

A Longitudinal Analysis of University Rankings: Supplementary Material

Friso Selten¹, Cameron Neylon², Chun-Kai Huang², Paul Groth¹

¹Informatics Institute, University of Amsterdam, Amsterdam, The Netherlands

²Centre for Culture and Technology, Curtin University, Perth, Australia

A. SIMILARITY BETWEEN RANKING YEARS OVERALL

Table 1. Similarity between ranking years (O: Overlap; F: Spearmans correlation coefficient, M: M-measure).

Measure	2012			2013			2014			2015			2016			2017		
	O	F	M	O	F	M	O	F	M	O	F	M	O	F	M	O	F	M
ARWU																		
2013	489	0.99	0.97															
2014	467	0.95	0.96	473	0.96	0.95												
2015	468	0.94	0.96	472	0.95	0.95	485	0.99	0.98									
2016	440	0.87	0.9	446	0.88	0.92	458	0.94	0.93	459	0.95	0.93						
2017	432	0.87	0.89	438	0.88	0.89	448	0.94	0.92	449	0.94	0.92	467	0.97	0.94			
2018	432	0.86	0.88	434	0.87	0.88	443	0.93	0.91	444	0.94	0.91	459	0.96	0.93	471	0.98	0.97
THE																		
2013	338	0.98	0.91															
2014	324	0.95	0.89	334	0.97	0.93												
2015	301	0.91	0.86	303	0.92	0.88	307	0.92	0.85									
2016	297	0.9	0.78	299	0.91	0.79	303	0.91	0.77	331	0.97	0.86						
2017	289	0.89	0.72	291	0.9	0.74	297	0.9	0.71	320	0.94	0.8	335	0.98	0.92			
2018	277	0.86	0.7	278	0.87	0.72	286	0.88	0.7	307	0.93	0.78	319	0.96	0.89	342	0.97	0.95
QS																		
2013	376	0.99	0.92															
2014	370	0.97	0.89	384	0.99	0.91												
2015	368	0.95	0.83	373	0.96	0.88	371	0.96	0.85									
2016	359	0.94	0.82	365	0.95	0.84	364	0.96	0.84	381	0.99	0.94						
2017	357	0.93	0.81	361	0.94	0.83	361	0.95	0.82	375	0.98	0.91	384	0.98	0.96			
2018	354	0.91	0.8	356	0.92	0.8	357	0.93	0.8	367	0.96	0.88	374	0.97	0.93	383	0.99	0.95

All Spearmans correlations (F) were significant: $p < .001$

For the ARWU the top 500 and for the THE and QS the top 400 universities are analysed

When interpreting these results one has to take into account two considerations:

1. Results for the ARWU and THE are largely based on re-calculated ranks. These ranks are not provided by the rankings
2. For universities with missing data re-calculation was impossible. These were removed from the analysis.

B. SIMILARITY BETWEEN DIFFERENT RANKINGS OVERALL

Table 2. Similarity between different rankings (O: Overlap; F: Spearman correlation coefficient; M: M-measure)

Measure	Top 400					
	ARWU			THE		
	O	F	M	O	F	M
2012						
THE	270	0.74***	0.6			
QS	301	0.67***	0.56	278	0.82***	0.57
2013						
THE	273	0.72***	0.56			
QS	309	0.68***	0.58	278	0.82***	0.57
2014						
THE	275	0.73***	0.6			
QS	302	0.67***	0.56	281	0.8***	0.56
2015						
THE	276	0.72***	0.54			
QS	299	0.63***	0.6	274	0.78***	0.59
2016						
THE	272	0.75***	0.57			
QS	291	0.66***	0.61	276	0.81***	0.6
2017						
THE	267	0.74***	0.57			
QS	288	0.67***	0.61	278	0.8***	0.6
2018						
THE	270	0.74***	0.58			
QS	290	0.67***	0.6	275	0.82***	0.61

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

When interpreting these results one has to take into account two considerations:

1. Results for the ARWU and THE are largely based on re-calculated ranks. These ranks are not provided by the rankings
2. For universities with missing data re-calculation was impossible. These were removed from the analysis.

