Proportion of Open Access Papers Published in Peer-Reviewed Journals at the European and World Levels—1996–2013

RTD-B6-PP-2011-2: Study to develop a set of indicators to measure open access

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Executive Summary

This study report assesses the free availability of scholarly publications during the 1996 to 2013 period. It is the largest scale measurement of open access availability performed to date: a sample of one-quarter of a million records was used to study the historical evolution of open access (OA) between 1996 and 2013 and a larger, one million records sample was used to perform an in-depth assessment of the proportion and scientific impact of OA between 2008 and 2013 in different types of OA, for different scientific fields of knowledge, and for 44 countries, the EU28, ERA, and the world.

Compared to previous studies done on the availability of OA, the present study presents the following characteristics: (1) it used the Scopus database, which currently covers a broader range of journals from various countries and scientific disciplines than other comprehensive databases; (2) it uses a simple definition of OA—freely available online to all (no money had to be paid, no registration to a service or website had to be made); (3) it used huge samples to maximise statistical precision; (4) it made careful and extensive efforts to harvest papers wherever they could be downloaded for free, without restriction, rather than restricting the approach to a search engine (in order to obtain a high 'recall' rate, that is, the capacity to retrieve a large part of the relevant records, while, in addition, carefully minimising the number of false records collected (that is, the approach maximised retrieval precision); and (5) it carefully characterised the strengths and weaknesses of the measurement instrument in order to apply a correction that would provide a truer measure based on an Adjusted OA score.

This study also provided a series of rational definitions of access, open access, and ideal open access. The definitions provided examine aspects such as restrictions, payment, delay, transiency, and legitimacy. Because of the limited means (time and budget) available for this project, it was necessary to use operational definitions of OA which do not provide all the details one may wish to obtain. Though it was easy to obtain a clear and easily operational definition of Gold OA by stating that it referred to papers published in Gold OA journals listed in the Directory of Open Access Journals, defining and measuring Green OA was more challenging. The operational definition restricted Green OA to researchers' self-archived papers in institutional and some thematic repositories listed in *Open*DOAR and ROAR. This left a sizeable residual number of papers that could still be downloaded for free; these were classified as Other OA. This comprises, for example, Gold OA papers from subscription-based journals, which are made available through article processing charges (APC). Other OA also include papers available in large repositories such as PubMed Central and aggregator sites such as CiteSeerX. There are also Robin Hood OA or Rogue OA papers, that is, papers that infringe on copyrights by making them accessible to the public despite licenses that restrict them to being behind pay walls.

Measurement instrument calibration

A sample of 500 articles used in a pilot study (December 2012) and in a previous version of this study (April 2013) was used to characterise the harvester used to measure the proportion of OA papers. Slight variations were observed in the availability of articles in this sample measured in December 2012 (47.6%), April 2013 (44.8%) and April 2014 (48.6%). It is noteworthy that 272 articles were available for free at one time or another between December 2012 and April 2013, that is, about 54.4%. These results suggest that there are important transient aspects that need to be taken into consideration while measuring OA availability. These results also show that the harvesting engine developed by Science-Metrix

has very good retrieval precision (99.1%) and fairly good recall (86.4%), resulting in fairly robust measures of OA availability. This characterisation of the measurement instrument allowed the use of a calibration to produce 'Adjusted OA' measures. The total OA measures by the harvester are multiplied by 1.146. However, because the sample size of the calibration was only 500 records, the margin of error is ± 4.5 percentage points.

Evolution of the proportion and of the number of OA papers

As of April 2014, more than 50% of the scientific papers published in 2007, 2008, 2009, 2010, 2011, and 2012 can be downloaded for free on the Internet. This is an important finding as only one year ago, in April 2013, the proportion of papers that was freely available was just a hair below 50% (49.54%) in 2011 and did not reach that mark for any other year. On average, the citation advantage of OA papers is 40.3% while the citation disadvantage is 27% for non-OA papers (based on a total sample size of 209,000 papers).

The growth of OA appears as the result of four main forces: (1) historical growth in the interest in OA, which translates into *new papers* being increasingly available for free; (2) the growing interest in OA also translates into actors increasingly making *old papers* available for free; (3) OA policies that allow for delaying OA to scientific papers with embargo periods produce a concomitant disembargoing of scientific articles, which creates additional growth in old papers being made available for free; and (4) the number of published scientific papers is growing, so even for a stable proportion of OA, the number of OA papers would keep growing.

The effect of backfilling has not been studied extensively before. Evidence suggests that during the last year alone, some 700,000 papers indexed in Scopus between 1996 and 2011 became available for free, that is, an addition of 3.9 percentage points. Studying the OA availability curve for the 2004–2011 period of one year ago compared to this year (April 2013 vs. April 2014) reveals that the present curve has made an upward translation of 3.6 percentage points (measured for 2004) but in addition to going up, the curve is also becoming steeper—the exponent of the curve increased from 1.9% overall growth to 2.4% growth this year. This means backfilling is accelerating over time.

The statistics just presented were on the proportion of OA; it is also relevant to assess how the number of papers is growing per se. These data show that, as of April 2014, the number of available papers increased by 9.4% per year. Of the papers published in 1996, 240,000 are now available for free, as are 950,000 of the papers published in 2012. Based on the adjusted OA availability statistics, one can estimate that about 47% of the papers indexed in Scopus between 1996 and 2013 can be downloaded for free as of April 2014. This means that 10.1 million papers would be downloadable, out of the 21.5 million papers indexed in Scopus for that period and which can be considered to be peer-reviewed papers published in scientific journals.

While the number of Green OA papers has grown steadily, this appears to be due to the background growth, that is, the growth in published scientific papers. Green OA as a percentage of the papers indexed in Scopus appears to have levelled off from around 2004. This requires further investigation to determine whether this is measurement artefact—an effect of the imperfect operational definition of Green OA used here—or whether Green OA is somewhat losing steam. Despite this, there were approximately 1.2 million papers available in Green OA form in repositories across the world, and the growth rate of OA papers was 8.8% between 1997 and 2011.

The percentage of peer-reviewed articles published in Gold OA journals indexed in Scopus for 1996 was only 0.9%, but grew to 12.8% for 2012, the annual growth rate being 18% for this

period, which means that the proportion of articles in Gold OA journals doubles every 4.1 years. Scopus covers less than half of the quantity of journals listed in the DOAJ, so this figure likely underestimates the true extent of the role played by Gold OA journals.

Furthermore, Gold OA papers indexed in Scopus grew exponentially up until 2012. The growth rate was 24% per year between 1996 and 2012, which means that the number of papers published in Gold OA journals doubles every 3.2 years. There are currently about 1,380,000 papers indexed from Gold journals in Scopus for 1996 to 2013. This represents only 200,000 papers more than those available in Green OA form, but Gold OA journals papers are growing with a clear momentum, which is not so clearly the case with Green OA available in institutional repositories.

The evolution of Other OA is somewhat similar to that of Green OA. In terms of percentage, it increases substantially from 1996 until about 2003, at which time it levels off until 2008, when there is an observed decline in the proportion of Other OA papers. It is not so easy to determine what creates this shape due to the heterogeneity of the underlying dataset. What seems to be obvious here is that unless we are witnessing a slowdown in OA development, the embargoing and other form of DOA (Delayed OA) is having a very tangible effect on scientific knowledge availability. This creates a situation whereby a substantial part of the material openly available is relatively old, and as some would say, outdated. As in the case of Green OA, the growth as measured in number of papers is greater than the growth of the proportion. There is a regular increase of 8.4% per year in the number of papers from 1996 to 2009, after which the increase slows down and drops in 2013 as the full effect of embargos surpasses the growth in available papers (which is 6.6% per year in Scopus between 2003 and 2012).

Green OA papers, those deposited in institutional repositories, do not contribute a large share of the overall OA stock of papers. As seen previously, their number does not increase much after 2004. A word of warning is important though, authors can also backfill repositories and the current measurement does not take this into account as no baseline for Green OA was measured last year.

Other forms of OA—Gold OA Papers (that is, those with article processing charges published in subscription journal or so-called hybrid journals), Green DOA and Gold DOA (embargoed self-archiving and embargoed journals), ROA (Robin Hood or Rogue OA) and papers archived in non-institutional repositories such as ResearchGate—account for a large part of the pie. This large, heterogeneous set contributes the largest proportion of OA papers, and there is therefore an urgent need to disaggregate this category. More research and more careful classification and thus finer-grained measures are required to better understand how these various categories contribute to OA growth, what their pattern of time-delay is, what their transiency is (especially of the ROA), how important backfilling is and how far back it goes.

OA papers were between 26% and 64% more cited on average for any given year than all papers combined, whereas non-OA received between 17% and 33% fewer citations (based on a sample size of at least 10,000 papers any given year). Green OA and Other OA papers have somewhat similar patterns. Papers in subscription-based journals (non-OA articles only) and Gold OA journals are also somewhat similar to one another. On average, Green OA (operational definition used here) papers have the greatest citation advantage, being cited 53% more frequently than all papers. They are followed by the Other OA category, which is 47% more frequently cited on average. Papers published in Gold OA journals have a citation disadvantage of 35% on average, compared to a disadvantage of 27% for non-OA papers.

Evolution of OA by scientific field

Considering the last three years together (2011–2013), as of April 2014 more than 50% of the papers can be freely downloaded in 12 fields out of 22. A growth index was computed by dividing the percentage of OA availability in 2011 and 2012 by that observed in 2008 and 2009 (2013 was left aside as embargos would distort calculated growth rates). Overall, between the two periods, there has been a 4% increase in OA availability (slightly less than 2 percentage points). The fields with the fastest growth during these periods are general science & technology, enabling & strategic technologies, public health and health services, visual & performing arts, clinical medicine, and built & environment design. Here, one can suspect that the NIH OA mandate is at play (in public health and clinical medicine).

The fields with the greatest proportion of OA are General Science & Technology (Adjusted OA=90%), Biomedical Research (71%), Mathematics & Statistics (68%), and Biology (66%). OA is not as commonly used in Visual & Performing Arts (Adjusted OA=25%), Communication & Textual Studies (31%), Historical Studies (34%), Engineering (35%), and Philosophy & Theology (35%).

Green OA is particularly present in physics & astronomy (25.6%), which is certainly helped by the presence of arXiv, which probably also plays role in mathematics & statistics (24.3%), while economics & business is the leading field in the social sciences and humanities (11.3% of papers in Green OA).

Gold OA availability is greatest in general S&T (58% of the sampled papers) and lowest in general arts, humanities & social sciences (2.6%); it is also very low in the visual & performing arts (2.8%), built environment & design (3.5%) and engineering (4.1%). Other fields with high availability in Gold journals include biology (17%), agriculture, fisheries & forestry (16%), and public health & health services (16%).

Other forms of OA are frequently encountered in biomedical research (48%), psychology and cognitive sciences (43%), biology (42%), earth & environmental sciences (38%), and clinical medicine (35%).

The absolute number of papers in OA form is rising rapidly (as there is also underlying growth in the number of papers generally). For example, the growth of the OA proportion in agriculture, fisheries & forestry was 1.02, but the number of papers grew at 1.16 (16% growth in the number of OA papers indexed in Scopus in 2011–2013 compared to the 2008–2009 period).

Overall, out of the 4.6 million scientific papers from peer-reviewed journals indexed in Scopus during the 2011–2013 period, 2.5 million were available for free in April 2014 (adjusted OA score). A very large number of papers are freely available in clinical medicine (adjusted OA = 680,000 papers), biomedical research, and physics and astronomy (close to 250,000 papers, as calculated with an adjusted measure). This is partly because of the policy of the US National Institutes of Health (NIH) that mandates the use of the PubMed Central repository for supported research and because of the arXiv e-print archive, which has been largely adopted by researchers in the field of physics.

All the fields derive an OA citation advantage. Paradoxically, many of the fields where the OA proportion is low have a sizeable citation advantage, such as the visual & performing arts (80% more cited), communication & textual studies (66%), philosophy & textual studies (63%), historical studies (55%), general arts, humanities and social sciences (51%), and engineering (38%). An explanation to this is likely to be that papers from researchers in these fields are more likely to have their papers used as there are fewer OA papers available.

There is a huge citation advantage to publishing in Green OA, as has been demonstrated time and again in other serious studies conducted previously. Papers in general science & technology, in historical studies and in visual & performing arts all receive, on average, twice as many citations as the overall population of papers. Two fields stand out for a fairly small Green OA citation advantage: clinical medicine (+8% vs. +56% in Other OA) and biomedical research (+10% vs. +23%). The reason may be that other sources of freely downloadable papers, classified here as 'Other OA', such as BioMed Central, are so large that the reflex of users is to first see what is available there and to shun institutional repositories. Still, 8% and 10% more citation remains a sizeable advantage, and it is worthwhile using institutional repositories and immediate Green OA to cut the delays associated with what many consider to be weak OA mandates, that is, the one allowing for papers to be embargoed instead of being made immediately available.

On average, publishing in Gold OA journals is the least advantageous solution if one wants to maximise scientific impact. It is still more advantageous than Strict Paid Access in seven fields, and ranks as the second best solution for physics & astronomy. Currently, there is a marked disadvantage for publishing in Gold journals in general arts, humanities & social sciences, built environment & design, economics & business and in visual & performing arts. Interestingly, visual & performing arts has one of the highest advantages derived from the use of Green and of OA generally, yet it is the field with the least prevalent use of OA.

The statistics on Gold journals require careful interpretation. First, many Gold journals are younger and smaller, and these factors have an adverse effect on the citation rate and hence on measured citation scores. Authors frequently prefer reading and citing established journals, and it is therefore a challenge to start a journal from scratch, and to have authors submit high-quality articles. It takes time to build a reputation and to attract established authors.

An examination of OA availability was performed for EU28 and ERA countries and for four additional countries, namely, Brazil, Canada, Japan, and the US. For the 2008–2013 period considered as a whole, the Adjusted OA suggests that all 44 countries have more than 50% of papers in OA for that period. Four EU28 countries have even reached an aggregate availability score above 70%—the Netherlands, Croatia, Estonia, and Portugal. It is interesting to note that the Netherlands, which is also scientific publishers' land of predilection, is the EU country with the largest share of papers available in OA form (74%) as a whole for papers published in the 2008–2013 period and available for free download as of April 2014.

All ERA countries have tipped towards having a majority of papers in OA, though in the case of the Republic of Moldova, the margin of error is quite high, and it is quite possible that the country has not tipped to OA yet. Swiss researchers contribute to making their country a leader in OA, with 70% of the papers being downloadable for free.

In countries outside the ERA, it is noteworthy that the US has passed the tipping point by a fair margin (Adjusted OA = 67.9%), as is also the case for Canada (64.4%). Even more salient is the proportion of 76% observed in Brazil. This is no doubt due to the important contribution of Scielo, which plays a key role in the Southern hemisphere in making scientific knowledge more widely available. Japan is just a hair over 50% and given the margin of error of Adjusted OA may or may not have tipped to having a majority of papers in OA form.

Within the European Union, Green OA is more widely used in Portugal (16.3%), Ireland (15.8%), France (14.0%), and Belgium (13.8%), and least used in Lithuania (4.5%), Malta (5.0%), Croatia (5.2%), and Romania (5.3%).

Publishing in Gold journals is much more frequently encountered in Eastern Europe, as it is much higher in Croatia, Slovenia, Latvia, Poland, Estonia, and Lithuania (in addition to Malta). One interesting hypothesis is that researchers in these countries may use Gold journals because they more frequently allow publishing in languages other than English. Should that be the case, this may also contribute to explaining the lower citation scores received by papers in Gold journals as the readership for 'vernacular languages', as Eugene Garfield (1998) would put it, is lower and the size of the potential reference pool is consequently also smaller. There is therefore a potentially fertile ground for studying the social and linguistic aspects of science by examining where and why Gold open access journals are appearing and who actually makes use of them. The countries that least use Gold OA journals are France (6.6%), the United Kingdom (7.2%), and Belgium (7.4%).

Policy implications

Much has been said about the cost of publishing in Gold OA journals and for Gold OA articles ('hybrid publishing'). The cost of academic papers in the US is over $100,000—which is calculated by dividing the higher education expenditures on R&D (HERD) by the number of papers published by academia. In addition to or included in this amount, a $2,000 OA publication fee only accounts for a few percentage points of a typical research project budget, especially in the natural and health sciences. Green OA is free, and the majority of publishers accept that papers can be self-archived in one form or another (pre-print, post-print with final revision, or PDF) with no delay. Moreover, two-thirds of Gold OA journals do not levy author processing charges (Suber, 2013). There are free avenues to OA and cost should not be construed as a barrier.

The current model of back end toll access is simply unsustainable because of the gross social inefficiency and ineffectiveness. Examining the OECD statistics on gross domestic expenditure on R&D in OECD and selected 'Non-OECD Member Economies' (Argentina, China, Romania, Russian Federation, Singapore, South Africa, Chinese Taipei),[1] and using some conservative extrapolations, one can see that about $400 billion (current dollars at purchasing dollar parity) were spent by governments (GovERD) to support R&D. The revenues generated by science, technical and medical publishing (STM) for English-speaking countries was worth approximately $9.4 billion in the same year (Ware and Mabe, 2012). Though these figures are not immediately comparable as part of the industry must derive income from non-English journals, the fact remains that a sizeable part of the research results paid for by $400 billion in publicly spent money is either delayed, restricted, or still simply behind thick pay walls to generate only $10 billion in private wealth. This is a case of gross inefficiency, one that taxpayers the world over should not tolerate.

Green OA advocates could respond that the lowest marginal cost to the system to make papers available for free is currently through the use of self-archiving in Green OA form: this would be a valid point. Yet, there is always a toll to be paid to create, diffuse, and use peer-reviewed papers. Few things are entirely free, be it a fee for a subscription or a fee to download an article, a fee to publish an article, the public or philanthropic money that goes into supporting OA journals or article processing charges, or the opportunity cost associated with academics running journals instead of performing research and lecturing and training students, or providing other types of services to society.

[1] https://stats.oecd.org/Index.aspx?DataSetCode=GERD_FUNDS.

Just as there is a need to continue to work vigilantly to remove the inefficiency created by all this public expenditure being made unavailable or available with undue restrictions, difficulties, and delays, there is a need to closely monitor the effects of moving the scientific world from one based on Back End Paid Access (BEPA) to one based on Front End Paid Access (FEBA). BEPA created huge social inefficiency; FEBA has the potential to enlarge the rift between wealthier and more feebly financed countries, researchers, and scientific disciplines. Many mandates being promulgated at the moment run the risk of favouring a shift from BEPA to FEBA, from inaccessibility to inequality. Neither inaccessibility nor growing inequality are acceptable considering that universalism is one of the core values of scientific research.

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1 Introduction

Since the 1990s, the academic community's interest in open access (OA) publications has been increasing steadily, especially following the introduction of the arXiv e-print archives (arXiv.org). Several articles promoted self-archiving in the interest of making scientific knowledge freely available to all. In parallel, an emerging movement aimed to measure and monitor OA availability and impact. Quite early on, OA advocates used measurement to promote free availability, in particular after it was discovered that OA presented a 'citation advantage'. As a consequence, it is not always easy to distinguish what the authors of papers on OA are attempting to do, advocate for or measure OA. The firm objective of this report is to advance the measure of freely accessible papers published in scientific peer-reviewed journals.

The initial interest in the use of bibliometric methods in OA measurement focused on accessing the so-called citation advantage of OA[2] as opposed to subscription-based journals (Lawrence, 2001; Antelman, 2004; Harnad & Brody, 2004; Craig, 2007). Strong advocacy by authors such as Harnad (2003, 2008, 2012) suggested that benefits would ensue from so-called Green OA, that is, research papers self-archived by their authors in institutional repositories. Unsurprisingly, in this context, librarians and information scientists noted that they had a new mission, which meant setting up and curating OA repositories (Proser, 2003; Bailey, 2005; Chan, Kwok, & Yip, 2005; Chan, Devakos & Mircea, 2005; Repanovici, 2012).

Part of the OA literature has discussed how authors, researchers (Pelizzari, 2004; Swan & Brown, 2004; Dubini, Galimberti & Micheli, 2010) and publishers (Morris, 2003; Regazzi, 2004) would react to this new paradigm. Evidently, business and economic models were discussed (Bilder, 2003; Kurek, Geurts & Roosendaal, 2006; Houghton, 2010; Lakshmi Poorna, Mymoon & Hariharan, 2012), but there was also interest in what models academia and libraries would follow (Rowland et al., 2004; Swan et al., 2005; Hu, Zhang & Chen, 2010).

As OA continued to make inroads, a growing number of papers examined the state of development of OA in specific countries (Nyambi & Maynard, 2012; Sawant, 2012; Woutersen-Windhouwer, 2012; Miguel et al., 2013) and in specific fields of research (Abad-Garcí et al., 2010; Gentil-Beccot, Mele, & Brook, 2010; Charles, & Booth, 2011; Henderson, 2013). In this context, it is not surprising to find papers that addressed the general question of OA availability as a proportion of the scientific literature, and the proportion of OA papers available in different fields of science (Björk et al. 2010; Gargouri et al., 2012).

This study assesses OA availability during the 1996–2013 period by carefully tuning harvesting methods in order to substantially increase recall (recall is the capacity to harvest all relevant items). A deep dive was also performed for the last six years to cross-tabulate the data in 22 scientific fields with the proportion of OA papers in the European Research Area (ERA) and in selected countries. Some 1.25 million papers were sampled to carry out the present study, making it, to the best of our knowledge, the largest-scale study undertaken to date on this subject. A preclude to the present study included an important pilot phase as well as a first phase of large-scale measurement (sample size of 320,000 records), the results of which were presented in an earlier version of the present report (Archambault et al. 2013).

[2] An annotated bibliography is provided by Wagner (2010). http://www.istl.org/10-winter/article2.html.

The harvesting engine developed by Science-Metrix searches on a large number of specific sites, including Scielo, PubMed Central and the websites of scientific peer-reviewed journal publishers, uses a locally hosted version of large-scale specialised repositories such as arXiv, and systematically harvests metadata from institutional repositories listed in the Registry of Open Access Repositories (ROAR) and the Directory of Open Access Repositories (*Open*DOAR), in addition to having a portion of the harvesting engine working in the cloud and searching for freely available papers.

Before entering into the methodological details associated with the measurement of freely accessible papers, it is important to produce both theoretical and operational definitions of Green, Gold, and other types of freely accessible papers.

1.1 Rational definitions of open access

The previous iterations of the research work behind this report have shown that freely available scientific papers published in peer-reviewed journals can take a wide variety of forms (e.g. pre-print, HTML, PDF), be diffused through a wide range of media (e.g. institutional repositories, journal publishers' websites, content aggregators) and have varying levels of availability (immediate, delayed, transient) that simple definitions based on open access, Green and Gold were no longer satisfactorily describing. If that was not enough to convince one that more elaborate definitions were needed, much feedback received by the authors of the previous version of this study argued that what was measured wasn't really open access. Though it took a while to realise this, current definitions of OA are frequently reshaped by advocates to suit the needs of the particular battles they are waging at any moment.

For instance, though we had measured the same items as one of our critics who has published numerous papers in which he referred to these items as OA, it seemed that for him the definition of 'real' open access had shifted to be restricted to only those items with 'immediate availability'. Delayed OA frequently occurs when journal publishers make some papers or whole journal contents available for free only after an embargo period. However, it can also happen when authors encounter delays in self-archiving their papers, by, for example, being overly busy or not having an institutional repository in place, or simply because they are late converts to the idea of increasing the potential outcomes of their own research through OA. Placing immediacy as a criterion for earning the OA stamp seems to be overly restrictive, though one could say that this is one important quality of OA and should be accounted for in policies.

Some objections were also made to the effect that part of what we measured had a transient character—some papers do indeed come and go from the freely available status. For example, in December 2012, Springer had a large promotion as part of which it made many papers temporarily available, but placed them behind a pay wall later on. Most of the time, an item's transient availability is hardly known to a user who wants to download a paper. This is a quality of OA that should be reflected in policies, but should not a considered to be a condition to achieving the OA stamp.

Overall, what most transpired from the feedback received after the publication of the first version of this series of studies was the need for precise definitions of OA. Most conceptual representations of OA are derived from the established definitions provided in the three Bs:

- the Budapest Open Access Initiative (BOAI);[3]
- the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities;[4] and
- the Bethesda Statement on Open Access Publishing.[5]

The Berlin Declaration and Bethesda Statement build on the definition developed in Budapest, which remains authoritative. BOAI defines OA as follows:

> Free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited.

Also, importantly, as the Wikipedia article on OA notes,[6] "[i]n order to reflect actual practice in providing two different degrees of open access, the further distinction between gratis OA and libre OA was added in 2006," by Stevan Harnad and Peter Suber (Suber, 2008). The Wikipedia article mentions that "[g]ratis OA refers to free online access, and libre OA refers to free online access plus some additional re-use rights. The Budapest, Bethesda, and Berlin definitions had corresponded only to libre OA." More specifically, Suber (2012) proposed the following definitions:

Gratis OA—access that is free of charge but not necessarily free of copyright and licensing restrictions (users must seek permission to exceed fair use). Gratis OA removes price barriers but not permission barriers.

Libre OA—access that is both free of charge (gratis OA) and free of at least some copyright and licensing restrictions. Users have permission to exceed fair use, at least in certain ways. Libre OA removes price barriers and at least some permission barriers.

