

Scientific publishing and global university rankings. How well are top publishing universities recognized?

Osmo Kivinen • Juha Hedman • Kalle Artukka

Abstract

The paper asks to what extent the top 200 universities in scientific publishing in four research fields are the same universities that occupy the top 200 positions in global university rankings. In this article, the top 200 lists of universities in scientific publishing are compiled of universities' contribution rates in four fields: biological, physical, social and life sciences. Out of some 4000 academic institutions included in InCites, the paper identifies 437 top publishing universities in at least one field. The paper analyses the extent to which those universities are covered in six global university rankings' top 200 listings: Academic Ranking of World Universities (ARWU), Performance Ranking of Scientific Papers for World Universities (NTU), QS World University Rankings (QS), Times Higher Education World University rankings (THE), University Ranking by Academic Performance (URAP) and US News & World Report Best Global University Rankings (USNWR). Out of these rankings, URAP, NTU and USNWR are more distinctive than ARWU, QS and THE in covering the 437 top publishing universities in their top 200 listings. Therefore URAP, NTU and USNWR are utilized in analyzing top publishing universities' chances to be recognized.

The paper identifies a total of 64 top publishing universities in at least three out of four fields recognized without exception in the top 200 lists of NTU, URAP and USNWR; out of them 24 reside in the USA, 21 in the EU and 19 in the rest of the World. In addition, the paper identifies other (373) top publishing universities variably recognized by the relevant of the three rankings (in terms of odds) depending on the fields in which the universities reach the top 200; odds range from 0.01 (biological sciences) to 12.00 (life, social and biological sciences). The region of residence of these 373 universities also varies, so that those reaching the top 200 in life sciences reside most frequently in the EU, those reaching the top 200 in social sciences in the USA and those reaching the top 200 in physical or in biological sciences in the rest of the World.

Keywords University rankings • Scientific publishing by fields • Regional differences

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Introduction

Visibility in global rankings has taken a role in the ‘branding’ of universities across the World. In addition, recent higher education (HE) policy catalyzes universities’ thirst for ranking success to demonstrate their international prestige in the eyes of funders and wider audiences. Higher education and research policy share the common goals of reducing costs, improving efficiency and intensifying universities’ contribution to solve societal problems. Consequently, interest in measuring university performance is increasing worldwide. Policymakers, advisors and experts are expected to be aware of the metrics and data yielded by various evaluations such as international university rankings. While the competition between universities becomes fiercer, the ‘price’ of decisions based on inappropriate evidence is rising accordingly (Kivinen et al. 2013; cf. Abramo and d’Angelo 2014a).

Global league tables witness the international reputation of universities and charm audiences worldwide – due to their crude simplicity adds Ellen Hazelkorn (2014). However, global rankings serve nationally various purposes; in the worst case, rankings and league tables only boost uncertainty among the ranks of politicians and decision makers who are not able to discriminate between the pros and cons of various indicators (see Pagell 2014). Already a decade ago, Anthony van Raan (2005) asked if bibliometric indicators developed for ranking entire universities really bring out appropriate knowledge about the scientific action in a particular university (cf. Kivinen and Hedman 2008; Safòn 2013; see Soh 2015a; 2015b). Domingo Docampo, in turn, defends global ranking measures, Academic Ranking of World Universities (ARWU) in particular, by arguing that ARWU succeeds in measuring what it declares to measure; namely “research quality” (Docampo 2011; 2013). Docampo (2011) also remarks that evaluations based on sufficient repetition are likely to eventually lead toward more accurate results, even if they were initially somewhat biased. The unspoken

message, slightly sarcastic in tone, is that a theoretically ideal method never put up for a serious test of practice will not produce any worthy results (see Billaut et al. 2010).

Stating first that global rankings are here to stay, the sociologist Simon Marginson (2014) proposes social scientists in particular to give up their fierce opposition of rankings, and instead focus on how to develop them so that their negative effects could be minimized. Even though league tables serve the ‘branding’ of universities striving for high international status, ranking success can, in fact, rarely be operationalized as rigorous policy measures enforceable by a single university (see Amara et al. 2015; cf. Hazelkorn 2011, p. 28).

Rankings have provoked plenty of objections for highlighting the norms and standards set by time-honored ‘research universities’ located mainly in the United States and the United Kingdom. It has been noted that performance indicators tend to be one-sided, emphasizing norms set by the top research universities in the style of “one size fits for all” (e.g. Altbach 2006, p. 2). Poor ranking success of universities in non-English speaking countries has been explained, for example, by the fact that the key reference databases contain relatively few non-English scientific publications. It has also been suggested that rankings highlighting publishing in English, the *lingua franca* of the academic world, favors those whose native language it is. (E.g. Hwang 2005; Gantman 2012; Jöns and Hoyler 2013; Safòn 2013.)

Rising popularity of rankings in branding universities easily draw attention to sheer visibility pushing aside core tasks of universities, such as research and teaching, for instance (Kivinen and Hedman 2008; Safòn 2013; cf. Soh 2015a; 2015b). From a traditional Humboldtian perspective, teaching and doctoral training are thought to draw on basic research. Although the American research university model does not stand one to one with the Humboldtian model, strong basic research lies in the core of both models. It is customary

to think basic research as organized by the logic of disciplines, yet it is strange that so little attention has been addressed to the ways in which basic research by disciplines eventually comes into play in university rankings.