C. RESULTS OF PRINCIPAL COMPONENT ANALYSIS

Table 3. PCA Loadings on Components 2012

Measure	PC1	PC2	PC3
ARWU			
1. Alumni	-0.58	0.09	
2. Award	-0.46	0.06	
3. HiCi	-0.60	-0.04	
4. NS	-0.50	-0.16	
5. PUB	0.00	-0.87	
THE			
1. Teaching	-0.93	-0.04	
2. Research	-0.96	-0.04	
3. Citations	-0.57	0.61	
4. Industry Income	-0.40	-0.73	
5. International Outlook	-0.14	0.57	
QS			
1. Academic reputation	-0.93	0.00	-0.05
2. Employer reputation	-0.70	-0.25	-0.15
3. Faculty Student	-0.01	0.03	-0.99
4. International Faculty	0.02	-0.95	0.10
5. International Student	-0.02	-0.94	-0.06
6. Citations	-0.77	0.15	0.18

Note: Loadings larger than .40 are in bold

Table 4. PCA Loadings on Components 2014

Measure	PC1	PC2	PC3
ARWU			
1. Alumni	0.11	0.64	
2. Award	0.02	0.47	
3. HiCi	-0.33	0.42	
4. NS	-0.28	0.45	
5. PUB	-0.88	-0.01	
THE			
1. Teaching	-0.79	-0.06	
2. Research	-0.85	-0.03	
3. Citations	-0.49	0.60	
4. Industry Income	-0.35	-0.76	
5. International Outlook	-0.21	0.59	
QS			
1. Academic reputation	-0.93	0.10	-0.17
2. Employer reputation	-0.94	-0.11	0.15
3. Faculty Student	0.04	-0.01	-0.87
4. International Faculty	0.03	-0.96	0.01
5. International Student	-0.03	-0.94	-0.04
6. Citations	-0.19	-0.13	-0.58

Note: Loadings larger than .40 are in bold

Table 5. PCA Loadings on Components 2013

Measure	PC1	PC2	PC3
ARWU			
1. Alumni	-0.58	0.09	
2. Award	-0.45	0.04	
3. HiCi	-0.62	-0.01	
4. NS	-0.52	-0.16	
5. PUB	0.00	-0.88	
THE			
1. Teaching	-0.70	-0.22	
2. Research	-0.75	-0.23	
3. Citations	-0.68	0.44	
4. Industry Income	-0.19	-0.82	
5. International Outlook	-0.38	0.54	
QS			
1. Academic reputation	-0.98	0.08	-0.09
2. Employer reputation	-0.90	-0.12	0.13
3. Faculty Student	0.03	-0.02	-0.94
4. International Faculty	0.03	-0.97	0.03
5. International Student	-0.03	-0.94	-0.05
6. Citations	-0.38	-0.08	-0.43

Note: Loadings larger than .40 are in bold

Table 6. PCA Loadings on Components 2015

Measure	PC1	PC2	PC3
ARWU			
1. Alumni	-0.63	0.14	
2. Award	-0.48	0.04	
3. HiCi	-0.47	-0.27	
4. NS	-0.50	-0.22	
5. PUB	0.00	-0.87	
THE			
1. Teaching	-0.41	-0.40	
2. Research	-0.50	-0.44	
3. Citations	-0.86	-0.13	
4. Industry Income	0.05	-1.00	
5. International Outlook	-0.88	0.22	
QS			
1. Academic reputation	-0.94	-0.06	-0.01
2. Employer reputation	-0.93	0.10	0.08
3. Faculty Student	0.00	0.02	-0.99
4. International Faculty	0.02	0.89	0.00
5. International Student	-0.02	1.00	-0.02
6. Citations	-0.69	-0.07	-0.25

Note: Loadings larger than .40 are in bold

Table 7. PCA Loadings on Components 2016

Measure	PC1	PC2	PC3
ARWU			
1. Alumni	0.05	0.67	
2. Award	-0.04	0.46	
3. HiCi	-0.63	0.04	
4. NS	-0.37	0.37	
5. PUB	-0.85	-0.03	
THE			
1. Teaching	-0.33	-0.47	
2. Research	-0.46	-0.47	
3. Citations	-0.85	-0.21	
4. Industry Income	0.08	-0.90	
5. International Outlook	-0.96	0.19	
QS			
1. Academic reputation	-0.61	0.04	0.59
2. Employer reputation	-0.67	-0.16	0.35
3. Faculty Student	-0.93	0.01	-0.20
4. International Faculty	0.11	-0.95	0.04
5. International Student	-0.12	-0.93	-0.05
6. Citations	0.09	-0.04	0.96

