World University Rankings
A Principal
Component Analysis

João E. Steiner

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SUMMARY

In search for institutional excellence, university rankings have been proposed both at national and world levels. In order to establish which parameters and corresponding weights are more appropriate for the assessment of academic excellence, we have made a multivariate data analysis on a set of parameters for 178 world universities which are in common in the Shangai Jiao Tong University and the Times Higher Education Supplement rankings. In addition to their combined 12 institutional parameters, we have added the ranking of the Webometrics presence of universities on the web.

It is found that the main component expressed in the data can be identified with the academic performance, strongly correlated with publications, citations, awards and reviews – canonical indicators of excellence. The second component is identified with the degree of internationalism – the fraction of foreign staff and students (this should not be confused with international cooperation). Distinct countries and regions have different performance with respect to the internationalism, depending on their size, integration with other countries or political and geographical isolation. The third component is associated to the faculty/student ratio. This ratio has also distinct values in different countries, France and Australia being the two extremes.

I demonstrate that academic performance is not correlated with the internationalism or with the faculty/student ratio. The criteria of internationalism as well as of faculty/student ratio discriminate unfavorably public universities when compared to private ones. Correlation of each parameter with respect to the three main components is provided; they might be useful for the strategic planning of institutional development. A list of universities, ordered according to the Principal Component 1, is also provided.

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INTRODUCTION

Institutions are, in general, in permanent quest for excellence. But… in the case of universities, what is really excellence? The word somehow expresses a diffuse idea, given its complexity but also the universality and scope of the involved subjects. How can one combine themes of humanities with those of natural sciences? How can one equilibrate pure and applied studies? We will hardly find a singular parameter that can evaluate and express, in a credible form, subjects that are so complex.

The evaluation of universities has been the theme of recurrent discussions. Some of these evaluations have been expressed in the form of rankings. University rankings have been frequent among American and Canadian universities, for example. In recent years, some initiatives have established world rankings. The visibility of such initiatives may have implications on policies of institutional development. "Rankings serve a variety of purposes, good and bad… and are also inevitable in the era of massification" (Altbach, 2006).

As there is not a singular parameter that expresses the university excellence, the rankings have been based on a number of parameters that focus the institutional performance in a variety of perspectives. The larger the number of parameters and the better they are selected, greater are the chances that the conclusions will have credibility. A small number of parameters (would 6 be reasonable?) will always be regarded as problematic. In addition, when dealing with institutions of a large number of countries, uniformity becomes an issue (van Raan, 2005). One faces the problem of heterogeneity of criteria, languages and cultures. Even more problematic may be the form of establishing weights for the distinct parameters.

The choices of both, parameters and weights, may represent cultural, political or economic perspectives that could introduce non-universal values and, therefore, should be regarded with caution.

EXISTING WORLD UNIVERSITY RANKIGS

In recent years, three rankings of world universities have been published. We will list, here, the main parameters and respective weights (in parenthesis). A label from "A" to "M" has been assigned to each parameter according to Table 3.

- **Shanghai Jiao Tong University ranking - SJTU.** This ranking is established using six parameters and arbitrarily attributed weights.

A - (20%) - N&S. Number of articles published in Nature or Science;

B - (20%) - HiCi. Number of highly cited researchers in 21 broad subject categories;

C - (10%) - Size. Academic performance with respect to the size of the institution;

D - (20%) - Award. Number of staff of the institution winning Nobel Prize and Field Medals;

E - (10%) - Alumni. Number of alumni of the institution winning Nobel Prizes and Fields Medals;

F - (20%) - SCI. Articles in Science Citation Index-expanded, Social Science Citation Index, and Arts and Humanities Citation Index;

- The ranking of the **Times Higher Education Supplement** - **THES** adopted the following parameters and respective weights:

G - (40%) - Peer review – opinion of 2,375 research-active academics;

H - (20%) - Citation/faculty;

I - (10%) - Recruiter's review – the opinion of employers;

K - (20%) - Faculty to student ratio;

L - (5%) - International student score – percentage of foreign students;

M - (5%) - International faculty score – percentage of foreign staff.