In our study, the top 200 lists of universities in scientific publishing are compiled of contribution rates calculated for each university in biological sciences, physical sciences, social sciences and life sciences. Contribution rate indicates in how many Web of Science articles a university is involved for each 10,000 articles published in the field. We utilize Thomson Reuter's (at present known as Clarivate Analytics') InCites database by regrouping 21 Essential Science Indicators (ESI) disciplines into four broad fields. Then we ask to what extent the top 200 universities in scientific publishing in four fields are the same ones that occupy the top 200 positions in the latest editions of the following six global university rankings: *Academic Ranking of World Universities (ARWU)*, *Times Higher Education World University rankings (THE)*, *QS World University Rankings (QS)*, *US News & World Report Best Global University Rankings (USNWR)*, *Performance Ranking of Scientific Papers for World Universities (NTU)* and *University Ranking by Academic Performance (URAP)*.¹

Not least to serve university 'branding' and to appeal to worldwide audience, rankings preserve an image of competing with each other by constantly improving their metrics. Furthermore, as many as five out of the six university rankings at hand report that their final score and respective rank order reflects performance: academic or research performance (USNWR, ARWU, URAP), university performance (THE) and scientific paper performance (NTU). QS, on the other hand, states that their final score and respective rank order reflects "success in the notional mission of becoming or remaining world class".

¹ For a more detailed description of these six rankings, see for instance Shebatta and Mahmood (2016).

Each of the six rankings reports to use bibliometric data (i.e. publication and citation counts) at least to some extent in determining their final scores. The total weight assigned to bibliometric indicators, however, differs greatly between rankings. The least weight to bibliometric indicators is given by QS (20 %), whereas NTU and URAP both have the full weight of 100 % assigned to bibliometric indicators. The other rankings fall in between: USNWR (65 %), ARWU (60 %) and THE (39 %). Let us note that none of the six rankings use disciplinary weightings in the final score of their main league tables.

A well-known technical solution to overcome comparability issues arising from differences in disciplinary profiles between universities is the Centre for Science and Technology Studies' (CWTS's) Leiden ranking's normalized indicators. Although normalization is likely to improve the comparability of universities' performance indicators, it has its limitations (e.g. Robinson-Garcia and Calero-Medina 2014) when applied, for example, in research concentrating on universities' actual productivity (the relation between input and output) by fields. In our approach, research is first and foremost evaluated on each discipline's own terms (Kivinen et al. 2013; cf. Abramo and D'Angelo 2007; King 2004).

Some global rankings break down the selected pool of top universities by fields. For instance, bibliometric rankings such as NTU and URAP use a combination of article and citation counts to sieve out the top universities in each field. From the point of view of evidence-based policy, it is important to notice the difference between past and current performance; citation counts imply how earlier published research is being noted in subsequent research, whilst article counts tell about the current state of research.

It has been said that global rankings illustrate the ranking success of national HE systems in the style of the more universities a country has at the top, the better is the HE system (see Docampo 2013; Saisana et al. 2011; Liu and Liu 2016). But referring, for

instance, to Ellen Hazelkorn (2009), we would like to point out that rankings grant prominence only to a limited number of universities and thus do not tell a great deal about the national HE system as a whole (see Universitas 21). It is noteworthy that even the number of universities included in a ‘national HE system’ depends strongly on the definition adopted. Malcolm Tight (2011) demonstrates that in the UK it is possible to calculate three different numbers (108, 138 or 162) of ‘universities’ (i.e. institutions performing at least a few of the functions of a university).

We set off by identifying top 200 universities in scientific publishing in the four fields, altogether 437 universities, and sieve out the university rankings which are most apt for recognizing the top publishing universities in the four fields. This enables us to analyse the chances of the top 200 universities in scientific publishing to be recognized by global rankings. Finally, top publishing universities by fields are specified by three regions (USA, EU, rest of the World).

Identifying the top 200 universities in scientific publishing in biological, physical, social and life sciences

There are today numerous databases entailing references of scientific publications; most famously Elsevier’s Scopus and Clarivate Analytics’ Web of Science (WoS). Scopus covers a large number of scientific journals including the vast majority of WoS journals at its core. Due to its longer history (cf. Mongeon and Paul-His 2016), Web of Science has been tested for longer in practice than Scopus. Not least because of this, Web of Science is the unsurpassable database when main interest lies in identifying top research by disciplines.² An article accepted in a WoS-indexed journal is ensured to hold scientific quality since it has successfully gone through peer-review process in discipline’s own terms (c.f. Abramo and

² Nowadays the Web of Science has started to include peer-reviewed conference proceedings in its core collection, perhaps responding to the critique from the scientists in technology.

d'Angelo 2014b; Macri and Sinha 2006; Kivinen et al. 2013). Journals worldwide inform their audience about their achieved WoS status measured by the journal impact factor (JIF), for instance. Even journals not yet included in the Web of Science are willingly informing the public about their anticipated WoS status.

Evidently, the Web of Science does not cover all peer-reviewed publications in any field (see Hicks 2012). Thomson Reuters/Clarivate Analytics continuously monitors the citation rates of journals worldwide and reviews each year over 3,500 journals for inclusion from which no more than 10 % meets the WoS standards (Testa 2016). The WoS Core Collection database limits itself to peer-reviewed journals with high enough impact factors in each discipline.

