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A comparative study on world university rankings: a bibliometric survey

Kuang-hua Chen · Pei-yu Liao

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Abstract Recently there are many organizations conducting projects on ranking world universities from different perspectives. These ranking activities have made impacts and caused controversy. This study does not favor using bibliometric indicators to evaluate universities' performances, but not against the idea either. We regard these ranking activities as important phenomena and aim to investigate correlation of different ranking systems taking bibliometric approach. Four research questions are discussed: (1) the inter-correlation among different ranking systems; (2) the intra-correlation within ranking systems; (3) the correlation of indicators across ranking systems; and (4) the impact of different citation indexes on rankings. The preliminary results show that 55 % of top 200 universities are covered in all ranking systems. The rankings of ARWU and PRSPWU show stronger correlation. With inclusion of another ranking, WRWU (2009–2010), these rankings tend to converge. In addition, intra-correlation is significant and this means that it is possible to find out some ranking indicators with high degree of discriminativeness or representativeness. Finally, it is found that there is no significant impact of using different citation indexes on the ranking results for top 200 universities.

Keywords Bibliometrics · Ranking indicators · World university rankings

Introduction

Bibliometrics, an important sub-domain of library and information science, is widely applied in many aspects, such as book and periodical selection, characteristics of subject literatures, evaluation of collections and bibliographies, and historical and sociological applications (Lawani 1981). Application of bibliometrics has been extended to academic

K. Chen (✉) · P. Liao
Department of Library and Information Science, National Taiwan University, 1, Sec. 4, Roosevelt RD, Taipei 10617, Taiwan
e-mail: khchen@ntu.edu.tw

P. Liao
e-mail: sophie.peiyu@gmail.com

evaluation and universities ranking since the past decade. The application of bibliometrics methods has caused a lot of discussions and controversy (Van Raan 2005; Van Raan et al. 2006).

Due to the phenomenon of globalization of higher education, the quality and competitiveness of universities have become important issues (Altbach 2006; Hazelkorn 2008). Ranking activities have made competition among universities no more under table. In the year of 2003, Shanghai Jiao Tong University of China announced an international universities ranking called "Academic Ranking of World Universities" (ARWU), and this made the very beginning of global ranking for universities.

In recent years, many organizations in England, Spain, Taiwan, Russia, and France have conducted projects on international universities rankings from different aspects (Cybermetrics Lab, Centro de Ciencias Humanas y Sociales, Consejo Superior de Investigaciones Científicas 2011; Higher Education Evaluation and Accreditation Council of Taiwan 2011; MINES ParisTech 2010; RatER 2010; Shanghai Ranking Consultancy & Shanghai Jiao Tong University, 2011; The Times Higher Education Supplement, 2011). Four rankings for world universities out of many others have drawn a lot of attention: "Academic Ranking of World Universities" (ARWU) implemented by Shanghai Jiao Tong University of China, "World University Rankings" (WUR) implemented by the Times Higher Education Supplement (THES) in England, "Webometrics Ranking of World Universities" (WRWU) implemented by Cybermetrics Lab in Spain, and "Performance Ranking of Scientific Papers for World Universities" (PRSPWU) implemented by the Higher Education Evaluation and Accreditation Council of Taiwan (HEEACT).

Regardless the debates over the results, some of the faculty, students, governments, and companies have taken a serious look at these ranking results and regarded them as some kind of criteria for educational quality. However, these rankings were carried out using different methodologies in various perspectives. For example, the ranking indicators designed by Shanghai Jiao Tong University emphasize excellent academic achievement; the Higher Education Evaluation and Accreditation Council of Taiwan emphasizes academic achievement based on publications of research outputs; the Times Higher Education's ranking is characterized by the reputation of universities; Webometric approach is used by Cybermetrics Lab to investigate the dissemination and sharing of academic information over Internet.

World university rankings have provoked some issues, especially the objectivity and suitability of indicators used in evaluation for academic organizations. (Altbach 2006; Marginson 2007; Ioannidis et al. 2007; Billaut et al. 2009; Vo et al. 2010) Therefore, in order to improve the quality of rankings, International Ranking Expert Group (2006) (IREG) announced "Berlin Principles on Ranking of Higher Education Institutions".

Because the activity of world university rankings is a multinational evaluation, the data for ranking indicators have to be available directly and analyzed easily. However, there is room for further discussions on whether it is a subjective or objective-oriented evaluation. The reliability and validity of ranking results are still challenged (Liu 2008).