- The **Webometrics** ranking measures the presence of the universities in the web, considering parameters such as size of the sites, rich files and visibility.

J - Presence in the web.

While the THES ranking is based on relative numbers such as indices, ratios etc, the SJTU mixes absolute numbers such as number of papers, scientists and prizes with relative numbers such as academic performance relative to size. The Webometrics ranking is established in terms of absolute numbers. It is important to notice that in one case we look at the relative performance, regardless of the size, while in the other case the size of the institution also impacts the ranking. In this case, larger institutions tend to be better ranked than smaller ones.

The present study performs an evaluation with a larger number of parameters by combining the 13 parameters described above. The main goal is to find out which parameters are more and less important for the assessment of the academic performance in the world universities. The focus is to discuss methodology and not to establish a new ranking.

We utilized the data from universities considered in the 2005 versions of the three rankings mentioned above: SJTU, THES and Webometrics. We found a total of 178 universities that are common among these three studies. The limiting factor of this set is the reduced number of universities in the THES survey that published data for only 200 universities.

The cross-correlation of parameters can be seen in Table 1. Parameters labeled from A to G are highly correlated among themselves (>0.50). Parameters K, L and M are weakly or not correlated at all or even anti-correlated with other parameters. The parameters from A to G are usually taken as canonical indicators of academic performance. It becomes apparent that three parameters (K, L and M), half of the ones considered by the THES, are indicators of aspects unrelated to academic performance.

Table 1 – Cross-correlation of parameters

	A	B	C	D	E	F	G	H	I	J	K	L	M
A-Nat&Sci	1												
B-HiCi	0,90	1											
C-Size	0,83	0,78	1										
D-Award	0,78	0,72	0,81	1									
E-Alumni	0,74	0,68	0,72	0,80	1								
F- SCI-Articles	0,74	0,72	0,61	0,52	0,58	1							
G-Peer Rev	0,60	0,55	0,57	0,62	0,63	0,59	1						
H-Cit/Fac	0,71	0,68	0,71	0,60	0,46	0,42	0,35	1					
I-Recruiter	0,49	0,51	0,47	0,50	0,49	0,36	0,57	0,31	1				
J-(-)Web	0,38	0,41	0,31	0,22	0,23	0,40	0,24	0,25	0,23	1			
K-Fac/Stu	0,21	0,15	0,25	0,12	0,13	0,04	0,02	0,04	0,09	-0,05	1		
L-Int'l student	0,01	0,06	0,14	0,11	0,13	-0,21	0,19	-0,02	0,29	-0,05	0,12	1	
M-Int'l faculty	-0,21	-0,21	-0,04	-0,09	-0,12	-0,27	0,07	-0,24	0,06	-0,06	0,04	0,60	1

PRINCIPAL COMPONENT ANALYSIS

In this study we will adopt a distinct strategy for analyzing the question: a multivariate analysis on the form of Principal Component Analysis (Murtag and Heck, 1987). This strategy is more robust than the existing methodology of rankings for two reasons: It does not establish weights a priori. In addition, we consider 13 parameters instead of only 6. This analysis calculates the principal components that maximize the explanation of the variances. If, by hypothesis, the first principal component can be associated to academic performance, then the correlation of the parameters (columns) with respect to this component will establish a relative scale of weights, not a priori but as a result. The correlation of the objects (universities) will establish a scale of performance (ranking) of the universities. For those interested in more details, see the technical note at the end of the paper.

The Academic performance – Principal Component 1

Principal Component 1 explains about half (47%) of the data variance (see Table 2). It is strongly determined by the correlation among the columns A, B….J (see Table 3). The top parameters in this correlation are the number of papers published in Nature and Science and the number of highly cited scientists. Such parameters are clearly associated to what one usually understands as academic performance of the institutions. This seems also to be confirmed by the correlation of the objects (universities) with the first principal component (see Appendix A) as most of the universities best placed in this order are also well ranked in the various studies.

Perhaps a surprise is to find that academic performance is not correlated with the internationalism of students (0.10) and faculty (-0.16). The later is even anti-correlated. The ratio faculty/ student is also only weekly correlated with academic performance.

