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# Availability of Open Access journals by scientific fields, specialization and Open Access regulations in the YERUN universities

## *Disponibilidade de revistas de acesso aberto por áreas científicas, especialização e regulamentos Open Access nas universidades YERUN*

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### Abstract

The availability of Open Access journals in the various fields of knowledge in Clarivate Analytics' Web of Science is hypothesized to present strong inequalities, thus affecting the choice of journals by researchers wishing to publish their research results in Open Access. The first objective of this research was to contrast this hypothesis, by crossing the list of journals available at WoS with the lists of the Directory of Open Access Journals. The availability of OA journals presents strong inequalities, ranging from 5 to 40% depending on the field of knowledge. At the level of universities, such disparity in the availability of Open Access journals is an important factor regarding their accomplishment of Open Access mandates considering their specialization profiles. In this work, as the second objective, the publications available on the Web of Science (from 2016 to 2020) of the universities belonging to the YERUN Network (Young European Research Universities) are studied in order to identify their specialization profiles, their Open Access types (and evolution) and the possible interactions between their specialization and the availability of Open Access journals and their respective fields of specialization. A general overview of the volumes of funded research and the different proportions of Open Access and non-Open Access in funded and non-funded research is also provided. The indicator "Open Access Likelihood" is introduced and applied as a proxy for the likelihood of Open Access publications taking into account the fields of specialization of the YERUN universities. The results of its application underline the need to take into consideration both, specialization and Open Access availability when designing feasible Open Access mandates. Future research includes the study of the availability of Open Access journals by tiers of impact actors.

**Keywords:** Journal Choice. Open Access. Scientific journals. Thematic specialization.

### Resumo

*A disponibilidade de periódicos de Acesso Aberto nos vários campos do conhecimento na Web of Science da Clarivate Analytics apresenta a hipótese de apresentar fortes desigualdades, afetando, assim, a escolha de periódicos por pesquisadores que desejam publicar seus*

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resultados em Open Access. O primeiro objetivo desta pesquisa foi contrastar essa hipótese, cruzando a lista de periódicos disponíveis na WoS com as listas do Directory of Open Access Journals. A disponibilidade de periódicos Open Access apresenta fortes desigualdades, variando de 5% a 40% dependendo da área do conhecimento. No nível das universidades, essa disparidade na disponibilidade de periódicos de acesso aberto é um fator importante em relação ao cumprimento dos mandatos de acesso aberto, considerando seus perfis de especialização. Como segundo objetivo deste trabalho, foram estudadas as publicações disponibilizadas na Web of Science entre 2016 e 2020 de universidades pertencentes à Rede YERUN (Young European Research Universities) a fim de identificar os seus perfis de especialização, seus tipos de Open Access (e sua evolução) e as possíveis interações entre a sua especialização e a disponibilidade de revistas Open Access em seus campos de especialização. Uma visão geral dos volumes de pesquisas financiadas e as diferentes proporções de Open Access e não Open Access em pesquisas financiadas e não financiadas também é apresentada. O indicador OAL (Open Access Likelihood) é desenvolvido e aplicado como um proxy para a probabilidade de publicações Open Access levando em consideração as áreas de especialização das universidades YERUN. Os resultados da sua aplicação sublinham a necessidade de levar em consideração tanto a especialização como a disponibilidade de Open Access ao conceber mandatos de Open Access viáveis. Pesquisas futuras poderão incluir o estudo da disponibilidade de periódicos Open Access por níveis de fator de impacto.

**Palavras-chave:** Escolha da Revista. Acesso Aberto. Revistas Científicas. Especialização Temática.

## Introduction

Open Access (OA hereafter) is an integral part of Open Science and a central topic at the European Commission's Open Science Policy Platform (Mendez *et al.*, 2020). The European Commission (2017, online) defines Open Access as "the practice of providing online access to scientific information that is free of charge to the user and is reusable". Vicente and Martínez (2018) deduced four characteristics of Open Science from the existing literature: transparent, accessible, shared, and collaborative knowledge. OA plays a prominent role as one of the pillars of Open Science (Ayris, 2018; De Filippo; Silva; Borges, 2019; De Filippo; Mañana Rodríguez, 2020): it has evolved from a final objective to a central element of the new Open Science Paradigm (Anglada; Abadall, 2018; Fressoli; De Filippo, 2021).