For our analysis, we shall employ the Essential Science Indicators (ESI) schema. Each WoS journal is found exclusively in one of the 21 ESI disciplines and in a small category of multidisciplinary field without any overlap between them (Incites indicators handbook 2014, p. 6). For the purposes of our study, however, we do not need a detailed 21-field breakdown of article counts. Therefore, we shall regroup the ESI disciplines into four broad fields: life sciences, physical sciences, social sciences and biological sciences. In our analysis, life sciences include journals in clinical medicine, immunology, neuro & behavioral sciences, molecular biology & genetics, biology & biochemistry, pharmacology & toxicology and microbiology. Physical sciences encompass journals in physics, chemistry, material sciences, engineering, mathematics, computer sciences, geosciences and space sciences. Social sciences comprise journals in the social sciences (general), economics & business and psychology & psychiatry. Biological sciences include journals in plant & animal sciences, agricultural sciences and ecology & environment sciences.

InCites is in itself a ‘live’ data source, which calls for logistic measures and relational methodology as opposed to sample-based statistical inference. In this article, the crucial search criteria combine the recomposed four fields presented above and the particular time period (2010-2015) in which we are interested. By utilizing the *research area* search in InCites, we are able to obtain the total number of articles published in each field. Through InCites’ *organization* search, we are able to check the total number of articles in which at least one author’s address refers to the university in question. By relating this figure to the total number of articles published in each field between 2010 and 2015, we obtain a contribution rate that depicts in how many of the published articles a particular university is involved during this specific period. Based on these contribution rates, we choose the top 200 universities in scientific publishing in each of the four fields. Here, it is enough to identify universities at campus level and to concentrate only on universities as academic institutions. Therefore, we exclude research centres and similar institutions from the analysis by manually cleaning the data (cf. Huang et al. 2014). There are altogether 437 universities reaching the top 200 in scientific publishing in at least one of the four broad fields. Let us note that InCites includes approximately 4000 different academic institutions which have contributed to articles in WoS-indexed journals.³

In the field of life sciences, the university with the highest contribution rate (0.0265) is involved in 265 per 10,000 articles published with at least one of the authors affiliating with this particular institution. The university with the highest contribution rate in the social sciences contributes to 176 per 10,000 articles published, in biological sciences to 112 and in physical to 86. Let us note that the last (200th) university included in the group of the top universities in scientific publishing in life sciences has a contribution rate of 0.0021, i.e. is involved in 21 per 10,000 articles published. The university with the lowest contribution rate

³ Data extracted from InCites 4.4.2016.

in the social sciences contributes to 18 per 10,000 articles published, in physical sciences to 17 and in biological sciences to 16.

In order to double-check the applicability of our regrouping of the ESI discipline journals into four broad fields, we have utilized the contribution rates of universities in all of the 21 ESI disciplines. The result of the factor analysis (with equamax rotation method) verifies our regrouping yielding the most optimal combination of the 21 disciplines into four fields. (See appendix.)

The chances of the top publishing universities to be recognized by rankings' top 200

In this section, we ask, to what extent the 437 top publishing universities are covered in the top 200 listings of the six global university rankings. On average, the six rankings' top 200 lists cover 186 of the 437 universities. Three rankings exceed the average 186: URAP covers 197, NTU 190 and USNWR 188 universities. Three rankings in turn remain below the average 186: ARWU covers 184, QS 183 and THE 175 universities.

The differences between rankings in the number of top publishing universities covered are quite moderate. However, when considering universities not reaching the top 200 in scientific publishing in any of the fields, we find noteworthy differences between the six rankings. For instance, in its top 200, THE lists 25 such universities, which is more than eight times the respective number of URAP (3). Out of the six university rankings, URAP is the most apt for the purposes of our study, whilst THE is the least apt. For our analyses, we utilize the three most distinctive rankings (NTU, URAP and USNWR) exceeding the average of 186.

When specified field by field, we find more differences between URAP, NTU and USNWR. Out of the three rankings, the top 200 list of NTU covers the most (158) out of the

top 200 universities in life sciences, USNWR's top 200 covers the most (141) out of the top 200 in social sciences and URAP's top 200, in turn, covers the most out of both the top 200 in physical sciences and the top 200 in biological sciences (129 and 104 respectively).

The differences presented above between the three rankings indicate that concerning universities reaching the top 200 in life sciences, the ranking most likely to include them in its top 200 listing is NTU. Hence, for recognizing top publishing universities in life sciences, the most relevant of the three rankings is NTU. Similarly, for the top 200 universities in social sciences, the most relevant of the three rankings is USNWR, and for the top publishing universities in either physical sciences or biological sciences, the most relevant ranking is URAP. Consequently, a top publishing university in all four fields can be expected to be appropriately recognized by all three rankings.

As we can see from figure 1, there are altogether 53 universities reaching the top 200 in scientific publishing in all four fields and they are recognized without exception in all three rankings' top 200. From here on, the term 'allrounders' refers to these particular 53 universities. There are also 11 universities reaching the top 200 in life sciences, physical sciences and social sciences that are recognized without exception in the top 200 by NTU, URAP and USNWR. By adding these 11 universities to the 53 allrounders, we have a pool of 64 universities reaching the top 200 in scientific publishing in at least three fields recognized invariably in the top 200 by the three rankings.