The use of the terms "not necessarily" and "of at least some" implies uncertainties. Moreover, there are more than "two different degrees of open access." This explains why the following binary definitions were preferred in the present series of reports produced by Science-Metrix for the European Commission.

A: Access—can be open (free), restricted or paid; with unrestricted or restricted usage rights; quality controlled or not; pre-print (pre-referring), post-print (post-referring), or published version (with final copy editing and page layout); immediate or delayed; permanent or transient.

OA: Open Access—freely available online to all.

IOA: Ideal OA—free; quality controlled (peer-reviewed or editorially controlled); with unrestricted usage rights (e.g. CC BY); in final, published form; immediate; permanent.

RA: Restricted Access—access restricted to members of a group, club, or society.

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[3] http://www.budapestopenaccessinitiative.org/read.

[4] http://openaccess.mpg.de/286432/Berlin-Declaration.

[5] http://legacy.earlham.edu/~peters/fos/bethesda.htm.

[6] http://en.wikipedia.org/wiki/Open_access.

PA: Paid Access—access restricted by a pay wall; includes subscription access, licensed access, and pay-to-view access.

Restricted OA—free but with download restrictions (e.g. registration required, restricted to manual download, HTML-only as opposed to self-contained format such as PDF) or re-use rights (e.g. CC NC).

Green OA—OA provided before or immediately after publication by author self-archiving.

Gold OA—immediate OA provided by a publisher, sometimes with paid for publication fee. Note that several Gold journals have right restriction: they are Gold ROA. For example, of the 38% of journals listed in the DOAJ that use a Creative Common licence, only 53% use the CC-BY licence that would allow them to qualify for the IOA definition above (Herb, 2014).

> ***Gold OA Journal***—journal offering immediate cover-to-cover access.
>
> ***Gold OA Article***—immediately accessible paper appearing in a Gold journal, or in a PA journal (the latter is also sometimes referred to as hybrid open access).

ROA: Robin Hood OA or Rogue OA—Available for free in spite of restrictions, usage rights, or copyrights (overriding RA, PA, Restricted OA). As the publishers' copyright policies and self-archiving rules are compiled by the University of Nottingham in the SHERPA/RoMEO database, Rogue OA is synonymous with Robin Hood OA.

DOA: Delayed OA—access after a delay period or embargo.

> ***Delayed Green OA***—free online access provided by the author after a delay (due to author's own delay to make available for free) or embargo period (typically imposed by publisher).
>
> ***Delayed Gold OA***—free online access provided by the publisher after a delay (e.g. change of policy that makes contents available for free) or embargo period.
>
> > ***Delayed Gold OA Journal***—Journal offering cover-to-cover access after an embargo period or after a delay.
> >
> > ***Delayed Gold OA Article***—Paper appearing in a Gold journal or in a PA journal (the latter is also sometimes referred to as hybrid open access) which is available after an embargo period or after a delay.

TOA: Transient OA—free online access during a certain time.

> ***Transient Green OA***—free online access provided by the author for a certain time which then disappears. Note that a substantial part of Green OA could be Transient Green OA due to the unstable nature of the internet, websites, and institutional repositories, many of which are not updated or maintained after a period of time and are therefore susceptible to deletion in subsequent institutional website overhauls. There are also integrator repositories that can change access rules, for example after being acquired by a third party.
>
> ***Transient Gold OA***—free but temporary online access provided by the publisher, instead of permanent. Sometimes appears as part of promotion. Note that some Gold journals and articles sometimes become paid access after a certain time, because of revised strategies by a publisher or because they are sold to another publisher who instaures paid access.

1.2 Operational definitions of open access

In the present report, the following operational definitions were used to perform measurement:

Green OA: refers to papers which are self-archived by authors and available on institutional repositories as listed in *Open*DOAR[7] and/or in ROAR.[8] Listings in *Open*DOAR and ROAR which correspond to known Gold OA Journals were set aside. Aggregator sites such as CiteSeerX were not considered here, since, even though they access article submissions, they do not constitute a repository in the classical sense. Likewise, articles in the main PubMed Central sites were not counted as Green as they have curtailed usage rights or limited download rights.[9] Because it is commonly difficult to determine whether a paper was self-archived before, at the same time or after publication and also how long it will be available on the internet, Green OA includes Green OA, Delayed Green and Transient Green. Note that some of these articles may not respect restrictions placed by journal publishers (many of whose rules can be found on SHERPA/ROMEO)[10] and therefore contain a certain number of Robin Hood OA papers. Finally, only articles which could be downloaded without user registrations were considered.

Gold Journals OA: refers to papers appearing in journals listed in the Directory of Open Access Journals (DOAJ)[11] and on the PubMed Central list of journals.[12] When a paper is published during the first year that a journal appears in the DOAJ, it is not counted. This is a conservative decision due to the fact that one cannot determine whether a journal started publishing Gold articles early or late during the year. For PubMed Central, only open access journals with full participation and immediate access were considered to be Gold, hence all journals with an embargo and in the 'NIH Portfolio' were not considered. Thus, this category covers articles appearing in Gold journals and excludes delayed Gold as well as piecemeal Gold (Gold articles in paid access journals, also called hybrid OA).

Other OA: refers to pretty much everything that could be found on the web by a determined researcher and downloaded for free and which was not part of the Green and Gold operational definitions above. This comprises articles appearing in journals with an embargo period (Delayed Gold OA); articles appearing on authors' webpages and elsewhere (both Green OA and Rogue OA); articles appearing on aggregator sites such as ResearchGate and CiteSeerX in addition to PubMed Central. The category comprises both transiently and permanently accessible items as there are no reliable ways to ascertain at measurement time whether an item will be permanently accessible or not.

Total OA: The mutually exclusive sum of Green OA, Gold Journal OA, and Other OA.

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[7] http://www.opendoar.org/.

[8] http://roar.eprints.org/.

[9] The PubMed Central site mentions 'You may NOT use any kind of automated process to download articles in bulk from the main PMC site. PMC will block the access of any user who is found to be violating this policy'. See http://www.ncbi.nlm.nih.gov/pmc/about/faq/#q12.

[10] http://www.sherpa.ac.uk/romeo/.

[11] https://doaj.org/about.

[12] http://www.ncbi.nlm.nih.gov/pmc/journals/.

2 Methods

This section presents the key metrology concepts used in this study (Section 2.1) and a detailed characterisation of the accuracy of the measurement techniques used for the present study (Section 2.2). This report covers the largest and final measurement phase (Section 2.3).

2.1 Key OA metrology concepts

This study report presents results using two important metrology concepts (JCGM, 2008): (1) *trueness*, which reflects the quality of the instruments used and the care taken in making measurements; and (2) *precision*, which reflects the use of repeated measures, sampling and statistical analysis (see Figure 1). The latter concept will be called *statistical precision* to distinguish the need to use multiple measures in order to reduce the margin of error from the different tasks involved in performing binary classification work the aim of which is to determine whether a document belongs to a category (e.g. OA or Non-OA).

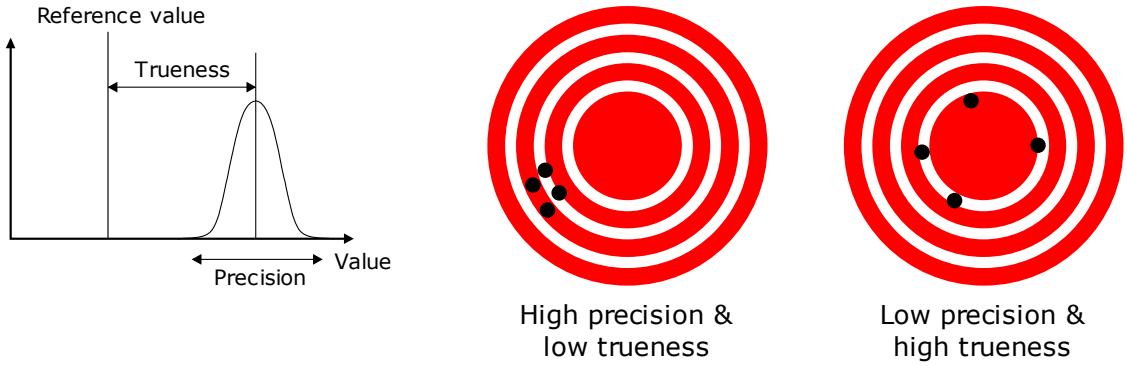

Figure 1 Trueness and statistical precision

Source: Adapted from http://en.wikipedia.org/wiki/Accuracy_and_precision.

Statistical precision can be assessed with the margin of error (ME). For a proportion (p) where the population is finite and known (which is the case here as the population from which we are sampling is the Scopus database), (N) is not systematically much larger than the sample size (n), and in which the values are discrete (for example, papers are discrete as one does not publish one third of a paper), given a critical score Z (which will be set at 0.95 in the study), ME is calculated as follows:

$$ME = Z\sqrt{\frac{p(1-p)(N-n)}{n(N-1)}} + \frac{0.5}{n}$$

What complicates the use of these definitions is the need to examine how true our measures are using two more concepts used in information retrieval: recall and precision (as opposed to the first concept of 'statistical precision'; the second precision-related concept will be referred to as 'retrieval precision').

Recall is the proportion of relevant records that are retrieved (capacity to avoid having false negatives or of not making type II errors), while retrieval precision is the proportion of retrieved records that are relevant (capacity to avoid including false positives or of not making type I errors). In a way, low recall might be seen as undershooting a target, while low precision could be seen as overshooting. Recall is frequently an easy-to-reach design goal, as it can be achieved by just selecting everything. However, a good measurement instrument has

to avoid including items that are not relevant (that is, including false positives) and to balance recall with precision, since increasing recall usually comes at the cost of lowering precision.

If an instrument retrieves 25 records of which only 20 are relevant, and fails to retrieve 30 additional relevant records, its retrieval precision is 20/25=80%, and its recall 25/50=50%. Thus, high recall means that an instrument returned most of the relevant results, while high retrieval precision means that it retrieved more relevant results than irrelevant ones.

Overall, in order to perform an accurate estimate of the proportion of OA in a population of papers published in peer-reviewed journals, one needs to (1) keep the statistical level of error low (high statistical precision) by having a large sample size; (2) have a high level of recall in order to avoid missing relevant records (and underestimate the real population); and (3) have a high level of retrieval precision to avoid including spurious records (and overestimate the real population).

2.2 Characterisation of the measurement apparatus

The results from a perfect classifier would solely comprise a mix of true positives and true negatives. A true positive (*tp*) in the present case is a paper known to be available in OA which is found by the harvesting instrument developed for the current project. A true negative (*tn*) is an article which is not available for free and is not found by the instrument. However, such an instrument rarely is perfect and there are usually false positives (*fp*), that is, articles not available for free but wrongly assigned to this category, and false negatives (*fn*), that is, articles available for free but that are not found by the instrument. These concepts can be used to characterise how good measurement is in terms of retrieval precision and recall.

Retrieval precision, also called positive predictive value, provides an estimation of how frequently the instrument finds correct positive results and is calculated as follows:

$$\textit{Retrieval Precision} = \frac{tp}{tp+fp}$$

Recall, also called true positive rate or sensitivity, is the capacity to correctly identify a large proportion of the positive records:

$$\textit{Recall} = \frac{tp}{tp+fn}$$

Knowing the precise characteristics in terms of true and false positives and negatives allows for the computation of an adjustment score, which can then applied to recalibrate the results to obtain a truer measure, one that corrects the limits of the instrument. The adjustment made in the previous study is based on the following formula:

$$\textit{Adjustment} = \frac{tp+fn}{tp+fp}$$

The same sample of 500 articles previously used in a pilot study was also used for the characterisation of the OA harvester used to measure availability of the million papers and the close to a quarter million samples of papers used for the present study. Whereas 238 articles were available for free in December 2012 (47.6%), some 224 articles could be found in April 2013 (44.8%) and 243 in April 2014 (48.6%). It is also noteworthy that 272 articles were available for free at one time or another between December 2012 and April 2013, that is 54.4%. Between December 2012 and April 2013, 11 new records appeared in OA, but 25 disappeared, a large part of the latter (13 out of 25) actually being Springer articles available for free during the limited time of a promotion. Most of the others were on websites that disappeared, or no longer appeared on the website where they were originally

found. A further 10 papers that could be found in April 2013 had disappeared by April 2014 (or could only be found because we had the old link since neither Google, Google Scholar, or our own harvester could find them). That is, a total of 35 papers that could be found either in December 2012 or in April 2013 disappeared afterwards (7% of the sample). These results suggest that there are important transient aspects that need to be taken into consideration when measuring OA availability. Free articles sometimes come and go and it is therefore important to present information not only on the year of publication of articles, but also when the measure was actually made. This also makes replication of results a challenging undertaking.

The characterisation of the harvester reveals that this measurement instrument has excellent retrieval precision (99.1%) and fairly good recall (86.4%). Our design goal is to maximize retrieval precision at the expense of recall, and progressively improve recall while maintaining or improving precision. We therefore consider the harvesting engine's results as consistent with these goals and sufficiently good to present robust measures of OA availability. Please note that even the method used here is a floor of OA availability as neither Google nor Google Scholar, which were used to determine the 'ground truth', can be expected to have perfect recall scores.

Because our harvester tends overall to underestimate the availability of OA, an adjustment factor of 1.146 was used in some graphs and tables for Total OA (this adjustment cannot be used for Green OA, Gold OA, or Other OA, which would need their own calibration). When in use, this calibrated measure is always indicated as 'Adjusted OA'. In the absence of the adjusted measure, the statistics should be considered to be floor values providing a conservative estimate of the OA proportion.

The following limits to the calibration should be noted: the 500-record sample size used to calibrate the score is relatively small and increasing that sample size would increase the reliability of the adjustment. For a confidence interval of 95%, the margin of error for a proportion of 50% is 4.5 percentage points. Only records from 2008 were calibrated, which might create some imperfection in randomness as these records may have different characteristics from records of other years. The adjustment was computed only for overall OA; separate calibrations for Green OA, Gold OA and Other OA would also be desirable.

Please note that in the tables, the values are presented as percentages and the errors in percentage points, that is, 50±2 means that the proportion could be as low as 48% and as high as 52%. When presenting data with Adjusted scores, the margin of error was obtained using the following Pythagorean formula where ME_{tot} is the margin of error, ME_s is the margin of error due to the actual sample size used for the measurement of the OA proportion whereas ME_a is the margin of error due to the sample size used for the calibration of the harvesting instrument:

$$ME_{tot} = \sqrt{ME_s + ME_a}$$

Table I OA availability in April 2014 of a sample of 500 articles published in 2008

Type of results	Articles	Characteristics	Score
True positive (tp)	210	Retrieval precision	99.1%
True negative (tn)	255	Recall	86.4%
False positive (fp)	2	Adjustment factor	1.146
False negative (fn)	33	ME of the Adjustment	4.5%

2.3 Strategy to measure the proportion of Green, Gold and Other OA

Two random samples were created for this last phase of the study. The first one spanned the 1996 to 2013 period. Articles were randomly selected from Scopus until the year with the least papers had 10,000 papers; this year happened to be 1996, as expected, as it had the least records. The target of 10,000 papers was computed on the basis that it would yield a statistical margin of error of 1%, which we had arbitrarily selected. This sample, comprising metadata for more than 245,000 papers, was used to study the overall proportion of Green OA, Gold Journal OA, Other OA, and Total OA at the world level.

A second sample comprising one million records was drawn to perform detailed measurements for the relatively recent past, that is, the 2008 to 2013 period. More specifically, this sample was used to cross-tabulate 22 scientific domains with all the countries in the ERA. Additional articles were retrieved for smaller fields, but these were only used to compute statistics at the field level

The determination of whether a paper in the sample was available in Green or Other OA form involved the use of a custom-built harvester. Please also refer to the operational definitions offered in Section 1. The harvesting engine developed by Science-Metrix searches specific sites, including Scielo, PubMed Central, Research Gate and CiteSeerX, and the websites of scientific, peer-reviewed journal publishers. It uses a locally hosted version of large-scale specialised repositories such as arXiv and systematically harvests metadata from institutional repositories listed in ROAR and *Open*DOAR; in addition, a portion of the harvesting engine works in the cloud and searches for freely available papers.

For Gold Journal OA articles, an estimate of the proportion of papers was made from the random sample by matching the journals that were known to be Gold to the year a paper was published. These journals were obtained from the Directory of Open Access Journals (DOAJ) and the list of OA journals in PubMed Central. This was done by matching journals' ISSN, E-ISSN and names from Scopus to the relevant records in the sample (the matching had close to 100% precision, but recall may have been imperfect, hence the figures presented here can be considered to be a floor, rather than a ceiling).

3 OA availability and impact of papers published between 1996 and 2013

This section examines the evolution of the proportion of papers published between 1996 and 2013 which can be downloaded for free as of April 2014 (Section 3.1) followed by the different types of OA: Green OA (Section 3.2), papers published in Gold OA journals (Section 3.3), and papers published in other types of OA (Section 3.4). Section 3.5 examines the contribution of each type of OA to the overall availability of freely downloadable papers. Finally, Section 3.6 examines the evolution of the impact of OA and non-OA papers.

3.1 Growth of OA

Measuring the growth of OA was one of the central aspects of this research project. It is considerably difficult to measure the growth of OA compared to the majority of growth phenomena. The reason is that growth in OA appears as the result of four main forces: (1) historical growth in the interest in OA which translates into *new papers* being increasingly available for free; (2) the growing interest in OA also translates into actors increasingly making available *old papers* for free; (3) OA policies that allow for delaying OA to scientific papers with embargo periods produce a concomitant disembargoing of scientific articles that creates additional growth in old papers being made available for free; and (4) the fact that the number of published scientific papers is growing, so even for a stable proportion of OA, the number of OA papers would keep growing.

Whereas growth of new items typically creates geometric patterns such as exponential and logistic growth curves, backfilling creates an upward movement of the curve presenting the proportion of freely available papers, which is called a translation movement in mathematics. Embargoes makes measurement more complex as the growth curves experience a levelling off and a fall as one gets closer to the present day. As mentioned, the number of scientific papers is itself increasing over time—6.6% growth per year can be observed in Scopus between 2003 and 2012. Again, this means that even in the absence of growth in OA availability, one could actually see an increase in the *number of papers* available in OA.

These concepts can be seen clearly in Figure 2. The figure presents the results of the latest measurement phase based on 245,000 records randomly selected between 1996 and 2013, in addition to the previous round of measurement performed in April 2013 on the 2004 to 2011 period. Adjusted scores are based on the careful characterisation of the harvesting engine presented in Section 2 (Table I) and take into account the retrieval precision and recall of the OA harvester used for this study. The curves illustrate the growth over time, the translation of the curves that appear in a period of one year, and the effect of embargoes and Delayed OA.

Figure 3 shows the difference in the curve as measured in April 2013 and in April of the current year (2014) to see the type of change that occurred in the availability of OA over one year. There are interesting observations to be made from the adjusted OA curves. Firstly, if one does not take the translation movement into account, the overall growth of OA appears to be quite slow. The curve obtained last year suggested that OA was growing at a rate of 1.9% per year. Interestingly, the curve obtained this year shows an acceleration of OA availability, since the growth rate is now 2.4%, an increase in growth of 0.5%. The translation is therefore not a perfect parallel movement as the curves diverge going forward. As measured in 2004, there is a 3.6 percentage point gap between the two curves, and this gap is 6 percentage points wide in 2011.

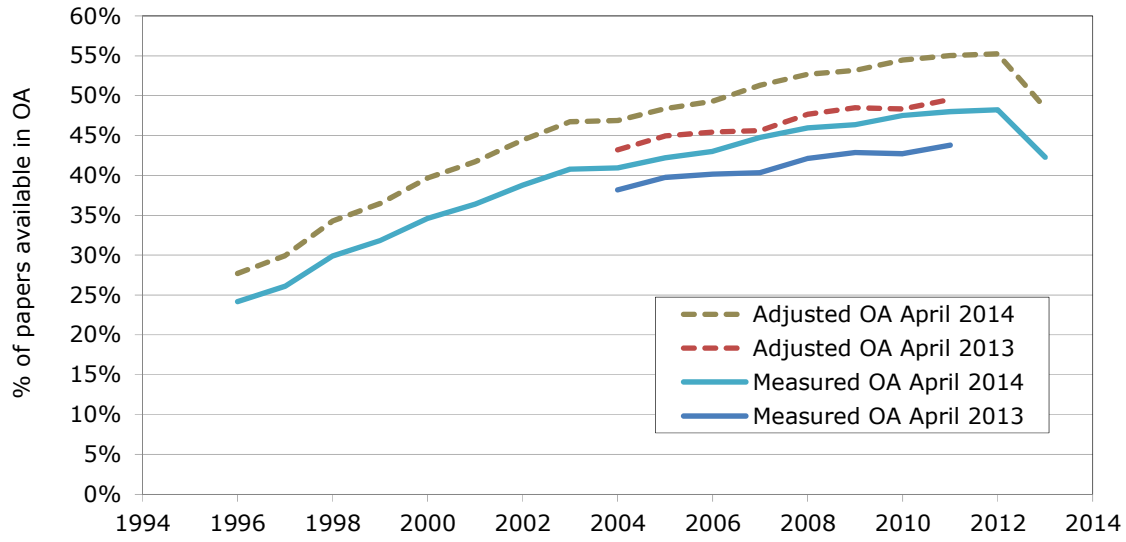

Figure 2 **Evolution of the proportion of OA scientific papers as measured in April 2013 and April 2014, 1996–2013**

Source: Computed by Science-Metrix using Scopus, DOAJ and numerous sources of freely downloadable papers.

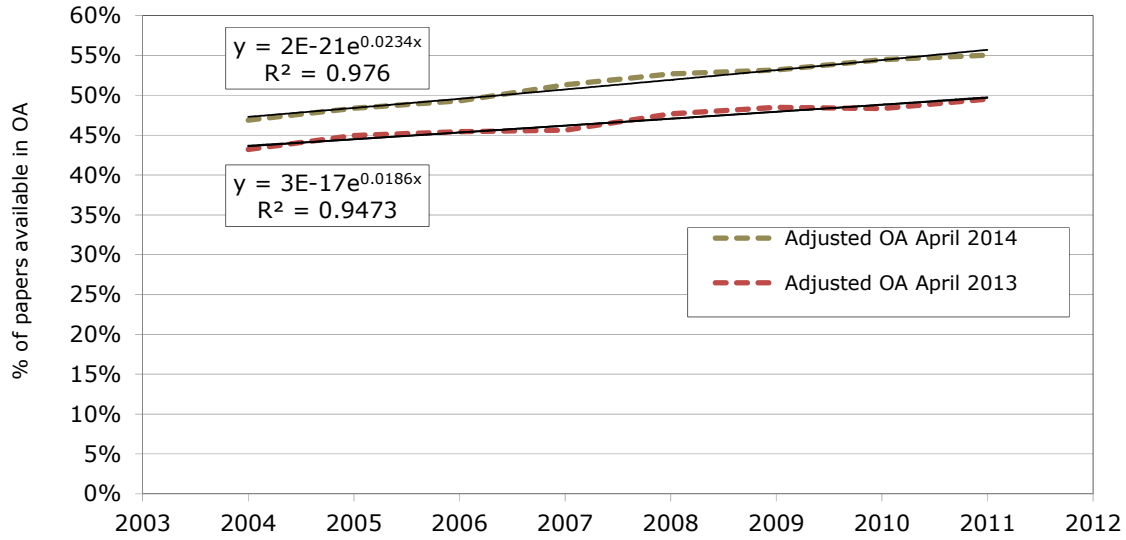

Figure 3 **Translation of OA availability between April 2013 and April 2014**

Source: Computed by Science-Metrix using Scopus, DOAJ and numerous sources of freely downloadable papers.

These estimates were used to produce an estimate of the backfilling of old papers published between 1996 and 2011 that were made available for free during the year separating the measures made in April 2013 and those made in April 2014. This estimate is presented in Figure 4. According to this model, close to 14,000 papers published in 1996 were made available for free during the last year, and nearly 100,000 papers published in 2011. Backfilling is really important to understand how OA grows: a total of 700,000 papers published between 1996 and 2011, as indexed in Scopus, were made available for free between April 2013 and April 2014. Considering that there are about 18 million papers in Scopus for this period, this represents an increase in availability of 3.9 percentage points.

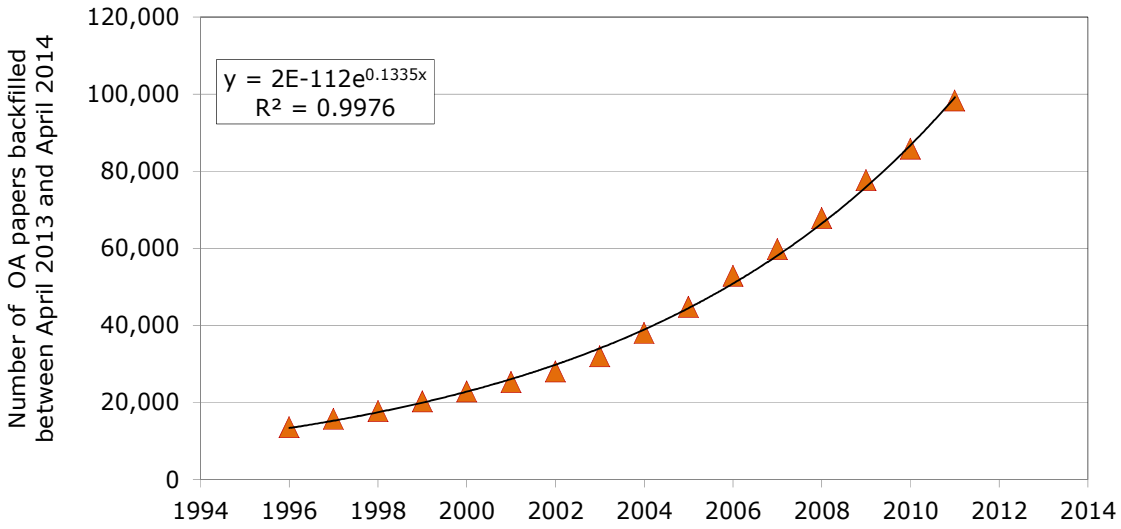

Figure 4 OA backfilling between April 2013 and April 2014 of papers published from 1996 to 2011

Source: Computed by Science-Metrix using Scopus, DOAJ and numerous sources of freely downloadable papers.