Internationalism – Principal Component 2

Principal Components 2 and 3 are, by construction, not correlated with each other and also with respect to the principal component 1; they are responsible for explaining 14% and 8% of the data variance. Principal Component 2 is dominated by the internationalism of the universities as defined by the parameters L and M of Table 3. The correlation with the faculty score is 0.84 and with student score, 0.88. One of the relevant

results of the present study is to show that the internationalism is not correlated with the academic performance. The internationalism is weakly correlated with peer review (0.23) and recruiter's review (0.35) and weakly anti-correlated with the number of articles in the Science Citation Index (-0.28).

Principal Component 2, the internationalism of the universities, points towards a geographic discrimination. Appendix 2 shows the 10 first and the 10 last institutions projected on this eigenvector. Among the top ten are universities from UK (4), Switzerland (3), Singapore (2) and France (1). Highly centered in Europe and/or small countries. In the other extreme are universities from large countries such as USA (6) and Brazil (1) or countries that are geographically or politically isolated as Israel (1) and Taiwan (1).

Table 2: Explained Variances

	% of Variance	Cumulative %
PC-1	47.8	47.8
PC-2	14.4	62.2
PC-3	8.4	70.6
PC-4	6.6	77.2
PC-5	5.9	83.1

It seems obvious that to cross the frontier from Germany to Switzerland or to go from Amsterdam to London is easier than to go from New York to California or from Recife to Porto Alegre. Why should the assessment of university academic performance be affected by its locations? Principal Component 2 may perhaps be more useful for geopolitical studies than for university academic rankings.

Table 3 – Correlation of parameters with Principal Components 1, 2 and 3

Parameter	PC-1	PC-2	PC-3
A – Articles published in Nature and Science	0,94	-0,10	0,09
B – Highly cited researchers	0,91	-0,09	0,02
C – Academic performance with respect to the size	0,89	0,08	0,17
D – Staff Nobel/Fields Prizes	0,86	0,09	0,09
E – Alumni Nobel/Fields Prizes	0,83	0,09	0,03
F – Articles in the Science Citation Index	0,77	-0,30	-0,16
G – Peer review	0,73	0,24	-0,25
H – Citations/faculty	0,72	-0,18	0,13
I – Recruiter review	0,62	0,34	-0,18
J – Presence in the web	0,42	-0,16	-0,46
K – Faculty/student ratio	0,17	0,20	0,82
L – International student score	0,08	0,89	-0,03
M – International faculty score	-0,16	0,83	-0,15

International cooperation is important in science as well as in academic life in general and should not bee confused with the definition of internationalism considered here. The point is how to quantify it. Joint projects, interchange of faculty and students, learning of foreign languages, joint publications etc are of great importance in the promotion of excellence. There are numerous examples on how careful selection of foreign professors has played a strategic role and positively impacted the institutional development. One form of quantifying the international cooperation could, perhaps, be the measurement of multinational co-authorship in publications.

The faculty/ student ratio – Principal Component 3

Principal Component 3 is dominated by the faculty/student ratio (0.89) and weakly correlated with performance/size (0.21) and anti-correlated with peer review (-0.33), recruiter's review (-0.18) and presence in the web (-0.22).

The extremes of the projections of universities with respect to eigenvector 3 are (see Appendix C): at the high faculty/student ratio, universities from France (5), US (3), Switzerland (1) and Denmark (1); at the low faculty/student ratio, are universities from Australia (5), Canada (2), Singapore (1), US (1) and UK (1). As mentioned above, this

component is not correlated with academic performance but it could be relevant for the study of cost/benefits of the higher learning institutions.