Note: Loadings larger than .40 are in bold

Table 9. PCA Loadings on Components 2017

Measure	PC1	PC2	PC3
ARWU			
1. Alumni	0.03	0.67	
2. Award	-0.05	0.47	
3. HiCi	-0.69	-0.08	
4. NS	-0.40	0.30	
5. PUB	-0.78	0.03	
THE			
1. Teaching	-0.35	-0.40	
2. Research	-0.47	-0.43	
3. Citations	-0.89	-0.11	
4. Industry Income	0.05	-0.95	
5. International Outlook	-0.95	0.14	
QS			
1. Academic reputation	-0.90	0.08	-0.27
2. Employer reputation	-0.76	-0.13	-0.34
3. Faculty Student	-0.10	-0.03	-0.92
4. International Faculty	0.02	-0.92	-0.01
5. International Student	0.00	-0.95	0.00
6. Citations	-0.88	-0.06	0.46

Note: Loadings larger than .40 are in bold

Table 8. PCA Loadings on Components 2018

Measure	PC1	PC2	PC3
ARWU			
1. Alumni	0.04	0.66	
2. Award	-0.03	0.48	
3. HiCi	-0.66	-0.02	
4. NS	-0.36	0.35	
5. PUB	-0.84	-0.01	
THE			
1. Teaching	-0.28	-0.45	
2. Research	-0.42	-0.45	
3. Citations	-0.89	-0.12	
4. Industry Income	0.07	-0.88	
5. International Outlook	-0.96	0.12	
QS			
1. Academic reputation	-0.99	-0.05	0.03
2. Employer reputation	-0.92	0.04	0.10
3. Faculty Student	-0.15	0.04	0.92
4. International Faculty	0.01	0.94	-0.08
5. International Student	0.02	0.95	0.10
6. Citations	-0.55	0.14	-0.58

Note: Loadings larger than .40 are in bold

D. RESULTS OF FACTOR ANALYSIS

Table 10. NIPA Loadings on Factors 2012

Measure	PA1	PA2	PA3
ARWU			
1. Alumni	0.04	0.79	
2. Award	0.01	0.85	
3. HiCi	0.82	0.07	
4. NS	0.81	0.14	
5. PUB	0.83	-0.15	
THE			
1. Teaching	0.94	0.01	
2. Research	0.95	0.01	
3. Citations	0.32	0.43	
4. Industry Income	0.38	-0.36	
5. International Outlook	0.06	0.25	
QS			
1. Academic reputation	0.76	-0.04	0.18
2. Employer reputation	0.81	0.06	-0.12
3. Faculty Student	0.19	-0.02	0.09
4. International Faculty	-0.05	0.78	0.02
5. International Student	0.06	0.76	0.00
6. Citations	0.16	0.07	0.41

Note: Loadings larger than .40 are in bold

Table 11. NIPA Loadings on Factors 2014

Measure	PA1	PA2	PA3
ARWU			
1. Alumni	0.03	0.80	
2. Award	0.03	0.84	
3. HiCi	0.87	0.03	
4. NS	0.75	0.22	
5. PUB	0.82	-0.14	
THE			
1. Teaching	0.94	-0.01	
2. Research	0.95	0.02	
3. Citations	0.27	0.40	
4. Industry Income	0.33	-0.35	
5. International Outlook	0.09	0.31	
QS			
1. Academic reputation -0.17	0.78	-0.06	0.22
2. Employer reputation	0.82	0.08	-0.16
3. Faculty Student	0.15	0.06	0.11
4. International Faculty	-0.02	0.77	0.00
5. International Student	0.03	0.77	0.03
6. Citations	0.08	0.15	0.50

Note: Loadings larger than .40 are in bold

Table 12. NIPA Loadings on Factors 2013

Measure	PA1	PA2	PA3
ARWU			
1. Alumni	0.03	0.79	
2. Award	0.02	0.84	
3. HiCi	0.81	0.06	
4. NS	0.81	0.14	
5. PUB	0.82	-0.15	
THE			
1. Teaching	0.93	0.00	
2. Research	0.94	0.01	
3. Citations	0.31	0.40	
4. Industry Income	0.36	-0.34	
5. International Outlook	0.08	0.27	
QS			
1. Academic reputation	0.76	-0.05	0.23
2. Employer reputation	0.82	0.08	-0.15
3. Faculty Student	0.13	0.04	0.14
4. International Faculty	-0.03	0.79	0.02
5. International Student	0.03	0.79	0.01
6. Citations	0.09	0.14	0.51