Objectivity is one of the important principles for research study, especially for the evaluation of universities. WUR's ranking results have been questioned, since its indicators focus on reputation of universities. Two reputation-oriented indicators, "academic peer review" and "employer survey", have 50 % weight of the final evaluation scores. The two indicators are questioned in experts selection and response rates of questionnaires (Huang 2009; Bookstein et al. 2010; Holmes 2006; Ioannidis et al. 2007).In 2010, THES has changed its ranking indicators (from 6 to 13) and lowered the weight of reputation-oriented indicators(from 50 to 34.5 %) as a response to the aforementioned questions.

Basically, taking bibliometric approach is a more objective way comparing to the reputation survey, such as some ranking indicators in ARWU and PRSPWU. However, it doesn't mean bibliometric approach can be always applied to evaluate universities. In fact, bibliometric methodology is easily used in an improper way and lost its actual meaning (van Raan 2005). Temporal issue should be considered while we evaluate academic performance for research institutions, since the time from an article being completed to published, the researcher of that article may not in the same institutions (Billaut et al. 2009; Ioannidis et al. 2007; van Raan 2005). The other problem is obtaining the information about institutions. Pat of data, e.g., numbers of faculty and students needs to be provided by institutions. Huang (2009) points out that the data may be questionable if the information provided is incomplete or incorrect, and is likely to affect the overall assessment results.

In general, the suitability of ranking indicators has been regarded as one of important issue in world university ranking, and subjectivity or objectivity of evaluation have to be sincerely considered in ranking systems. Therefore, Vo et al. (2010) and Qiu (2009) proposed their own ranking systems in order to improve the current evaluation systems. Billaut et al. (2009) and Williams (2008) considered that the ranking indicators should be made-to-order for different higher educational systems. Moreover, Van Raan (2005) emphasized that quantitative bibliometric indicators require the support of peer review.

Intuitively, ranking systems with all/some different indicators will have different impacts on ranking results. It would be interesting for anyone concerning world university rankings to investigate the correlation among different ranking results to ensure if good universities are good in terms of any indicators. This study focuses on this point to investigate 2007–2010 ranking results of three well-known ranking systems.

This article is structured as follows: Research design section describes the research design including data acquisition, processing, and analysis. Comparison and analysis section investigates results and compares various indicators which have impacts on rankings of world universities. Related work section discusses previous work and the results from pervious works and this study. Conclusions section gives brief conclusions.

Research design

The methodology of secondary data analysis is used in this study and statistical tests are applied as well. Due to the problem of data gathering for WRWU before 2008, only three independent rankings for top 200 world universities in 2007–2010 are used in this study, i.e., ARWU, WUR, and PRSPWU. Four main research questions of this study are shown as follows.

1. Compare inter-correlation between different rankings of ARWU, WUR, and PRSPWU (2007–2010);
2. Compare intra-correlation within rankings and respective bibliometric indicators for ARWU, WUR, and PRSPWU;
3. Compare the correlation of indicators across ranking systems;
4. Investigate impacts on rankings in term of different citation indexes.

Before carrying out analyses for various ranking results, the universities listed in the top 200 universities covered by all of the ranking systems have to be figured out. The authors examine each bibliometric indicator as shown in Table 1, and transform original scores into ranking orders. Then we reassign the original ranking orders to make ranking orders

Table 1 Bibliometric ranking indicators

Name of ranking	Bibliometric ranking indicators	Code
ARWU: Academic ranking of world universities	Highly cited researchers in 21 broad subject categories	*AHiCi*
	Articles published in Nature and Science	*ANS*
	Articles indexed in SCI/E & SSCI	*APUB*
WUR: World university rankings	Citation/Faculty (in the year of 2007 to 2009)	*Wavci*
	Research excellence (in the year of 2010)	
PRSPWU: Performance ranking of scientific papers for world universities	Number of articles of the last 11 years	*P11N*
	Number of articles of the current year	*PCN*
	Number of citations of the last 11 years	*P11ci*
	Number of citations of the last 2 years	*P2ci*
	Average number of citations of the last 11 years	*P11avci*
	H-index of the last 2 years	*P2H*
	Number of highly cited papers	*PHiCiN*
	Number of articles of the current year in high-impact journals	*PHimjN*

successive. Finally, Spearman rank correlation coefficient is used to examine the correlation among the ranking results. Figure 1 shows the research procedure of this study.

