfaction	0.00	0.71	-0.44	0.51	0.18	0.10	0.04	0.06	0.04	-0.02
3. Research quality	0.35	-0.07	-0.14	0.02	-0.55	0.35	0.18	0.60	0.17	0.08
4. Research intensity	0.36	0.09	-0.17	-0.02	-0.48	0.07	-0.09	-0.52	-0.51	-0.24
5. Graduate prospects	0.34	0.12	-0.08	-0.36	0.28	0.43	-0.59	-0.11	0.21	0.25
6. Staff-student ratio	0.33	-0.09	0.21	0.49	-0.14	-0.51	-0.51	0.10	0.08	0.20
7. Academic services spend	0.29	-0.19	0.48	0.46	0.34	0.48	0.20	-0.05	-0.21	-0.08
8. Facilities spend	0.07	0.65	0.67	-0.25	-0.19	-0.09	0.13	0.01	0.07	0.05
9. Good honours	0.38	-0.05	-0.16	-0.06	0.12	-0.22	0.52	-0.29	0.07	0.64
10. Degree completion	0.36	0.07	-0.09	-0.30	0.39	-0.31	0.03	0.48	-0.50	-0.20
% variation	54.5	13.0	8.0	6.9	4.8	3.7	3.4	2.3	2.1	1.3

Table 5: Rank correlations between the first two principal components and the university ranking

	1	**2**
1. University ranking		
2. Principal component 1	0.97	
3. Principal component 2	0.21	0.09

Note: Data sourced from *The Complete University Guide 2018*

Table 6: Groupings of universities produced by the peeling approach applied to data from *The Complete University Guide* 2015-16

Tier 1	*Rank*
Cambridge	1
Oxford	2
St Andrews	3
Imperial College London	5
Durham	6
University College London	7
Loughborough	10
East Anglia (UEA)	12
Essex	33
Queen's, Belfast	36
Harper Adams	46
St George's, University of London	53
University for the Creative Arts	54
Liverpool Hope	59
Middlesex	73

Tier 2	*Rank*
London School of Economics	4
Warwick	8
Lancaster	9
Bath	11
Surrey	13
Exeter	14
Leeds	15
Birmingham	16
Bristol	17
Sussex	19
York	20
King's College London	21
Edinburgh	23
Kent	25
Southampton	26
Glasgow	28
Heriot-Watt	29
Leicester	30
Dundee	30
Queen Mary, University of London	34
Cardiff	37
SOAS University of London	38
Coventry	43
Keele	48
West London	79

Tier 3	*Rank*
Nottingham	18
Manchester	22
Newcastle	23
Reading	27
Sheffield	32
Royal Holloway, University of London	35
Stirling	39
Aberdeen	40
Liverpool	41
City, University of London	42
Strathclyde	45
Brunel University London	47
Aston	49
Lincoln	50
Goldsmiths, University of London	51
Nottingham Trent	52
West of England, Bristol	60
Edge Hill	64
Bangor	65
Cardiff Metropolitan	67
Aberystwyth	68
Ulster	71
Hertfordshire	79
Abertay	88
Chester	91
Royal Agricultural University	107
Northampton	111
East London	114
Bishop Grosseteste	115

Tier 4	*Rank*
Swansea	44
Northumbria	55
Portsmouth	56
Bournemouth	57
Bradford	58
Arts University Bournemouth	61
Manchester Metropolitan	62
Falmouth	63
Oxford Brookes	66
Sheffield Hallam	69
Roehampton	69
Huddersfield	72
Hull	74
Robert Gordon	75
Glasgow Caledonian	79
University of the Arts, London	83
Chichester	86
Queen Margaret	92
Central Lancashire	95
Derby	97
Staffordshire	105
London South Bank	108
Bedfordshire	109
Birkbeck, University of London	116
University of Wales Trinity Saint David	119
Buckinghamshire New	124
Wrexham Glyndwr	128