The combination of all the trends, including the growth in scientific papers published every year, yields the curves (as measured, and as adjusted for the instrument's shortcomings) presented in Figure 5. As of April 2014, the number of available papers increases by 9.4% per year. Of the papers published in 1996, 240,000 papers are now available for free, as are 950,000 of the papers published in 2012. Based on the adjusted OA availability statistics, one can estimate that about 47% of the papers indexed in Scopus between 1996 and 2013 can be downloaded for free as of April 2014. This means that 10.1 million papers would be downloadable out of the 21.5 million papers indexed in Scopus for that period that can be considered to be peer-reviewed papers published in scientific journals. The results presented here clearly show that understanding the growth of OA availability cannot be undertaken without references to simultaneously occurring phenomena such as growth in OA interest, backfilling, disembargoing and the growth in scientific papers publishing.

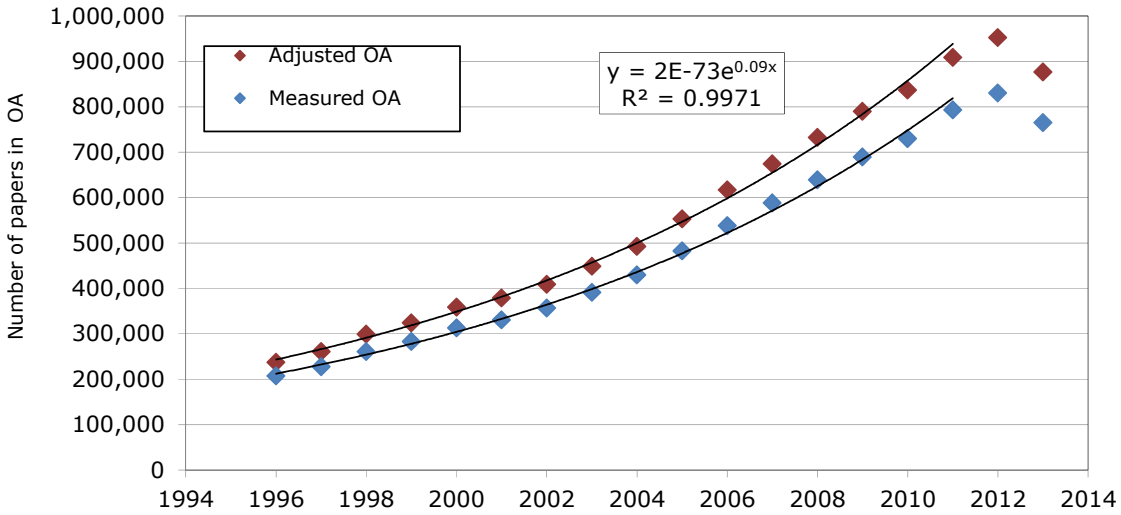

Figure 5 Growth of the number of papers available in OA as measured in April 2014, 1996–2013

Source: Computed by Science-Metrix using Scopus, DOAJ and numerous sources of freely downloadable papers.

3.2 Green OA as a proportion of scientific papers

Green OA is the most difficult aspect of OA to measure. Advocates of OA such as Stevan Harnad insist that Green OA should only include immediately available OA, i.e., it should exclude DOA Green (Delayed OA). This creates considerable problems from a measurement point of view as, for each paper, one would need to have in hand both the official date of publication (which in itself is open to discussion by definition) and the date when a paper is placed in a repository. As mentioned by Björk et al. (2014), '[t]ypically, green OA copies become available with considerable time delays, partly caused by publisher imposed embargo periods, and partly by author tendencies to archive manuscripts only periodically'.

The definition also mentions that Green OA is self-archiving by authors and given the increasingly complex set of mandates being promulgated by numerous parties in the promotion of OA, it is sometimes difficult to determine whether it was the author or the publisher who archived the paper. Because of this, in part, repositories such as PubMed Central were not considered here. The focus on Green OA measurement is therefore the repositories listed in ROAR and *Open*DOAR (see also sections 1 and 2 on the methodological aspects). Also note that last year's measurement did not provide an estimate of Green OA and it is therefore not possible to examine changes that have occurred since. The evolution of Green OA, as defined operationally here, is shown in Figure 6.

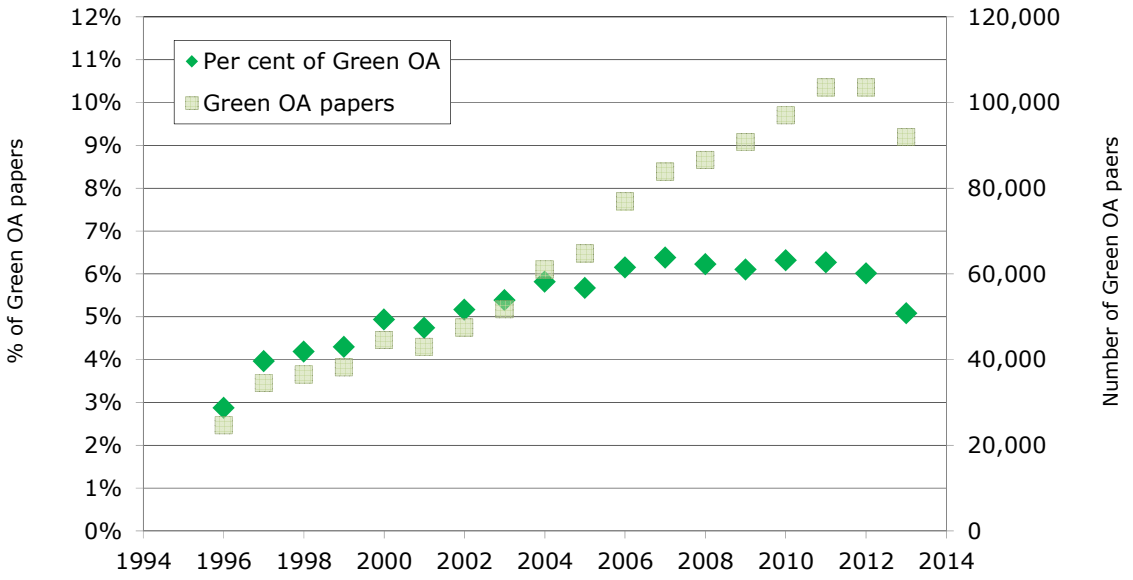

Figure 6 Growth of the proportion and number of Green OA papers as measured in April 2014, 1996–2013

Source: Computed by Science-Metrix using Scopus as well as ROAR, *Open*DOAR, and institutional repositories.

While the number of papers has grown steadily, this appears to be due to the background growth, that is, the growth in published scientific papers. Green OA as a percentage of the papers indexed in Scopus appears to have levelled off from around 2004. This requires further investigation to determine whether this is measurement artefact—an effect of the imperfect operational definition of Green OA used here—or Green OA is somewhat losing steam. Despite this, approximately 1.2 million papers were available in Green OA form in repositories across the world, and the growth rate of OA papers was 8.8% between 1997 and 2011.

3.3 Papers in Gold OA journals as a proportion of scientific papers

Figure 7 presents current trends on the availability of articles published in Gold OA journals indexed in Scopus from 1996 to 2013. The percentage of peer-reviewed articles published in Gold OA journals indexed in Scopus for 1996 was only 0.9% but grew to 12.8% for 2012, the annual growth rate being 18% for this period, which means that the proportion of articles in Gold OA journals doubles every 4.1 years. Scopus covers less than half of the quantity of journals listed in the DOAJ, so this figure is likely to underestimate the true extent of the role played by Gold OA journals.

Furthermore, Gold OA papers indexed in Scopus grew exponentially up until 2012. The growth rate was 24% per year between 1996 and 2012, which means that the number of papers published in Gold OA journals doubles every 3.2 years. A decrease is observed for 2013, which cannot be readily explained. One hypothesis is that the number of Gold OA journals indexed by the Scopus database has dropped or that these articles took longer than the average article to be indexed by Elsevier. At the moment, about 1,380,000 papers from Gold journals are indexed in Scopus for 1996 to 2013.[13] This represents only 200,000 papers more than those available in Green OA form, but Gold OA journals papers are growing with a clear momentum, which is not so clearly the case with Green OA available in institutional repositories.

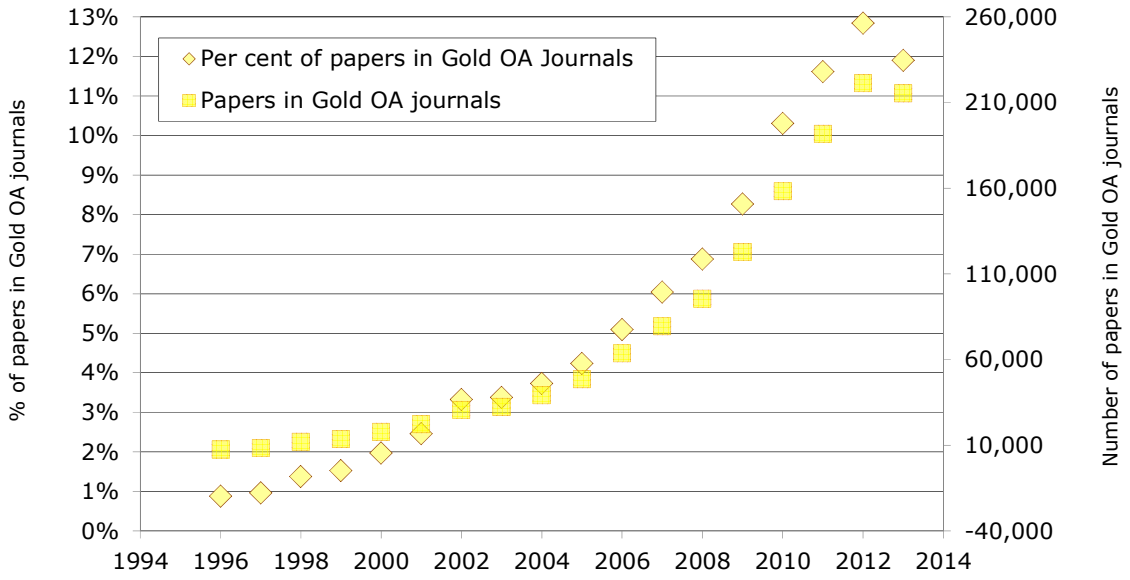

Figure 7 Growth of the proportion and number of papers published in Gold OA journals as measured in April 2014, 1996–2013

Source: Computed by Science-Metrix using Scopus as well as DOAJ and PubMedCentral.

3.4 Other OA as a proportion of scientific papers

As one can see in Figure 8, the evolution of Other OA is somewhat similar to that of Green OA. In terms of percentage, it increases substantially from 1996 until about 2003, at which time it levels off until 2008, when there is an observed decline in the proportion of Other OA

[13] Since Scopus data is incomplete for 2013, a correction coefficient was applied based on an exponential regression of the number of publications (excluding those from conference proceedings) in Scopus between 1996 and 2013.

papers. It is not so easy to determine what creates this shape due to the heterogeneity of the underlying dataset. These data include papers in repositories such as Pub Med Central and CiteSeerX, papers with article processing charges (so-called hybrid journals), Robin Hood or Rogue OA papers, and papers stemming from journals with embargo periods. What seems to be obvious here is that unless we are witnessing a slowdown in OA development, the embargoing and other form of DOA (Delayed OA) is having a very tangible effect on the availability of scientific knowledge. This creates a situation whereby a substantial part of the material openly available is relatively old, or as some would say, outdated.

As in the case of Green OA, the growth as measured in number of papers is greater than the growth of the proportion. There was a regular increase of 8.4% per year in the number of papers from 1996 to 2009, after which the increase slowed down and dropped in 2013 as the full effect of embargos surpassed the growth in available papers (which is 6.6% per year in Scopus between 2003 and 2012).

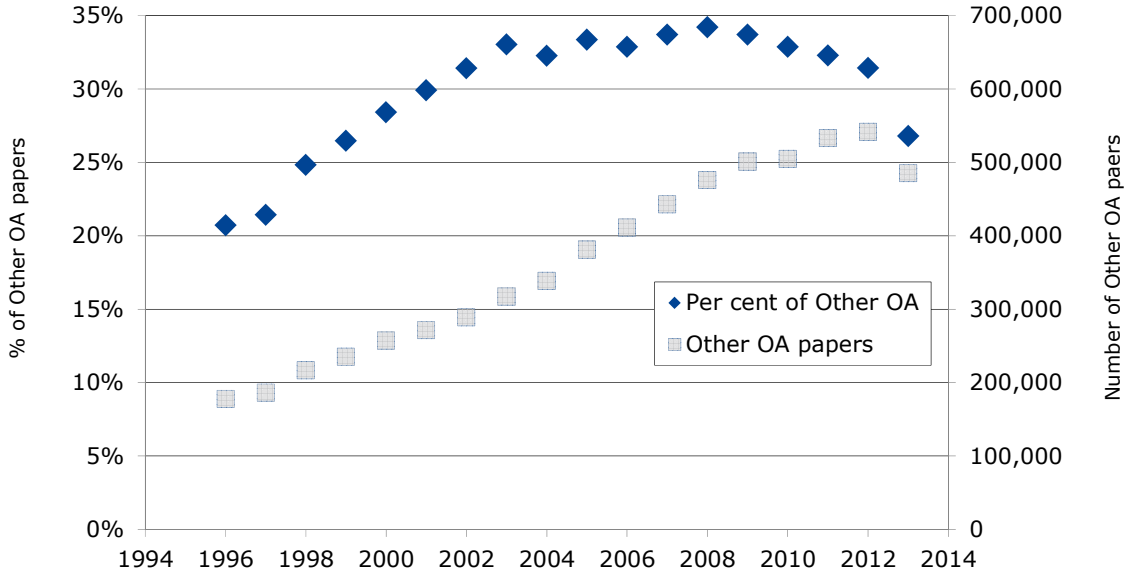

Figure 8 Growth of the proportion and number of Other OA papers as measured in April 2014, 1996–2013

Source: Computed by Science-Metrix using Scopus and numerous sources of freely downloadable papers.

3.5 Types of OA and total OA as a proportion of scientific papers

The results for the three types of OA measured here are presented in Figure 9. Starting from the bottom, one can find the availability of papers published in Gold OA journals. Though this was initially the lowest contributor to OA, papers in Gold OA journals are now more numerous than Green OA papers. Moreover, as one can see in the figure, the growth from Gold OA journals is what provides overall OA growth with its capacity to keep climbing. In fact, if it was for Green OA and other types of OA papers, the increase in OA availability would be more or less flat from 2003/2004.

Green OA papers, those deposited in institutional repositories, do not contribute a large share of the overall OA stock of papers. As seen previously, their number does not increase much after 2004. A word of warning here though: authors can also backfill repositories, and the current measurement does not take this into account as no baseline for Green OA was measured last year.

Other forms of OA—Gold OA Papers (that is, those with article processing charges published in subscription journal or so-called hybrid journals), Green DOA and Gold DOA (embargoed self-archiving and embargoed journals), ROA (Robin Hood or Rogue OA) and papers archived in non-institutional repositories such as ResearchGate—account for a large part of the pie. This large heterogeneous set contributes the largest proportion of OA papers and there is therefore an urgent need to disaggregate this category. More research and more careful classification and thus finer-grained measures are required to better understand how these various categories contribute to OA growth, what their pattern of time-delay is, what their transiency is (especially the ROA), how important the backfilling is and how far back it goes.

One can see that we also need better measurement instruments overall as the one currently used for this study has an important gap (difference between the adjusted and the total OA) that is larger than the number of papers in Green OA that it measures and nearly as large as the number of papers published in Gold OA journals.

Still, with the tools at our disposal, we can confidently assert that, as of April 2014, more than 50% of the scientific papers published in 2007, 2008, 2009, 2010, 2011 and 2012 can be downloaded for free on the Internet. This is an important finding as only one year ago, in April 2013, the proportion of papers that were freely available was just a hair below 50% (49.54%) in 2011 and did not reach that mark for any other year.

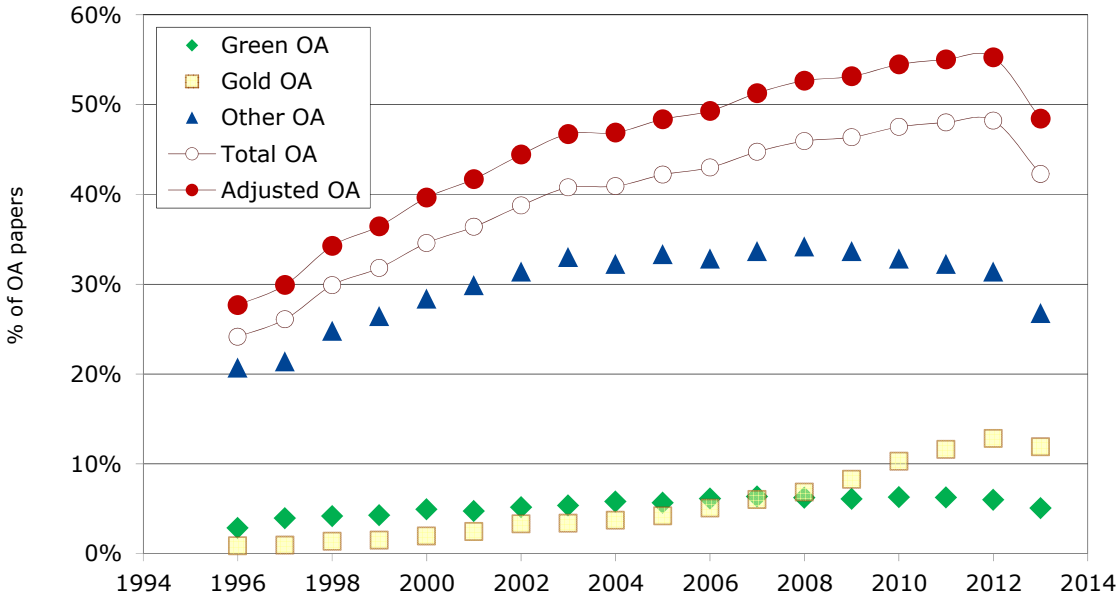

Figure 9 Percentage of freely available peer-reviewed papers as measured in April 2014, 1996–2013

Source: Computed by Science-Metrix using Scopus as well as DOAJ, ROAR, *Open*DOAR, PubMedCentral, and numerous sources of freely downloadable papers.

3.6 Scientific Impact of OA papers

A question that has animated OA advocates has been the so-called OA citation advantage. Evidence on this question is examined in using the Average of Relative Citation (ARC), a measure that reflects citation rates and is normalised to account for differences among scientific specialities in the propensity to use references and receive citations.

On average, the citation advantage of OA papers is 40.3% while the citation disadvantage is 27% for non-OA papers (based on a total sample-size of 209,000 papers). Figure 10 reveals that OA papers were between 26% and 64% more cited on average for any given year than

all papers considered, whereas non-OA received between 17% and 33% fewer citations (based on a sample size of at least 10,000 papers for any given year). Though OA papers received 64% more citations on average in 1998, the citation advantage has disappeared somewhat, probably as a result of the underlying calculations, whereby the average increasingly reflects the score of the OA papers themselves, as they constitute a growing share of the papers and a growing part of the average. The citation disadvantage of papers whose diffusion is limited to subscriptions has been quite stable.

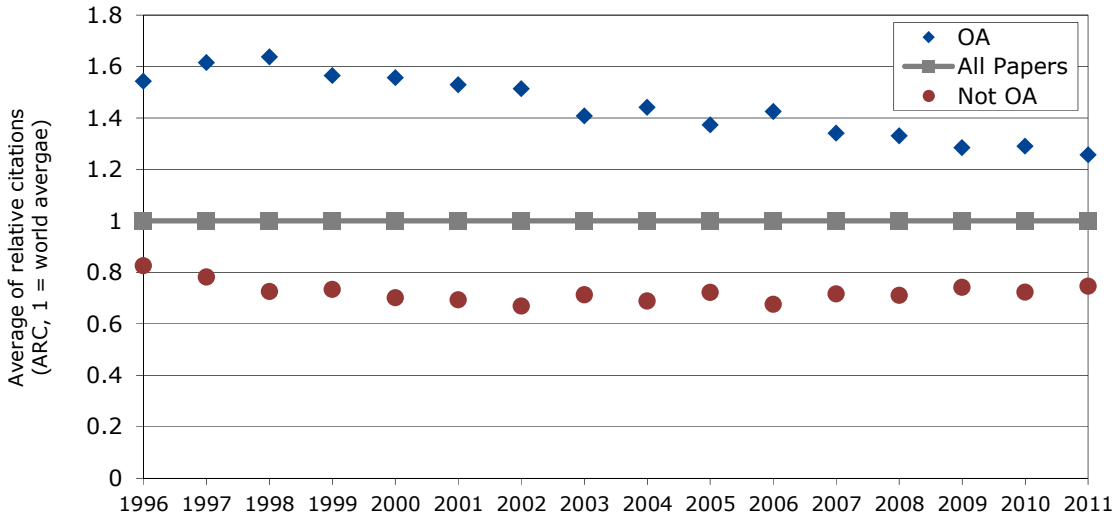

Figure 10 Scientific impact of OA and non-OA papers published 1996–2011

Source: Computed by Science-Metrix using Scopus and numerous sources of freely downloadable papers.

Figure 11 presents data on the relative citation rate of Green OA, papers in Gold OA journals, Other OA and Non-OA papers compared to all publications. As one can see, Green OA and Other OA papers have somewhat similar patterns. Papers in subscription-based journals (non-OA articles only) and Gold OA journals are also somewhat similar to one another. On average, Green OA (operational definition used here) papers have the greatest citation advantage, being cited 53% more frequently than all papers (n=11,429). They are followed by the Other OA category, the papers of which are 47% more frequently cited on average (n=64,244). Papers published in Gold OA journals have a citation disadvantage of 35% on average (n=10,913), compared to a disadvantage of 27% for non-OA papers (n=124,784).

The statistics on the impact of papers published in Gold OA journals require careful interpretation. First, many Gold journals are younger and smaller, and these factors have an adverse effect on the citation rate and hence on measured ARC values. Authors frequently prefer reading and citing more established journals, and it is therefore a challenge to start a journal from scratch, and to have authors submit high-quality articles. It takes time to build a reputation and to attract established authors. Also, the ARC is not scale-invariant, and larger journals have an advantage as this measure is not corrected sufficiently for journal size (namely, it is not a scale-independent measure). So it might not always be the Gold nature of journals that lowers their 'citedness'; instead structural aspects and imperfect measures (i.e. the scale-dependency of the ARC) might be at play. Even so, the Gold journal industry is young, and it is still difficult to separate the wheat from the chaff. In this respect, it might be useful for authors to examine Beall's List of 'potential, possible, or probable predatory

scholarly open-access publishers' to lower one's risk of spending money on journals that do not espouse scientific publishing best practices.[14]

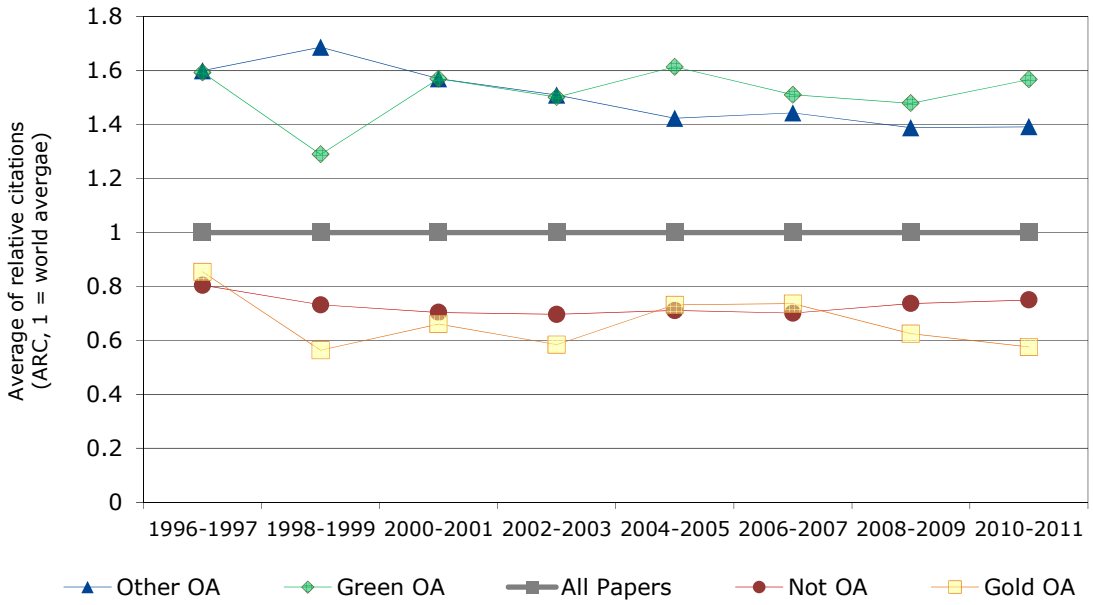

Figure 11 Scientific impact of different types of OA papers and of non-OA papers, 1996–2013

Source: Computed by Science-Metrix using Scopus as well as DOAJ, ROAR, *Open*DOAR, PubMedCentral, and numerous sources of freely downloadable papers.