Data processing

This study focuses on the top 200 universities of ARWU, WUR, and PRSPWU to investigate the correlation of ranking results of 2007, 2008, 2009, and 2010. Spearman rank correlation coefficient (r_s) with significance level of 0.01 is used. Spearman coefficient is shown as follows:

$$r_s = 1 - \frac{6}{n(n^2-1)} \sum_{i=1}^{n} d_i^2$$

Any two of top 200 universities' lists are compared, for example, assessment organizations of X and Y have$n$ universities out of top 200 are the same, the ranking orders of n universities will be reassigned and made successive. Average rating will be used if the new orders of universities are the same (as shown in Fig. 2).

Data analysis

In order to mention rankings and each indicator in brief, codes will be used to represent the ranking results carried out by different evaluation systems, such as *Wt* represents the total ranking of WUR (reported by THES), *At* represents the total ranking of ARWU (reported by Shanghai Jiao Tong University), *Pt* represents the total ranking of PRSPWU (reported by HEEACT), and *WRt* represents the total ranking of WRWU (reported by Cybermetrics Lab). As to the codes for ranking indicators analyzed, please refer to Table 1. Table 2 shows involved indicators in each research questions.

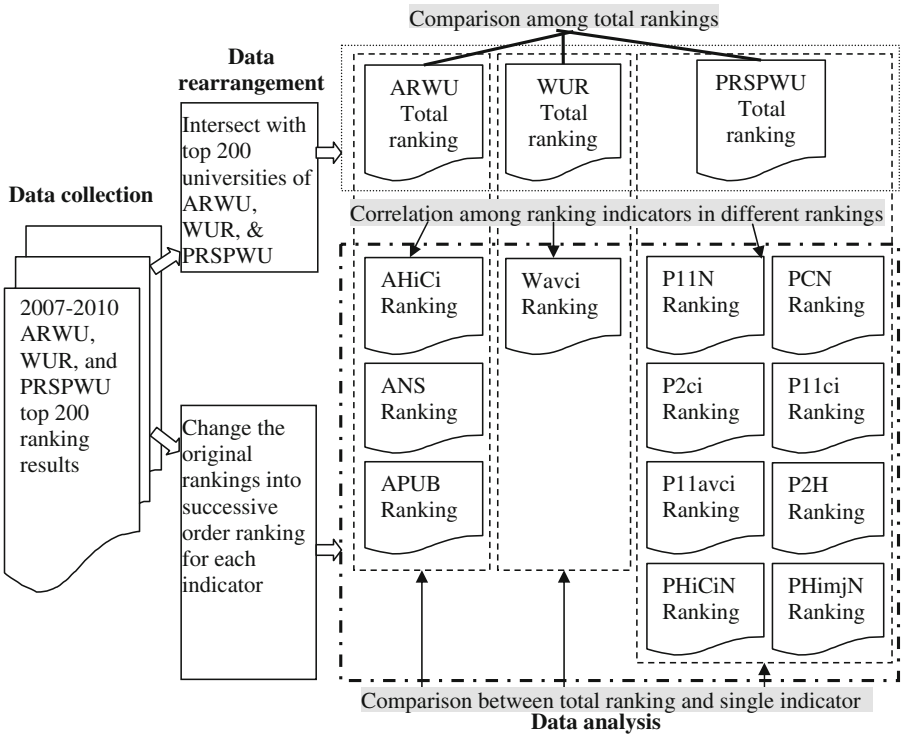

Fig. 1 Research procedure

X	Y
X_1	Y_1
X_2	Y_2
. . .	. . .
X_i	Y_i
X_n	Y_n

Original ranking orders of universities in top 200 of any two evaluation organizations

Transform

X'	Y'	d = X'- Y'
X'_1	Y'_1	d_1
X'_2	Y'_2	d_2
. . .	. . .	. . .
X'_i	Y'_i	d_i
X'_n	Y'_n	d_n

Re-assign the ranking orders to make successive.