Public versus Private Universities: internationalism and faculty/student ratio

The international faculty and student score as defined by the THES considers that the more international members in the university, the better it should be ranked. Is this reasonable? In Figure 1 we display the degree of internationalism (PC-2) versus the academic performance (PC-1) only for US universities. We separate public universities from private (not-for-profit) ones. It is clear that they have distinct behaviors. Private universities show a correlation in the sense that institutions with better academic performance have higher degree of internationalism. Public universities show the opposite behavior: universities with higher academic performance have less internationalism. In fact, considering only the institutions ranked better then 40 in academic performance, one can see a clear separation of these two groups. Why is that so? It is clear that private universities look for student from everywhere, as long they pay their (usually high) fees and tuition. Public universities are usually subsidized to some level. Why should they subsidize foreign students? The dichotomy of these two groups, clearly seen in Figure 1 is, therefore, easy to understand. The conclusion is that introducing criteria of international score as an evaluation parameter discriminates unfavorably public universities. If this is a relevant conclusion for a country like the United States, it might be even more relevant for developing countries.

The faculty/student ratio is also correlated with the private versus public nature of the universities. For example, among the 10 US universities ranked highest in PC-3, 9 are private and 1 is public. Among the 10 lowest ranked institutions, all are public. The conclusion is that using this parameter for evaluating academic performance, favors improperly private institutions. As the US News ranking also uses the faculty/student ratio as an evaluation criterion, it is not a surprise that it ranks 20 out of the first 21 universities as private institutions (www.usnews.com/usnews/edu/college/ranking). Appendix A shows that among the 20 highest ranked US universities, 12 are private and 8 are public – which shows much more equilibrated situation.
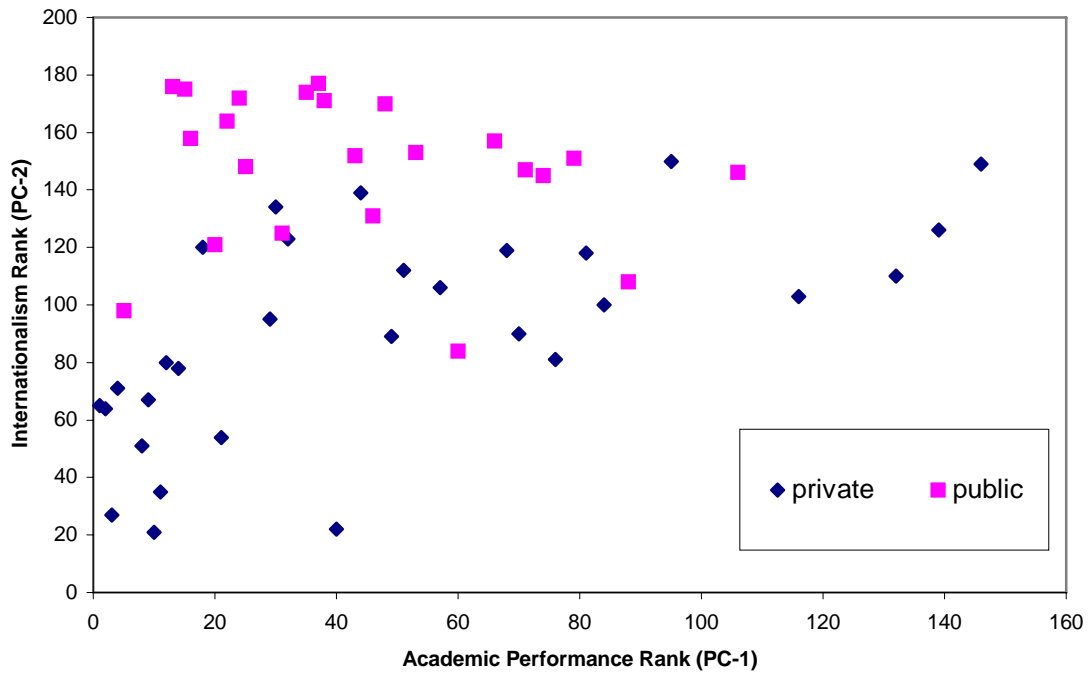
Picture 1 – *The Internationalism (PC-2) versus the Academic Performance (PC-1) for US universities. This displays distinct behaviors between public and private institutions.*

All three rankings analyzed in this study present some flaws. From the six parameters of the THES ranking, only three are correlated with academic performance. The SJTU ranking also is based on six parameters. All six are correlated with PC-1. However five of them are absolute parameters and, in this sense, tend to favor larger institutions. A second flaw is that the Nobel Prize seems to be overweighed. Although both staff and alumni achievements are well correlated with PC-1, the weight attributed to them (total of 30%) seems out of proportion. Finally the correlation of the Webometric ranking with PC-1 is meddling.