[14] http://scholarlyoa.com/publishers/.

4 OA availability and impact of papers by field

This section examines the availability of OA papers by field (Section 4.1) and advantages and disadvantages from publishing in OA papers (Section 0).

4.1 Availability of OA papers by field

Table II presents data on the proportion of OA per field and Table III on the number of papers per field available in Green forms, in Gold journals, in Other OA and in OA overall. Considering the last three years combined (2011–2013), as of April 2014, more than 50% of the papers can be freely downloaded in 12 fields out of 22. The fields with the greatest proportion of OA are General Science & Technology (Adjusted OA=90%), Biomedical Research (71%), Mathematics & Statistics (68%), and Biology (66%). OA is not as commonly used in Visual & Performing Arts (Adjusted OA=25%), Communication & Textual Studies (31%), Historical Studies (34%), Engineering (35%), and Philosophy & Theology (35%).

A growth index was computed by dividing the percentage of OA availability in 2011 and 2012 by that observed in 2008 and 2009 (2013 was left aside as embargos would distort calculated growth rates). Overall, between the two periods, there has been a 4% increase in OA availability (slightly less than 2 percentage points). The fields with the fastest growth during these periods are general science & technology, enabling & strategic technologies, public health and health services, visual & performing arts, clinical medicine, and built & environment design. Here, one can suspect that the NIH OA mandate is at play (in public health and clinical medicine).

Some of the more applied sciences, where OA was not all that prevalent in 2008, appear to be catching up, to some extent (enabling & strategic technologies, built environment & design, engineering). Growth is negative in general arts, humanities & social sciences, and slightly negative in mathematics & statistics, communication & textual studies, psychology & cognitive sciences, and economics & business.

Green OA is particularly present in physics & astronomy (25.6%), helped by the presence of arXiv, which also plays role in mathematics & statistics (24.3%), while economics & business is the leading field in the social sciences and humanities (11.3% of papers in Green OA).

Gold OA availability is greatest in general S&T (58% of the sampled papers) and lowest in general arts, humanities & social sciences (2.6%), and is also very low in visual & performing arts (2.8%), built environment & design (3.5%) and engineering (4.1%). Other fields with high availability in Gold journals include biology (17%), agriculture, fisheries & forestry (16%), and public health & health services (16%).

Other forms of OA are frequently encountered in biomedical research (48%), psychology and cognitive sciences (43%), biology (42%), earth & environmental sciences (38%), and clinical medicine (35%).

Data in Table III show that the absolute number of papers in OA form is rising rapidly (as there is also underlying growth in the number of papers generally). For example, the growth of the OA proportion in agriculture, fisheries & forestry was 1.02, but the number of papers grew at 1.16 (16% growth in the number of OA papers indexed in Scopus in 2011–2013 compared to the 2008–2009 period).

Overall, out of the 4.6 million scientific papers from peer-reviewed journals indexed in Scopus during the 2011–2013 period, 2.5 million were available for free in April 2014 (adjusted OA score). A very large number of papers are freely available in clinical medicine (adjusted OA =

680,000 papers), biomedical research, and physics and astronomy (close to 250,000 papers, as calculated with an adjusted measure). This is partly because of the policy of the US National Institutes of Health (NIH) mandating the use of the PubMed Central repository for supported research and because of the arXiv e-print archive, which has been largely adopted by researchers in the field of physics.

The fields where OA availability is most limited are within the social sciences and humanities and in the more applied sciences, engineering, and technology. The lowest prevalence of OA availability is in visual and performing arts (adjusted OA = 27%) and in communication & textual studies (31%). It is also comparatively low (less than 40% availability) in historical studies, engineering, philosophy & theology, general arts, humanities & social sciences, built environment & design, chemistry, and enabling & strategic technologies.

4.2 Citation advantage and disadvantage of OA papers

Table IV presents data on the relative citation rate of Green OA, papers in Gold OA journals, Other OA forms and Total OA relative to all publications in each field. The ARC has been rebased at 1.0 for all fields to allow for the calculation of a citation advantage/disadvantage: this baseline comprises all the papers in a field for the given time period. A score above 1 denotes that papers are more cited than in the field overall, while a score below 1 means that these publications are less frequently cited.

All the fields derive an OA citation advantage (rebased ARC > 1) and, conversely, there is a sizeable citation disadvantage that goes with publishing papers that are not openly accessible one way or another. Paradoxically, many of the fields where the OA proportion is low have a sizeable citation advantage, such as the visual & performing arts (80% more cited), communication & textual studies (66%), philosophy & textual studies (63%), historical studies (55%), general arts, humanities and social sciences (51%), and engineering (38%). An explanation to this is likely that papers from researchers in these fields are more likely to have their papers used as there are fewer OA papers available.

What is particularly interesting here is that the citation advantage is derived almost exclusively from the Green and Other OA portion, as Gold OA is associated with a citation disadvantage on average for all fields except for physics & astronomy. In earth & environment sciences and in biomedical research, there is only a fairly slight difference between Gold papers and all journals in terms of average citation rates. Currently, there is a marked disadvantage for publishing in Gold journals in general arts, humanities & social sciences, built environment & design, economics & business, and visual & performing arts. Interestingly, visual & performing arts has one of the highest advantages derived from the use of Green and of OA generally, yet it is the field with the least prevalent use of OA.

There is a huge citation advantage to publishing in Green OA, as has been demonstrated time and again in other serious studies conducted previously. Papers in general science & technology, historical studies, and visual & performing arts all receive, on average, twice as many citations as the overall population of papers. Two fields stand out for a fairly small Green OA citation advantage: clinical medicine (+8% versus +56% in Other OA) and biomedical research (+10% vs. +23%). The reason may be that other sources of freely downloadable papers, classified here as 'Other OA', such as BioMed Central, are so large that the reflex of users is to first see what is available there and to shun institutional repositories. Still, 8% and 10% more citations remains a sizeable advantage and it is worthwhile using institutional repositories and immediate Green OA to cut the delays associated with what many consider as weak OA mandates, that is, allowing for papers to be embargoed instead of being made available immediately.

Table II Proportion of OA per field for papers published between 2011 and 2013

Field	Sample	Green OA		Gold OA journals		Other OA		Total OA		OA Growth	
		Found	%	Found	%	Found	%	Found	%	Trend	Index
Agriculture, Fisheries & Forestry	18,719	519	2.8 ± 0.2	3,019	16.1 ± 0.5	5,829	31.1 ± 0.6	8,784	46.9 ± 0.7		1.02
Biology	21,348	792	3.7 ± 0.2	3,631	17.0 ± 0.5	8,974	42.0 ± 0.6	12,324	57.7 ± 0.6		1.00
Biomedical Research	39,031	832	2.1 ± 0.1	4,840	12.4 ± 0.3	18,777	48.1 ± 0.5	24,062	61.6 ± 0.5		0.99
Built Environment & Design	3,246	151	4.7 ± 0.7	115	3.5 ± 0.6	860	26.5 ± 1.4	1,062	32.7 ± 1.5		1.05
Chemistry	42,799	752	1.8 ± 0.1	4,082	9.5 ± 0.3	9,931	23.2 ± 0.4	14,375	33.6 ± 0.4		1.03
Clinical Medicine	134,640	2,904	2.2 ± 0.1	19,865	14.8 ± 0.2	46,844	34.8 ± 0.2	66,172	49.1 ± 0.3		1.08
Communication & Textual Studies	3,891	140	3.6 ± 0.6	339	8.7 ± 0.8	700	18.0 ± 1.2	1,046	26.9 ± 1.3		0.94
Earth & Environmental Sciences	16,589	922	5.6 ± 0.3	1,344	8.1 ± 0.4	6,379	38.5 ± 0.7	8,358	50.4 ± 0.7		0.98
Economics & Business	13,475	1,529	11.3 ± 0.5	725	5.4 ± 0.4	4,506	33.4 ± 0.8	6,457	47.9 ± 0.8		0.96
Enabling & Strategic Technologies	41,591	1,119	2.7 ± 0.1	3,851	9.3 ± 0.3	9,712	23.4 ± 0.4	14,262	34.3 ± 0.4		1.10
Engineering	36,025	1,148	3.2 ± 0.2	1,476	4.1 ± 0.2	8,412	23.4 ± 0.4	10,879	30.2 ± 0.4		1.03
Gen. Arts, Humanities & Social Sciences*	6,012	212	3.5	158	2.6	1,651	27.5	1,882	31.3		0.85
Gen. Science & Technology	13,663	530	3.9 ± 0.3	7,922	58.0 ± 0.8	2,876	21.0 ± 0.6	10,692	78.3 ± 0.7		1.35
Historical Studies	3,491	88	2.5 ± 0.5	251	7.2 ± 0.8	819	23.5 ± 1.3	1,049	30.0 ± 1.4		0.98
Information & Communication Tech.	17,781	1,550	8.7 ± 0.4	2,205	12.4 ± 0.5	5,051	28.4 ± 0.6	8,373	47.1 ± 0.7		0.97
Mathematics & Statistics	14,288	3,476	24.3 ± 0.7	1,629	11.4 ± 0.5	3,590	25.1 ± 0.7	8,421	58.9 ± 0.8		0.90
Philosophy & Theology	2,517	129	5.1 ± 0.8	129	5.1 ± 0.8	563	22.4 ± 1.6	763	30.3 ± 1.7		1.00
Physics & Astronomy	46,351	11,862	25.6 ± 0.4	2,382	5.1 ± 0.2	10,369	22.4 ± 0.4	24,012	51.8 ± 0.4		1.03
Psychology & Cognitive Sciences	9,849	358	3.6 ± 0.4	548	5.6 ± 0.4	4,194	42.6 ± 0.9	4,961	50.4 ± 0.9		0.97
Public Health & Health Services	15,758	476	3.0 ± 0.3	2,485	15.8 ± 0.5	5,168	32.8 ± 0.7	7,864	49.9 ± 0.7		1.10
Social Sciences	17,439	898	5.1 ± 0.3	1,510	8.7 ± 0.4	4,740	27.2 ± 0.6	6,638	38.1 ± 0.7		1.01
Visual & Performing Arts*	5,162	151	2.9	145	2.8	988	19.1	1,204	23.3		1.10
Total**	**513,753**	**30,212**	**5.9 ± 0.1**	**62,386**	**12.1 ± 0.1**	**158,573**	**30.9 ± 0.1**	**240,885**	**46.9 ± 0.1**		1.04

Notes: *In General Arts, Humanities & Social Sciences, and Visual & Performing Arts, the whole populations of papers were used instead of a sample.
** The total is computed on the sample only rather than on the sample for all fields and the populations for General Arts, Humanities & Social Sciences, and Visual & Performing Arts.
The growth index was computed using a non-weighted average of 2011 and 2012 over 2008 and 2009. The year 2013 was not used in growth calculation because embargoed OA publications highly affect the score for that year and would give a false sense that OA growth is slowing.

Source: Computed by Science-Metrix using Scopus as well as DOAJ, ROAR, *Open*DOAR, PubMedCentral, and numerous sources of freely downloadable papers.

Table III Number of OA papers published between 2011 and 2013 per field

Field	Sample	Papers in Scopus	Green OA		Gold OA		Other OA		Total OA		Adjusted OA		OA Growth	
			Papers	%	Papers	%	Papers	%	Papers	%	Papers	%	Trend	Index
Agriculture, Fisheries & Forestry	18,719	166,355	4,614	2.8	26,845	16.1	51,807	31.1	78,078	46.9	89,495	53.8		1.16
Biology	21,348	190,080	7,064	3.7	32,321	17.0	79,916	42.0	109,741	57.7	125,788	66.2		1.12
Biomedical Research	39,031	349,681	7,447	2.1	43,364	12.4	167,905	48.0	215,250	61.6	246,725	70.6		1.09
Built Environment & Design	3,246	29,951	1,391	4.6	1,062	3.5	7,933	26	9,796	33	11,228	37.5		1.33
Chemistry	42,799	385,577	6,756	1.8	36,728	9.5	89,396	23.2	129,373	33.6	148,291	38.5		1.18
Clinical Medicine	134,640	1,207,148	26,026	2.2	178,081	14.8	419,871	34.8	593,128	49.1	679,859	56.3		1.19
Communication & Textual Studies	3,891	35,547	1,283	3.6	3,101	8.7	6,405	18	9,573	27	10,973	30.9		1.27
Earth & Environmental Sciences	16,589	149,500	8,315	5.6	12,121	8.1	57,495	38.5	75,342	50.4	86,359	57.8		1.08
Economics & Business	13,475	120,997	13,714	11.3	6,504	5.4	40,432	33.4	57,930	47.9	66,401	54.9		1.16
Enabling & Strategic Technologies	41,591	375,514	10,114	2.7	34,780	9.3	87,681	23.3	128,778	34.3	147,609	39.3		1.34
Engineering	36,025	324,981	10,356	3.2	13,326	4.1	75,885	23.4	98,149	30.2	112,501	34.6		1.20
Gen. Arts, Humanities & Social Sciences*	6,012	6,012	212	3.5	158	2.6	1,651	27.5	1,882	31.3	2,157	35.9		1.04
Gen. Science & Technology	13,663	122,938	4,767	3.9	71,291	58.0	25,874	21.0	96,215	78.3	110,284	89.7		2.43
Historical Studies	3,491	31,256	791	2.5	2,243	7.2	7,330	23	9,389	30	10,762	34.4		1.18
Information & Communication Tech.	17,781	159,873	13,933	8.7	19,856	12.4	45,378	28.4	75,268	47.1	86,275	54.0		1.10
Mathematics & Statistics	14,288	128,423	31,240	24.3	14,613	11.4	32,306	25.2	75,695	58.9	86,764	67.6		1.04
Philosophy & Theology	2,517	22,297	1,140	5.1	1,146	5.1	4,989	22	6,756	30	7,744	34.7		1.24
Physics & Astronomy	46,351	420,062	107,491	25.6	21,582	5.1	93,959	22.4	217,586	51.8	249,403	59.4		1.09
Psychology & Cognitive Sciences	9,849	89,681	3,263	3.6	4,988	5.6	38,195	42.6	45,181	50.4	51,787	57.7		1.10
Public Health & Health Services	15,758	142,459	4,296	3.0	22,462	15.8	46,668	32.8	71,034	49.9	81,421	57.2		1.26
Social Sciences	17,439	156,900	8,085	5.2	13,601	8.7	42,668	27.2	59,763	38.1	68,502	43.7		1.28
Visual & Performing Arts*	5,162	5,162	151	2.9	145	2.8	988	19.1	1,204	23.3	1,380	26.7		1.42
Total**	**513,753**	**4,620,394**	**271,673**	**5.9**	**561,063**	**12.1**	**1,425,851**	**30.9**	**2,166,106**	**46.9**	**2,482,848**	**53.7**		1.19

Notes: *In General Arts, Humanities & Social Sciences, and Visual & Performing Arts, the whole populations of papers were used instead of a sample.
** The total is computed on the sample only rather than on the sample for all fields and the populations for General Arts, Humanities & Social Sciences, and Visual & Performing Arts.
The growth index was computed using a non-weighted average of 2011 and 2012 over 2008 and 2009. The year 2013 was not used in growth calculation because embargoed OA publications highly affect the score for that year and would give a false sense that OA growth is slowing.

Source: Computed by Science-Metrix using Scopus as well as DOAJ, ROAR, *Open*DOAR, PubMedCentral, and numerous sources of freely downloadable papers.

Table IV Rebased scientific impact (ARC) of OA publications, 2009–2011

Field	All types		Green OA		Gold OA		Other OA		Total OA		Not OA	
	Sample	ARC	Found	ARC	Found	ARC	Found	ARC	Found	ARC	Found	ARC
Agriculture, Fisheries & Forestry	18,822	1.00	580	1.57	3,123	0.51	6,009	1.32	9,036	1.13	9,786	0.88
Biology	22,160	1.00	912	1.30	3,658	0.47	9,837	1.37	13,317	1.21	8,843	0.69
Biomedical Research	40,225	1.00	949	1.10	4,618	0.91	21,385	1.23	26,495	1.18	13,730	0.65
Built Environment & Design	3,102	1.00	169	1.56	108	0.19	803	1.28	1,009	1.29	2,093	0.86
Chemistry	42,457	1.00	897	1.28	4,152	0.34	10,354	1.34	15,022	1.09	27,435	0.95
Clinical Medicine	138,945	1.00	3,216	1.08	16,747	0.64	52,253	1.56	69,119	1.37	69,826	0.63
Communication & Textual Studies	4,156	1.00	169	1.51	242	0.66	879	1.82	1,188	1.66	2,968	0.73
Earth & Environmental Sciences	16,365	1.00	1,059	1.46	1,201	0.98	6,594	1.26	8,540	1.26	7,825	0.72
Economics & Business	13,518	1.00	1,638	1.46	712	0.22	4,918	1.30	6,988	1.28	6,530	0.71
Enabling & Strategic Technologies	39,694	1.00	1,277	1.68	3,445	0.52	9,270	1.53	13,550	1.33	26,144	0.83
Engineering	35,285	1.00	1,311	1.84	927	0.55	8,681	1.38	10,788	1.38	24,497	0.83
General Arts, Humanities & Social Sciences	6,772	1.00	268	1.74	116	0.13	2,068	1.49	2,354	1.51	4,418	0.73
General Science & Technology	9,594	1.00	405	2.56	3,710	0.69	2,633	2.24	6,157	1.50	3,437	0.11
Historical Studies	3,840	1.00	144	2.37	264	0.37	885	1.61	1,173	1.55	2,667	0.76
Information & Communication Technology	17,167	1.00	1,667	1.62	1,482	0.76	5,517	1.36	8,345	1.33	8,822	0.69
Mathematics & Statistics	13,750	1.00	3,147	1.35	1,073	0.67	4,547	1.11	8,518	1.15	5,232	0.75
Philosophy & Theology	2,532	1.00	108	1.72	144	0.86	595	1.63	783	1.63	1,749	0.72
Physics & Astronomy	46,239	1.00	11,864	1.43	2,177	1.18	11,158	1.04	24,658	1.24	21,581	0.73
Psychology & Cognitive Sciences	9,803	1.00	457	1.31	529	0.59	4,451	1.35	5,284	1.29	4,519	0.66
Public Health & Health Services	15,812	1.00	533	1.30	2,291	0.71	5,575	1.38	8,073	1.23	7,739	0.76
Social Sciences	17,606	1.00	1,020	1.54	1,441	0.52	5,199	1.44	7,136	1.36	10,470	0.76
Visual & Performing Arts	5,724	1.00	167	2.16	185	0.29	1,034	1.86	1,280	1.80	4,444	0.77
Total	**512,443**	1.00	**31,561**	1.53	**52,080**	0.61	**171,885**	1.36	**245,571**	1.26	**266,872**	0.76

Note: Colour-coding indicates performances above the world level in a given field (Green) or below the world level in the same field (red).
Source: Computed by Science-Metrix using Scopus as well as DOAJ, ROAR, *Open*DOAR, PubMedCentral, and numerous sources of freely downloadable papers.

Table V presents the same data as in Table IV except this time it shows, all things being equal, how rational scientists would behave if they wanted to maximise their chance of having a great scientific impact. Clearly, if one wants to increase the chance of being highly cited, self-archiving in Green OA is the way to go, as it comes in first 15 times, and second 7 times. Considering that self-archiving is free, rationale scientists would consider this choice the most obvious choice. Other forms of OA, which is not a homogeneous category and varies by field, would appear to be the second best choice. The third place would go to publishing in a subscription journal and leaving it as it is. Papers that are not available in OA, on average, for 22 fields never make it to the top position in terms of impact, and do not even make second place once. In fact, in the case of seven fields, this would be the least rational choice to make for a scientist who wants to make a difference and be cited as much as possible. Gold OA makes it to the second position once and to third place six times, but loses out in 15 fields.

Giving a full point for the first place, 2/3 of a point for the second, 1/3 for the third, and no point for having the least impact confirms the general ranking: Green OA, Other OA, Not OA, and Gold OA.

Table V Impact contest by OA type by field, 2009–2011

Field	1st place		2nd place		3rd place		Least impact	
	Type	ARC	Type	ARC	Type	ARC	Type	ARC
Agriculture, Fisheries & Forestry	Green OA	1.57	Other OA	1.32	Not OA	0.88	Gold OA	0.51
Biology	Other OA	1.37	Green OA	1.30	Not OA	0.69	Gold OA	0.47
Biomedical Research	Other OA	1.23	Green OA	1.10	Gold OA	0.91	Not OA	0.65
Built Environment & Design	Green OA	1.56	Other OA	1.28	Not OA	0.86	Gold OA	0.19
Chemistry	Other OA	1.34	Green OA	1.28	Not OA	0.95	Gold OA	0.34
Clinical Medicine	Other OA	1.56	Green OA	1.08	Gold OA	0.64	Not OA	0.63
Communication & Textual Studies	Other OA	1.82	Green OA	1.51	Not OA	0.66	Gold OA	0.73
Earth & Environmental Sciences	Green OA	1.46	Other OA	1.26	Gold OA	0.98	Not OA	0.72
Economics & Business	Green OA	1.46	Other OA	1.30	Not OA	0.71	Gold OA	0.22
Enabling & Strategic Technologies	Green OA	1.68	Other OA	1.53	Not OA	0.83	Gold OA	0.52
Engineering	Green OA	1.84	Other OA	1.38	Not OA	0.83	Gold OA	0.55
General Arts, Humanities & Social Sciences	Green OA	1.74	Other OA	1.49	Not OA	0.73	Gold OA	0.13
General Science & Technology	Green OA	2.56	Other OA	2.24	Gold OA	0.69	Not OA	0.11
Historical Studies	Green OA	2.37	Other OA	1.61	Not OA	0.76	Gold OA	0.37
Information & Communication Technology	Green OA	1.62	Other OA	1.36	Gold OA	0.76	Not OA	0.69
Mathematics & Statistics	Green OA	1.35	Other OA	1.11	Not OA	0.75	Gold OA	0.67
Philosophy & Theology	Green OA	1.72	Other OA	1.63	Gold OA	0.86	Not OA	0.72
Physics & Astronomy	Green OA	1.43	Gold OA	1.18	Other OA	1.04	Not OA	0.73
Psychology & Cognitive Sciences	Other OA	1.35	Green OA	1.31	Not OA	0.66	Gold OA	0.59
Public Health & Health Services	Other OA	1.38	Green OA	1.30	Not OA	0.76	Gold OA	0.71
Social Sciences	Green OA	1.54	Other OA	1.44	Not OA	0.76	Gold OA	0.52
Visual & Performing Arts	Green OA	2.16	Other OA	1.86	Not OA	0.77	Gold OA	0.29
Total	Green OA	1.53	Other OA	1.36	Not OA	0.76	Gold OA	0.61

Contest Results

Contestants	Count of 1st place	Points (1)
Green OA	15	15
Other OA	7	7
Contestants	**Count of 2nd place**	**Points (2/3)**
Other OA	14	9.3
Green OA	7	4.7
Gold OA	1	0.7
Contestants	**Count of 3rd place**	**Points (1/3)**
Not OA	15	5.0
Gold OA	6	2.0
Other OA	1	0.3
Contestants	**Count of Least impact**	**Points (0)**
Not OA	7	0
Gold OA	15	0

Contest Total Point Table

Type	Points
Green OA	19.7
Other OA	16.7
Not OA	5.0
Gold OA	2.7

Source: Computed by Science-Metrix using Scopus as well as DOAJ, ROAR, *Open*DOAR, PubMedCentral, and numerous sources of freely downloadable papers.

5 OA availability of papers published between 2008 and 2013 in the European Research Area and selected countries

The EU28 and ERA have slightly more than the level of OA observed at the world level (around 58.6% for the 2008–2013 period for the EU and ERA versus 53.9% at the world level, although there are notable differences among countries (Table VI)). For the 2008–2013 period as a whole, all EU28 countries have reached a 'tipping point'. Looking at OA score adjusted for retrieval precision and recall, four countries have even reached an aggregate availability score above 70%—the Netherlands, Croatia, Estonia, and Portugal. It is interesting to note that the Netherlands, which is also scientific publishers' land of predilection, is the EU country with the largest share of papers available in OA form (74%) as a whole for papers published in the 2008–2013 period and available for free downloading as of April 2014.

All ERA countries have tipped towards having a majority of papers in OA, though in the case of the Republic of Moldova the margin of error is quite high and it is quite possible that the country has not tipped to OA yet. Swiss researchers contribute to making their country a leader in OA with 70% of the papers being downloadable for free.

In countries outside the ERA, it is noteworthy that the US has passed the tipping point by a fair margin (Adjusted OA = 67.9%), as is also the case for Canada (64.4%). Even more salient is the proportion of 76% observed in Brazil. This is no doubt due to the important contribution of Scielo, which plays a key role in the Southern hemisphere in making scientific knowledge more widely available. Japan is just a hair over 50% and given the margin of error of Adjusted OA may or may not have tipped to having a majority of papers in OA form.