Fig. 2 Data processing procedure

Comparisons and analyses

Inter-correlation between rankings

Three different rankings reported from 2007 to 2010, WUR, ARWU, and PRSPWU, are examined and compared. Table 3 quantifies the number of universities which are ranked in

Table 2 Indicators involved in research questions

Research question	Analyzed indicators' codes	Note
Comparison among three well-known rankings	*Wt vs. At*	Year analyzed: 2007–2010
	At vs. Pt	3 data sets per year
	Pt vs. Wt	Total data sets: 12
Comparison among three rankings to WRWU ranking	*Wt vs. At*	Year analyzed: 2009–2010
	At vs. Pt	6 data sets per year
	Pt vs. Wt	Total data sets: 12
	WRt vs. Wt	
	WRt vs. At	
	WRt vs. Pt	
Investigation of intra-correlation of ranking systems	*Wt vs. Wavci*	Year analyzed: 2007–2010
	At vs. AHiCi, ANS, APUB	12 data sets per year
	Pt vs. P11N, PCN, P11ci, P2ci, P11avci, P2H, PHiCiN, PHimjN	Total data sets: 48
Investigation of correlation of indicators across different ranking systems	*Wavci vs. AHiCi, ANS, APUB*	Year analyzed: 2007–2010
	Wavci vs. P11N, PCN, P11ci, P2ci, P11avci, P2H, PHiCiN, PHimjN	35 data sets per year
	AHiCi vs. P11N, PCN, P11ci, P2ci, P11avci, P2H, PHiCiN, PHimjN	Total data sets: 140
	ANS vs. P11N, PCN, P11ci, P2ci, P11avci, P2H, PHiCiN, PHimjN	
	APUB vs. P11N, PCN, P11ci, P2ci, P11avci, P2H, PHiCiN, PHimjN	
Investigation of impacts on ranking in term of different citation indexes.	*Wavci06 vs. Wavci07*	Year analyzed: 2006–2007
		Total data set: 1

Table 3 Number of universities covered in all of the three ranking systems

Year	Number
2007	116
2008	121
2009	115
2010	116

all of the three lists of top 200 universities. It demonstrates 55 % overlapping rate among the top 200 universities from 2007 to 2010.

Examining the statistics of Spearman rank correlation coefficient (r_s) in three rankings from 2007 to 2010 (see Table 4, where *r*/*p*/*n* denotes r_s, p value, and number of

Table 4 Spearman rank correlation coefficient in three rankings

	Wt07	**At07**	**Pt07**
Wt07	–	.573**/p = .000/n = 116	.511**/p = .000/n = 116
At07	–	1.000/./.	.800**/p = .000/n = 116
	Wt08	**At08**	**Pt08**
Wt08	–	.621**/p = .000/n = 121	.592**/p = .000/n = 121
At08	–	–	.818**/p = .000/n = 121
	Wt09	**At09**	**Pt09**
Wt09	–	.613**/p = .000/n = 115	.582**/p = .000/n = 115
At09	–	–	.824**/p = .000/n = 115
	Wt10	**At10**	**Pt10**
Wt10	–	.719**/p = .000/n = 116	.704**/p = .000/n = 116
At10	–	–	.825**/p = .000/n = 116

* $p < .05$; ** $p < .01$

universities), the strong correlation between PRSPWU and ARWU is found (r_s = 0.800–0.825). However, WUR is less relevant to PRSPWU (with r_s = 0.511–0.592) and ARWU (with r_s = 0.573–0.621), except the ranking results of WUR in 2010.

According to the results, we find that not all of the total rankings for world universities exhibit strong correlations, only total rankings of ARWU and PRSPWU (both rankings focus on academic research performance) have much stronger correlation. It shows that the similar ranking perspectives result in the similar rankings.

As for WUR, it doesn't reach strong correlation with ARWU and PRSPWU in 2007, 2008, and 2009, the reason may be that their evaluating perspectives are different. WUR focuses on reputation of universities, and the weights of reputation-related indicators are of 50 % of total score. But if we examine 2010s results, it is obvious that WUR has a stronger correlation with ARWU (r_s = 0.719) and PRSPWU (r_s = 0.704). This resulted from the revision of ranking indicators of WUR in 2010. THES has replaced its original 6 ranking indicators with 13 indicators. Two ranking indicators, "peer review" (weight of 40 %) and "recruiter review" (weight of 10 %), were replaced with "reputation survey-teaching" (weight of 15 %) and "reputation survey-research" (weight of 19.5 %). The weights of reputation are decreased obviously. Research performance indicators, "citation/faculty score" (weight of 20 %) has been replaced with "papers per academic and research staff" (weight of 4.5 %) and "citation impact" (weight of 32.5 %). In contrast, the weights of research related indicators are increased.

Comparisons to WRWU

WRWU carried out by Cybermetrics Lab is added to compare the difference with ARWU, WUR and PRSPWU in 2009 and 2010 (with WRWU's ranking in July of 2009 and 2010). *WRt* represents the total ranking of WRWU. As shown in Table 5, ARWU and PRSPWU still have strong correlation (r_s = 0.801 in 2009 and 0.847 in 2010). ARWU is more relevant to WRWU than the other two rankings (PRSPWU and WUR) with r_s = 0.713 in 2009 and 0.721 in 2010. The results show that a university with good performance in academic research would also demonstrate her broad visibility in cyberspace.