CONCLUSIONS

1. A multivariate analysis of a set of indicators for 178 world universities shows that 70% of the data variance can be explained by three main components: the academic performance (Principal Component 1 explains 48% of the variance); the degree of internationalism (Principal Component 2 explains 14% of the variance) and the faculty-to-student ratio (Principal Component 3 explains 8% of the variance).

2. As it is usual in the assessment of institutions, the academic performance is strongly correlated with publications, citations, awards and reviews – canonical indicators of excellence.

3. The degree of internationalism as defined by the THES (this should not be confused with international cooperation in general) is not correlated with academic performance. Distinct countries and regions have different performance with respect to the internationalism, depending on their size, integration with other countries or political and geographical isolation.

4. The ratio faculty/student is only weakly correlated with academic performance. This ratio has also distinct values in different countries, France and Australia being the two extremes.

5. The correlations of the parameters with the three main principal components are provided.

6. A list of universities ordered according to Principal Component 1 is provided. This should not be regarded as a new ranking.

7. Internationalism criteria as well as the faculty/student ratio discriminate unfavorably public universities when compared to private ones.

8. The conclusion derived in the present study may be relevant for institutional strategic planning or for the formulation of public policies. The quest for identifying and implementing policies for supporting world class universities is associated to risks; some of them are identified in this work.

TECHNICAL NOTE

The Principal Component Analysis - PCA - is a multivariate procedure in which a set of correlated variables is transformed into a set of uncorrelated variables (called Principal Components) that are ordered by reducing variability (Murtag and Heck, 1987). The uncorrelated variables are a linear combination of the original variables. The principal components are calculated as eigenvectors which, by construction, are orthogonal among themselves and, therefore, uncorrelated. The significance of each eigenvector is expressed as its eigenvalue. The first Principal Component is the combination of variables that explains the greatest amount of variance. The main use of the PCA is to reduce the dimensionality of the data set while retaining as much information as possible. It computes a compact and optimal description of the data set.

In the present case, the projection of each column (parameter) with respect to each eigenvector is given in Table 3 for the first three components. The rank of the universities is given in order to the projection of each object with respect to the respective eigenvector (see Appendices).

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 ACKNOWLEDGEMENTS

APPENDIX A

Academic Performance

The projection of the objects (universities) according to Principal Component 1. This should not be regarded as a new ranking as the universe of objects was limited to the set of universities in common among the three rankings considered in this paper. The main limiting factor is the small number (200) of universities in the THES rank.

Rank PC-1	Rank THES	Rank SJTU	Rank WEB	Name	Country	Projection
1	1	1	4	Harvard University	US	12,26
2	5	3	3	Stanford University	US	8,54
3	2	5	1	Massachusetts Institute of Technology	US	8,12
4	8	6	42	California Institute of Technology	US	8,10
5	6	4	2	University of California, Berkeley	US	7,89
6	3	2	21	Cambridge University	UK	7,86
7	4	10	28	Oxford University	UK	6,02
8	9	8	39	Princeton University	US	5,67
9	20	7	13	Columbia University	US	5,33
10	7	11	29	Yale University	US	5,09
11	17=	9	19	University of Chicago	US	4,89
12	14	12	5	Cornell University	US	4,74
13	42	13	33	University of California, San Diego	US	3,73
14	32	15	14	Pennsylvania University	US	3,49
15	37	14	16	University of California, Los Angeles	US	3,33
16	17=	18	99	University of California, San Francisco	US	3,31
17	16	20	83	Tokyo University	Japan	3,25
18	27	19	44	Johns Hopkins University	US	3,21
19	29	24	25	University of Toronto	Canada	2,90
20	36	21	9	University of Michigan	US	2,89
21	11=	32	32	Duke University	US	2,66
22	73=	16	10	University Wisconsin-Madison	US	2,54
23	13	23	102	Imperial College London	UK	2,53
24	88=	17	8	Washington University	US	2,40
25	26	36	7	University of Texas at Austin	US	2,36
26	28	26	68	University College London	UK	2,35
27	21	27	41	ETH Zurich	Switzerland	2,28
28	31	22	190	Kyoto University	Japan	2,26
29	46	31	77	Northwestern University	US	2,16
30	58=	28	45	Washington University, St Louis	US	2,06
31	58=	25	6	University of Illinois	US	1,90
32	56	29	38	New York University	US	1,44
33	30	47	54	Edinburgh University	UK	1,36
34	38=	37	49	University of British Columbia	Canada	1,35
35	150=	32	11	University of Minnesota	US	1,27
36	24=	67	80	McGill University	Canada	1,15
37	64	39	12	Pennsylvania State University	US	1,14
38	159=	34	47	University of California, Santa Barbara	US	1,04