Within the European Union, Green OA is more widely used in Portugal (16.3%), Ireland (15.8 %), France (14.0%) and Belgium (13.8%), and least used in Lithuania (4.5%), Malta (5.0%), Croatia (5.2%), and Romania (5.3%).

Publishing in Gold journals is much more frequently encountered in Eastern Europe, as it is much higher in Croatia, Slovenia, Latvia, Poland, Estonia, and Lithuania (in addition to Malta). One interesting hypothesis is that researchers in these countries may use Gold journals because they more frequently allow publishing in languages other than English. Should that be the case, this may also contribute to explaining the lower citation scores received by papers in Gold journals as the readership for 'vernacular languages', as Eugene Garfield (1998) would put it, is lower and the size of the potential reference pool is consequently also smaller. There is therefore potentially fertile ground for studying the social and linguistic aspects of science by examining where and why Gold open access journals are appearing and who actually makes use of them. The countries that least use Gold OA journals are France (6.6%), the United Kingdom (7.2%), and Belgium (7.4%).

The large sample of publications used for this final version of the study (n=1,000,000) makes it possible to produce more disaggregated data. The Appendix presents data across the selected countries at the field level for Green, Gold, Other OA and Total OA availability (not adjusted for the harvesting instrument's limits, so these are floor values).

Table VI Proportion of OA per country, 2008–2013

Group	Country	Sample size	Green OA		Gold OA journals		Other OA		Total OA		Adjusted OA
			Found	%	Found	%	Found	%	Found	%	%
	Austria	8,764	821	9.4 ± 0.6	775	8.8 ± 0.6	3,450	39.4 ± 1.0	4,855	55.4 ± 1.0	63.5 ± 4.6
	Belgium	13,147	1,813	13.8 ± 0.6	968	7.4 ± 0.4	5,210	39.6 ± 0.8	7,841	59.6 ± 0.8	68.4 ± 4.6
	Bulgaria	1,707	161	9.4 ± 1.3	126	7.4 ± 1.2	558	33 ± 2	829	49 ± 2	56 ± 5
	Croatia	2,954	153	5.2 ± 0.8	687	23 ± 1.5	1,149	38.9 ± 1.7	1,876	63.5 ± 1.7	72.8 ± 4.8
	Cyprus	584	72	12 ± 3	43	7 ± 2	223	38 ± 4	329	56 ± 4	65 ± 6
	Czech Republic	7,637	521	6.8 ± 0.5	736	9.6 ± 0.6	2,598	34.0 ± 1.0	3,718	48.7 ± 1.1	55.8 ± 4.6
	Denmark	9,097	871	9.6 ± 0.6	819	9.0 ± 0.6	3,539	38.9 ± 1.0	5,127	56.4 ± 1.0	64.6 ± 4.6
	Estonia	932	81	8.7 ± 1.8	123	13 ± 2	390	42 ± 3	577	62 ± 3	71 ± 5
	Finland	7,414	659	8.9 ± 0.6	690	9.3 ± 0.6	2,838	38.3 ± 1.0	4,102	55.3 ± 1.1	63.4 ± 4.6
	France	48,991	6,881	14.0 ± 0.3	3,255	6.6 ± 0.2	16,560	33.8 ± 0.4	25,915	52.9 ± 0.4	60.6 ± 4.5
	Germany	66,268	7,575	11.4 ± 0.2	5,065	7.6 ± 0.2	21,993	33.2 ± 0.3	33,735	50.9 ± 0.4	58.4 ± 4.5
	Greece	8,043	525	6.5 ± 0.5	773	9.6 ± 0.6	3,067	38.1 ± 1.0	4,246	52.8 ± 1.0	60.5 ± 4.6
	Hungary	4,559	454	10.0 ± 0.8	356	7.8 ± 0.7	2,023	44 ± 1.4	2,782	61.0 ± 1.3	69.9 ± 4.7
	Ireland	5,150	815	15.8 ± 0.9	472	9.2 ± 0.8	1,839	36 ± 1.2	3,018	58.6 ± 1.3	67.2 ± 4.7
EU28	Italy	39,117	3,691	9.4 ± 0.3	3,112	8.0 ± 0.3	14,594	37.3 ± 0.5	21,021	53.7 ± 0.5	61.6 ± 4.5
&	Latvia	387	21	5.4 ± 2.3	57	15 ± 3	156	40 ± 5	232	60 ± 5	69 ± 7
ERA	Lithuania	1,434	65	4.5 ± 1.0	183	12.8 ± 1.7	593	41 ± 2	811	57 ± 2	65 ± 5
	Luxembourg	417	46	11.0 ± 3.0	36	9 ± 3	174	42 ± 5	253	61 ± 5	70 ± 6
	Malta	140	7	5.0 ± 3.8	30	21 ± 7	41	29 ± 7	75	54 ± 8	61 ± 9
	Netherlands	23,564	2,863	12.1 ± 0.4	1,883	8.0 ± 0.3	10,707	45.4 ± 0.6	15,177	64.4 ± 0.6	73.8 ± 4.5
	Poland	15,628	1,112	7.1 ± 0.4	2,099	13.4 ± 0.5	4,695	30.0 ± 0.7	7,416	47.5 ± 0.7	54.4 ± 4.5
	Portugal	7,190	1,169	16.3 ± 0.8	747	10.4 ± 0.7	2,636	36.7 ± 1.1	4,422	61.5 ± 1.1	70.5 ± 4.6
	Romania	5,105	271	5.3 ± 0.6	487	9.5 ± 0.8	1,994	39.1 ± 1.3	2,647	51.9 ± 1.3	59.4 ± 4.7
	Slovakia	2,372	156	6.6 ± 1.0	240	10.1 ± 1.2	798	33.6 ± 1.8	1,155	48.7 ± 1.9	55.8 ± 4.9
	Slovenia	2,586	181	7.0 ± 0.9	425	16.4 ± 1.4	871	33.7 ± 1.7	1,369	52.9 ± 1.8	60.7 ± 4.8
	Spain	35,557	3,517	9.9 ± 0.3	4,074	11.5 ± 0.3	12,119	34.1 ± 0.5	18,341	51.6 ± 0.5	59.1 ± 4.5
	Sweden	14,872	1,527	10.3 ± 0.5	1,460	9.8 ± 0.5	5,767	38.8 ± 0.7	8,587	57.7 ± 0.8	66.2 ± 4.5
	United Kingdom	73,621	8,506	11.6 ± 0.2	5,265	7.2 ± 0.2	28,173	38.3 ± 0.3	41,133	55.9 ± 0.3	64.0 ± 4.5
Total EU28		**337,231**	**31,635**	**9.4 ± 0.1**	**29,165**	**8.6 ± 0.1**	**117,793**	**34.9 ± 0.2**	**172,956**	**51.3 ± 0.2**	**58.8 ± 4.5**
	Albania	87	4	5 ± 5	16	18 ± 8	25	29 ± 10	43	49 ± 11	57 ± 11
	Bosnia and Herzegovina	362	3	0.8 ± 1.0	92	25 ± 4	139	38 ± 5	226	62 ± 5	72 ± 7
	Iceland	554	57	10.3 ± 2.5	37	7 ± 2	269	49 ± 4	354	64 ± 4	73 ± 6
	Israel	8,450	894	10.6 ± 0.6	502	5.9 ± 0.5	3,552	42.0 ± 1.0	4,882	57.8 ± 1.0	66.2 ± 4.6
ERA	Liechtenstein	40	5	13 ± 11			20	50 ± 16	25	63 ± 15	72 ± 16
Associated	FYR Macedonia	255	18	7 ± 3	75	29 ± 5	87	34 ± 6	173	68 ± 6	78 ± 7
Countries	Montenegro	104	6	6 ± 5	30	29 ± 9	38	37 ± 9	71	68 ± 9	78 ± 10
	Norway	7,280	629	8.6 ± 0.6	705	9.7 ± 0.6	2,907	39.9 ± 1.1	4,145	56.9 ± 1.1	65.3 ± 4.6
	Rep. of Moldova	160	14	9 ± 4	5	3 ± 3	52	33 ± 7	71	44 ± 8	51 ± 9
	Serbia	2,997	135	4.5 ± 0.7	906	30.2 ± 1.6	803	26.8 ± 1.5	1,786	59.6 ± 1.7	68.3 ± 4.8
	Switzerland	16,896	2,497	14.8 ± 0.5	1,547	9.2 ± 0.4	6,630	39.2 ± 0.7	10,369	61.4 ± 0.7	70.3 ± 4.5
	Turkey	17,420	475	2.7 ± 0.2	3,458	19.9 ± 0.6	4,853	27.9 ± 0.6	7,962	45.7 ± 0.7	52.4 ± 4.5
Total ERA		**375,820**	**33,766**	**9.0 0.1**	**34,932**	**9.3 0.1**	**130,244**	**34.7 0.1**	**192,202**	**51.1 0.2**	**58.6 4.5**
Others	Brazil	26,158	1,626	6.2 ± 0.3	10,482	40.1 ± 0.6	6,515	24.9 ± 0.5	17,322	66.2 ± 0.5	75.9 ± 4.5
	Canada	41,114	2,895	7.0 ± 0.2	3,098	7.5 ± 0.2	17,438	42.4 ± 0.5	23,096	56.2 ± 0.5	64.4 ± 4.5
	Japan	58,527	4,170	7.1 ± 0.2	5,382	9.2 ± 0.2	16,883	28.8 ± 0.3	25,846	44.2 ± 0.4	50.6 ± 4.5
	United States	258,815	17,865	6.9 ± 0.1	17,709	6.8 ± 0.1	119,943	46.3 ± 0.2	153,416	59.3 ± 0.2	67.9 ± 4.5
World		**1,000,000**	**60,271**	**6.0 ± 0.04**	**104,050**	**10.4 ± 0.1**	**324,637**	**32.5 ± 0.1**	**470,530**	**47.1 ± 0.1**	**53.9 ± 4.5**

Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

6 Discussion and policy implications

If one makes a straight reading of the data presented here, between 2008 and 2013, the average annual rate of increase of OA availability was relatively limited. Importantly though, the present study has demonstrated that examining the growth of OA based solely on a snapshot of OA availability at a given time tells only a small part of the story. This report shows four types of growth in freely available papers: (1) historical growth in the interest in OA which translates into *new papers* being increasingly available for free; (2) the growing interest in OA also translates into actors increasingly making available *old papers* for free; (3) OA policies that allow for delaying OA to scientific papers with embargo periods produce a concomitant disembargoing of scientific articles that creates additional growth in old papers being made available for free; and (4) the fact that the number of papers is growing, so even for a stable proportion of OA, the number of OA papers would keep growing.

The percentage of peer-reviewed articles published in Gold OA journals indexed in Scopus for 1996 was only 0.9% but grew to 12.8% for 2012, the annual growth rate being 18% for this period, meaning that the proportion of articles in Gold OA journals doubles every 4.1 years. The other type of growth is also exemplified here. The number of Gold OA papers indexed in Scopus up until 2012 also grew exponentially. The growth rate was 24% per year between 1996 and 2012, which means that the number of papers published in Gold OA journals doubles every 3.2 years. Although the growth of papers is particularly clear for those in Gold OA journals, papers in Green OA form and in Other OA have also been available in increasingly large numbers during the 18-year period covered by this study.

An estimate of the backfilling of old papers published between 1996 and 2011 and made available for free during the year separating the measures made in April 2013 (previous version of this study) and in April 2014 (the present update) reveals that close to 14,000 papers published in 1996 were made available for free during the last year and that nearly 100,000 papers were published in 2011. Backfilling is really important for understanding how OA grows: a total of 700,000 papers published between 1996 and 2011, as indexed in Scopus, were made available for free between April 2013 and April 2014. Considering that there are about 18 million papers in Scopus for that period, this represents an increase in availability of 3.9 percentage points in just one year.

When one looks at the availability curve, it can be seen that availability fell somewhat in more recent years. This is due to the presence of embargos for some of the subscription-based journals, which make all articles freely available to all after a few years—the form of open access called DOA ('Delayed OA). DOA is a multi-faceted phenomenon. The translation in the availability curve is itself a manifestation of DOA. This occurs when researchers decide to make their own papers available for free and self-archive them in institutional repositories or in Robin Hood OA (ROA), that is, when they decide to make papers available in whatever form they were finally published regardless of the rules that publishers have stated and that are compiled on the University of Nottingham's SHERPA/RoMEO list. It also occurs when subscription-based journals ('Paid Access' or PA) convert to Gold journals and provide back issues for free.[15] Also, and importantly, several OA mandates, the types of mandates which OA advocates frequently consider to be half-baked measures, allow research results to be available in the form of DOA.

[15] See for example: http://oad.simmons.edu/oadwiki/Journals_that_converted_from_TA_to_OA.

There are also transient effects that have to be considered when measuring OA availability, and papers that come and go can be called TOA (Transient OA). To characterise the trueness in the measurement of the harvesting engine developed by Science-Metrix to measure OA availability, the same sample of 500 records was used on three occasions: December 2012, April 2013, and April 2014. It is noteworthy that 272 articles were freely downloadable at one time or another between December 2012 and April 2013, that is 54.4%, though only 243 papers in this sample were available in April 2014 (48.6%).

Many articles that were available for free in December 2012 were no longer available for free in April 2013, and some articles that were available last year disappeared during the year. This is in part due to a promotion Springer was running in late 2012 by making several subscription-journal papers available for free, and later making them available for a fee again. Some articles disappeared from websites, and some websites were not responding when visited, thus reducing further OA availability. A total of 35 papers that could be found either in December 2012 or in April 2013 disappeared afterwards (7% of the sample), showing that TOA is an important phenomenon to contend with. This shows that measuring phenomena on the Internet requires particular attention to detail and constant questioning on the meaning of the results—one has to ask whether these results are permanent or transient.

Björk et al. (2014) note that '[a]lthough green OA copies should ideally be archived in proper repositories, a large share is stored on home pages and similar locations, with no assurance of long-term preservation. Often such locations contain exact copies of published articles, which may infringe on the publisher's exclusive rights'. Hence, TOA and ROA are likely to be encountered together.

The fact that more than 50% of the papers published in peer-reviewed journals can now be downloaded for free by users who do not have to register to use a web site or to pay, that is, papers available in OA (though the particular form of OA, such as DOA, could be far remote from Ideal OA), certainly has important implications for academia, for university librarians, and perhaps even more so for the scientific, technical and medical publishing industry.

Much has been said about the cost of publishing in Gold OA journals and for Gold OA articles ('hybrid publishing'). The cost of academic papers in the US is over $100,000—which is calculated by dividing the higher education expenditures on R&D (HERD) by the number of papers published by academia. In addition to or included in this amount, a $2,000 OA publication fee only accounts for a few percentage points of a typical research project budget, especially in the natural and health sciences. Green OA is free, and the majority of publishers accept that papers can be self-archived in one form or another (pre-print, post-print with final revision, or PDF) with no delay. Moreover, two-thirds of Gold OA journals do not levy author processing charges (Suber, 2013). There are free avenues to OA and cost should not be construed as a barrier.

The current model of back end toll access is simply unsustainable because of the gross social inefficiency and ineffectiveness. Examining the OECD statistics on gross domestic expenditure on R&D in OECD and selected 'Non-OECD Member Economies' (Argentina, China, Romania, Russian Federation, Singapore, South Africa, Chinese Taipei),[16] and using some conservative extrapolations, one can see that about $400 billion (current dollars at purchasing dollar parity) were spent by governments (GovERD) to support R&D. The revenues generated by science, technical and medical publishing (STM) for English-speaking countries was worth

[16] https://stats.oecd.org/Index.aspx?DataSetCode=GERD_FUNDS.

approximately $9.4 billion in the same year (Ware and Mabe, 2012). Though these figures are not immediately comparable as part of the industry must derive income from non-English journals, the fact remains that a sizeable part of the research results paid for by $400 billion in publicly spent money is either delayed, restricted, or still simply behind thick pay walls to generate only $10 billion in private wealth. This is a case of gross inefficiency, one that taxpayers the world over should not tolerate.

Green OA advocates could respond that the lowest marginal cost to the system to make papers available for free is currently through the use of self-archiving in Green OA form: this would be a valid point. Yet, there is always a toll to be paid to create, diffuse, and use peer-reviewed papers. Few things are entirely free, be it a fee for a subscription or a fee to download an article, a fee to publish an article, the public or philanthropic money that goes into supporting OA journals or article processing charges, or the opportunity cost associated with academics running journals instead of performing research and lecturing and training students, or providing other types of services to society.

Just as there is a need to continue to work vigilantly to remove the inefficiency created by all this public expenditure being made unavailable or available with undue restrictions, difficulties, and delays, there is a need to closely monitor the effects of moving the scientific world from one based on Back End Paid Access (BEPA) to one based on Front End Paid Access (FEBA). BEPA created huge social inefficiency; FEBA has the potential to enlarge the rift between wealthier and more feebly financed countries, researchers, and scientific disciplines. Many mandates being promulgated at the moment run the risk of favouring a shift from BEPA to FEBA, from inaccessibility to inequality. Neither inaccessibility nor growing inequality are acceptable considering that universalism is one of the core values of scientific research.

Appendix OA by type, by field and by country

Table VII Proportion of Green papers per country and field of science, 6-year non-weighted sampling, 2008–2013

Group	Country	Total number of papers in sample	Agriculture, Fisheries & Forestry	Biology	Biomedical Research	Built Environment & Design	Chemistry	Clinical Medicine	Communication & Textual Studies	Earth & Environmental Sciences	Economics & Business	Enabling & Strategic Technologies	General Arts, Humanities & Social Sciences	Visual & Performing Arts
	Austria	8,764	5 ± 3	2.1 ± 1.5	2.9 ± 1.2	11 ± 13	1.9 ± 1.1	1.5 ± 0.4	3 ± 7	7 ± 2	20 ± 5	4.1 ± 1.9	3.8	1.1
	Belgium	13,147	12 ± 3	11 ± 2	6.1 ± 1.3	23 ± 9	9 ± 2	5.4 ± 0.7	13 ± 5	20 ± 4	23 ± 4	12 ± 2	11.7	8.2
	Bulgaria	1,707	3 ± 4	3 ± 3		20 ± 42	1.1 ± 1.6	3 ± 2		10 ± 9	11 ± 16	6 ± 3	20	
	Croatia	2,954	0.5 ± 1.2	1.2 ± 1.8	1.2 ± 1.8		1.4 ± 1.7	3.5 ± 1.3		3 ± 4		2 ± 3		
	Cyprus	584		5 ± 10			5 ± 7	1 ± 3		11 ± 11	8 ± 9	6 ± 9	8	
	Czech Republic	7,637	1.4 ± 1	1.7 ± 1.1	1.3 ± 1.0	3 ± 8	1.6 ± 0.8	0.8 ± 0.4		3 ± 2	11 ± 5	5 ± 2	5	
	Denmark	9,097	3.8 ± 1.8	6 ± 2	2.5 ± 0.9	13 ± 8	3.8 ± 1.8	1.6 ± 0.4	5 ± 6	10 ± 3	16 ± 4	10 ± 3	7.5	1.8
	Estonia	932	2 ± 5	2 ± 3	2 ± 4	11 ± 24		4 ± 3		8 ± 7	15 ± 14	3 ± 5	2.4	
	Finland	7,414	4 ± 2	3 ± 1.6	2.5 ± 1.2	8 ± 8	2.1 ± 1.5	1.5 ± 0.5	5 ± 6	8 ± 3	12 ± 3	5 ± 2	9.4	1.6
	France	48,991	9.4 ± 1.5	8.5 ± 1.1	4.9 ± 0.6	14 ± 5	3.6 ± 0.6	3.0 ± 0.3	4 ± 2	15.4 ± 1.4	19 ± 2	10.1 ± 1.1	3.9	2.3
	Germany	66,268	3 ± 0.8	7.5 ± 1.0	3.6 ± 0.4	5 ± 3	2.4 ± 0.4	1.6 ± 0.2	2.5 ± 1.7	12.1 ± 1.2	30 ± 2	5.9 ± 0.7	4	1.3
	Greece	8,043	2.1 ± 1.8	1.4 ± 1.5	1.8 ± 1.1	2 ± 5	1.5 ± 1.2	0.6 ± 0.3		5 ± 3	9 ± 4	1.7 ± 1.1	1.5	
	Hungary	4,559	0.6 ± 1.4	2.6 ± 1.9	4 ± 2	5 ± 12	3.2 ± 1.7	1.9 ± 0.8		7 ± 4	14 ± 7	3 ± 3	6.9	0.8
	Ireland	5,150	7 ± 3	7 ± 4	7 ± 2	21 ± 13	15 ± 4	6.5 ± 1.2	10 ± 10	18 ± 6	26 ± 6	15 ± 4	9.4	9.3
EU28	Italy	39,117	3.9 ± 1.1	3.4 ± 0.9	2.0 ± 0.5	7 ± 4	1.5 ± 0.4	1.1 ± 0.2	3 ± 3	8.8 ± 1.4	17 ± 2	4.6 ± 0.9	3.9	1.3
&	Latvia	387					3 ± 6		50 ± 85	11 ± 25		6 ± 10		
ERA	Lithuania	1,434	2 ± 3	4 ± 7	1 ± 3					5 ± 7				
	Luxembourg	417	20 ± 44		10 ± 8			6 ± 5			25 ± 16	5 ± 12		
	Malta	140								33 ± 28		25 ± 53		
	Netherlands	23,564	4.7 ± 1.6	7.7 ± 1.7	5.0 ± 0.9	17 ± 5	5.4 ± 1.4	5.3 ± 0.5	18 ± 6	15 ± 2	19 ± 2	8.0 ± 1.7	11.7	2.8
	Poland	15,628	0.8 ± 0.6	3 ± 1.2	2.1 ± 0.9		0.9 ± 0.5	1.0 ± 0.3	9 ± 6	2.4 ± 1.1	7 ± 6	2.3 ± 1.0	5.1	3.3
	Portugal	7,190	16 ± 4	12 ± 3	8 ± 2	16 ± 9	9 ± 2	7.0 ± 1.3	7 ± 11	14 ± 4	24 ± 5	15 ± 3	10.4	8.6
	Romania	5,105	2 ± 4	1 ± 2	3 ± 2	3 ± 8	0.5 ± 0.6	0.6 ± 0.6		6 ± 4	2.2 ± 1.8	1.1 ± 0.9	11	
	Slovakia	2,372	1 ± 2	1 ± 2			0.4 ± 0.9			5 ± 5		3 ± 3		
	Slovenia	2,586	0.6 ± 1.5	3 ± 4	3 ± 3	11 ± 16	2 ± 2	0.4 ± 0.7	2 ± 5	3 ± 4	4 ± 5	2 ± 2		
	Spain	35,557	6.2 ± 1.1	9.1 ± 1.2	3.9 ± 0.7	6 ± 3	2.9 ± 0.6	1.9 ± 0.3	3.5 ± 1.8	8.7 ± 1.5	12.3 ± 1.9	7.8 ± 1.1	5	1.8
	Sweden	14,872	8 ± 3	7 ± 1.8	3.3 ± 0.9	9 ± 6	4.0 ± 1.4	2.6 ± 0.4	5 ± 5	10 ± 2	19 ± 3	6.9 ± 1.7	5.6	0.8
	United Kingdom	73,621	4.7 ± 1.0	7.2 ± 0.9	4.1 ± 0.5	13 ± 2	4.5 ± 0.6	2.9 ± 0.2	8.4 ± 1.8	14.3 ± 1.2	19.1 ± 1.3	9.2 ± 1.0	9.9	8.7
Total EU28		**337,231**	**4.7 ± 0.4**	**6.0 ± 0.4**	**3.3 ± 0.2**	**9.2 ± 1.1**	**3.1 ± 0.2**	**2.1 ± 0.1**	**5.9 ± 0.8**	**10.0 ± 0.5**	**16.8 ± 0.7**	**6.7 ± 0.3**	**6.9**	**4.5**
	Albania	87		13 ± 28				7 ± 16			33 ± 68			
	Bosnia and Herzegovina	362						1.1 ± 1.7						
	Iceland	554	3 ± 7	6 ± 10	7 ± 7			2 ± 2		9 ± 11	7 ± 11	6 ± 14		
	Israel	8,450	0.6 ± 1.3	2.7 ± 1.8	1.8 ± 0.9	3 ± 6	3.5 ± 1.9	0.9 ± 0.4	6 ± 6	3 ± 3	9 ± 3	4 ± 2	0.8	1.5
ERA	Liechtenstein	40									25 ± 34			
Associated	FYR Macedonia	255	20 ± 29		5 ± 11		8 ± 12			20 ± 28		15 ± 23		
Countries	Montenegro	104			33 ± 68									
	Norway	7,280	5 ± 2	6 ± 2	3.2 ± 1.4	3 ± 6	3 ± 2	3.1 ± 0.8	4 ± 5	10 ± 2	19 ± 4	4 ± 2	7.4	5.6
	Rep. of Moldova	160										4 ± 9		
	Serbia	2,997	3 ± 4	1.1 ± 1.7	0.8 ± 1.9		0.7 ± 1.1	0.5 ± 0.5	14 ± 32	3 ± 4		0.7 ± 1.1		
	Switzerland	16,896	5 ± 2	10 ± 2	5.1 ± 1.0	6 ± 6	5.6 ± 1.3	4.2 ± 0.5	7 ± 6	12 ± 2	20 ± 4	10 ± 2	8.7	2.4
	Turkey	17,420	1.4 ± 0.7	0.6 ± 0.6	0.4 ± 0.4	3 ± 2	0.5 ± 0.4	0.8 ± 0.2	9 ± 9	2.6 ± 1.5	6 ± 3	1.3 ± 0.6	0.6	
Total ERA		**373,197**	**4.3 ± 0.3**	**5.8 ± 0.4**	**3.2 ± 0.2**	**8.4 ± 1**	**3 ± 0.2**	**2.1 ± 0.1**	**6.0 ± 0.8**	**9.6 ± 0.5**	**16.3 ± 0.6**	**6.3 ± 0.3**	**6.4**	**3.9**
Others	Brazil	26,158	1.8 ± 0.4	4.0 ± 0.8	3.6 ± 0.8	2 ± 4	3.0 ± 0.8	2.4 ± 0.3	4 ± 7	5.8 ± 1.9	7 ± 2	3.9 ± 1.0	5.6	
	Canada	41,114	2.4 ± 0.7	4.5 ± 0.9	1.8 ± 0.4	5 ± 2	2.1 ± 0.6	1.5 ± 0.2	1.8 ± 1.5	6.7 ± 1.1	10.1 ± 1.6	3.5 ± 0.8	2.9	1.3
	Japan	58,527	3.8 ± 0.9	4.8 ± 0.9	2.5 ± 0.4	5 ± 3	2.5 ± 0.4	2.8 ± 0.2	4 ± 5	8.7 ± 1.3	15 ± 3	3.4 ± 0.5	4.1	3.7
	United States	258,815	3.3 ± 0.4	4.2 ± 0.4	1.8 ± 0.2	3.4 ± 1.0	2.6 ± 0.3	1.3 ± 0.1	1.9 ± 0.5	7.8 ± 0.5	10.1 ± 0.6	3.8 ± 0.3	3.3	1.8
World		**1,000,000**	**3.1 ± 0.2**	**4.0 ± 0.2**	**2.3 ± 0.1**	**5.1 ± 0.5**	**1.9 ± 0.1**	**2.2 ± 0.1**	**4.0 ± 0.4**	**6.3 ± 0.3**	**11.7 ± 0.4**	**2.9 ± 0.1**	**3.9**	**2.8**