Tier 5	*Rank*
Liverpool John Moores	76
Plymouth	77
De Montfort	82
Norwich University of the Arts	84
Winchester	85
Gloucestershire	87
Brighton	89
Bath Spa	90
Greenwich	93
Edinburgh Napier	94
Westminster	95
Salford	98
Birmingham City	99
West of Scotland	100
Teesside	101
Sunderland	102
Kingston	102
Worcester	104
Leeds Trinity	112
Southampton Solent	117
Anglia Ruskin	118
York St John	122
Bolton	125
London Metropolitan	127

Tier 6	*Rank*
Canterbury Christ Church	106
South Wales	110
Newman	113
St Mary's, Twickenham	120
Leeds Beckett	121
Cumbria	123

Table 7: Mean, minimum and maximum values of the indicators for each tier

		Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6
Entry standards	Mean	430.73	416.72	356.24	310.63	305.04	296.83
	Minimum	300.00	301.00	273.00	244.00	257.00	279.00
	Maximum	592.00	537.00	480.00	390.00	349.00	321.00
Student satisfaction	Mean	4.14	4.10	4.10	4.08	4.06	4.03
	Minimum	3.83	3.75	3.95	3.93	3.96	3.99
	Maximum	4.39	4.30	4.25	4.19	4.15	4.07
Research quality	Mean	2.99	3.06	2.73	2.55	2.42	2.22
	Minimum	2.21	2.61	1.40	1.92	1.63	1.98
	Maximum	3.36	3.35	3.17	3.12	2.84	2.51
Research intensity	Mean	0.693	0.731	0.546	0.303	0.241	0.190
	Minimum	0.100	0.130	0.090	0.090	0.070	0.080
	Maximum	0.950	0.910	0.850	0.810	0.500	0.240
Graduate prospects	Mean	79.85	79.86	71.94	67.32	64.30	64.17
	Minimum	53.50	70.60	51.80	43.60	56.30	56.10
	Maximum	95.10	87.70	82.90	80.30	75.30	70.00
Staff-student	Mean	0.077	0.073	0.061	0.061	0.057	0.057
	Minimum	0.060	0.057	0.045	0.048	0.047	0.050
	Maximum	0.097	0.088	0.075	0.070	0.066	0.062
Academic services	Mean	1990.67	1621.36	1426.48	1330.74	1192.13	1087.33
	Minimum	877.00	1092.00	600.00	800.00	740.00	891.00
	Maximum	2622.00	2254.00	1868.00	1643.00	1497.00	1227.00
Facilities	Mean	793.93	649.32	625.41	517.07	480.42	472.83
	Minimum	118.00	286.00	298.00	85.00	124.00	366.00
	Maximum	1575.00	1024.00	1028.00	1269.00	694.00	590.00
Good honours	Mean	79.73	80.30	73.51	69.18	68.25	64.13
	Minimum	61.40	66.00	61.70	55.50	50.20	59.70
	Maximum	92.80	87.00	83.10	78.00	77.60	70.00
Degree completion	Mean	90.77	91.64	86.78	81.89	81.43	80.50
	Minimum	77.60	85.60	71.40	67.60	68.40	75.60
	Maximum	98.90	95.90	94.50	90.10	88.00	84.10
Overall	Mean	826.87	807.16	684.66	606.26	560.79	512.33
	Minimum	633.00	620.00	517.00	412.00	414.00	476.00
	Maximum	1000.00	952.00	825.00	725.00	627.00	547.00
Rank	Mean	26.67	25.48	59.07	82.30	99.13	115.50
	Minimum	1	4	18	44	76	106
	Maximum	73	79	115	128	127	123