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39	23	56	62	Australian National University	Australia	0,92
40	44	54	15	Carnegie Mellon University	US	0,89
41	55	51	199	Munich University	Germany	0,85
42	35	53	582	Manchester University & Umist	UK	0,82
43	163	35	48	Colorado University	US	0,77
44	114=	39	136	Vanderbilt University	US	0,70
45	49	64	134	Bristol University	UK	0,64
46	133=	47	22	Maryland University	US	0,59
47	105=	52	194	Technical University Munich	Germany	0,52
48	143=	55	18	North Carolina University	US	0,51
49	73=	65	133	Rochester University	US	0,49
50	120	41	118	Utrecht University	Netherlands	0,47
51	109=	69	271	Case Western Reserve University	US	0,43
52	19	82	81	Melbourne University	Australia	0,41
53	193	43	60	Pittsburgh University	US	0,32
54	45	71	217	Heidelberg University	Germany	0,30
55	66	57	240	Copenhagen University	Denmark	0,30
56	77=	78	148	Hebrew University of Jerusalem	Israel	0,27
57	124	50	53	University of Southern California	US	0,27
58	62=	76	63	Helsinki University	Finland	0,18
59	105=	62	252	Osaka University	Japan	0,18
60	61	75	27	Purdue University	US	0,16
61	79	67	395	Lomonosov Moscow State University	Russia	0,09
62	24=	93	543	Ecole Normale Supérieure, Paris	France	0,04
63	143=	65	130	Sheffield University	UK	-0,01
64	65	85	138	Vienna University	Austria	-0,01
65	136=	73	289	Tohoku University	Japan	-0,04
66	68	101-152	75	Massachusetts University	US	-0,06
67	138=	72	245	Leiden University	Netherlands	-0,07
68	54	80	67	Boston University	US	-0,09
69	180=	60	91	Uppsala University	Sweden	-0,10
70	150=	78	92	Rice University	US	-0,15
71	121=	77	26	Michigan State University	US	-0,15
72	85	57	186	Zurich University	Switzerland	-0,19
73	138=	69	72	Oslo University	Norway	-0,22
74	105=	101-152	17	Virginia University	US	-0,26
75	99	93	247	Tokyo Institute of Technology	Japan	-0,28
76	71	86	87	Brown University	US	-0,28
77	97	83	285	Nottingham University	UK	-0,28
78	38=	101-152	93	Sydney University	Australia	-0,34
79	125=	89	20	Texas A&M University	US	-0,34
80	58=	101-152	124	Amsterdam University	Netherlands	-0,37
81	164	100	156	Tufts University	US	-0,38
82	184=	90	174	McMaster University	Canada	-0,39
83	88=	46	1675	Pierre and Marie Curie University	France	-0,41
84	117	101-152	117	Dartmouth College	US	-0,45
85	22	101-152	121	National University of Singapore	Singapore	-0,47
86	73=	80	377	King's College London	UK	-0,47
87	143=	98	129	Birmingham University	UK	-0,49
88	147=	101-152	40	Georgia Institute of Technology	US	-0,51
89	188=	101-152	280	Tel Aviv University	Israel	-0,63
90	103=	101-152	73	Leeds University	UK	-0,65