Table 5 Spearman rank correlation coefficient in four rankings

	WRt09	**At09**	**Pt09**
Wt09	.260*/p = .0180/n = 82	.533**/p = .000/n = 82	.483**/p = .000/n = 82
Pt09	.556**/p = .000/n = 82	.801**/p = .000/n = 82	–
At09	.713**/p = .000/n = 82	–	–
	WRt10	**At10**	**Pt10**
Wt10	.626**/p = .000/n = 83	.809**/p = .000/n = 83	.735**/p = .000/n = 83
Pt10	.665**/p = .000/n = 83	.847**/p = .000/n = 83	–
At10	.721**/p = .000/n = 83	–	–

* $p < .05$; ** $p < .01$

After the revision of WUR's ranking indicators in 2010, the r_s between WUR and WRWU has increased from 0.260 in 2009 to 0.626 in 2010. In addition, we could find out that the r_s of any two out of the four rankings is greater than 0.6 after examining the r_s of these four rankings in 2010. It seems that the four rankings with different perspectives tend to converge.

Intra-correlation between indicators

In order to investigate the correlation between the total ranking and its single indicator, each bibliometric indicator of a ranking system is compared to its respective total ranking. The results show that some indicators have correlation coefficient over 0.6 with their respective total rankings in Spearman test. For example, the results of the total ranking of ARWU versus the ranking of each indicator, AHiCi, ANS and APUB, are shown in Table 6. Besides, the results of the total ranking of PRSPWU versus the rankings of indicator, P11ci, P2ci, P2H, PHiCiN, and PHimjN, have correlation coefficient over 0.7 and even over 0.9 in Spearman, which show strong correlation (please refer to Table 7). However, as shown in Table 8, there is a weak correlation between the total ranking of WUR and the indicator Wavci in 2007, 2008, and 2009 with r_s no more than 0.4. In contrast, the r_s of the two reaches to 0.7 in 2010, showing that the revision of WUR's ranking indicators has affected the correlation with its total ranking.

Table 6 Total ranking vs. single indicator ranking for ARWU's data in 2007–2010

At07	**AHiCi07**	**ANS07**	**APUB07**
	.764**/p = .000/n = 202	.774**/p = .000/n = 202	.650**/p = .000/n = 202
At08	**AHiCi08**	**ANS08**	**APUB08**
	.752**/p = .000/n = 200	.767**/p = .000/n = 200	.671**/p = .000/n = 200
At09	**AHiCi09**	**ANS09**	**APUB09**
	.765**/p = .000/n = 200	.757**/p = .000/n = 200	.681**/p = .000/n = 200
At10	**AHiCi10**	**ANS10**	**APUB10**
	.758**/p = .000/n = 200	.766**/p = .000/n = 200	.639**/p = .000/n = 200

* $p < .05$; ** $p < .01$

Table 7 Total ranking vs. single indicator ranking for PRSPWU's data in 2007–2010

Pt07	**P11N07**	**PCN07**	**P11ci07**	**P2ci07**	**P11avci07**	**P2H07**	**PHiCiN07**	**PHimjN07**
	.840**	.826**	.949**	.937**	.487**	.892**	.896**	.886**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$
Pt08	**P11N08**	**PCN08**	**P11ci08**	**P2ci08**	**P11avci08**	**P2H08**	**PHiCiN08**	**PHimjN08**
	.756**	.758**	.932**	.958**	.509**	.907**	.886**	.896**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 201$	$n = 201$	$n = 201$	$n = 201$	$n = 201$	$n = 201$	$n = 201$	$n = 201$
Pt09	**P11N09**	**PCN09**	**P11ci09**	**P2ci09**	**P11avci09**	**P2H09**	**PHiCiN09**	**PHimjN09**
	.781**	.776**	.933**	.954**	.483**	.884**	.896**	.909**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$
Pt10	**P11N10**	**PCN10**	**P11ci10**	**P2ci10**	**P11avci10**	**P2H10**	**PHiCiN10**	**PHimjN10**
	.799**	.785**	.927**	.946**	.463**	.912**	.911**	.909**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$	$n = 200$