Note: No margin of error is presented for GAHSS and Visual & Performing Arts since their total populations were sampled.
Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

Table VIII Proportion of Green papers per country and field of science, 6-year non-weighted sampling, 2008–2013 (continued)

Group	Country	Total number of papers in sample	Engineering	General Science & Technology	Historical Studies	Information & Communication Technologies	Mathematics & Statistics	Philosophy & Theology	Physics & Astronomy	Psychology & Cognitive Sciences	Public Health & Health Services	Social Sciences	Total
	Austria	8,764	5 ± 2	12 ± 5	5 ± 7	14 ± 4	36 ± 5		42 ± 3	4 ± 3	2 ± 2	5 ± 3	9.4 ± 0.6
	Belgium	13,147	14 ± 3	4 ± 2	8 ± 4	24 ± 5	38 ± 5	9 ± 5	39 ± 2	18 ± 4	10 ± 3	13 ± 3	13.8 ± 0.6
	Bulgaria	1,707	6 ± 6	3 ± 3		10 ± 15	32 ± 10		33 ± 6				9.4 ± 1.3
	Croatia	2,954			2 ± 2	6 ± 10	6 ± 5		44 ± 6				5.2 ± 0.8
	Cyprus	584		20 ± 43			12 ± 14		60 ± 10		10 ± 23	3 ± 5	12 ± 3
	Czech Republic	7,637	5 ± 2	5 ± 5		18 ± 5	21 ± 5	2 ± 4	31 ± 3	6 ± 5	6 ± 6	4 ± 4	6.8 ± 0.5
	Denmark	9,097	12 ± 3	9 ± 4	6 ± 6	24 ± 6	45 ± 9	10 ± 10	52 ± 3	4 ± 3	2.7 ± 1.8	4 ± 2	9.6 ± 0.6
	Estonia	932		7 ± 11		33 ± 26	9 ± 13		41 ± 9			5 ± 7	8.7 ± 1.8
	Finland	7,414	4 ± 2	8 ± 4		14 ± 4	33 ± 7	4 ± 9	39 ± 3	3 ± 3	3 ± 2	5 ± 3	8.9 ± 0.6
	France	48,991	16.3 ± 1.4	10.8 ± 1.7	2.0 ± 1.2	34 ± 2	51 ± 2	4 ± 2	39.9 ± 1.1	4.0 ± 1.2	4.9 ± 1.4	4.9 ± 1.4	14.0 ± 0.3
	Germany	66,268	4.7 ± 0.7	9.7 ± 1.4	5 ± 2	16.2 ± 1.8	40 ± 2	4 ± 3	42.2 ± 0.9	4.9 ± 1	4.8 ± 1.4	6.4 ± 1.3	11.4 ± 0.2
	Greece	8,043	2.2 ± 1.3	12 ± 8		10 ± 3	14 ± 4		40 ± 3	3 ± 5	2 ± 3	3 ± 3	6.5 ± 0.5
	Hungary	4,559	3 ± 3	9 ± 7	2 ± 4	16 ± 5	24 ± 6	13 ± 28	45 ± 4	2 ± 4	2 ± 5	3 ± 3	10.0 ± 0.8
	Ireland	5,150	26 ± 6	13 ± 7	8 ± 8	25 ± 6	29 ± 8	7 ± 10	54 ± 4	16 ± 7	10 ± 4	11 ± 4	15.8 ± 0.9
EU28	Italy	39,117	5.7 ± 1.0	9 ± 2	1.3 ± 1.3	14.0 ± 1.9	28 ± 2	6 ± 5	44.9 ± 1.3	3.4 ± 1.4	2.7 ± 1.4	5.6 ± 1.9	9.4 ± 0.3
&	Latvia	387		25 ± 53		6 ± 13			16 ± 8			6 ± 14	5 ± 2
ERA	Lithuania	1,434	1.6 ± 1.6	10 ± 22		5 ± 5	17 ± 11		19 ± 5	13 ± 27		1 ± 3	4.5 ± 1.0
	Luxembourg	417	15 ± 15			17 ± 16	55 ± 33		24 ± 14		17 ± 37	4 ± 10	11 ± 3
	Malta	140							50 ± 60				5 ± 4
	Netherlands	23,564	11.1 ± 1.9	7 ± 2	6 ± 4	26 ± 4	40 ± 6	13 ± 5	50 ± 2	11 ± 2	7.8 ± 1.6	14 ± 2	12.1 ± 0.4
	Poland	15,628	2.2 ± 0.8	6 ± 4	7 ± 10	9 ± 3	22 ± 3		31.6 ± 1.8	1 ± 2	3 ± 3	10 ± 5	7.1 ± 0.4
	Portugal	7,190	15 ± 3	5 ± 4	4 ± 6	17 ± 5	30 ± 5		46 ± 3	19 ± 6	4 ± 4	5 ± 4	16.3 ± 0.8
	Romania	5,105	2.6 ± 1.2	9 ± 10		9 ± 5	15 ± 3		20 ± 3	8 ± 13	14 ± 33	2 ± 4	5.3 ± 0.6
	Slovakia	2,372	2 ± 3			14 ± 8	11 ± 8		32 ± 5	3 ± 6		6 ± 6	6.6 ± 1.0
	Slovenia	2,586	0.6 ± 1.4	12 ± 14		7 ± 4	23 ± 9		34 ± 5			1 ± 2	7.0 ± 0.9
	Spain	35,557	7.2 ± 1.2	7.2 ± 1.9	1.8 ± 1.5	12.2 ± 1.7	22 ± 2	5 ± 4	46.4 ± 1.5	4.6 ± 1.5	2.5 ± 1.1	6.3 ± 1.4	9.9 ± 0.3
	Sweden	14,872	12 ± 3	7 ± 2	7 ± 7	22 ± 4	47 ± 6	9 ± 7	42 ± 2	5 ± 3	5.0 ± 1.5	6 ± 2	10.3 ± 0.5
	United Kingdom	73,621	12.6 ± 1.2	9.6 ± 1.3	6.7 ± 1.4	20.5 ± 1.7	42 ± 2	7 ± 2	47.3 ± 1.2	9.2 ± 1.1	6.9 ± 0.8	10.1 ± 0.8	11.6 ± 0.2
Total EU28		**337,231**	**8 ± 0.4**	**7.4 ± 0.6**	**3.7 ± 0.6**	**17.4 ± 0.7**	**33.5 ± 0.9**	**5.7 ± 1.0**	**37.4 ± 0.5**	**6.6 ± 0.5**	**5.3 ± 0.4**	**7.6 ± 0.5**	**9.4 ± 0.1**
	Albania	87							50 ± 92				5 ± 5
	Bosnia and Herzegovina	362				14 ± 32							0.8 ± 1.0
	Iceland	554	15 ± 23	25 ± 35		32 ± 17	14 ± 32		58 ± 16	13 ± 20		9 ± 13	10 ± 2
	Israel	8,450	8 ± 3	3 ± 2	1 ± 2	33 ± 5	47 ± 5	1 ± 3	42 ± 3	2.3 ± 1.7	0.5 ± 1.1	5 ± 2	10.6 ± 0.6
ERA	Liechtenstein	40							27 ± 28				13 ± 11
Associated	FYR Macedonia	255		33 ± 68					21 ± 16		33 ± 44		7 ± 3
Countries	Montenegro	104				8 ± 17	36 ± 31						6 ± 5
	Norway	7,280	10 ± 3	5 ± 4	7 ± 7	17 ± 5	38 ± 7	3 ± 5	39 ± 4	1.5 ± 1.9	6 ± 2	6 ± 2	8.6 ± 0.6
	Rep. of Moldova	160							21 ± 10				9 ± 4
	Serbia	2,997	0.4 ± 0.9			7 ± 5	12 ± 5		28 ± 5	3 ± 8		1 ± 3	4.5 ± 0.7
	Switzerland	16,896	11 ± 2	12 ± 3	2 ± 4	32 ± 5	47 ± 6	8 ± 7	56 ± 2	12 ± 3	7 ± 3	14 ± 4	14.8 ± 0.5
	Turkey	17,420	2.5 ± 1.0	3 ± 4	5 ± 6	6 ± 2	7 ± 2		23 ± 3	1 ± 2	1.3 ± 1.6	1.1 ± 0.9	2.7 ± 0.2
Total ERA		**373,197**	**7.7 ± 0.4**	**7.2 ± 0.6**	**3.7 ± 0.6**	**17.5 ± 0.7**	**32.6 ± 0.8**	**5.4 ± 0.9**	**37.1 ± 0.5**	**6.3 ± 0.5**	**5.2 ± 0.4**	**7.2 ± 0.4**	**9.0 ± 0.1**
Others	Brazil	26,158	4.0 ± 1.2	6 ± 2	2 ± 2	7 ± 2	22 ± 3	3 ± 6	43 ± 2	3 ± 2	1.6 ± 0.6	1.8 ± 1.1	6.2 ± 0.3
	Canada	41,114	3.8 ± 0.7	5.4 ± 1.5	5 ± 3	13.1 ± 1.6	32 ± 3	3 ± 2	42.5 ± 1.7	3.0 ± 0.9	2.0 ± 0.6	4.4 ± 1.0	7.0 ± 0.2
	Japan	58,527	3.1 ± 0.5	5.7 ± 1.4	6 ± 7	8.6 ± 1.4	31 ± 3		26.2 ± 0.9	5 ± 2	3.5 ± 1.5	6 ± 3	7.1 ± 0.2
	United States	258,815	5.2 ± 0.4	5.1 ± 0.5	3.0 ± 0.7	15.3 ± 0.8	34.4 ± 1.1	3.5 ± 0.8	39.0 ± 0.6	2.8 ± 0.3	1.5 ± 0.2	4.5 ± 0.3	6.9 ± 0.1
World		**1,000,000**	**3.6 ± 0.1**	**3.9 ± 0.2**	**3.3 ± 0.4**	**9.6 ± 0.3**	**23.2 ± 0.5**	**4.7 ± 0.6**	**25.3 ± 0.3**	**4.1 ± 0.3**	**3.2 ± 0.2**	**5.5 ± 0.2**	**6.0 ± 0.0**

Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

Table IX Proportion of Gold OA per country and field of science, 6-year non-weighted sampling, 2008–2013

Group	Country	Total number of papers in sample	Agriculture, Fisheries & Forestry	Biology	Biomedical Research	Built Environment & Design	Chemistry	Clinical Medicine	Communication & Textual Studies	Earth & Environmental Sciences	Economics & Business	Enabling & Strategic Technologies	General Arts, Humanities & Social Sciences	Visual & Performing Arts
	Austria	8,764	9 ± 3	8 ± 3	8.6 ± 1.9		4.4 ± 1.6	9.5 ± 1	3 ± 7	17 ± 4	2 ± 2	7 ± 2		
	Belgium	13,147	4.1 ± 1.6	4.9 ± 1.6	9.2 ± 1.5	3 ± 4	4.6 ± 1.4	6.5 ± 0.7	2 ± 2	15 ± 3	1 ± 1	12 ± 2	0.9	2.1
	Bulgaria	1,707	21 ± 8	15 ± 7	11 ± 5		4 ± 3	10 ± 4	25 ± 53	10 ± 9	6 ± 13	3 ± 3		
	Croatia	2,954	35 ± 7	23 ± 6	24 ± 6		26 ± 6	17 ± 3	28 ± 19	17 ± 9	55 ± 9	33 ± 8		
	Cyprus	584	8 ± 17	14 ± 16	16 ± 14		5 ± 7	9 ± 7		25 ± 14	5 ± 8	3 ± 7		
	Czech Republic	7,637	19 ± 3	9 ± 2	7 ± 2	3 ± 8	6.5 ± 1.6	4.8 ± 0.9		14 ± 4	6 ± 4	16 ± 3		0.6
	Denmark	9,097	3.6 ± 1.7	5.1 ± 1.9	9.4 ± 1.7	3 ± 4	4.3 ± 1.9	9.9 ± 1	8 ± 7	13 ± 3	0.3 ± 0.7	10 ± 3		1.8
	Estonia	932	28 ± 13	4 ± 4	11 ± 7		11 ± 10	12 ± 6	56 ± 27	38 ± 11	4 ± 8	10 ± 8		20
	Finland	7,414	16 ± 4	5 ± 2	12 ± 2		5 ± 2	7.9 ± 1.2	11 ± 9	27 ± 4	1.2 ± 1.3	10 ± 3		
	France	48,991	3.7 ± 1	6.4 ± 1	9.7 ± 0.8	1.5 ± 1.9	3.3 ± 0.6	4.8 ± 0.4	1.5 ± 1.4	11.2 ± 1.2	4 ± 1.1	8.1 ± 1	1	1.6
	Germany	66,268	3.5 ± 0.9	6.5 ± 0.9	9.6 ± 0.7	4 ± 3	5 ± 0.5	6.8 ± 0.3	2 ± 1.5	13.8 ± 1.2	1.9 ± 0.7	8.7 ± 0.9		1.1
	Greece	8,043	7 ± 3	11 ± 4	10 ± 2		3.3 ± 1.6	14.4 ± 1.2		9 ± 3	6 ± 3	8 ± 2		5
	Hungary	4,559	15 ± 5	13 ± 4	7 ± 2		3.9 ± 1.8	6.1 ± 1.3	17 ± 15	7 ± 4	2 ± 3	6 ± 3		
	Ireland	5,150	6 ± 3	6 ± 4	10 ± 3		4 ± 2	13 ± 1.7	5 ± 8	7 ± 4	4 ± 3	12 ± 4		
EU28	Italy	39,117	8.8 ± 1.5	7.4 ± 1.3	9 ± 0.9	2 ± 3	4.4 ± 0.7	8.1 ± 0.4	5 ± 4	10.1 ± 1.5	3.1 ± 1.1	10.2 ± 1.3		1.3
&	Latvia	387	18 ± 26	8 ± 12	29 ± 21		16 ± 12	22 ± 10		22 ± 32		10 ± 11		
ERA	Lithuania	1,434	27 ± 8	13 ± 10	9 ± 6		34 ± 8	8 ± 4	43 ± 38	28 ± 14	4 ± 6	7 ± 6		
	Luxembourg	417		5 ± 11	17 ± 10		6 ± 14	7 ± 5				20 ± 19		
	Malta	140		17 ± 37	22 ± 31			41 ± 14		17 ± 23				
	Netherlands	23,564	4 ± 1.5	6.7 ± 1.6	9.8 ± 1.2	6 ± 3	2.3 ± 0.9	6.5 ± 0.5	3 ± 3	12 ± 2	1.1 ± 0.7	12 ± 2		
	Poland	15,628	10.1 ± 1.9	9 ± 2	14 ± 2		7.2 ± 1.2	25.1 ± 1.2		7.5 ± 1.9	7 ± 6	14 ± 2	2.6	
	Portugal	7,190	6 ± 2	10 ± 3	9 ± 2	3 ± 4	6.8 ± 1.8	17 ± 2	32 ± 18	5 ± 2	8 ± 3	8 ± 2		28.6
	Romania	5,105	16 ± 10	28 ± 9	4 ± 3	13 ± 13	5.1 ± 1.6	15 ± 3	30 ± 18	7 ± 5	15 ± 4	3.3 ± 1.5		
	Slovakia	2,372	14 ± 6	10 ± 6	8 ± 4		6 ± 3	9 ± 2		7 ± 5	8 ± 10	15 ± 6		
	Slovenia	2,586	40 ± 8	12 ± 7	10 ± 4	5 ± 12	20 ± 5	24 ± 4	4 ± 6	26 ± 9	13 ± 8	23 ± 6		
	Spain	35,557	7.6 ± 1.2	8.5 ± 1.2	13.2 ± 1.2	25 ± 5	4.7 ± 0.7	11.3 ± 0.6	16 ± 3	8 ± 1.4	12.5 ± 1.9	9.9 ± 1.2	17.1	43.9
	Sweden	14,872	7 ± 2	6.4 ± 1.7	11 ± 1.5	2 ± 4	2.3 ± 1.1	9.9 ± 0.8	12 ± 8	14 ± 3	2.9 ± 1.5	12 ± 2		0.8
	United Kingdom	73,621	3.7 ± 0.9	5.5 ± 0.8	10.2 ± 0.7	1.1 ± 0.8	3.5 ± 0.6	8.2 ± 0.4	2.3 ± 1	7.8 ± 0.9	1.4 ± 0.4	9.5 ± 1	0.4	0.1
Total EU28		**337,231**	**8.4 ± 0.5**	**7.7 ± 0.4**	**10 ± 0.3**	**4.5 ± 0.8**	**5.2 ± 0.3**	**9 ± 0.2**	**6 ± 0.8**	**9.7 ± 0.5**	**4.5 ± 0.4**	**9.6 ± 0.4**	**1.2**	**4**
	Albania	87	33 ± 44	25 ± 35	50 ± 60		17 ± 37	20 ± 23			33 ± 68	6 ± 13		
	Bosnia and Herzegovina	362		39 ± 24			60 ± 26	34 ± 7			20 ± 44	42 ± 31		
	Iceland	554	6 ± 9	3 ± 7	9 ± 8		8 ± 18	7 ± 4		3 ± 7		6 ± 14		20
	Israel	8,450	5 ± 3	2.7 ± 1.8	8.3 ± 1.9		2.2 ± 1.5	5.1 ± 0.8	2 ± 4	4 ± 3	0.4 ± 0.9	13 ± 3		1.5
ERA	Liechtenstein	40												
Associated	FYR Macedonia	255	50 ± 34	24 ± 22	64 ± 22		44 ± 20	37 ± 11		20 ± 28	11 ± 25	8 ± 18		
Countries	Montenegro	104	67 ± 68	40 ± 27	33 ± 68			36 ± 19				38 ± 37		
	Norway	7,280	2.9 ± 1.7	6 ± 2	15 ± 3	3 ± 6	5 ± 3	9.6 ± 1.3	9 ± 7	12 ± 2	0.7 ± 1	13 ± 4		
	Rep. of Moldova	160					3 ± 6					4 ± 9		
	Serbia	2,997	41 ± 9	49 ± 7	27 ± 8		41 ± 5	41 ± 3	43 ± 42		40 ± 16	31 ± 5		
	Switzerland	16,896	2.9 ± 1.6	6.7 ± 1.7	10.6 ± 1.4	1 ± 3	3.7 ± 1	9.7 ± 0.8	6 ± 6	12 ± 2	0.5 ± 0.7	10 ± 2		
	Turkey	17,420	40 ± 3	44 ± 4	23 ± 3	2 ± 2	13.6 ± 1.8	23.5 ± 0.9	14 ± 11	17 ± 3	14 ± 4	11.9 ± 1.7		
Total ERA		**373,197**	**10.6 ± 0.5**	**9.1 ± 0.4**	**10.4 ± 0.3**	**4.1 ± 0.7**	**5.5 ± 0.3**	**9.8 ± 0.2**	**6.1 ± 0.8**	**9.7 ± 0.5**	**4.5 ± 0.4**	**9.9 ± 0.4**	**1.1**	**3.5**
Others	Brazil	26,158	66.6 ± 1.5	34.3 ± 1.9	28.6 ± 1.8	31 ± 10	35 ± 2	38.4 ± 1.1	19 ± 12	17 ± 3	58 ± 4	28 ± 2	28.1	70.5
	Canada	41,114	2.3 ± 0.7	5.1 ± 0.9	9.3 ± 0.9	0.4 ± 0.8	3.6 ± 0.8	8.6 ± 0.5	0.9 ± 1.1	7.1 ± 1.1	1.9 ± 0.7	7.8 ± 1.1		0.4
	Japan	58,527	14.7 ± 1.7	9.7 ± 1.2	9.6 ± 0.7	1.2 ± 1.4	4.9 ± 0.5	12.1 ± 0.4	9 ± 7	7.2 ± 1.2	5.1 ± 1.9	5.8 ± 0.6		
	United States	258,815	4.1 ± 0.4	5.6 ± 0.4	10.6 ± 0.4	1.4 ± 0.6	2.9 ± 0.3	6.4 ± 0.2	2.7 ± 0.6	6.6 ± 0.5	2 ± 0.3	9 ± 0.5	0.3	0.5
World		**1,000,000**	**15.6 ± 0.4**	**15.3 ± 0.3**	**11.4 ± 0.2**	**3.3 ± 0.4**	**8.7 ± 0.2**	**12.4 ± 0.1**	**6.5 ± 0.5**	**7.5 ± 0.3**	**5.1 ± 0.3**	**8.3 ± 0.2**	**2**	**3.1**

Note: No margin of error is presented for GAHSS and Visual & Performing Arts since their total populations were sampled.
Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

Table X Proportion of Gold papers per country and field of science, 6-year non-weighted sampling, 2008–2013 (continued)