91	142	101-152	204	Frankfurt University	Germany	-0,68
92	180=	99	197	Lund University	Sweden	-0,71
93	15	203-300	213	Beijing University	China	-0,72
94	119	101-152	303	Liverpool University	UK	-0,73
95	141	101-152	127	Emory University	US	-0,75
96	125=	97	306	La Sapienza University, Rome	Italy	-0,75
97	101=	101-152	82	Glasgow University	UK	-0,76
98	127=	87	378	Basel University	Switzerland	-0,76
99	194=	101-152	183	Technion - Israel Inst of Technology	Israel	-0,77
100	149	101-152	58	University of Alberta	Canada	-0,80
101	129	101-152	192	Nagoya University	Japan	-0,81
102	47	101-152	177	Queensland University	Australia	-0,84
103	138=	101-152	312	Aarhus University	Denmark	-0,90
104	34	153-202	152	Ecole Polytech Fédérale de Lausanne	Switzerland	-0,94
105	11=	203-300	336	London School of Economics	UK	-0,95
106	175=	101-152	144	State Univ of New York, Stony Brook	US	-0,97
107	93=	101-152	316	Seoul National University	South Korea	-1,01
108	40	153-202	125	University of New South Wales	Australia	-1,03
109	95=	153-202	149	National Autonomous Univ of Mexico	Mexico	-1,07
110	88=	101-152	98	Geneva University	Switzerland	-1,09
111	57	153-202	625	Erasmus University Rotterdam	Netherlands	-1,09
112	196=	101-152	109	São Paulo University	Brazil	-1,11
113	33	203-300	103	Monash University	Australia	-1,14
114	132	153-202	101	Université de Montréal	Canada	-1,19
115	95=	101-152	161	Catholic University of Leuven (Flemish)	Belgium	-1,24
116	179	153-202	111	Notre Dame University	US	-1,26
117	157=	101-152	362	Hokkaido University	Japan	-1,28
118	191	203-300	116	University of Western Ontario	Canada	-1,29
119	52	203-300	248	Auckland University	New Zealand	-1,38
120	190	153-202	198	Gothenburg University	Sweden	-1,39
121	83	203-300	267	Durham University	UK	-1,40
122	80=	153-202	230	University of Western Australia	Australia	-1,41
123	10	203-300	801	Ecole Polytechnique	France	-1,43
124	62=	153-202	389	Tsing Hua University	China	-1,44
125	114=	153-202	170	National Taiwan University	Taiwan	-1,44
126	41	203-300	295	Hong Kong University	Hong Kong	-1,45
127	100	101-152	343	Sussex University	UK	-1,51
128	154=	153-202	268	Technical University of Denmark	Denmark	-1,52
129	43	203-300	481	Hong Kong University Sci & Technol	Hong Kong	-1,53
130	186=	153-202	294	Free University of Amsterdam	Netherlands	-1,55
131	168	203-300	139	Newcastle upon Tyne University	UK	-1,58
132	159=	203-300	172	Georgetown University	US	-1,61
133	51	203-300	211	Chinese University of Hong Kong	Hong Kong	-1,63
134	108	153-202	768	Wageningen University	Netherlands	-1,64
135	183	153-202	375	Madrid Autonomous University	Spain	-1,64
136	53	203-300	185	Delft University of Technology	Netherlands	-1,67
137	154=	203-300	100	Technical University Berlin	Germany	-1,67
138	111	203-300	260	Trinity College, Dublin	Ireland	-1,73
139	199=	203-300	157	George Washington University	US	-1,74
140	159=	203-300	78	Bologna University	Italy	-1,74
141	136=	203-300	403	St Andrews University	UK	-1,74
142	80=	203-300	329	Adelaide University	Australia	-1,77