The rapid move of print scientific journals to online versions in the 1990s gave rise to the so-called 'serials crisis', characterized by a sudden increase in the cost of online subscription journals. An increase of over 900% in the number of OA publications followed during the 2000–2009 period (Laakso *et al.*, 2011). Drawing on the preceding developments, a set of specific declarations and initiatives began to emerge: the Budapest Open Access Initiative (2002), the Bethesda Statement on Open Access Publishing (2004), and the Berlin Declaration (2003).

The study of OA has developed in several directions. One of the most prolific lines of research is studying the growth of OA in general and the evolution of its different types. Laakso *et al.* (2011) showed figures of an 18% increase in OA journals and a 30% increase in OA articles between 2000 and 2011. From the various types of OA (see section 'Data and methodology' for full details), Gold OA shows a clear growth pattern. This type of OA implies making an article openly available on the journal's website; this is frequently, but not necessarily, preceded by the payment of Article Processing Charges (APCs). Some subscription journals provide OA to articles for which APCs have been paid. This type of OA is called Gold-Hybrid. As mentioned in the report by Crawford (2019), Gold OA has been growing at a rate of roughly 10% per year since 2014 at the Directory of Open Access Journals (DOAJ, one of the main sources of OA scientific journals). The most extensive data analysis on OA proportions (Piwowar; Priem; Orr, 2019) estimates that by 2025 44% of all journal articles and 70% of article views will be available as OA. Also, Robinson-García, Costas e van Leeuwen (2020) carried out a study on the OA volumes and types for 939 institutions using Unpaywall<sup>3</sup> as a source for OA status. Apart from the specific results, the authors point out the need for indicators and further research into the factual implementation of OA policies.

<sup>3</sup> YERUN universities with an institutional repository listed as a source at Unpaywall are: Maastricht University, University of Southern Denmark, Antwerp University, University of Ulm, Universidade Nova de Lisboa, University of Bremen, Brunel University, University of Konstanz, University of Essex, and Dublin City University. The universities without an institutional repository listed as a source at Unpaywall are: Tor Vergata University, Autonomous University of Madrid, University of Eastern Finland, Pompeu Fabra University, University of Limerick, Universidad Carlos III de Madrid, Cyprus University, University of Rijeka, and Paris Dauphine University.

Other research lines include the study of OA by countries (Archambault *et al.*, 2014), specific OA routes (Gargouri *et al.*, 2012), or the so-called 'citation advantage' of OA publications. According to Piwowar *et al.* (2018), OA articles receive 18% more citations than average, normalizing by age and field-specific citation parameters. Moya-Anegón, Guerrero-Bote e Herrán-Páez (2020) found that there is a clear difference in scientific impact for papers in OA, albeit this holds true for Green and Hybrid modes while Platinum and Gold remain below the mean of citations. Also, Bautista-Puig *et al.* (2020) found that journals flipping from non-OA to Gold OA present a statistically significant citation advantage.

## Background of this study

Open access: funding, mandates, and policies: The rapid growth of OA together with its incidence in the free online availability of research and the various declarations mentioned in the previous section have crystallized into a series of so-called OA mandates. These mandates are normative documents developed by policy makers, higher education institutions, research organizations, and research-funding organizations. They contain regulations on the OA publication of funded research. As an example of early adoption of OA mandates, the UK Higher Education Funding Council (HEFCE) requests the immediate deposit of peer-reviewed articles funded by the Council in institutional repositories since 2013. Several precedents and many other later examples of country-level mandates are available in a dynamic database (ROARMAP available at: <https://roarmap.eprints.org/>).

At the supra-national level, the various initiatives related to OA publication of publicly funded research resulted in Plan S in 2018. Plan S is an initiative backed by cOAlition S, a group of funders consisting of the European Commission, the European Research Council, and the national research agencies and funders from twelve European countries. Some other organizations have signed on to Plan S afterwards, such as the Wellcome Trust or the Research Council of Norway. It intends to provide goals and procedures for the OA publication of publicly funded research. Another relevant example is that of the European Union's Horizon 2020 research-granting scheme. Its Grant Agreement Model, art. 29.2, states that OA is compulsory for all publications derived from funded research within specific provisions. The implications of Plan S for the journals included in Clarivate Analytics' Web of Science (WoS hereafter) have also been extensively analyzed in a report by the Institute for Scientific Information (Quaderi *et al.*, 2019).