Figure 1: Radar plot of two HEIs

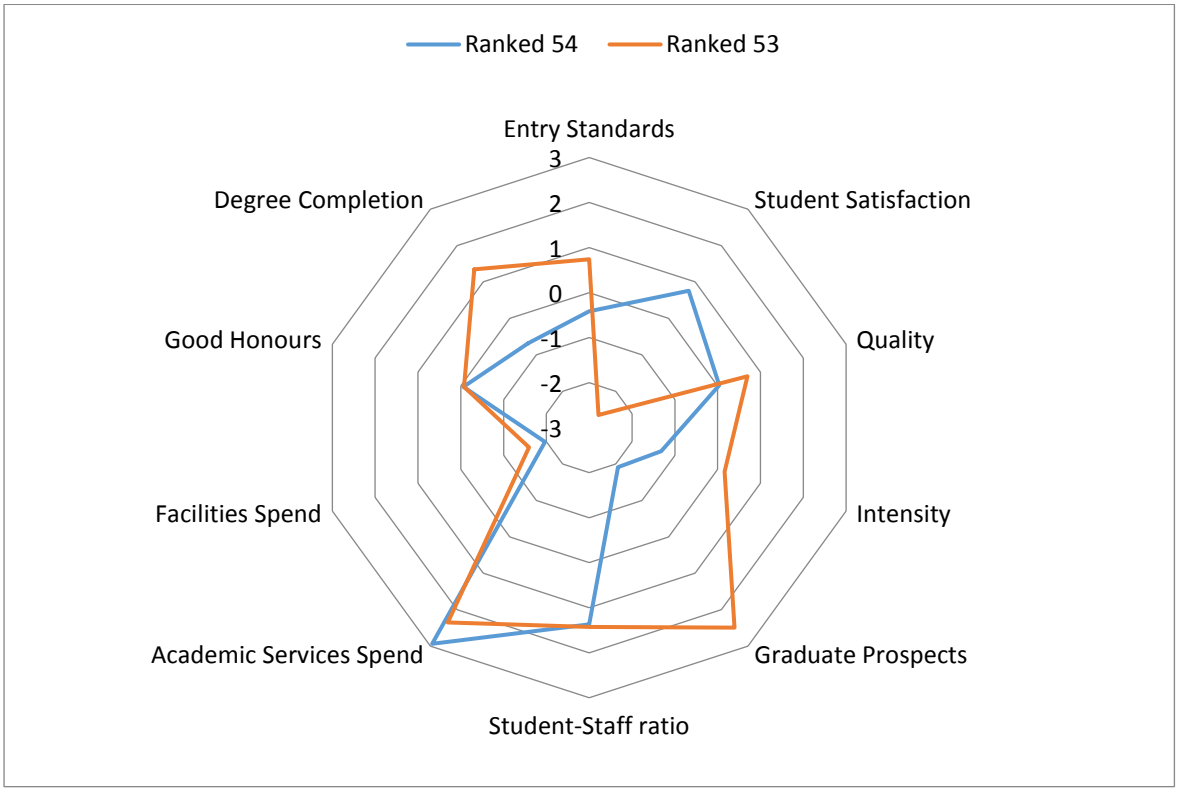


Figure 2: Plot of first two principal components