* $p < .05$; ** $p < .01$

Table 8 Total ranking vs. single indicator ranking for WUR's data in 2007–2010

Wt07	**Wavci07**
	.425**/$p = .000$/$n = 201$
Wt08	**Wavci08**
	.457**/$p = .000$/$n = 201$
Wt09	**Wavci09**
	.400**/$p = .000$/$n = 200$
Wt10	**Wavci10**
	.721**/$p = .000$/$n = 200$

* $p < .05$; ** $p < .01$

Correlation of indications across ranking systems

In order to investigate correlations of bibliometric indicators across different ranking systems, a series of Spearman tests are carried out as well. Table 9 shows correlation of Wavci bibliometric indicator of WUR and three bibliometric indicators, AHiCi, ANS and APUB, of ARWU. There is no evidence shows strong correlation. Table 10 shows correlation of Wavci and eight bibliometric indicators of PRSPWR. It does not show strong correlation either. Especially, PCN and P11N of PRSPWR (counts of articles based indicators) show weak correlation to Wavci (citation related indicator). In contrast, P11ci, p2ci, P11avci, P2H, and PHiCi (citation related indicators) show a little bit stronger correlation to Wavci.

In the comparison of AHiCi of ARWU and eight bibliometric indicators of PRSPWU, similar indicators show strong correlation such as AHiCi and PHiCiN indicators as shown in Table 11. Comparing another bibliometric indicator of ARWU, APUB, to eight indicators of PRSPWU, the results shows strong correlation with exception of P11avci (Please refer to Table 12). This implies a subtle relation of citation index database and tendency of citation.

Table 9 Wavci vs. ARWU's three indicators in 2007–2010

Wavci07	**AHiCi07**	**ANS07**	**APUB07**
	.536**/p = .000/n = 131	.425**/p = .000/n = 131	.297**/p = .000/n = 131
Wavci08	**AHiCi08**	**ANS08**	**APUB08**
	.610**/p = .000/n = 130	.564**/p = .000/n = 130	.247**/p = .000/n = 130
Wavci09	**AHiCi09**	**ANS09**	**APUB09**
	.644**/p = .000/n = 133	.586**/p = .000/n = 133	.349**/p = .000/n = 133
Wavci10	**AHiCi10**	**ANS10**	**APUB10**
	.519**/p = .000/n = 125	.522**/p = .000/n = 125	.190**/p = .000/n = 125

* $p < .05$; ** $p < .01$

Table 10 Wavci vs. PRSPWU's eight indicators in 2007–2010

Wavci07	**P11N07**	**PCN07**	**P11ci07**	**P2ci07**	**P11avci07**	**P2H07**	**PHiCiN07**	**PHimjN07**
	.379**	.344**	.526**	.451**	.453**	.500**	.603**	.458**
	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000
	n = 130	n = 130	n = 130	n = 130	n = 130	n = 130	n = 130	n = 130
Wavci08	**P11N08**	**PCN08**	**P11ci08**	**P2ci08**	**P11avci08**	**P2H08**	**PHiCiN08**	**PHimjN08**
	.270**	.200**	.511**	.438**	.559**	.522**	.605**	.424**
	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000
	n = 131	n = 131	n = 131	n = 131	n = 131	n = 131	n = 131	n = 131
Wavci09	**P11N09**	**PCN09**	**P11ci09**	**P2ci09**	**P11avci09**	**P2H09**	**PHiCiN09**	**PHimjN09**
	.292**	.246**	.527**	.447**	.612**	.473**	.601**	.435**
	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000
	n = 134	n = 134	n = 134	n = 134	n = 134	n = 134	n = 134	n = 134
Wavci10	**P11N10**	**PCN10**	**P11ci10**	**P2ci10**	**P11avci10**	**P2H10**	**PHiCiN10**	**PHimjN10**
	.266**	.223**	.410**	.409**	.578**	.481**	.558**	.379**
	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000	p = .000
	n = 131	n = 131	n = 131	n = 131	n = 131	n = 131	n = 131	n = 131

* $p < .05$; ** $p < .01$

In summary, some important findings are itemized as follows.

1. Average number of citations and number of articles are not correlated strongly.
2. There exists subtle relation of citation index database and tendency of citation.
3. Citation related indicators in ARWU and PRSPWU show strong correlation.
4. Indicators of "Articles indexed in SCI/E & SSCI" and "Articles published in Nature and Science" in ARWU show stronger correlation to indicator of "Number of highly cited papers" in PRSPWU.
5. Only indicator of "Articles indexed in SCI/E & SSCI" in ARWU shows strong correlation to indicators of "Number of citations of the last 11 years" and "Number of citations of the last 2 years" in PRSPWU.