Note: Loadings larger than .40 are in bold

Table 13. NIPA Loadings on Factors 2015

Measure	PA1	PA2	PA3
ARWU			
1. Alumni	0.04	0.80	
2. Award	0.03	0.84	
3. HiCi	0.86	0.05	
4. NS	0.75	0.22	
5. PUB	0.81	-0.16	
THE			
1. Teaching	0.95	-0.04	
2. Research	0.89	0.10	
3. Citations	0.22	0.57	
4. Industry Income	0.46	-0.18	
5. International Outlook	-0.06	0.66	
QS			
1. Academic reputation	0.87	-0.07	0.02
2. Employer reputation	0.84	0.07	-0.04
3. Faculty Student	0.39	0.10	0.14
4. International Faculty	-0.03	0.69	-0.01
5. International Student	0.03	0.70	0.01
6. Citations	0.46	-0.01	0.10

Note: Loadings larger than .40 are in bold

Table 14. NIPA Loadings on Factors 2016

Measure	PA1	PA2	PA3
ARWU			
1. Alumni	0.84	-0.01	
2. Award	0.84	0.03	
3. HiCi	-0.02	0.80	
4. NS	0.37	0.60	
5. PUB	-0.07	0.75	
THE			
1. Teaching	0.95	-0.04	
2. Research	0.86	0.14	
3. Citations	0.24	0.61	
4. Industry Income	0.57	-0.18	
5. International Outlook	-0.06	0.71	
QS			
1. Academic reputation	0.87	-0.06	0.07
2. Employer reputation	0.76	0.11	-0.07
3. Faculty Student	0.50	-0.05	-0.20
4. International Faculty	-0.06	0.73	0.03
5. International Student	0.07	0.72	-0.02
6. Citations	0.40	0.12	0.31

Note: Loadings larger than .40 are in bold

Table 16. NIPA Loadings on Factors 2017

Measure	PA1	PA2	PA3
ARWU			
1. Alumni	0.84	0.00	
2. Award	0.85	0.03	
3. HiCi	-0.04	0.80	
4. NS	0.34	0.63	
5. PUB	-0.07	0.74	
THE			
1. Teaching	0.94	-0.03	
2. Research	0.88	0.13	
3. Citations	0.20	0.64	
4. Industry Income	0.59	-0.18	
5. International Outlook	-0.06	0.74	
QS			
1. Academic reputation	0.87	-0.09	0.05
2. Employer reputation	0.76	0.14	-0.05
3. Faculty Student	0.38	-0.01	-0.31
4. International Faculty	-0.03	0.69	0.01
5. International Student	0.02	0.68	0.00
6. Citations	0.36	0.11	0.35

Note: Loadings larger than .40 are in bold

Table 15. NIPA Loadings on Factors 2018

Measure	PA1	PA2	PA3
ARWU			
1. Alumni	0.84	0.00	
2. Award	0.86	0.01	
3. HiCi	0.01	0.79	
4. NS	0.41	0.58	
5. PUB	-0.09	0.75	
THE			
1. Teaching	0.92	-0.02	
2. Research	0.86	0.15	
3. Citations	0.16	0.66	
4. Industry Income	0.63	-0.20	
5. International Outlook	-0.04	0.73	
QS			
1. Academic reputation	0.88	-0.06	0.07
2. Employer reputation	0.83	0.08	-0.08
3. Faculty Student	0.24	-0.01	-0.40
4. International Faculty	-0.02	0.75	0.07
5. International Student	0.02	0.76	-0.06
6. Citations	0.26	0.13	0.44

Note: Loadings larger than .40 are in bold

E. CRONBACH'S ALPHA FOR COMPLETE RANKING

Table 17. Standardized Cronbach's alpha for complete ranking

	ARWU	THE	QS
2018	0.88	0.82	0.67
2017	0.88	0.82	0.67
2016	0.89	0.82	0.72
2015	0.9	0.78	0.67
2014	0.91	0.62	0.67
2013	0.90	0.64	0.69
2012	0.91	0.64	0.66