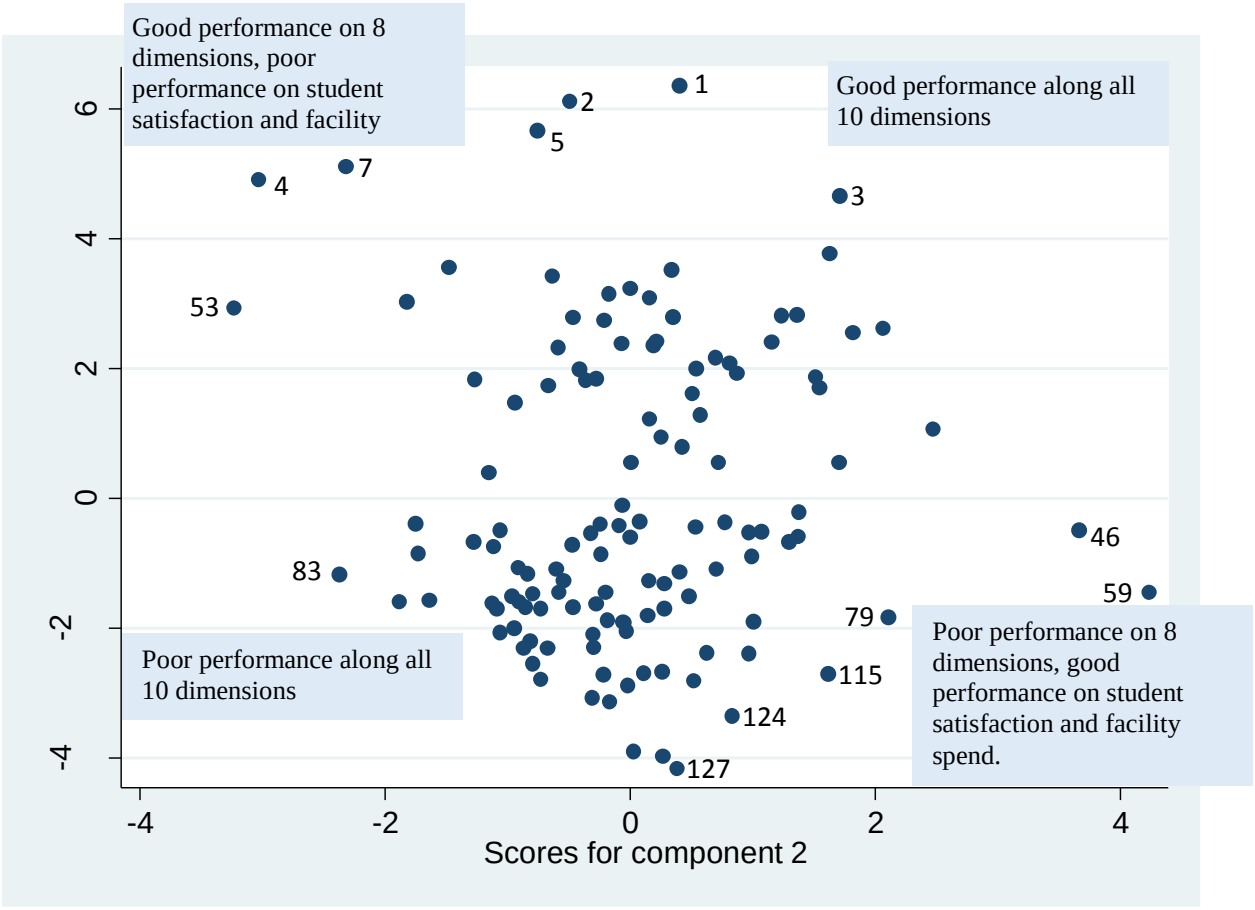


Figure 3: A plot of HEIs' rank versus score

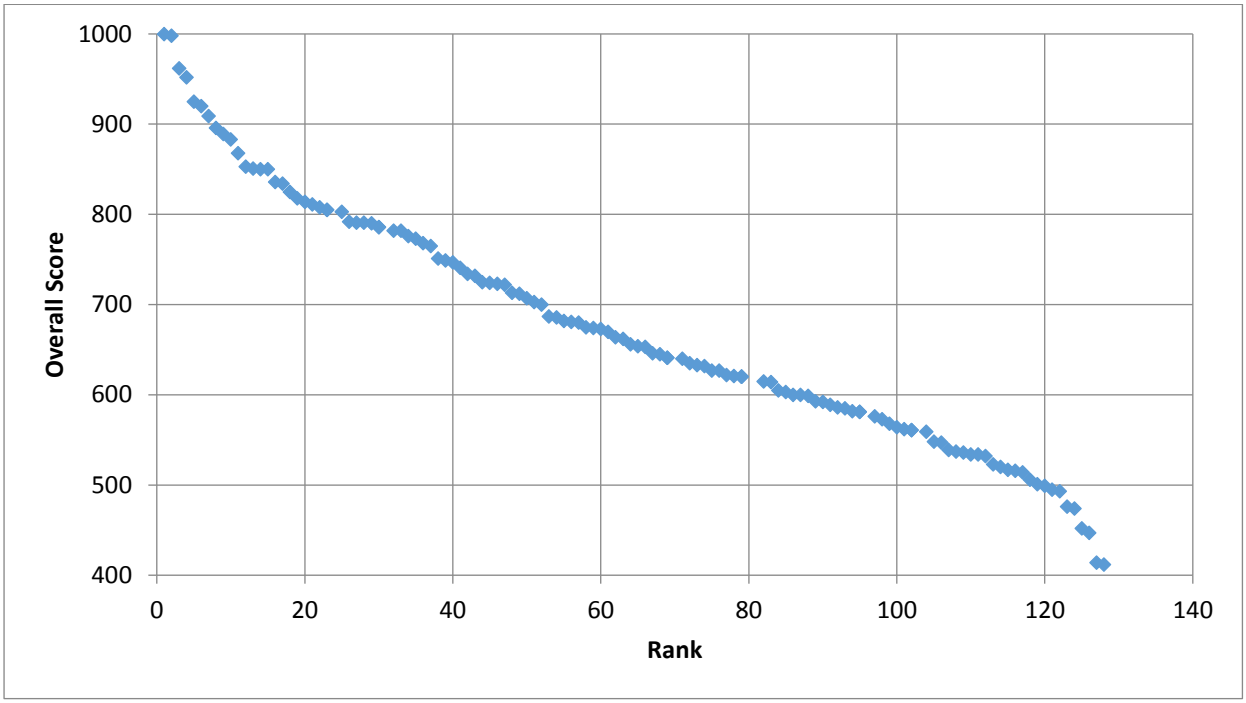