OA mandates present great diversity in terms of their degree of enforcement and technical requirements. Several studies have addressed the results of their practical implementation. Gargouri *et al.* (2012) identified a positive correlation between the strength of OA mandates and the number of OA deposits. Van Noorden (2014) pointed out some of the specific consequences of non-compliance with OA mandates by the Wellcome Trust (UK) and the National Institutes of Health (US): grant payments withholding. De Groote, Shultz and Smalheiser (2015) identified the Public Access Policy of the National Institutes of Health Central as one of the key factors contributing to the increase in the citations received by the articles available on PubMed. Some information systems, such as VIRTAs in Finland, have also rapidly adapted to the use of OA data in their Current Research Information Systems (Puuska *et al.*, 2018), both in the case of scientific journals and books (Giménez-Toledo *et al.*, 2018).

Larivière and Sugimoto (2018) analyzed more than 1.3 million papers derived from publicly-funded research by a selection of organizations from the US, UK, and Canada. They identified relevant differences in the percentages of OA and its types between funding programs, agencies, and fields of knowledge. De-Castro and Franck (2019) developed an in-depth analysis of the European Commission Pilot initiative to fund APCs associated with finished FP7 projects (*FP7 Post-Grant Open Access Pilot*). They concluded that the transference of OA funding policies to specific institutions might have a positive effect on the overall efficiency of publicly assumed APCs.

## Specialization, Open Access policies, and Open Access availability

One of the less-studied issues concerning OA is that of the availability of OA journals in scientific fields and its intersections with OA mandates, policies, and research specialization profiles. OA mandates tend to equalize the expected outcome (in general terms, the maximization of OA publications of publicly funded research) regardless of the availability of OA journals in the different fields of knowledge or the extent of such differences. In this sense, most of the mandates pointed out in previous paragraphs imply the requirement of publishing in OA – or with licenses compatible with OA publications – the publications derived from publicly funded research. The research available relating to the different impacts of OA mandates in the various fields of knowledge is focused almost exclusively on Plan S, although some early examples include the availability of OA journals by fields of knowledge when studying the various types of OA (Gargouri *et al.*, 2012).

One of the most relevant studies relating the compliance of scientific papers to Plan S and the availability of OA journals by fields of knowledge in terms of their presence in DOAJ is that of Quaderi *et al.* (2019). In this report, produced by Clarivate Analytics, the authors specifically assess how Plan S might affect the papers in different fields following the Essential Science Indicators classification (22 fields, which in 2017 left 0.2% of the indexed papers in Web of Science not classified). They point out that “[...] the papers funded by Plan S that are not published in DOAJ-listed journals might be described as ‘papers at risk’” (Quaderi *et al.*, 2019, p. 8). The analysis of the different fields of knowledge led to the conclusion that areas such as mathematics and chemistry might face difficulties to comply with the specifications of Plan S. This situation is explained by a clear imbalance between the large volume of Plan S funders acknowledged in the papers published in those fields and the limited number of DOAJ-listed journals. On the opposite end, fields such as molecular biology & genetics are in a far better position, given the availability of many OA journals in DOAJ.

Guzik and Ahluwalia (2019, p. 951) also underline the controversy generated around the way in which Plan S might affect the publication patterns of the various fields stating that “Another key criticism is that Plan S enforces the same solutions for different fields, not considering for example, that in physics most papers are published on pre-publication servers, while in informatics, publications in conference proceedings are of primary importance. Thus, not every field can be measured by the same standards”. Frantsvåg and Strømme (2019) analyze to what extent journals currently comply with Plan S using DOAJ data. They conclude that small publishers in the humanities and the social sciences might face strong difficulties in attaining compliance with Plan S requirements.