The impacts on ranking results in term of different citation indexes

In order to explore the impact of different citation indexes, the indicator of "Citation/Faculty" indicator (Wavci) of WUR are used and investigated. THES used Web of Science

Table 11 ARWU's AHiCi vs. PRSPWU's eight indicators in 2007–2010

AHiCi07	**P11n07**	**PCN07**	**P11ci07**	**P2ci07**	**P11avci07**	**P2H07**	**PHiCiN07**	**PHimjN07**
	.538**	.521**	.691**	.611**	.458**	.641**	.818**	.595**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$
AHiCi08	**P11n08**	**PCN08**	**P11ci08**	**P2ci08**	**P11avci08**	**P2H08**	**PHiCiN08**	**PHimjN08**
	.522**	.492**	.688**	.642**	.488**	.659**	.826**	.674**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$
AHiCi09	**P11n09**	**PCN09**	**P11ci09**	**P2ci09**	**P11avci09**	**P2H09**	**PHiCiN09**	**PHimjN09**
	.517**	.492**	.719**	.637**	.543**	.605**	.852**	.676**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$
AHiCi10	**P11n10**	**PCN10**	**P11ci10**	**P2ci10**	**P11avci10**	**P2H10**	**PHiCiN10**	**PHimjN10**
	.536**	.466**	.755**	.645**	.617**	.674**	.853**	.661**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .000$
	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$

* $p < .05$; ** $p < .01$

Table 12 ARWU's APUB vs. PRSPWU's eight indicators in 2007–2010

APUB07	**P11n07**	**PCN07**	**P11ci07**	**P2ci07**	**P11avci07**	**P2H07**	**PHiCiN07**	**PHimjN07**
	.920**	.953**	.709**	.815**	−0.001	.577**	.636**	.777**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .990$	$p = .000$	$p = .000$	$p = .000$
	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$
APUB08	**P11n08**	**PCN08**	**P11ci08**	**P2ci08**	**P11avci08**	**P2H08**	**PHiCiN08**	**PHimjN08**
	.938**	.978**	.727**	.821**	−0.010	.567**	.648**	.868**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .878$	$p = .000$	$p = .000$	$p = .000$
	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$	$n = 160$
APUB09	**P11n09**	**PCN09**	**P11ci09**	**P2ci09**	**P11avci09**	**P2H09**	**PHiCiN09**	**PHimjN09**
	.941**	.982**	.732**	.841**	−0.008	.575**	.666**	.865**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .925$	$p = .000$	$p = .000$	$p = .000$
	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$	$n = 162$
APUB10	**P11n10**	**PCN10**	**P11ci10**	**P2ci10**	**P11avci10**	**P2H10**	**PHiCiN10**	**PHimjN10**
	.930**	.979**	.708**	.828**	0.013	.616**	.660**	.879**
	$p = .000$	$p = .000$	$p = .000$	$p = .000$	$p = .871$	$p = .000$	$p = .000$	$p = .000$
	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$	$n = 152$

* $p < .05$; ** $p < .01$

to carry out ranking of world universities from 2004 to 2006, but Web of Science was replaced with Scopus from 2007 to 2009. In 2010, THES used Web of Science as again. This gives us an opportunity to explore the impact of different citation index tools.

We selected the ranking results of Wavci in 2006 and 2008 and found out 165 universities ranked in both of the 2 years. Table 13 shows the result of Spearman test. It exhibits strong correlation with $r_s = 0.811$. This result demonstrates that different citation indexes make little influence on ranking of this indicator.

Table 13 Comparison of Wavci indicator in 2006 and 2008

	Wavci08
Wavci06	.811**/p = .000/n = 165

** $p < .01$

Related work

Yu et al. (2008) used the 2007 THES-QS world university rankings (i.e., WUR in this paper) to examine the consistency based on six methods. They concluded that the consistency of top ranking universities is significant, but not the case for bottom ranking universities.

Huang (2011) compared the top 20 results of THES, QS, ARWU and PRSPWU in 2010. In their results, it was found that the similarities of ranking results between ARWU and PRSPWU because the performances of bibliometric indicators have been emphasized by Shanghai Jiao Tong University and Taiwan Higher Education Evaluation and Accreditation Council. In addition, it is shown that the rankings of THES and QS are consistent owning to their characters of peer review. Compared with the Huang's findings, the results in this study based on top 200 shows similar case, and further indicated that the rankings of ARWU and PRSPWU have strong correlation every year (over 0.8 from 2007 to 2010).