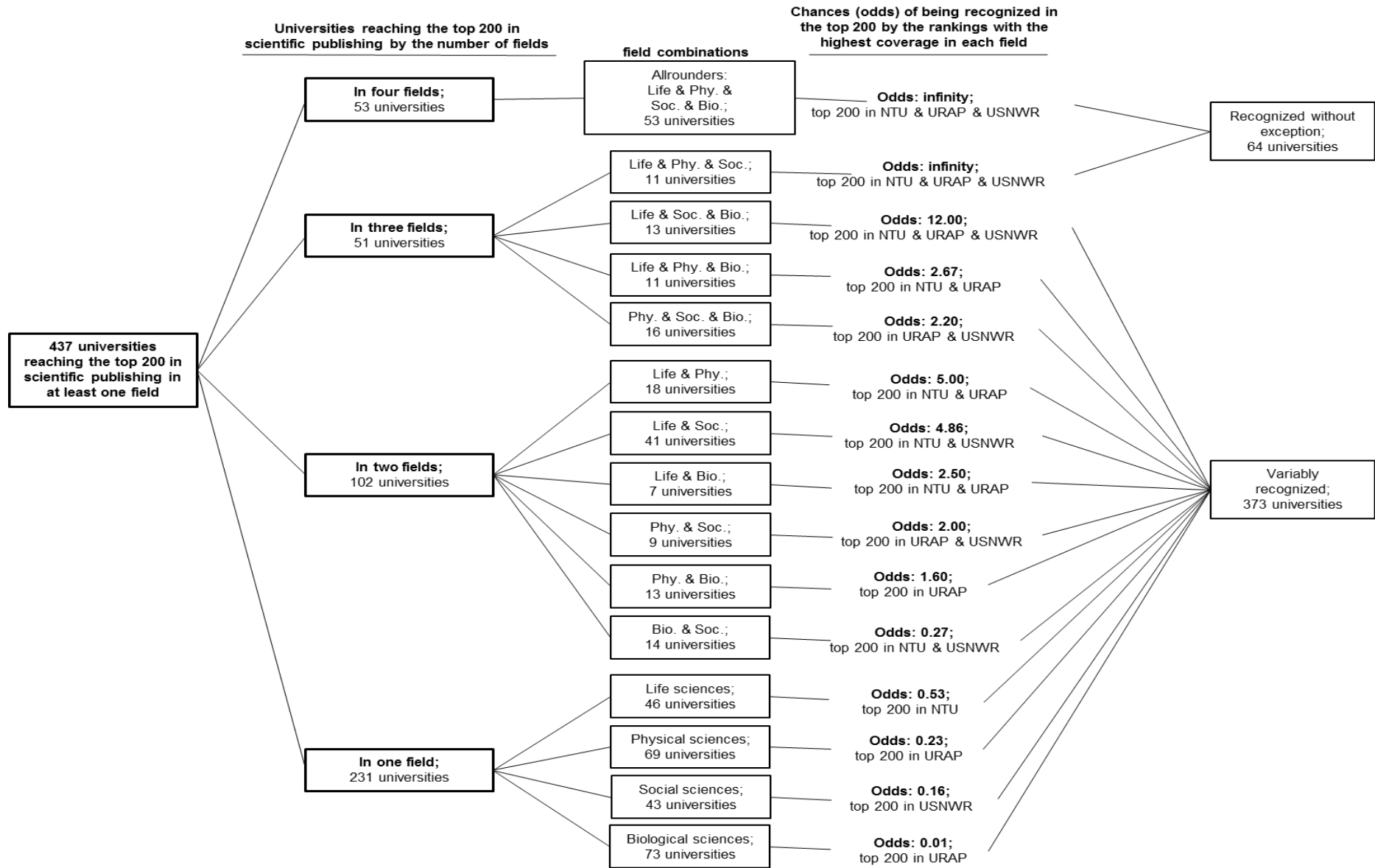


Fig. 1 Universities reaching the top 200 in scientific publishing by the number of fields and their chances of being recognized by NTU, URAP and USNWR

Concerning the remaining 373 universities, we find great variation in the universities' chances of being recognized in the top 200 lists of NTU, URAP and USNWR (from here on we refer to these universities as variably recognized). There are 231 universities reaching the top 200 in scientific publishing in one field only. Such universities are likely to remain unrecognized by the most relevant of the three rankings; the odds range from 0.01 in biological sciences (URAP) to 0.53 in life sciences (NTU). When measured by odds ratio, universities reaching the top 200 in scientific publishing in life sciences only are recognized by the most relevant ranking 38 times more often compared to biological sciences. (See fig. 1.)

There are 102 universities reaching the top 200 in scientific publishing in two fields. Their odds of being recognized range from 0.27 (biological sciences and social sciences) to 5.00 (life sciences and physical sciences), which in terms of odds ratios can be expressed so that top publishing universities in physical and life sciences are recognized 18 times more often than top publishing universities in biological and social sciences. The top publishing universities in social, biological and life sciences (odds 12.00) are recognized by the relevant of the three rankings 5 times more often than the top publishing universities in physical, social and biological sciences (odds 2.20). (See fig. 1.)

To sum up, for variably recognized universities, the higher the number of fields in which universities reach the top 200 in scientific publishing, the lower the difference between the highest and the lowest chances to be recognized by the relevant of the three rankings (measured by odds ratio): For universities reaching the top 200 in one field only, the chances in life sciences are 38-fold compared to biological sciences. For top publishing universities in two fields, the difference between the highest and the lowest chances is 18-fold (life and physical sciences vs. biological and social sciences), and respectively in three fields 5-fold (biological, life and social sciences vs. biological, physical and social sciences).

Top publishing universities by three regions: USA, EU and the rest of the World

In a previous study (Kivinen and Hedman 2008), we suspected that the “weight-and-sum” scoring applied in university rankings is at best capable of sieving out the best 50 universities, and consequently the “weight-and-sum” cannot be used to differentiate between universities outside the top 50 (see also Soh 2015b). Our analyses in this paper confirm that there are 53 universities reaching the top 200 in scientific publishing in all four fields belonging without exception to the top 200 positions in global rankings. In addition, there are 11 top 200 universities in life sciences, social sciences and biological sciences that are recognized in the top 200 by NTU, URAP and USNWR. Next, as is illustrated in table 1, we take a closer look at the 64 universities invariably recognized in global top 200 rankings by three regions.