F. CORRELATIONS BETWEEN CONCEPTS

Table 18. Spearman correlations between concepts

	1	2	3	4	5
2018					
1. ARWU Publication					
2. THE Publication	0.56***				
3. QS Publication	0.40***	0.40***			
4. ARWU Reputation	0.45***	0.46***	0.19***		
5. THE Reputation	0.71***	0.44***	0.53***	0.51***	
6. QS Reputation	0.56***	0.24***	0.34***	0.40***	0.74***
2017					
1. ARWU Publication					
2. THE Publication	0.69***				
3. QS Publication	0.40***	0.44***			
4. ARWU Reputation	0.64***	0.67***	0.30***		
5. THE Reputation	0.79***	0.59***	0.56***	0.59***	
6. QS Reputation	0.67***	0.47***	0.40***	0.49***	0.83***
2016					
1. ARWU Publication					
2. THE Publication	0.72***				
3. QS Publication	0.46***	0.54***			
4. ARWU Reputation	0.62***	0.65***	0.36***		
5. THE Reputation	0.77***	0.64***	0.56***	0.59***	
6. QS Reputation	0.68***	0.50***	0.46***	0.50***	0.84***
2015					
1. ARWU Publication					
2. THE Publication	0.72***				
3. QS Publication	0.40***	0.45***			
4. ARWU Reputation	0.72***	0.64***	0.39***		
5. THE Reputation	0.81***	0.67***	0.54***	0.69***	
6. QS Reputation	0.72***	0.48***	0.49***	0.60***	0.84***
2014					
1. ARWU Publication					
2. THE Publication	0.55***				
3. QS Publication	0.61***	0.60***			
4. ARWU Reputation	0.53***	0.52***	0.41***		
5. THE Reputation	0.72***	0.38***	0.58***	0.44***	
6. QS Reputation	0.53***	0.18**	0.25***	0.36***	0.70***
2013					
1. ARWU Publication					
2. THE Publication	0.52***				
3. QS Publication	0.62***	0.58***			
4. ARWU Reputation	0.56***	0.53***	0.44***		
5. THE Reputation	0.70***	0.40***	0.59***	0.44***	
6. QS Reputation	0.53***	0.23***	0.26***	0.36***	0.68***
2012					
1. ARWU Publication					
2. THE Publication	0.56***				
3. QS Publication	0.66***	0.62***			
4. ARWU Reputation	0.52***	0.51***	0.41***		
5. THE Reputation	0.74***	0.45***	0.57***	0.45***	
6. QS Reputation	0.50***	0.25***	0.22***	0.34***	0.68***

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

G. CORRELATIONS BETWEEN VARIABLES FOR THE 2018 RANKINGS

Table 19. Means, standard deviations, and correlations of variables within rankings

Measure	Mean	SD	Correlations					
			1.	2.	3.	4.	5.	6.
ARWU								
1. Alumni	23.54	18.50						
2. Award	27.34	23.47	0.64					
3. HiCi	33.71	14.43	0.06	0.16				
4. NS	31.93	15.10	0.46***	0.54***	0.54***			
5. PUB	57.43	12.99	0.15	0.02	0.50***	0.45***		
6. PCP	35.09	13.47	0.24*	0.38***	0.37***	0.29**	−0.15	
7. Overall Score	36.70	12.87	0.57***	0.69***	0.61***	0.84***	0.53***	0.36***
THE								
1. Teaching	54.04	16.32						
2. Research	56.12	18.00	0.82**					
3. Citations	85.69	12.00	0.18*	0.17*				
4. Industry Income	59.35	20.46	0.19**	0.30***	−0.23**			
5. International Outlook	71.26	18.51	−0.19**	0.04	0.11	−0.11		
6. Overall Score	69.17	39.30	0.80***	0.87***	0.48***	0.17*	0.12	
QS								
1. Academic reputation	40.07	26.85						
2. Employer reputation	40.38	28.16	0.76***					
3. Faculty Student	51.99	30.19	0.08	0.09*				
4. International Faculty	53.98	34.99	0.19***	0.25***	−0.05			
5. International Students	47.74	32.45	0.16***	0.26***	0.03	0.67***		
6. Citations	44.19	26.88	0.41***	0.26***	−0.21***	0.32***	0.24***	
7. Overall Score	44.50	18.66	0.85***	0.73***	0.32***	0.38***	0.38***	0.55***

Note: * $p < .05$, ** $p < .01$, *** $p < .001$