As shown in the previous paragraphs, disciplinary differences in the availability of OA journals have been the object of limited study. One dimension that has not been included in previous analyses to the best of the authors’ knowledge is how the output of different organizations is affected by their specialization. The disciplinary specialization is a relevant variable for any research, policymaking, and evaluation of scientific publications, particularly at the level of universities and/or research organizations, since many of the characteristics of research and, therefore, its associated publications are field-specific (from citation habits to publication channels: Robinson-García; Calero-Medina, 2014). Assuming that most OA mandates have the general aim of maximizing the volume of OA publications, and given the existing evidence of potential differences between fields of knowledge, it remains unknown how OA mandates might affect different organizations, specializing in different fields.

In this research, we explore the variability in the availability of OA journals in different fields in combination with the thematic specialization of a set of universities with the ultimate objective of obtaining evidence leading to a nuanced design of OA policies, mandates and regulations.

The Young European Research Universities Network (YERUN hereafter) is an organization comprised of 18 research-oriented European universities of recent creation with the aim of establishing strategic collaboration among their members. It has set up strategic actions in Education Collaboration, EU Policy, Graduate Employability, Research

Collaboration, and Open Science (<https://www.yerun.eu/about-yerun/>). Of particular interest for this research, the Open Science Statement of YERUN includes the following text regarding Open Access: “YERUN members will have a (new or renewed) policy on Open Science, which includes the objective of having all publications (publically funded research) 100% Open Access by 2020” (Yerun, 2020, p. 2). The overarching nature of this policy makes it possible to analyze the intersections between specialization and the availability of OA journals in the framework of such specific regulation of OA publication practices.

The universities in the YERUN network include institutions with different profiles, specializing in different fields. Such specialization might imply different starting positions concerning the accomplishment of OA goals if the percentages of OA journals across fields are not the same. Universities specializing in fields where OA journals are more abundant have a better starting position for the accomplishment of policies fostering OA publication than universities specializing in fields where OA journals are scarcer, in a similar fashion to the observations of Quaderi *et al.* (2019). I concerning Plan S, as well in the open letter Plan S open letter (2018). The YERUN network presents a common OA policy and a diversity of research specialization profiles, allowing the study of the interactions between specialization, OA publication, and OA policy. A first analysis of the current OA policies of YERUN universities, their implementation, and the scientific output of the Network published in OA was carried out by De Filippo and Jorge Mañana Rodríguez in 2020 (De Filippo; Mañana-Rodríguez, 2020), finding a close correspondence between both realms (OA policies and OA output for YERUN universities). However, the relationship between the specialization profiles and the availability of OA journals has not been studied. This relationship is hypothesized to be an important factor for the elaboration of OA policies at the network’s level, as well as potentially for its integrating institutions.

## Objectives

The main objective of this work is a) to present evidence of the different starting points of the YERUN universities regarding OA publication (and, thus the accomplishment of the OA mandates), b) to analyze the extent of such different initial situations, and c) to extract conclusions on the relevance of the specialization and OA availability in the design of OA policies. Given the relationship between funding and OA publication (Belli *et al.*, 2020) we also included information concerning the percentages of funded research and the percentages of OA in funded and non-funded research, by university.

## Data and methodology

Data sources: The main data source for the current study is the Web of Science (WoS), one of the largest commercial bibliometric databases. Developed by Clarivate Analytics, this database contains information on the articles of over 21,100 scientific, peer-reviewed journals including the citations received and the OA type of each article for over 12 million articles. Within Web of Science, three sub-databases from its core collection have been used: Social Sciences Citation Index, Science Citation Index (expanded), and Arts & Humanities Citation Index. This source was chosen because of its large coverage of the scientific literature and the immediate availability of OA types at the level of articles, and the selection of the three sub-databases is dictated by the fact that they concentrate the greatest proportion of documents with OA information (journal articles). YERUN OA policies do not make an explicit distinction between publication channels (*i.e.*, scholarly books). At the same time, the majority of OA mandates refer mainly to journal articles. This is another reason for the use of the above-mentioned source.

In this report, we will use the definitions of OA types specified by Web of Science (<https://clarivate.com/webofsciencegroup/release-notes/wos/new-wos-july-22-release-notes/>), which coincide with the definitions given by the original provider of the data, the nonprofit organization OurResearch:

- Gold (formerly DOAJ Gold): Identified as having a Creative Commons (CC) license by OurResearch Unpaywall Database. All articles in these journals must have a license in accordance with the Budapest Open Access Initiative to be called Gold.