Table 1 The 64 universities recognized without exception in the top 200 by NTU, URAP and USNWR by three regions (United States, European Union and the rest of the World). The 53 universities in bold are allrounders among the top 200 in scientific publishing in all four fields

United States (24)	European Union (21)	Rest of the World (19)
<u>CA: (6)</u>	<u>UK: (8)</u>	<u>AU: (5)</u>
Stanford U *	U Edinburgh	U of Queensland
U California: Berkeley *	U Oxford *	U of Melbourne
U California: Davis *	Imperial College London	Monash U
U California: Los Angeles *	U Bristol	U of New South Wales
U California: San Diego *	U Nottingham	U of Sydney
U California: Irvine *	U Cambridge *	<u>CA: (5)</u>
<u>IL: (2)</u>	U London: U College London	U of British Columbia
Northwestern U *	U Manchester	McGill U
U Chicago *	<u>IT: (3)</u>	U of Toronto
<u>MA: (2)</u>	U Bologna	U of Alberta
Harvard U *	U Padua	U of Montreal
Massachusetts Inst. Tech *	U Rome la Sapienza	<u>BR: (1)</u>
<u>NY: (2)</u>	<u>BE: (2)</u>	U Sao Paulo
Cornell U *	Katholieke U Leuven	<u>CH: (1)</u>
Columbia U *	Ghent U	U Geneva
<u>PA: (2)</u>	<u>DE: (2)</u>	<u>CN: (1)</u>
U Pennsylvania *	Ludwig Maximilian: U Munich	Peking U
Pennsylvania State U: University Park *	Ruprecht Karl U Heidelberg	<u>HK: (1)</u>
<u>AZ: (1)</u>	<u>ES: (2)</u>	U Hong Kong
U Arizona	U Barcelona	<u>IS: (1)</u>
<u>CT: (1)</u>	Autonomous U Barcelona	Tel Aviv U
Yale U *	<u>SE: (2)</u>	<u>JP: (1)</u>
<u>FL: (1)</u>	Uppsala U	U of Tokyo
U Florida *	Lund U	<u>KR: (1)</u>
<u>MD: (1)</u>	<u>DK: (1)</u>	Seoul National U
Johns Hopkins U *	U Copenhagen	<u>SG: (1)</u>
<u>MI: (1)</u>	<u>FR: (1)</u>	National U Singapore *
U Michigan: Ann Arbor *	Aix Marseille U	<u>TW: (1)</u>
<u>MN: (1)</u>		National Taiwan U
U Minnesota: Twin Cities *		
<u>NJ: (1)</u>		
Rutgers U: New Brunswick		
<u>OH: (1)</u>		
Ohio State U: Columbus *		
<u>WA: (1)</u>		
U Washington: Seattle *		
<u>WI: (1)</u>		
U Wisconsin: Madison *		

* Universities belonging to the top 64 wealthiest universities in the World (The Best Schools 2015)

From the 64 universities recognized without exception, 24 are located in the USA, 21 in the EU and 19 in the rest of the World. The US universities are located in 15 states: six in California, two in Illinois as well as in Massachusetts, New York and Pennsylvania and one in Arizona, Connecticut, Florida, Maryland, Michigan, Minnesota, New Jersey, Ohio, Washington and Wisconsin respectively. In the EU, these universities are located in eight member states, and in the rest of the World in 11 countries. Eight of those 21 universities

residing in the EU can be found in the UK, three in Italy, two in Belgium, Germany, Spain and Sweden and one in Denmark and France. In the rest of the World, 10 of those 19 universities are located in both Australia (5) and Canada (5) and one in Brazil, Switzerland, China, Hong Kong, Israel, Japan, South Korea, Singapore and Taiwan. (See table 1.)

One famous listing of World's wealthiest universities is The Best Schools' top 100, which measures the size of universities' endowments. By picking the 64 wealthiest universities from this particular list, we can find 25 universities that belong also to our pool of 64 universities recognized without exception. US universities dominate the list of wealthiest universities; 22 out of the 24 invariably recognized US universities belong to the wealthiest 64. There are only two invariably recognized US universities that do not make the wealthiest 64: the University of Arizona and Rutgers University. Quite contrary to the US case, out of the 21 invariably recognized EU universities only two, Oxford and Cambridge, make the wealthiest 64, and for the rest of the World, only one, the National University of Singapore, can be found on this list. It remains out of the scope of this paper, nonetheless, to examine if the list of the World's wealthiest universities holds inadequate endowment information on universities outside the USA. (See table 1.)

As stated above, there are altogether 437 universities belonging to the top 200 in scientific publishing in at least one of the four analysed fields. Table 2 shows these 437 universities divided into 64 universities recognized without exception and into 373 variably recognized universities from the USA, EU and the rest of the World.

Let it be noted that in 11 (out of the 28) EU countries, not a single university meets the criteria shared by the 437 universities reaching the top 200 in scientific publishing in at least one field. These 11 countries are Bulgaria, Cyprus, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Romania, Slovakia and Slovenia. In nine EU countries, not a single

university meets the criteria of invariably recognized universities, but these countries differ from each other by the number of variably recognized universities: the Netherlands has as many as 13 such universities and Austria five. (See table 2 for the rest.)