Hou et al. (2011) examined the 2009 rankings of ARWU, THES & QS, WRWU and PRSPWU. They conducted *K*-means clustering and estimations of correlation coefficient, and analyzed the major indicators which influencing different rankings of universities. In the universities in ranking intervals of top 30 and top 100, it is shown that the ARWU's total rankings have strong correlation with own single indicators of AHiCi (over 0.8) and ANS (over 0.9). In addition, it is found that the PRSPWU's total rankings can achieve the correlation coefficient over 0.8 with all of its own single indicators except for the indicator of P11N, and over 0.9 with P2ci, P11ci, P2H, PHiCiN and PHimjN, especially. Compared with their findings, similar correlation cases discussed above are further proved in this study based on top 200 from 2007 to 2010. In the ARWU, the strong correlation between the total ranking and own single indicators (AHiCi and ANS) is verified again in this study. Also, in the PRSPWU, the strong correlation over 0.8 between the total ranking and own five indicators mentioned above is found in this study. Table 14 summarizes the researches mentioned above and this study.

Conclusions

Four research questions concerning rankings of world universities are proposed and explored in this study. Three well-known rankings, ARWU, PRSPWU, and WUR (2007–2010), are first investigated and compared. A comparison of the WRWU (2009–2010) to aforementioned three rankings is carried out as well. First of all, the overlapping rate of top 200 in the first three rankings is about 55 %; that of top 200 with considering WRWU is about 41 %.

For the comparison of inter-correlation of different rankings, the results show that ARWU and PRSPWU (both rankings focus on academic research performance) have stronger correlation. In contrast, WUR (2007–2009) has weak correlation to ARWU and PRSPWU. However, after WUR revised its indicators, the ranking of WUR (2010) shows much stronger correlation to ARWU and PRSPWU. This demonstrates similar ranking perspectives result in the similar ranking results.

Table 14 The comparison with two previous studies

Researches	Purposes	Objects	Time span	Methods
Yuet al. (2008)	Examination of the consistency of ranking for universities based on six difference methods	WUR	2007	Principle components analysis, factor analysis, technique for order preference by similarity to ideal solution, rank sum ratio, grey relational analysis, and Entropy analysis
Huang (2011)	Comparison between the top 20 of different rankings and the results in various areas	WUR, ARWU, PRSPWU, and QS	2010	Enumerative comparison
Hou et al. (2011)	Analysis of the major indicators which influencing different rankings of universities	ARWU, WUR, WRWU, and PRSPWU	2009 (2010 for WRWU)	Correlation coefficient test and *K*-means clustering
This study (2011)	Investigation of the correlation of different rankings and their indicators	WUR, ARWU, PRSPWU, and WRWU	2007–2010 (2009–2010 for WRWU)	Spearman correlation coefficient test

For the comparison of intra-correlation of ranking systems, it is found that strong correlation of their rankings and respective bibliometric indicators is very significant, e.g., "Highly cited researchers in 21 broad subject categories" and "Articles published in Nature and Science" in ARWU, and "Research Excellence" in WUR. Furthermore, every indicator of PRSPWU strongly correlates with its ranking with exception of indicator of "Average number of citations of the last 11 years". This finding can be insightful, while we are confronted with a design of ranking system and have to decide involved indicators. That is to say, it is possible to find out significant indicators with high discriminativeness or representativeness.

For the comparison of correlation of indications across ranking systems, it is found that many indicators of ARWU and PRSPWU exhibit strong correlation. For example, the correlation coefficient between "Highly cited researchers in 21 broad subject categories" of ARWU and "Number of highly cited papers" of PRSPWU is over 0.8. Moreover, the ARWU indicator of "Articles indexed in SCI/E & SSCI" has also significant correlation to PRSPWU indicators of "Number of citations of the last 2 years" and "Number of articles of the current year in high-impact journals". Again, this demonstrates similar indicators result in the similar ranking results.

For the investigation of impact of different citation indexes for world university rankings, the comparison of the Wavci indicator of WUR in 2006 and 2008, which data was obtained from different citation indexes, are carried out. The result shows that different citation indexes make no significant influence on rankings for the top 200 universities.

Future study will consider other ranking systems, e.g., QS World University Rankings and Global Universities Ranking, to cover broad ranking data and to investigate indicators for deeply analyses.

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