143	77=	203-300	195	Warwick University	UK	-1,81
144	159=	203-300	61	University of Waterloo	Canada	-1,82
145	67	203-300	318	Macquarie University	Australia	-1,83
146	199=	203-300	171	Wake Forest University	US	-1,83
147	172=	203-300	135	Aachen RWTH	Germany	-1,85
148	199=	203-300	344	University of Florence	Italy	-1,86
149	109=	203-300	162	York University	UK	-1,88
150	165	203-300	251	Innsbruck University	Austria	-1,94
151	131	92	2797	University Louis Pasteur Strasbourg	France	-1,96
152	130	301-400	278	Bath University	UK	-1,99
153	166=	203-300	146	Chalmers University of Technology	Sweden	-2,03
154	196=	203-300	120	Royal Institute of Technology	Sweden	-2,05
155	147=	203-300	445	Hiroshima University	Japan	-2,05
156	172=	203-300	513	Kobe University	Japan	-2,12
157	143=	301-400	455	Korea Advanced Inst of Sci and Tech	South Korea	-2,15
158	177	203-300	720	Nijmegen University	Netherlands	-2,17
159	86	301-400	94	Vienna Technical University	Austria	-2,18
160	72	301-400	732	Fudan University	China	-2,23
161	76	401-500	313	Brussels Free University (French)	Belgium	-2,29
162	70	301-400	175	Eindhoven University of Technology	Netherlands	-2,34
163	48	301-400	479	Nanyang Technological University	Singapore	-2,37
164	169=	301-400	687	Shanghai Jiao Tong University	China	-2,43
165	186=	301-400	490	Otago University	New Zealand	-2,48
166	93=	301-400	1009	China University of Sci & Technology	China	-2,50
167	127=	301-400	390	University of Newcastle	Australia	-2,52
168	133=	301-400	538	Lausanne University	Switzerland	-2,54
169	150=	301-400	852	Nanjing University	China	-2,61
170	98	401-500	397	La Trobe University	Australia	-2,71
171	166=	401-500	359	Tasmania University	Australia	-2,73
172	157=	401-500	606	Maastricht University	Netherlands	-2,74
173	178	301-400	434	City University of Hong Kong	Hong Kong	-2,76
174	92	301-400	1032	Ecole Normale Supérieure, Lyon	France	-2,80
175	154=	401-500	510	University of South Australia	Australia	-2,89
176	194=	401-500	781	Helsinki University of Technology	Finland	-2,97
177	184=	401-500	930	Korea University	South Korea	-3,02
178	188=	401-500	575	Massey University	New Zealand	-3,15

APPENDIX B

Internationalism

The extremes of Principal Component 2: The international component among faculty and student. The first ranked are institutions with large scores of foreign fraction among faculty or students.

Rank PC-2	Name	Country
1	London School of Economics	UK
2	Ecole Polytech Fédérale de Lausanne	Switzerland
3	Nanyang Technological University	Singapore
4	Geneva University	Switzerland
5	Cambridge University	UK
6	ETH Zurich	Switzerland
7	National University of Singapore	Singapore
8	Ecole Polytechnique	France
9	Oxford University	UK
10	Imperial College London	UK
.....	....	....
169	National Taiwan University	Taiwan
170	North Carolina University	US
171	University of California, Santa Barbara	US
172	Washington University	US
173	São Paulo University	Brazil
174	University of Minnesota	US
175	University of California, Los Angeles	US
176	University of California, San Diego	US
177	Pennsylvania State University	US
178	Tel Aviv University	Israel

APPENDIX C

Faculty/ student ratio

Extremes of projections of universities with respect to the Principal Component 3: The faculty to student ratio. The first ranked are institutions with high faculty/student ratios.

Rank PC-3	Name	Country
1	Ecole Polytechnique	France
2	University of California, San Francisco	US
3	University Louis Pasteur Strasbourg	France
4	Ecole Normale Supérieure, Paris	France
5	Ecole Normale Supérieure, Lyon	France
6	California Institute of Technology	US
7	Ecole Polytech Fédérale de Lausanne	Switzerland
8	Pierre and Marie Curie University	France
9	Eindhoven University of Technology	Netherlands
10	Duke University	US
.....	....	....
169	Nanyang Technological University	Singapore
170	Queensland University	Australia
171	University of British Columbia	Canada
172	London School of Economics	UK
173	University of New South Wales	Australia
174	University of Toronto	Canada
175	Sydney University	Australia
176	Melbourne University	Australia
177	Monash University	Australia
178	National University of Singapore	Singapore