In altogether eight EU countries there is at least one university meeting the criteria of being recognized without exception. The UK tops the list with eight such universities, out of which seven are allrounders. In addition, the UK has 20 universities meeting the criteria of being variably recognized. Next in line is Italy with three invariably recognized universities, all of them allrounders. In addition, Italy has seven variably recognized universities. Germany, Spain, Sweden and Belgium have two invariably recognized universities each. All of them are allrounders, with the exception of one of Germany's two universities. When comparing the number of variably recognized universities, Germany leads with 24 such universities. Spain (8) and Sweden (7) are also clearly in front of Belgium (2). France and Denmark have only one invariably recognized university; however, both are allrounders. It should be noted that France tops Denmark in the number of variably recognized universities by 13 to 2. (See table 2.)

Table 2 The 64 universities recognized without exception and the 373 variably recognized universities among the top 200 in scientific publishing by three regions (United States, European Union and the rest of the World). Universities in parentheses are the 53 allrounders

Region	Number of universities		Region	Number of universities		Region	Number of universities	
	recognized without exception	variably recognized		recognized without exception	variably recognized		recognized without exception	variably recognized
United States	24 (18)	91	European Union	21 (19)	114	Rest of the World	19 (16)	168
California	6 (5)	6	UK	8 (7)	20	Canada	5 (5)	13
New York	2 (1)	7	Italy	3 (3)	7	Australia	5 (5)	12
Pennsylvania	2 (2)	4	Germany	2 (1)	24	China	1 (1)	53
Massachusetts	2 (1)	3	Spain	2 (2)	8	Brazil	1 (1)	15
Illinois	2 (-)	2	Sweden	2 (2)	7	Japan	1 (1)	10
Florida	1 (1)	3	Belgium	2 (2)	2	South Korea	1 (1)	9
Maryland	1 (-)	2	France	1 (1)	13	Taiwan	1 (1)	7
Michigan	1 (1)	2	Denmark	1 (1)	2	Switzerland	1 (-)	6
Ohio	1 (1)	2	Netherlands	-	13	Israel	1 (-)	4
Arizona	1 (1)	1	Austria	-	5	Hong Kong	1 (-)	4
Connecticut	1 (1)	1	Portugal	-	3	Singapore	1 (1)	1
New Jersey	1 (1)	1	Czech	-	2	Iran	-	5
Washington	1 (1)	1	Finland	-	2	South Africa	-	5
Wisconsin	1 (1)	1	Greece	-	2	Chile	-	3
Minnesota	1 (1)	-	Poland	-	2	New Zealand	-	3
Texas	-	7	Croatia	-	1	Norway	-	3
Georgia	-	4	Ireland	-	1	Argentina	-	2
Virginia	-	4				India	-	2
North Carolina	-	4				Malaysia	-	2
Colorado	-	3				Mexico	-	2
Indiana	-	3				Russia	-	2
Oregon	-	3				Saudi Arabia	-	2
Utah	-	3				Pakistan	-	1
Alabama	-	2				Qatar	-	1
D. of Columbia	-	2				Serbia	-	1
Iowa	-	2						
Kansas	-	2						
Missouri	-	2						
South Carolina	-	2						
Tennessee	-	2						
Alaska	-	1						
Arkansas	-	1						
Idaho	-	1						
Kentucky	-	1						
Louisiana	-	1						
Mississippi	-	1						
Nebraska	-	1						
New Hampshire	-	1						
Oklahoma	-	1						
Rhode Island	-	1						

In the United States, there are 10 states where no universities meet the criteria of (437) the top 200 universities in scientific publishing in at least one field. Those states are Delaware, Hawaii, Maine, Montana, Nevada, New Mexico, North Dakota, South Dakota, Vermont and West Virginia. In the US, there are further 25 states where not one university meets the criteria of being recognized without exception. Out of these 25 states, Texas stands

out with seven variably recognized universities and Georgia, Virginia and North Carolina have four such universities each. (See table 2 for the rest.)

In as many as 15 US states there is at least one invariably recognized university. California tops this group with six such universities, of which five are allrounders. In addition, in California there are six universities meeting the ‘variably recognized’ criteria. New York, Pennsylvania, Massachusetts and Illinois each have two invariably recognized universities. Pennsylvania tops both New York and Massachusetts 2 to 1 in the number of allrounders, while there are no allrounders in Illinois. New York, in turn, leads with seven variably recognized universities against Pennsylvania’s four and Massachusetts’s three. Illinois has two variably recognized universities. Altogether 10 states have one university recognized without exception differing from each other by the number of variably recognized universities: Florida, Maryland, Michigan, Ohio, Arizona, Connecticut, Minnesota, New Jersey, Washington and Wisconsin. Oddly enough, out of these 10 states, Minnesota does not have a single variably recognized university to accompany its allrounder. (See table 2.)

In the rest of the World, the vast majority of countries remain without any universities meeting the criteria of top 200 universities in scientific publishing, but 25 countries have at least one such university. In 11 countries, there is at least one university meeting the criteria of invariably recognized universities. Canada and Australia take the lead with five universities, all of them allrounders. Canada outnumbers Australia by 13 to 12 in the number of variably recognized universities. China, Brazil, Japan, South Korea, Taiwan, Switzerland, Israel, Hong Kong and Singapore have one invariably recognized university each; In China, Brazil, Japan, South Korea, Taiwan and Singapore, it is also an allrounder. China leads by a margin in the number of variably recognized universities (53). The other countries to follow are, in order, Brazil (15), Japan (10), South Korea (9), Taiwan (7), Switzerland (6), Israel (4), Hong Kong (4) and Singapore (1). 14 countries remain without any universities recognized

without exception. Out these 14 countries, Iran and South Africa take the lead with five variably recognized universities each. (See table 2 for the rest.)