Group	Country	Total number of papers in sample	Engineering	General Science & Technology	Historical Studies	Information & Communication Technologies	Mathematics & Statistics	Philosophy & Theology	Physics & Astronomy	Psychology & Cognitive Sciences	Public Health & Health Services	Social Sciences	Total
	Austria	8,764	2.2 ± 1.4	57 ± 7	2 ± 5	5 ± 3	6 ± 3		6.8 ± 1.5	4 ± 3	11 ± 6	8 ± 4	8.8 ± 0.6
	Belgium	13,147	3.6 ± 1.7	64 ± 5	2 ± 2	8 ± 3	5 ± 2	2 ± 3	2.4 ± 0.8	5 ± 2	13 ± 4	2.6 ± 1.5	7.4 ± 0.4
	Bulgaria	1,707	1 ± 3	2 ± 2		15 ± 17	6 ± 5		4 ± 2	14 ± 32	13 ± 28	17 ± 24	7.4 ± 1.2
	Croatia	2,954	18 ± 5	74 ± 21	3 ± 2	9 ± 11	19 ± 8	95 ± 11	2 ± 2	57 ± 10	53 ± 14	37 ± 9	23.3 ± 1.5
	Cyprus	584	6 ± 9	80 ± 43		3 ± 8	4 ± 9		1 ± 3		20 ± 29	3 ± 5	7 ± 2
	Czech Republic	7,637	5 ± 2	72 ± 9	2 ± 5	27 ± 5	11 ± 4		3.4 ± 1.2	50 ± 10	9 ± 8	2 ± 3	9.6 ± 0.6
	Denmark	9,097	3.1 ± 1.9	58 ± 6	4 ± 5	7 ± 4	2 ± 3	2 ± 6	5.7 ± 1.6	0.8 ± 1.8	15 ± 4	3 ± 2	9 ± 0.6
	Estonia	932	7 ± 8	63 ± 19		7 ± 15	4 ± 10		1 ± 2	5 ± 10	24 ± 18	7 ± 9	13 ± 2
	Finland	7,414	1.5 ± 1.4	69 ± 7	6 ± 8	10 ± 4	7 ± 4		3.1 ± 1.1	1 ± 2	8 ± 3	4 ± 3	9.3 ± 0.6
	France	48,991	2.3 ± 0.6	58 ± 3	2.8 ± 1.4	8.3 ± 1.4	3.8 ± 0.8	0.4 ± 0.9	3.7 ± 0.4	3.2 ± 1.1	5.3 ± 1.4	8.3 ± 1.8	6.6 ± 0.2
	Germany	66,268	2.7 ± 0.6	59 ± 2	2.2 ± 1.6	10.5 ± 1.5	4 ± 0.9	3 ± 2	4.9 ± 0.4	4.1 ± 0.9	9.1 ± 1.8	4.5 ± 1.1	7.6 ± 0.2
	Greece	8,043	3.2 ± 1.6	66 ± 12	5 ± 6	7 ± 2	9 ± 4	8 ± 17	3.1 ± 1.2	8 ± 7	5 ± 4	8 ± 4	9.6 ± 0.6
	Hungary	4,559	6 ± 4	66 ± 10		13 ± 5	8 ± 4		5.1 ± 1.8	2 ± 4	16 ± 12	4 ± 3	7.8 ± 0.7
	Ireland	5,150	1.5 ± 1.9	65 ± 10	2 ± 5	15 ± 5	9 ± 5		3.3 ± 1.6	3 ± 4	8 ± 3	3 ± 2	9.2 ± 0.8
EU28	Italy	39,117	2.9 ± 0.7	65 ± 4	4 ± 2	8.2 ± 1.5	4.9 ± 1.1	4 ± 4	4.2 ± 0.5	5.9 ± 1.8	11 ± 3	5.9 ± 1.9	8 ± 0.3
&	Latvia	387	3 ± 7	50 ± 60					21 ± 9				15 ± 3
ERA	Lithuania	1,434	9 ± 4	50 ± 34		3 ± 4			4 ± 3	13 ± 27	25 ± 36	24 ± 10	12.8 ± 1.7
	Luxembourg	417	8 ± 12	64 ± 31		4 ± 10			8 ± 9		17 ± 37		9 ± 3
	Malta	140		100 ± 50		33 ± 44						7 ± 16	21 ± 7
	Netherlands	23,564	4.5 ± 1.3	66 ± 4	5 ± 3	10 ± 2	6 ± 3	4 ± 3	4.3 ± 0.9	3.7 ± 1.2	14 ± 2	3 ± 1.1	8 ± 0.3
	Poland	15,628	6.7 ± 1.3	65 ± 8	3 ± 8	8 ± 3	4.1 ± 1.6		7.1 ± 1	9 ± 6	4 ± 3	7 ± 4	13.4 ± 0.5
	Portugal	7,190	2.4 ± 1.3	76 ± 7	19 ± 11	9 ± 3	5 ± 2	22 ± 32	2.4 ± 1	9 ± 5	39 ± 9	17 ± 6	10.4 ± 0.7
	Romania	5,105	1.2 ± 0.9	56 ± 17	2 ± 3	29 ± 7	14 ± 3	21 ± 9	3.3 ± 1.3		29 ± 40	52 ± 11	9.5 ± 0.8
	Slovakia	2,372	20 ± 7	69 ± 25		26 ± 10	16 ± 9		1.7 ± 1.4	51 ± 16		1 ± 3	10.1 ± 1.2
	Slovenia	2,586	4 ± 3	48 ± 21	20 ± 12	12 ± 6	4 ± 4	30 ± 31	2.9 ± 1.8	20 ± 14	14 ± 14	16 ± 6	16.4 ± 1.4
	Spain	35,557	1.8 ± 0.6	65 ± 3	26 ± 5	7.7 ± 1.4	4.3 ± 1.2	21 ± 8	4.9 ± 0.7	29 ± 3	31 ± 3	24 ± 2	11.5 ± 0.3
	Sweden	14,872	3.4 ± 1.5	66 ± 4	2 ± 4	11 ± 3	5 ± 3	2 ± 4	3.4 ± 0.9	3 ± 2	13 ± 2	4.5 ± 1.9	9.8 ± 0.5
	United Kingdom	73,621	1.8 ± 0.5	50 ± 2	1.3 ± 0.7	7.5 ± 1.1	4.1 ± 1	2.1 ± 1.2	3.8 ± 0.4	3.4 ± 0.7	7.4 ± 0.8	2.5 ± 0.4	7.2 ± 0.2
Total EU28		**337,231**	**3.3 ± 0.3**	**60.4 ± 1.1**	**5.1 ± 0.7**	**9.6 ± 0.6**	**5.5 ± 0.4**	**5.1 ± 0.9**	**4.8 ± 0.2**	**7.5 ± 0.5**	**11.2 ± 0.6**	**6.6 ± 0.4**	**8.6 ± 0.1**
	Albania	87	50 ± 93				40 ± 51	50 ± 87					18 ± 8
	Bosnia and Herzegovina	362					20 ± 22			43 ± 42	25 ± 53	4 ± 9	25 ± 4
	Iceland	554		75 ± 35		10 ± 11			5 ± 8		3 ± 8	9 ± 13	7 ± 2
	Israel	8,450	0.9 ± 1.1	47 ± 6	2 ± 3	7 ± 3	5 ± 2	1 ± 3	4.9 ± 1.3	4 ± 2	2 ± 2	2.2 ± 1.5	5.9 ± 0.5
ERA	Liechtenstein	40											
Associated	FYR Macedonia	255		67 ± 68			10 ± 22		7 ± 11	33 ± 67	50 ± 46	17 ± 24	29 ± 5
Countries	Montenegro	104			100 ± 50	15 ± 22	55 ± 32						29 ± 9
	Norway	7,280	5 ± 3	69 ± 8		10 ± 4	8 ± 4	3 ± 5	1.6 ± 1.2	4 ± 3	20 ± 4	4 ± 2	9.7 ± 0.6
	Rep. of Moldova	160					33 ± 45						3 ± 3
	Serbia	2,997	9 ± 4	55 ± 33		22 ± 8	23 ± 6	71 ± 39	6 ± 3	43 ± 19	39 ± 21	21 ± 9	30.2 ± 1.6
	Switzerland	16,896	4.6 ± 1.6	53 ± 4	6 ± 6	6 ± 2	4 ± 2		5 ± 0.9	4 ± 2	15 ± 4	4 ± 2	9.2 ± 0.4
	Turkey	17,420	3.4 ± 1.1	68 ± 10	10 ± 8	12 ± 3	20 ± 3	5 ± 12	6 ± 1.4	7 ± 5	18 ± 5	11 ± 2	19.9 ± 0.6
Total ERA		**373,197**	**3.3 ± 0.2**	**60.2 ± 1.1**	**5.0 ± 0.7**	**9.6 ± 0.5**	**6.2 ± 0.4**	**4.8 ± 0.9**	**4.9 ± 0.2**	**7.3 ± 0.5**	**11.6 ± 0.6**	**6.6 ± 0.4**	**9.1 ± 0.1**
Others	Brazil	26,158	23 ± 2	58 ± 5	64 ± 8	4.1 ± 1.8	9 ± 2	55 ± 16	5.6 ± 1	26 ± 6	84.7 ± 1.6	68 ± 4	40.1 ± 0.6
	Canada	41,114	1.9 ± 0.5	57 ± 3	1.4 ± 1.5	7.2 ± 1.2	3.7 ± 1.1	2.1 ± 1.7	4.6 ± 0.7	4.5 ± 1	13.1 ± 1.4	5.3 ± 1.1	7.5 ± 0.2
	Japan	58,527	1.3 ± 0.3	56 ± 3		8.9 ± 1.4	8.9 ± 1.6		3.9 ± 0.4	3.3 ± 1.7	31 ± 4	9 ± 4	9.2 ± 0.2
	United States	258,815	1.9 ± 0.3	47.5 ± 1.1	1.8 ± 0.6	6.4 ± 0.6	4.6 ± 0.5	1.3 ± 0.5	4.2 ± 0.3	2.5 ± 0.3	5.2 ± 0.4	4 ± 0.3	6.8 ± 0.1
World		**1,000,000**	**3.2 ± 0.1**	**46.5 ± 0.6**	**6.6 ± 0.6**	**10.0 ± 0.3**	**9.3 ± 0.3**	**5.0 ± 0.6**	**4.6 ± 0.1**	**5.5 ± 0.3**	**14.3 ± 0.4**	**8.1 ± 0.3**	**10.4 ± 0.1**

Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

Table XI Proportion of Other OA papers per country and field of science, 6-year non-weighted sampling, 2008–2013

Group	Country	Total number of papers in sample	Agriculture, Fisheries & Forestry	Biology	Biomedical Research	Built Environment & Design	Chemistry	Clinical Medicine	Communication & Textual Studies	Earth & Environmental Sciences	Economics & Business	Enabling & Strategic Technologies	General Arts, Humanities & Social Sciences	Visual & Performing Arts
	Austria	8,764	32 ± 5	54 ± 5	58 ± 3	44 ± 20	30 ± 4	40.9 ± 1.7	25 ± 16	49 ± 5	39 ± 6	34 ± 4	42.3	29.2
	Belgium	13,147	34 ± 4	54 ± 4	57 ± 3	34 ± 10	31 ± 3	44.6 ± 1.5	20 ± 6	38 ± 4	39 ± 5	33 ± 3	28.8	8.2
	Bulgaria	1,707	39 ± 10	47 ± 9	34 ± 8	20 ± 42	32 ± 7	32 ± 5	25 ± 53	29 ± 13	28 ± 22	38 ± 7		
	Croatia	2,954	37 ± 7	56 ± 7	46 ± 7	50 ± 93	20 ± 5	34 ± 3	28 ± 19	43 ± 11	31 ± 8	22 ± 7	64.7	24.1
	Cyprus	584	31 ± 27	45 ± 22	55 ± 18	17 ± 37	48 ± 15	45 ± 11	11 ± 25	33 ± 15	41 ± 16	18 ± 14	15	14
	Czech Republic	7,637	44 ± 4	55 ± 4	48 ± 4	34 ± 18	31 ± 3	26.9 ± 1.9	4 ± 10	44 ± 6	51 ± 8	30 ± 4	41	1.2
	Denmark	9,097	34 ± 4	58 ± 4	58 ± 3	22 ± 10	27 ± 4	41.7 ± 1.7	27 ± 11	38 ± 5	36 ± 5	28 ± 4	26.9	19.3
	Estonia	932	36 ± 14	70 ± 9	55 ± 11	22 ± 30	28 ± 13	41 ± 8	13 ± 19	34 ± 11	37 ± 19	36 ± 12	84.5	
	Finland	7,414	34 ± 5	61 ± 4	58 ± 4	24 ± 11	26 ± 4	43 ± 2	27 ± 12	33 ± 4	31 ± 5	28 ± 4	50.0	25.0
	France	48,991	33 ± 2	56 ± 2	54.4 ± 1.4	26 ± 6	27.6 ± 1.4	36.5 ± 0.8	6 ± 3	47 ± 2	31 ± 3	27.4 ± 1.6	18.8	8.1
	Germany	66,268	31 ± 2	51.8 ± 1.8	54.4 ± 1.2	26 ± 6	24.0 ± 1.1	33.8 ± 0.6	18 ± 4	43.2 ± 1.8	31 ± 2	28.7 ± 1.4	25.1	12.7
	Greece	8,043	34 ± 5	48 ± 6	51 ± 4	39 ± 14	29 ± 4	38.2 ± 1.7	38 ± 19	52 ± 6	38 ± 6	34 ± 4	23.1	17.5
	Hungary	4,559	29 ± 7	53 ± 5	59 ± 5	60 ± 23	29 ± 4	51 ± 3	38 ± 18	47 ± 7	51 ± 10	47 ± 7	44.8	60.0
	Ireland	5,150	34 ± 5	60 ± 8	57 ± 4	13 ± 11	26 ± 5	40 ± 2	21 ± 13	43 ± 7	29 ± 7	34 ± 6	34.4	12.0
EU28	Italy	39,117	36 ± 3	53 ± 3	51.7 ± 1.6	34 ± 7	28.8 ± 1.6	41.2 ± 0.8	18 ± 7	45 ± 2	42 ± 3	31 ± 2	31.3	10.2
&	Latvia	387	36 ± 32	60 ± 20	48 ± 23		16 ± 12	53 ± 11		33 ± 35	63 ± 39	19 ± 15		25
ERA	Lithuania	1,434	47 ± 9	33 ± 14	48 ± 10	18 ± 20	31 ± 8	64 ± 7	14 ± 29	44 ± 15	60 ± 14	24 ± 9		
	Luxembourg	417	60 ± 52	64 ± 21	57 ± 13		53 ± 26	40 ± 10		67 ± 30	34 ± 17	35 ± 23	67	
	Malta	140	33 ± 66	50 ± 47	56 ± 36			27 ± 13		33 ± 28		25 ± 53		33
	Netherlands	23,564	42 ± 4	65 ± 3	63.7 ± 1.9	32 ± 6	38 ± 3	50.2 ± 1.0	27 ± 7	46 ± 3	44 ± 3	36 ± 3	38.9	18.2
	Poland	15,628	43 ± 3	52 ± 3	42 ± 3	16 ± 8	21.8 ± 1.9	26.5 ± 1.3	7 ± 6	41 ± 4	31 ± 9	27 ± 3	38.5	30.0
	Portugal	7,190	43 ± 5	53 ± 4	53 ± 4	31 ± 11	36 ± 3	39 ± 3	21 ± 16	43 ± 6	35 ± 6	31 ± 4	27.1	20.0
	Romania	5,105	48 ± 13	49 ± 9	69 ± 6	7 ± 10	45 ± 3	41 ± 3	22 ± 17	50 ± 9	17 ± 4	38 ± 4	32	33
	Slovakia	2,372	44 ± 8	53 ± 9	52 ± 7	8 ± 17	29 ± 5	29 ± 4		54 ± 10	41 ± 17	26 ± 7	33	27
	Slovenia	2,586	34 ± 7	58 ± 10	49 ± 7	16 ± 18	23 ± 5	34 ± 4	14 ± 10	39 ± 10	44 ± 12	24 ± 6	13	29
	Spain	35,557	36 ± 2	53 ± 2	51.9 ± 1.7	22 ± 5	28.8 ± 1.5	35.9 ± 0.9	12 ± 3	41 ± 3	31 ± 3	28.9 ± 1.8	35.9	8.1
	Sweden	14,872	35 ± 4	58 ± 3	58 ± 2	28 ± 10	29 ± 3	45.8 ± 1.4	21 ± 9	38 ± 4	33 ± 4	26 ± 3	34.4	10.7
	United Kingdom	73,621	37 ± 2	58.8 ± 1.7	60.0 ± 1.1	25 ± 3	28.2 ± 1.4	45.5 ± 0.6	19 ± 2	42.8 ± 1.7	35.1 ± 1.6	30.3 ± 1.5	26.0	19.4
Total EU28		**337,231**	**34.6 ± 0.8**	**53.3 ± 0.8**	**53.5 ± 0.5**	**25.8 ± 1.7**	**27.1 ± 0.5**	**36.9 ± 0.3**	**16.2 ± 1.3**	**42.5 ± 0.8**	**34.2 ± 0.9**	**29.0 ± 0.6**	**28.8**	**16.3**
	Albania	87	50 ± 47	63 ± 38	25 ± 54		17 ± 37	27 ± 25		70 ± 32		6 ± 13		
	Bosnia and Herzegovina	362	88 ± 29	28 ± 22	57 ± 43		13 ± 19	38 ± 7		50 ± 46	60 ± 51	17 ± 24		
	Iceland	554	54 ± 17	48 ± 18	67 ± 12		69 ± 28	51 ± 7	100 ± 50	48 ± 18	33 ± 18	50 ± 26	17	40
	Israel	8,450	47 ± 7	57 ± 5	62 ± 3	57 ± 16	28 ± 4	47.0 ± 1.9	31 ± 12	61 ± 8	50 ± 6	31 ± 5	26.8	16.2
ERA	Liechtenstein	40					75 ± 53	50 ± 40			50 ± 39			
Associated	FYR Macedonia	255	30 ± 32	29 ± 23	18 ± 18		24 ± 18	37 ± 11		60 ± 33	67 ± 34	31 ± 28	67	
Countries	Montenegro	104		47 ± 27				36 ± 19			50 ± 92			
	Norway	7,280	41 ± 5	55 ± 5	52 ± 4	35 ± 15	24 ± 5	46 ± 2	28 ± 11	46 ± 4	36 ± 5	34 ± 5	34.6	15.5
	Rep. of Moldova	160					33 ± 15	67 ± 45		100 ± 13		48 ± 20		
	Serbia	2,997	28 ± 8	28 ± 6	47 ± 9	50 ± 61	19 ± 4	24 ± 3	14 ± 32	32 ± 11	28 ± 14	24 ± 5	50	
	Switzerland	16,896	32 ± 4	58 ± 3	60 ± 2	39 ± 12	32 ± 3	41.5 ± 1.3	17 ± 9	45 ± 3	42 ± 5	36 ± 3	28.8	12.7
	Turkey	17,420	26 ± 3	27 ± 3	33 ± 3	20 ± 6	26 ± 2	27.6 ± 1.0	26 ± 13	34 ± 4	29 ± 5	23 ± 2	30.3	6.9
Total ERA		**373,197**	**34.0 ± 0.8**	**52.0 ± 0.7**	**53.0 ± 0.5**	**25.9 ± 1.6**	**27.0 ± 0.5**	**36.5 ± 0.3**	**16.6 ± 1.3**	**42.5 ± 0.8**	**34.5 ± 0.8**	**28.8 ± 0.6**	**28.8**	**15.3**
Others	Brazil	26,158	13.2 ± 1.1	36.3 ± 1.9	36.4 ± 1.9	14 ± 8	19.9 ± 1.8	30.0 ± 1.0	13 ± 10	36 ± 4	16 ± 3	25 ± 2	15.7	6.3
	Canada	41,114	47 ± 2	60 ± 2	59.5 ± 1.5	36 ± 5	30.0 ± 1.9	49.0 ± 0.9	28 ± 5	49 ± 2	41 ± 3	29.7 ± 1.9	28.6	37.4
	Japan	58,527	25 ± 2	39 ± 2	48.2 ± 1.2	32 ± 6	21.1 ± 1.0	28.5 ± 0.6	25 ± 10	38 ± 2	36 ± 4	29.7 ± 1.2	25.5	38.9
	United States	258,815	44.4 ± 1.1	58.8 ± 0.9	66.1 ± 0.5	33 ± 3	40.4 ± 0.8	51.3 ± 0.3	25.2 ± 1.5	53.0 ± 1.0	42.7 ± 0.9	37.7 ± 0.8	32.1	20.4
World		**1,000,000**	**31.7 ± 0.5**	**43.8 ± 0.4**	**50.9 ± 0.3**	**26.1 ± 1.0**	**24.3 ± 0.3**	**36.4 ± 0.2**	**20.0 ± 0.9**	**39.8 ± 0.5**	**35.0 ± 0.5**	**23.3 ± 0.3**	**29.5**	**18.3**

Note: No margin of error is presented for GAHSS and Visual & Performing Arts since their total populations were sampled.
Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

Table XII Proportion of Other OA papers per country and field of science, 6-year non-weighted sampling, 2008–2013 (continued)

Group	Country	Total number of papers in sample	Engineering	General Science & Technology	Historical Studies	Information & Communication Technologies	Mathematics & Statistics	Philosophy & Theology	Physics & Astronomy	Psychology & Cognitive Sciences	Public Health & Health Services	Social Sciences	Total
	Austria	8,764	34 ± 4	31 ± 6	35 ± 15	41 ± 6	37 ± 5	11 ± 17	26 ± 3	46 ± 8	39 ± 8	26 ± 6	39.4 ± 1.0
	Belgium	13,147	35 ± 4	29 ± 5	26 ± 7	41 ± 5	35 ± 5	22 ± 7	27 ± 2	41 ± 5	39 ± 5	31 ± 4	39.6 ± 0.8
	Bulgaria	1,707	40 ± 11	21 ± 6	56 ± 36	40 ± 23	27 ± 10		27 ± 5	29 ± 39	38 ± 38	42 ± 31	33 ± 2
	Croatia	2,954	53 ± 7	16 ± 18	89 ± 4	41 ± 18	44 ± 10		22 ± 5	30 ± 10	17 ± 10	40 ± 9	38.9 ± 1.7
	Cyprus	584	41 ± 17		10 ± 22	73 ± 17	44 ± 21		24 ± 9	89 ± 25	40 ± 35	31 ± 12	38 ± 4
	Czech Republic	7,637	38 ± 5	21 ± 8	18 ± 12	35 ± 6	40 ± 6	11 ± 9	24 ± 3	21 ± 8	16 ± 9	29 ± 8	34.0 ± 1.0
	Denmark	9,097	32 ± 5	32 ± 6	16 ± 9	44 ± 7	28 ± 9	15 ± 11	20 ± 3	55 ± 8	46 ± 5	22 ± 5	38.9 ± 1.0
	Estonia	932	70 ± 14	33 ± 19	33 ± 35	40 ± 27	39 ± 21		25 ± 8	55 ± 22	40 ± 20	21 ± 13	42 ± 3
	Finland	7,414	31 ± 5	25 ± 6	31 ± 15	41 ± 6	35 ± 7	32 ± 20	25 ± 3	52 ± 8	40 ± 5	27 ± 5	38.3 ± 1.0
	France	48,991	27.1 ± 1.7	31 ± 3	13 ± 3	32 ± 2	26.8 ± 1.9	8 ± 3	24.4 ± 1.0	33 ± 3	22 ± 3	17 ± 2	33.8 ± 0.4
	Germany	66,268	23.8 ± 1.5	32 ± 2	23 ± 4	41 ± 2	33 ± 2	14 ± 4	21.7 ± 0.8	42 ± 2	30 ± 3	26 ± 2	33.2 ± 0.3
	Greece	8,043	37 ± 4	30 ± 11	26 ± 12	48 ± 4	35 ± 6	31 ± 27	28 ± 3	45 ± 13	43 ± 8	32 ± 7	38.1 ± 1.0
	Hungary	4,559	52 ± 8	28 ± 10	54 ± 13	48 ± 7	50 ± 7	25 ± 35	24 ± 3	63 ± 12	42 ± 15	43 ± 8	44.4 ± 1.4
	Ireland	5,150	30 ± 6	27 ± 9	25 ± 12	31 ± 7	32 ± 9	10 ± 12	21 ± 4	40 ± 10	29 ± 5	30 ± 6	35.7 ± 1.2
EU28	Italy	39,117	34 ± 2	26 ± 3	18 ± 4	39 ± 3	33 ± 2	13 ± 6	22.7 ± 1.1	45 ± 4	37 ± 4	31 ± 4	37.3 ± 0.5
&	Latvia	387	80 ± 14	50 ± 60		6 ± 13	75 ± 35		25 ± 10	100 ± 25	83 ± 36	25 ± 23	40 ± 5
ERA	Lithuania	1,434	55 ± 6	30 ± 31	67 ± 68	26 ± 9	23 ± 12	100 ± 50	33 ± 7	38 ± 37	63 ± 39	15 ± 9	41 ± 2
	Luxembourg	417	27 ± 18	18 ± 26		46 ± 21	27 ± 30	75 ± 50	34 ± 15	36 ± 32	17 ± 37	29 ± 19	42 ± 5
	Malta	140	22 ± 30		25 ± 52	33 ± 44	50 ± 92		25 ± 54	100 ± 25	13 ± 28	21 ± 24	29 ± 7
	Netherlands	23,564	36 ± 3	27 ± 4	24 ± 7	41 ± 4	39 ± 6	35 ± 8	25.8 ± 1.8	53 ± 3	44 ± 3	36 ± 3	45.4 ± 0.6
	Poland	15,628	32 ± 2	19 ± 6	23 ± 16	31 ± 5	31 ± 4	46 ± 30	23.8 ± 1.7	54 ± 10	29 ± 7	16 ± 6	30.0 ± 0.7
	Portugal	7,190	29 ± 4	19 ± 7	35 ± 14	40 ± 6	35 ± 5	11 ± 25	25 ± 3	41 ± 8	24 ± 8	27 ± 7	36.7 ± 1.1
	Romania	5,105	34 ± 4	32 ± 16	9 ± 5	27 ± 7	36 ± 5	61 ± 11	42 ± 4	33 ± 20	29 ± 40	16 ± 8	39.1 ± 1.3
	Slovakia	2,372	45 ± 8	19 ± 21	45 ± 32	27 ± 10	29 ± 11	15 ± 11	26 ± 4	11 ± 11	30 ± 22	25 ± 10	33.6 ± 1.8
	Slovenia	2,586	44 ± 7	24 ± 18	32 ± 14	50 ± 8	41 ± 10	10 ± 22	25 ± 4	23 ± 14	57 ± 19	20 ± 6	33.7 ± 1.7
	Spain	35,557	30 ± 2	21 ± 3	14 ± 4	40 ± 3	39 ± 3	11 ± 6	22.6 ± 1.3	31 ± 3	29 ± 3	20 ± 2	34.1 ± 0.5
	Sweden	14,872	26 ± 4	29 ± 4	23 ± 11	34 ± 5	25 ± 5	28 ± 11	23 ± 2	47 ± 6	34 ± 3	27 ± 4	38.8 ± 0.7
	United Kingdom	73,621	28.7 ± 1.6	38 ± 2	23 ± 2	37 ± 2	28 ± 2	26 ± 3	21.5 ± 1.0	43.2 ± 1.8	32.0 ± 1.4	24.9 ± 1.2	38.3 ± 0.3
Total EU28		**337,231**	**30.5 ± 0.6**	**28.3 ± 1.0**	**22.9 ± 1.3**	**37.5 ± 0.9**	**32.1 ± 0.9**	**20.7 ± 1.7**	**24.0 ± 0.4**	**40.1 ± 1.0**	**30.7 ± 0.9**	**24.9 ± 0.7**	**34.9 ± 0.2**
	Albania	87					20 ± 44		50 ± 92		33 ± 67		29 ± 10
	Bosnia and Herzegovina	362	30 ± 21		100 ± 3	43 ± 42	13 ± 19		60 ± 34	14 ± 32		24 ± 18	38 ± 5
	Iceland	554	38 ± 29	13 ± 29	22 ± 31	42 ± 18	71 ± 39		18 ± 13	47 ± 27	59 ± 19	48 ± 21	49 ± 4
	Israel	8,450	42 ± 5	47 ± 6	33 ± 9	41 ± 5	30 ± 5	20 ± 9	24 ± 2	52 ± 5	38 ± 6	29 ± 4	42.0 ± 1.0
ERA	Liechtenstein	40	67 ± 68			100 ± 25			45 ± 31				50 ± 16
Associated	FYR Macedonia	255	45 ± 33			40 ± 51	60 ± 34		36 ± 18	33 ± 67		25 ± 27	34 ± 6
Countries	Montenegro	104	75 ± 27			54 ± 29	18 ± 26		29 ± 39				37 ± 9
	Norway	7,280	36 ± 5	27 ± 8	13 ± 9	39 ± 7	34 ± 7	36 ± 12	22 ± 4	40 ± 7	34 ± 4	28 ± 5	39.9 ± 1.1
	Rep. of Moldova	160	13 ± 28				50 ± 47		25 ± 11				33 ± 7
	Serbia	2,997	32 ± 6	27 ± 30	46 ± 20	38 ± 10	32 ± 6		26 ± 5	37 ± 18	17 ± 17	11 ± 7	26.8 ± 1.5
	Switzerland	16,896	33 ± 4	37 ± 4	15 ± 9	42 ± 5	30 ± 5	18 ± 10	20.8 ± 1.6	47 ± 5	36 ± 5	33 ± 5	39.2 ± 0.7
	Turkey	17,420	30 ± 3	20 ± 9	34 ± 12	34 ± 4	36 ± 4	37 ± 23	23 ± 3	30 ± 8	24 ± 5	35 ± 4	27.9 ± 0.6
Total ERA		**373,197**	**30.7 ± 0.6**	**28.6 ± 1.0**	**22.8 ± 1.2**	**37.5 ± 0.9**	**32.3 ± 0.8**	**20.9 ± 1.6**	**23.9 ± 0.4**	**40.2 ± 1.0**	**30.6 ± 0.8**	**25.7 ± 0.7**	**34.7 ± 0.1**
Others	Brazil	26,158	26 ± 3	31 ± 5	7 ± 4	38 ± 4	30 ± 4	8 ± 9	22.1 ± 1.8	33 ± 6	5.5 ± 1.0	9 ± 2	24.9 ± 0.5
	Canada	41,114	31.8 ± 1.7	36 ± 3	32 ± 5	39 ± 2	36 ± 3	25 ± 5	23.9 ± 1.5	49 ± 2	37.0 ± 1.9	30 ± 2	42.4 ± 0.5
	Japan	58,527	29.3 ± 1.4	36 ± 3	37 ± 14	24 ± 2	24 ± 2	26 ± 21	17.4 ± 0.8	42 ± 4	21 ± 3	25 ± 5	28.8 ± 0.3
	United States	258,815	38.9 ± 0.9	43.6 ± 1.1	29.7 ± 1.9	43.8 ± 1.1	34.9 ± 1.1	26.7 ± 1.9	26.9 ± 0.6	52.7 ± 1.0	44.8 ± 0.8	35.2 ± 0.8	46.3 ± 0.2
World		**1,000,000**	**24.0 ± 0.3**	**25.2 ± 0.5**	**23.3 ± 0.9**	**30.6 ± 0.5**	**31.0 ± 0.5**	**22.6 ± 1.1**	**23.3 ± 0.3**	**44.0 ± 0.7**	**33.7 ± 0.5**	**28.4 ± 0.5**	**32.5 ± 0.1**

Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

Table XIII Proportion of OA papers per country and field of science, 6-year non-weighted sampling, 2008–2013

Group	Country	Total number of papers in sample	Agriculture, Fisheries & Forestry	Biology	Biomedical Research	Built Environment & Design	Chemistry	Clinical Medicine	Communication & Textual Studies	Earth & Environmental Sciences	Economics & Business	Enabling & Strategic Technologies	General Arts, Humanities & Social Sciences	Visual & Performing Arts
	Austria	8,764	45 ± 6	64 ± 5	69 ± 3	56 ± 20	36 ± 4	48.2 ± 1.7	31 ± 17	68 ± 5	61 ± 6	45 ± 5	46.2	30.3
	Belgium	13,147	49 ± 4	70 ± 3	72 ± 2	56 ± 11	44 ± 3	55.9 ± 1.5	34 ± 7	67 ± 4	63 ± 5	53 ± 4	40.5	16.5
	Bulgaria	1,707	62 ± 10	65 ± 9	43 ± 8	40 ± 49	37 ± 7	45 ± 6	50 ± 59	43 ± 14	44 ± 24	45 ± 7	20	
	Croatia	2,954	67 ± 6	78 ± 6	71 ± 7	50 ± 93	45 ± 6	51 ± 3	44 ± 20	62 ± 11	80 ± 7	53 ± 9	64.7	24.1
	Cyprus	584	38 ± 29	64 ± 21	71 ± 16	17 ± 37	57 ± 15	50 ± 11	11 ± 25	61 ± 16	51 ± 16	27 ± 16	23	14
	Czech Republic	7,637	57 ± 4	65 ± 4	56 ± 4	38 ± 18	39 ± 3	32 ± 2	4 ± 10	59 ± 6	66 ± 7	49 ± 5	45	1.2
	Denmark	9,097	40 ± 4	69 ± 4	69 ± 3	35 ± 11	35 ± 4	52.5 ± 1.7	34 ± 12	58 ± 5	51 ± 5	46 ± 4	34.3	22.8
	Estonia	932	62 ± 14	76 ± 8	68 ± 10	33 ± 34	39 ± 15	56 ± 8	38 ± 26	75 ± 10	52 ± 19	46 ± 13	86.9	20
	Finland	7,414	51 ± 5	68 ± 4	72 ± 3	32 ± 12	32 ± 5	52 ± 2	43 ± 13	61 ± 5	44 ± 5	41 ± 5	59.4	26.6
	France	48,991	46 ± 2	69.2 ± 1.9	67.6 ± 1.3	40 ± 7	33.9 ± 1.4	43.3 ± 0.8	11 ± 3	69.2 ± 1.8	52 ± 3	44.2 ± 1.8	22.9	11.5
	Germany	66,268	37 ± 2	64.7 ± 1.7	66.5 ± 1.1	31 ± 6	31.1 ± 1.2	41.3 ± 0.7	22 ± 4	64.6 ± 1.7	63 ± 2	41.7 ± 1.5	29.1	14.3
	Greece	8,043	42 ± 6	58 ± 6	62 ± 4	41 ± 14	34 ± 4	50.9 ± 1.8	38 ± 19	62 ± 6	51 ± 6	44 ± 4	24.6	20
	Hungary	4,559	44 ± 7	67 ± 5	69 ± 5	65 ± 22	35 ± 4	59 ± 3	45 ± 19	59 ± 7	68 ± 10	55 ± 7	51.7	60.8
	Ireland	5,150	45 ± 5	74 ± 7	73 ± 4	34 ± 15	44 ± 5	55 ± 2	33 ± 15	63 ± 7	57 ± 7	61 ± 6	43.8	21.3
EU28	Italy	39,117	47 ± 3	63 ± 2	62.3 ± 1.6	41 ± 7	34.5 ± 1.7	49.7 ± 0.8	24 ± 7	61 ± 2	60 ± 3	45 ± 2	35.2	11.5
&	Latvia	387	55 ± 33	68 ± 19	76 ± 20		34 ± 16	75 ± 10	50 ± 85	67 ± 35	63 ± 39	32 ± 17		25
ERA	Lithuania	1,434	72 ± 8	50 ± 15	58 ± 10	18 ± 20	63 ± 8	72 ± 7	57 ± 38	65 ± 15	65 ± 14	31 ± 10		
	Luxembourg	417	80 ± 44	68 ± 21	83 ± 10		59 ± 25	53 ± 10		67 ± 30	59 ± 18	55 ± 23	67	
	Malta	140	33 ± 66	67 ± 45	78 ± 31			67 ± 13		67 ± 28		50 ± 60		33
	Netherlands	23,564	50 ± 4	77 ± 3	77.3 ± 1.7	52 ± 7	46 ± 3	61.5 ± 1	48 ± 8	69 ± 3	63 ± 3	54 ± 3	50.6	21
	Poland	15,628	53 ± 3	63 ± 3	57 ± 3	16 ± 8	29 ± 2	44.2 ± 1.4	16 ± 8	49 ± 4	43 ± 10	42 ± 3	43.6	33.3
	Portugal	7,190	62 ± 5	73 ± 4	69 ± 4	49 ± 11	52 ± 4	61 ± 3	50 ± 19	61 ± 5	62 ± 6	53 ± 4	37.5	40
	Romania	5,105	65 ± 12	76 ± 8	76 ± 5	23 ± 16	50 ± 3	54 ± 4	33 ± 19	63 ± 8	26 ± 5	42 ± 4	42	33
	Slovakia	2,372	57 ± 8	63 ± 9	60 ± 7	8 ± 17	35 ± 6	36 ± 4		67 ± 9	49 ± 17	42 ± 8	33	27
	Slovenia	2,586	65 ± 7	72 ± 9	61 ± 7	26 ± 21	42 ± 6	53 ± 4	16 ± 11	51 ± 10	61 ± 11	46 ± 7	13	29
	Spain	35,557	47 ± 2	67 ± 2	67.3 ± 1.6	34 ± 6	36.2 ± 1.6	45.6 ± 1	21 ± 4	55 ± 3	49 ± 3	45 ± 2	42	13
	Sweden	14,872	50 ± 5	71 ± 3	71 ± 2	38 ± 10	35 ± 3	57.7 ± 1.4	33 ± 11	57 ± 4	53 ± 4	42 ± 3	40	12.4
	United Kingdom	73,621	44 ± 2	70.5 ± 1.6	73.2 ± 1	38 ± 3	36 ± 1.5	55.7 ± 0.6	29 ± 3	62.3 ± 1.7	55.1 ± 1.6	47.9 ± 1.7	35.8	28.2
Total EU28		**337,231**	**45.9 ± 0.9**	**65.4 ± 0.7**	**65.8 ± 0.5**	**36.5 ± 1.9**	**34.9 ± 0.6**	**46.5 ± 0.3**	**25.3 ± 1.5**	**59.3 ± 0.8**	**53.6 ± 0.9**	**44 ± 0.7**	**35.7**	**21.4**
	Albania	87	83 ± 37	88 ± 28	75 ± 54		33 ± 44	53 ± 28		70 ± 32	33 ± 68	12 ± 17		
	Bosnia and Herzegovina	362	88 ± 29	67 ± 23	57 ± 43		73 ± 24	69 ± 7		50 ± 46	80 ± 44	50 ± 31		
	Iceland	554	63 ± 17	58 ± 18	79 ± 11		77 ± 26	60 ± 7	100 ± 50	58 ± 18	41 ± 19	63 ± 26	17	60
	Israel	8,450	52 ± 7	62 ± 5	71 ± 3	59 ± 16	34 ± 5	52.4 ± 1.9	39 ± 12	67 ± 7	60 ± 6	47 ± 5	27.6	17.6
ERA	Liechtenstein	40					75 ± 53	50 ± 40			75 ± 34			
Associated	FYR Macedonia	255	90 ± 23	53 ± 25	77 ± 19		72 ± 19	72 ± 11		100 ± 5	78 ± 31	54 ± 30	67	
Countries	Montenegro	104	67 ± 68	87 ± 20	33 ± 68			72 ± 18			50 ± 92	38 ± 37		
	Norway	7,280	49 ± 5	66 ± 4	70 ± 4	40 ± 16	31 ± 6	57 ± 2	33 ± 11	64 ± 4	56 ± 5	49 ± 5	42	21.1
	Rep. of Moldova	160					36 ± 16	67 ± 45		100 ± 13		56 ± 20		
	Serbia	2,997	70 ± 8	76 ± 6	74 ± 8	50 ± 61	60 ± 5	63 ± 3	29 ± 39	35 ± 11	68 ± 15	54 ± 6	50	
	Switzerland	16,896	39 ± 4	74 ± 3	74 ± 2	45 ± 12	41 ± 3	53.9 ± 1.3	28 ± 10	66 ± 3	62 ± 5	55 ± 3	37.5	15.1
	Turkey	17,420	58 ± 3	62 ± 4	53 ± 3	24 ± 6	40 ± 3	44.7 ± 1.1	47 ± 15	49 ± 4	44 ± 5	35 ± 2	30.9	6.9
Total ERA		**373,197**	**46.7 ± 0.8**	**65 ± 0.7**	**65.5 ± 0.5**	**35.8 ± 1.8**	**35.1 ± 0.5**	**46.5 ± 0.3**	**25.9 ± 1.5**	**58.9 ± 0.8**	**53.4 ± 0.9**	**43.6 ± 0.6**	**35.3**	**19.8**
Others	Brazil	26,158	72.3 ± 1.4	70 ± 1.8	66.9 ± 1.9	21 ± 9	56 ± 2	67.2 ± 1	30 ± 13	51 ± 4	62 ± 4	56 ± 3	43.8	62.5
	Canada	41,114	51 ± 2	69.1 ± 1.9	70.1 ± 1.4	41 ± 6	35 ± 2	58.5 ± 0.9	30 ± 5	61 ± 2	53 ± 3	40 ± 2	31.5	38.9
	Japan	58,527	40 ± 2	52 ± 2	59.9 ± 1.2	37 ± 6	28 ± 1.1	42.8 ± 0.7	37 ± 11	52 ± 2	54 ± 4	38.5 ± 1.3	29.6	42.6
	United States	258,815	50.9 ± 1.1	67.7 ± 0.9	77.8 ± 0.5	37 ± 3	45.6 ± 0.8	58.5 ± 0.3	29.1 ± 1.6	66 ± 0.9	54.1 ± 1	49.8 ± 0.9	35.5	22.5
World		**1,000,000**	**47.4 ± 0.5**	**58.6 ± 0.4**	**63.6 ± 0.3**	**32.4 ± 1.1**	**34.1 ± 0.3**	**48.8 ± 0.2**	**27.9 ± 1.0**	**51.8 ± 0.5**	**49.7 ± 0.6**	**33.5 ± 0.3**	**33.8**	**22.5**

Note: No margin of error is presented for GAHSS and Visual & Performing Arts since their total populations were sampled.
Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

Table XIV Proportion of OA papers per country and field of science, 6-year non-weighted sampling, 2008–2013 (continued)

Group	Country	Total number of papers in sample	Engineering	General Science & Technology	Historical Studies	Information & Communication Technologies	Mathematics & Statistics	Philosophy & Theology	Physics & Astronomy	Psychology & Cognitive Sciences	Public Health & Health Services	Social Sciences	Total
	Austria	8,764	40 ± 5	97 ± 3	42 ± 15	60 ± 6	76 ± 5	11 ± 17	72 ± 3	54 ± 8	51 ± 9	36 ± 7	55.4 ± 1
	Belgium	13,147	52 ± 4	95 ± 3	34 ± 8	71 ± 5	76 ± 5	32 ± 8	68 ± 2	64 ± 5	60 ± 5	46 ± 5	59.6 ± 0.8
	Bulgaria	1,707	48 ± 11	26 ± 7	56 ± 36	60 ± 23	63 ± 10		64 ± 6	43 ± 42	50 ± 39	58 ± 31	49 ± 2
	Croatia	2,954	68 ± 6	89 ± 16	94 ± 3	56 ± 18	67 ± 9	62 ± 22	68 ± 6	77 ± 9	57 ± 13	65 ± 9	63.5 ± 1.7
	Cyprus	584	47 ± 17	100 ± 10	10 ± 22	77 ± 16	56 ± 21		85 ± 8	89 ± 25	70 ± 33	38 ± 13	56 ± 4
	Czech Republic	7,637	47 ± 5	96 ± 4	20 ± 12	70 ± 6	68 ± 5	13 ± 9	58 ± 3	72 ± 9	28 ± 11	33 ± 9	48.7 ± 1.1
	Denmark	9,097	45 ± 5	96 ± 3	26 ± 10	73 ± 7	74 ± 8	27 ± 14	75 ± 3	58 ± 8	63 ± 5	28 ± 5	56.4 ± 1
	Estonia	932	76 ± 13	96 ± 9	33 ± 35	73 ± 24	52 ± 21		66 ± 9	59 ± 22	64 ± 20	33 ± 15	62 ± 3
	Finland	7,414	37 ± 5	96 ± 3	36 ± 16	64 ± 6	72 ± 7	36 ± 20	67 ± 3	56 ± 8	51 ± 5	34 ± 6	55.3 ± 1.1
	France	48,991	45.1 ± 1.9	92.4 ± 1.5	17 ± 3	71 ± 2	78.9 ± 1.7	12 ± 4	66.7 ± 1.1	39 ± 3	31 ± 3	24 ± 3	52.9 ± 0.4
	Germany	66,268	30.7 ± 1.6	94.6 ± 1.1	30 ± 5	65 ± 2	75.2 ± 1.9	20 ± 5	67 ± 0.9	51 ± 2	43 ± 3	35 ± 3	50.9 ± 0.4
	Greece	8,043	42 ± 4	97 ± 5	28 ± 12	63 ± 4	58 ± 6	38 ± 29	70 ± 3	56 ± 13	50 ± 8	42 ± 8	52.8 ± 1
	Hungary	4,559	61 ± 8	95 ± 5	56 ± 13	75 ± 6	79 ± 5	38 ± 38	73 ± 3	66 ± 12	60 ± 15	49 ± 8	61 ± 1.3
	Ireland	5,150	58 ± 7	98 ± 3	33 ± 13	67 ± 7	69 ± 9	17 ± 15	78 ± 4	59 ± 10	45 ± 6	43 ± 6	58.6 ± 1.3
EU28	Italy	39,117	42 ± 2	95.7 ± 1.5	21 ± 4	60 ± 3	64 ± 2	22 ± 8	70.4 ± 1.2	54 ± 4	51 ± 4	40 ± 4	53.7 ± 0.5
&	Latvia	387	83 ± 13	100 ± 13		11 ± 16	75 ± 35		63 ± 11	100 ± 25	83 ± 36	31 ± 24	60 ± 5
ERA	Lithuania	1,434	65 ± 6	90 ± 22	67 ± 68	32 ± 9	40 ± 13	100 ± 50	56 ± 7	63 ± 37	88 ± 29	22 ± 10	57 ± 2
	Luxembourg	417	46 ± 20	82 ± 26		67 ± 20	82 ± 27	75 ± 50	66 ± 15	36 ± 32	50 ± 47	33 ± 20	61 ± 5
	Malta	140	22 ± 30	100 ± 50	25 ± 52	67 ± 44	50 ± 92		75 ± 54	100 ± 25	13 ± 28	29 ± 26	54 ± 8
	Netherlands	23,564	50 ± 3	97.1 ± 1.4	31 ± 7	74 ± 4	81 ± 5	51 ± 8	77.9 ± 1.7	67 ± 3	66 ± 3	51 ± 3	64.4 ± 0.6
	Poland	15,628	41 ± 2	88 ± 5	33 ± 18	46 ± 5	56 ± 4	46 ± 30	60.5 ± 1.9	64 ± 9	35 ± 8	33 ± 7	47.5 ± 0.7
	Portugal	7,190	46 ± 4	95 ± 4	50 ± 14	63 ± 6	68 ± 5	33 ± 35	73 ± 3	66 ± 8	59 ± 9	39 ± 8	61.5 ± 1.1
	Romania	5,105	37 ± 4	91 ± 10	10 ± 5	54 ± 8	63 ± 5	78 ± 9	64 ± 3	42 ± 21	57 ± 43	67 ± 10	51.9 ± 1.3
	Slovakia	2,372	61 ± 8	81 ± 21	45 ± 32	58 ± 11	54 ± 12	15 ± 11	60 ± 5	62 ± 16	30 ± 22	32 ± 11	48.7 ± 1.9
	Slovenia	2,586	49 ± 7	80 ± 17	39 ± 15	67 ± 8	68 ± 9	30 ± 31	60 ± 5	43 ± 17	71 ± 18	25 ± 7	52.9 ± 1.8
	Spain	35,557	38 ± 2	82 ± 3	19 ± 4	58 ± 3	64 ± 3	24 ± 8	72.1 ± 1.4	47 ± 4	56 ± 3	32 ± 3	51.6 ± 0.5
	Sweden	14,872	41 ± 4	96.8 ± 1.7	31 ± 12	65 ± 5	75 ± 5	38 ± 12	67 ± 2	56 ± 5	52 ± 3	37 ± 4	57.7 ± 0.8
	United Kingdom	73,621	42.7 ± 1.7	91.8 ± 1.2	30 ± 3	63 ± 2	73 ± 2	35 ± 4	71.2 ± 1.1	55.3 ± 1.9	44.9 ± 1.5	36.5 ± 1.3	55.9 ± 0.3
Total EU28		**337,231**	**41.2 ± 0.7**	**90.3 ± 0.7**	**28.3 ± 1.4**	**62.2 ± 0.9**	**69.4 ± 0.9**	**29.6 ± 1.9**	**64.7 ± 0.5**	**52 ± 1**	**45.7 ± 0.9**	**35.7 ± 0.8**	**51.3 ± 0.2**
	Albania	87	50 ± 93				60 ± 51	50 ± 87	100 ± 25		33 ± 67		49 ± 11
	Bosnia and Herzegovina	362	30 ± 21		100 ± 3	57 ± 42	33 ± 25		60 ± 34	57 ± 42	25 ± 53	28 ± 19	62 ± 5
	Iceland	554	54 ± 30	100 ± 6	22 ± 31	74 ± 16	86 ± 32		79 ± 14	60 ± 27	62 ± 19	65 ± 20	64 ± 4
	Israel	8,450	50 ± 5	97 ± 2	34 ± 9	78 ± 4	78 ± 4	21 ± 9	69 ± 3	58 ± 5	41 ± 7	34 ± 5	57.8 ± 1
ERA	Liechtenstein	40	67 ± 68			100 ± 25			73 ± 28				63 ± 15
Associated	FYR Macedonia	255	45 ± 33	100 ± 17		40 ± 51	70 ± 32		57 ± 19	67 ± 67	83 ± 37	42 ± 30	68 ± 6
Countries	Montenegro	104	75 ± 27		100 ± 50	77 ± 25	91 ± 21		29 ± 39				68 ± 9
	Norway	7,280	49 ± 5	97 ± 3	20 ± 11	63 ± 7	77 ± 6	41 ± 13	62 ± 4	46 ± 7	58 ± 4	37 ± 5	56.9 ± 1.1
	Rep. of Moldova	160	13 ± 28				83 ± 37		46 ± 13				44 ± 8
	Serbia	2,997	41 ± 6	82 ± 26	46 ± 20	68 ± 9	64 ± 7	29 ± 39	58 ± 5	83 ± 14	52 ± 21	31 ± 10	59.6 ± 1.7
	Switzerland	16,896	47 ± 4	94.7 ± 1.8	21 ± 10	78 ± 4	77 ± 5	26 ± 11	78.6 ± 1.6	62 ± 5	56 ± 5	48 ± 6	61.4 ± 0.7
	Turkey	17,420	35 ± 3	77 ± 9	49 ± 13	51 ± 4	61 ± 4	42 ± 24	51 ± 3	38 ± 9	32 ± 6	46 ± 4	45.7 ± 0.7
Total ERA		**373,197**	**41.1 ± 0.7**	**90.4 ± 0.7**	**28.3 ± 1.3**	**62.3 ± 0.9**	**69.2 ± 0.8**	**29.4 ± 1.8**	**64.3 ± 0.5**	**51.7 ± 1**	**45.7 ± 0.9**	**36.3 ± 0.8**	**51.1 ± 0.2**
Others	Brazil	26,158	51 ± 3	87 ± 3	69 ± 7	49 ± 4	60 ± 4	55 ± 16	69 ± 2	48 ± 7	83.4 ± 1.7	64 ± 4	66.2 ± 0.5
	Canada	41,114	37.4 ± 1.8	95.3 ± 1.4	38 ± 5	58 ± 2	70 ± 3	30 ± 5	69.6 ± 1.6	56 ± 2	52 ± 2	38 ± 2	56.2 ± 0.5
	Japan	58,527	33.6 ± 1.4	95 ± 1.4	43 ± 14	38 ± 2	61 ± 3	26 ± 21	46.6 ± 1	50 ± 4	43 ± 4	36 ± 6	44.2 ± 0.4
	United States	258,815	45.7 ± 0.9	93.4 ± 0.5	34 ± 2	63.8 ± 1.1	71.9 ± 1.1	31 ± 2	69.2 ± 0.6	57.7 ± 1	50.9 ± 0.8	42.9 ± 0.8	59.3 ± 0.2
World		**1,000,000**	**30.2 ± 0.3**	**70.8 ± 0.6**	**30.2 ± 1.0**	**48.1 ± 0.5**	**61.6 ± 0.5**	**30.2 ± 1.2**	**52.1 ± 0.3**	**52.1 ± 0.7**	**49.3 ± 0.5**	**39.0 ± 0.5**	**47.1 ± 0.1**

Source: Computed by Science-Metrix using DOAJ, PubMedCentral, and Scopus.

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