Figure 4: DEA BOD scores and confidence intervals

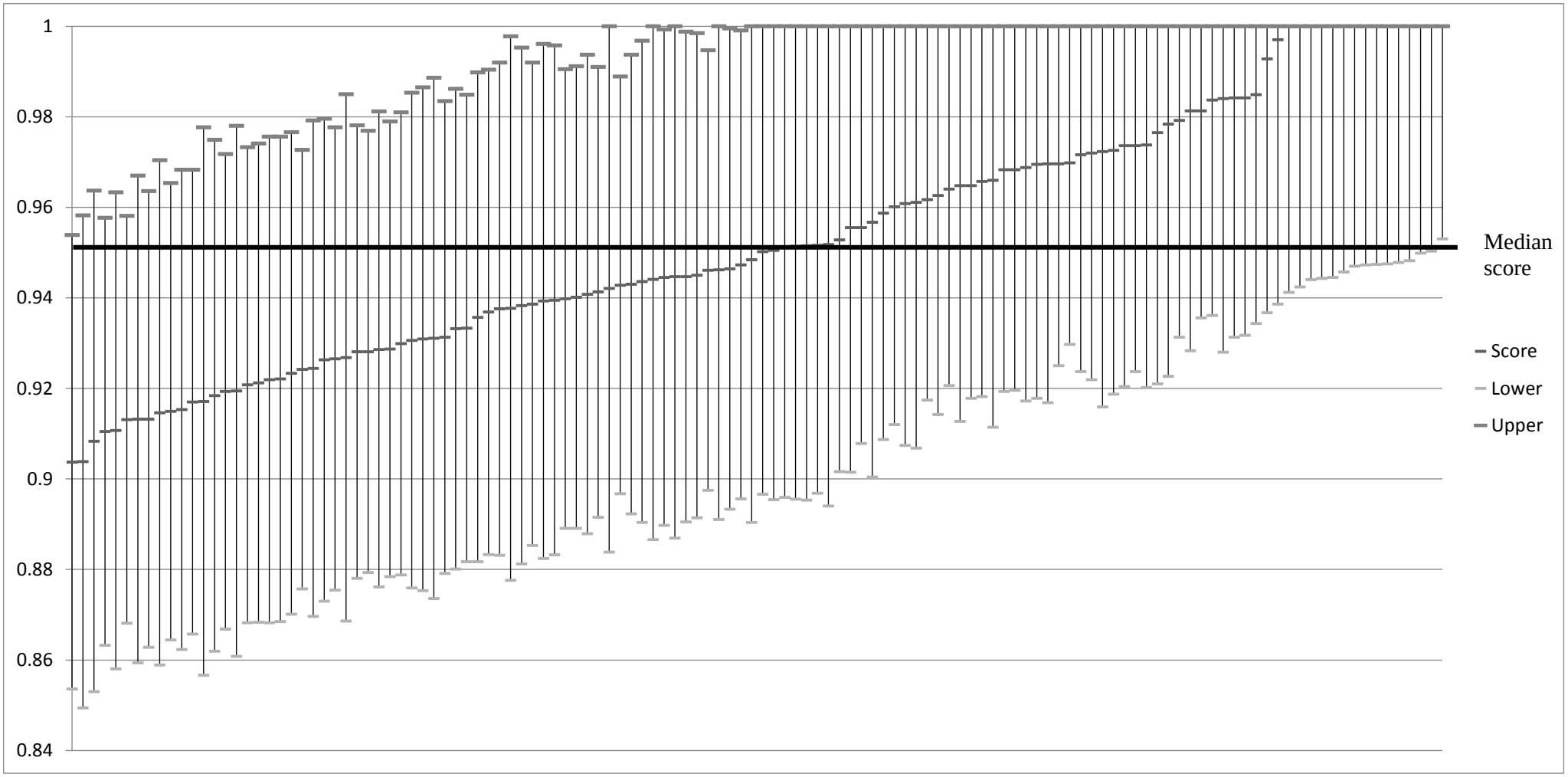