Finally, we take a brief look at regional differences in the number of variably recognized universities in four fields. In figure 2, the number of variably recognized universities are broken down by four fields and three regions (USA, EU, the rest of the World).

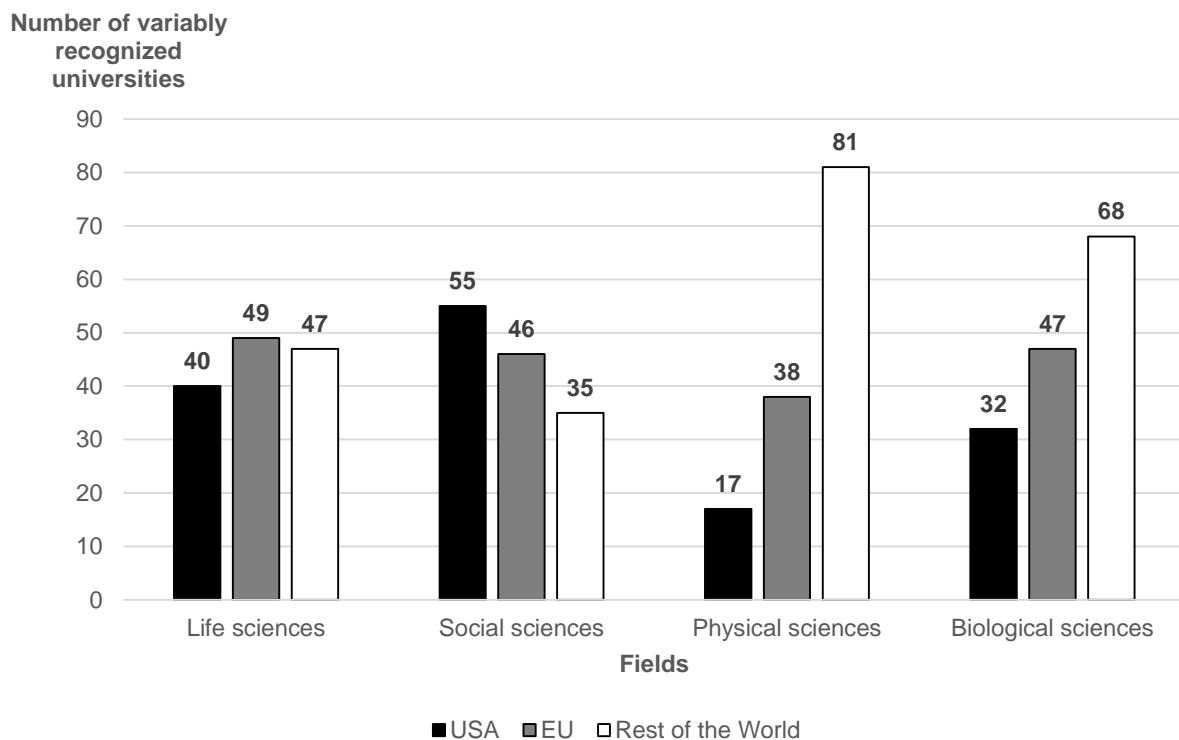


Fig. 2 The number of variably recognized universities among the top 200 in scientific publishing in four fields by three regions

The top 200 universities in scientific publishing in life sciences variably recognized in the top 200 by the relevant of the three rankings are quite evenly spread around each of the three regions: the EU has 49 universities, the rest of the World 47 and the USA 40. In the social sciences, we find wider regional differences insofar as the USA has 55 such universities against 35 for the rest of the World. Interestingly enough, both in the physical sciences and the biological sciences, the differences are even wider but also reversed, so that the rest of the World has the highest number of variably recognized universities; 81 in

physical sciences and 68 in biological sciences. The USA, in turn, remains third with the lowest numbers, i.e. 17 such universities in physical sciences and 32 in biological sciences. It is also noteworthy that out of the three regions, EU has clearly the smallest variation by fields in the number of variably recognized universities. (See fig. 2.)

Conclusion

For over a decade, global university rankings have been the topic of a keen discussion, both charming audiences and simultaneously giving rise to fierce opposition among researchers (cf. Berlemann and Haucap 2015). Little attention has been paid to how scientific publishing in different disciplines eventually comes into play in university rankings. In this paper, we have investigated the question to what extent the top 200 universities in scientific publishing in biological sciences, physical sciences, social sciences and life sciences are the very same universities that occupy the top 200 positions in major rankings.

The results show that out of the 437 top publishing universities, URAP covers 197 universities in its top 200 listing, NTU 190 universities, USNWR 188, ARWU 184, QS 183 and THE covers 175 universities. URAP's, NTU's and USNWR's coverage is thus above the average of 186. There are further differences between URAP, NTU and USNWR in how they cover the top 200 universities in scientific publishing in each field: NTU has the highest coverage in life sciences (158 universities), USNWR in social sciences (141 universities) and URAP both in physical sciences and biological sciences (129 and 104 universities respectively).

As noted, any prominence in global rankings is certainly welcomed by competitive universities around the World. Even tiny upward movements on ranking lists are reported by universities longing for holding world class status in the eyes of the wider audience. However, to become 'world class' seems to be about a century long endeavour. In addition to

longevity, the most successful universities share the common characteristics of wealth, abundant resources and various locational and other advantages; none of them are easily accessible (Kivinen et al. 2013; Safòn 2013; Shattock 2017).

In this article, we have sieved out from a pool of 437 top publishing universities in at least one field the 64 universities reaching the top 200 in at least three fields recognized without exception in the top 200 by NTU, URAP and USNWR. We could argue that if one should grant the title of ‘world class’ to a university, the aforementioned 64 invariably recognized universities are viable candidates. Out of these 64 candidates 25 belong also to the famous listing of the wealthiest 64 universities in the World.

In their study, Liu and Liu (2016) find 56 universally acknowledged world-class universities on the top 100 lists of THE, QS and ARWU; let us note that they lean on the three rankings which in our analysis qualify as the ones with the lowest coverages of the top 200 universities in scientific publishing. By comparing Liu and Liu’s (2016) list of universities appearing in more or less reputation-focused rankings with our list of universities recognized without exception, we see that they share no more than 35 universities in common.

There are 373 (out of the 437) top publishing universities recognized to a variable extent in the top 200 by URAP, NTU and USNWR. For such universities, the higher the number of fields in which they reach the top 200 in scientific publishing, the lower the difference between the highest and the lowest chances to be recognized by the relevant of the three rankings (measured by odds ratio): For universities reaching the top 200 in one field only, the chances in life sciences are 38-fold compared to biological sciences. For top publishing universities in two fields, the difference between the highest and the lowest chances is 18-fold (life and physical sciences vs. biological and social sciences), and

respectively in three fields 5-fold (biological, life and social sciences vs. biological, physical and social sciences).

The region of residence of the variably recognized universities depends on the field in which they reach the top 200 in scientific publishing, so that in life sciences such universities are quite evenly numbered in each of the three regions and they are most frequently located in the EU. In social sciences there are wider regional differences with the most likely location being the USA instead of the EU. In both physical and biological sciences, regional differences are even wider and the most likely location for a successful university is the rest of the World, whilst the USA remains third in both.

Our analysis has concentrated only on the research output concerning scientific publication of articles in the Web of Science. To be able to gather a sound evidence base for national HE and research policy, inputs should also be considered. We have earlier conducted such productivity analyses using comparative data (Kivinen et al. 2013; cf. Abramo and d'Angelo 2014b). Our intention is to develop analyses of the productivity of scientific action further by seizing new opportunities opened by big data.

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Appendix

Verifying the applicability of regrouping WoS journals from 21 ESI disciplines into four broad fields by factor analysis

To check the applicability of our regrouping of ESI discipline journals into four broad fields we ran a factor analysis. The analysis shows how the 21 ESI disciplines (multidisciplinary field is omitted) adjust into our four broad fields based on factor loadings of the contribution rates of 437 universities reaching the top 200 in scientific publishing. The number of the WoS articles, where at least one author's address refers to the university in question and the total number of WoS articles in each discipline were extracted from InCites. The analysis was made by SPSS software and for the extraction method maximum likelihood was selected (because of the size of the observations) with equamax-rotation and Kaiser-normalization and number of factors (4) determined beforehand.

The initial analysis suggested five factors to be used based on Kaiser Criterion of eigenvalues over 1. But based on the following facts that Kaiser Criterion should only be used in component analysis (e.g. Beavers et al. 2013, p. 8), that the fifth factor only explains less than four per cent of the common variance and that its total eigenvalue based on the common variance (from extraction sums of squared loadings) is below one we decided to reduce the factors into four. We therefore ran the same factor analysis again but only with four factors determined beforehand. Based on factor loadings being over 0.3, the contribution rates of 437 universities in 21 ESI disciplines are regrouped into four fields in table 3.

Table 3 The factor loadings of 21 ESI disciplines of contribution rates and the regrouping of them into four factors. The determining loadings are bolded and loadings below 0.3 are omitted

Rotated Factor Matrix				
	Factor			
	1	2	3	4
Clinical medicine	.888		.386	
Immunology	.854		.394	
Neuroscience & Behavioral	.835		.489	
Molecular biology & genetics	.830		.418	
Biology & Biochemistry	.791	.381	.315	
Pharmacology Toxicology	.744			
Microbiology	.718			.445
Physics		.852		
Chemistry		.822		
Material Sciences		.730		
Engineering		.722		
Mathematics		.717		
Computer Science		.563	.507	
Geoscience		.476	.337	.311
Space Sciences	.353	.384	.360	
Social Sciences	.461		.827	
Economics & Business			.818	
Psychiatry & Psychology	.542		.781	
Plant & Animal Science				.974
Agricultural sciences				.799
Environment & ecology			.339	.692

Extraction Method: Maximum Likelihood. Rotation Method: Equamax with Kaiser Normalization.

From table 3 we see how the journals are regrouped based on factor loadings. Into the first factor are regrouped contribution rates concerning journals of clinical medicine, immunology, neuro- & behavior sciences, molecular biology & genetics, biology & biochemistry, pharmacology & toxicology and microbiology. This group is renamed life sciences. The second factor includes journals of physics, chemistry, material sciences, engineering, mathematics, computer sciences, geosciences and space sciences, and the factor is renamed physical sciences. The third factor renamed social sciences entails contribution rates concerning journals of social sciences (general), economics & business and psychology & psychiatry. The fourth and final factor renamed biological sciences includes journals of plant & animal sciences, agricultural sciences and ecology & environment sciences. We may also conclude that with a different group of universities or rotation method psychology as well as space sciences may fall into life sciences.