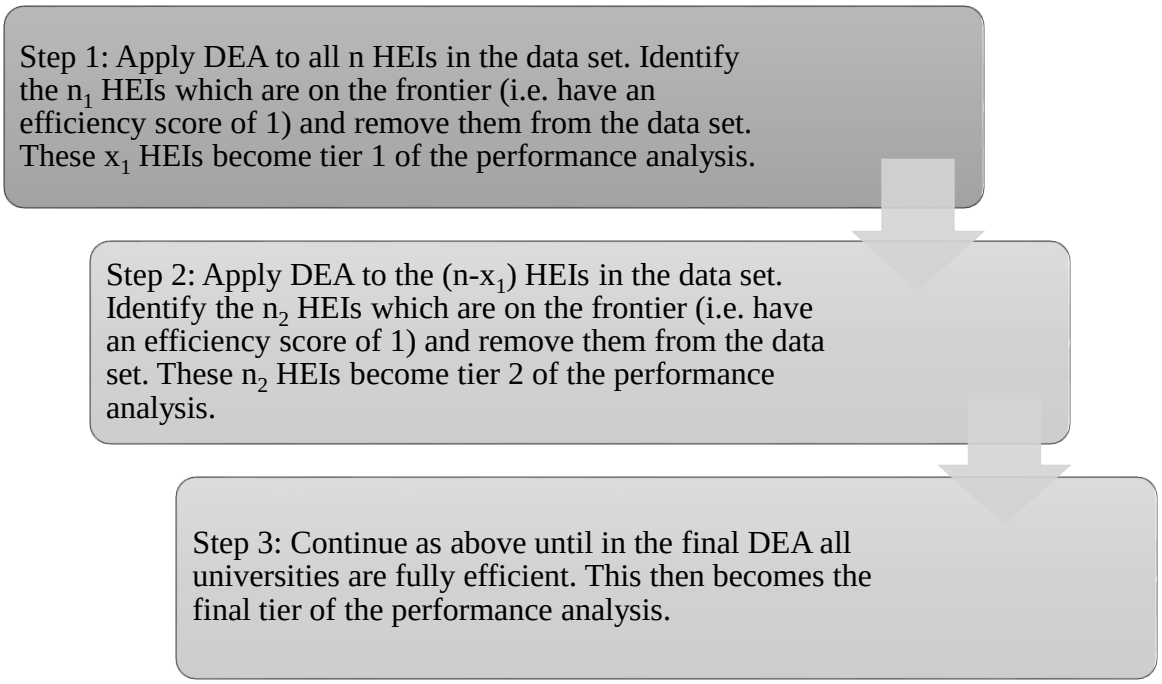


Figure 5: Peeling the DEA onion



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