- Gold-Hybrid (formerly Other Gold): Items identified as having a Creative Commons (CC) license by OurResearch but that are not in journals where all content is Gold.

- Free-to-Read (formerly Bronze): The licensing for these articles is either unclear or identified by OurResearch as non-CC license articles. These are free-to-read or public access articles located on a publisher's site.

- Green Published: Final published versions of articles hosted on an institutional or subject-based repository (e.g., an article out of its embargo period posted to PubMed Central).

- Green Accepted: Accepted manuscripts hosted on a repository. Content is peer-reviewed and final, but may not have been through the publisher's copy-editing or typesetting processes.

- Green Submitted: Original manuscripts submitted for publication, but have not been through a peer-review process.

Essential Science Indicators (ESI) Master Journal List: Web of Science provides a classification scheme with 254 categories. Any given journal can be classified into up to four categories. For the purposes of this article, all the journals retrieved from queries to the database have been crossed with the master journal list of Essential Science Indicators (ESI). This product of Web of Science contains a thematic classification of 11,855 journals into 22 research fields, with each journal classified into a single field, according to the citation patterns of the journal. This classification was found to be more suitable for the analysis of the output studied in this report. ESI does not employ a category for journals in the humanities; this has been taken into account by considering the journals without a match between the two lists (WoS Core Collection results and ESI journal master list) as belonging mainly to fields of the humanities. This assumption can be made with reasonable accuracy since both the ESI journal master list and WoS Core Collection queries are based on the same set of journals (WoS Core Collection), the ESI journal master list being a sub-set of the journals indexed in WoS Core Collection. The ISSN, e-ISSN (electronic ISSN), and source title were used (simultaneously) to retrieve the ESI fields for all the WoS registers queried. The classification of fields using the ESI scheme, grouping the journals not classified as 'Other fields (mainly humanities)' is referred to here as 'ESI +1'.

Directory of Open Access Journals (DOAJ): in order to identify the percentages of OA journals in each ESI field, the Directory of Open Access Journals was used. This source contains data on OA journals (over 16,000) and articles (over 6 million) and is used by the classification scheme of WoS regarding various types of OA articles. The full list of the journal's metadata was recovered from the website [doaj.org](http://doaj.org).

Data retrieval and processing: In order to obtain the metadata of the registers indexed in the WoS Core Collection for each university, the OG command of the advanced search was used. OG (organization enhanced) allows obtaining all records of a given organization, normalizing the diverse name variants of affiliations mentioned in the publications<sup>4</sup>. Using this command and the years 2016-2020 (in order to count with data that shows recent trends), the full set of records for each university (including all document types) was retrieved in June 2021.

The records contain numerous fields, from which the ones used for the elaboration of this report were: source title, ISSN, e-ISSN, OA type, and publication year. The ESI list and DOAJ lists were crossed in order to identify the percentages of OA journals within each ESI category using the ISSN, e-ISSN, and source titles. The Gini index of inequality was calculated for the distribution of documents across fields, in order to provide an overview of the

<sup>4</sup> Note on the data for Université Paris Dauphine: Due to a merger between Université Paris Dauphine and PSL University in 2018, it was checked if the registers contained in Web of Science as a result of querying the database using the OG (organization enhanced) command included those of PSL Research University. The analysis of the results of the query by 'Universite Paris Dauphine' produced 1073 records with that affiliation, and 1006 with the affiliation 'PSL Research University Paris Comue', allowing to conclude that the denomination used in the OG command did include PSL University. Despite this check, it cannot be assured that the data obtained under the OG command is completely accurate.

concentration of outputs and relative specialization. Also, the mean percentage of OA journals per ESI field was calculated. This allowed us to characterize each field as being over, equal to, or below the mean share of OA journals.

Open Access Likelihood Indicator (OAL): In order to resume the availability of OA journals taking into account the distribution of publications across fields for a given unit of analysis, we introduce an Open Access Likelihood (OAL) indicator.

If we have  $n$  disciplines, the disciplinary open access likelihood to publish in an open-access journal in discipline  $i$  ( $i=1, \dots, n$ ) is the fraction of open access journals in that discipline  $OAJ_i$  versus the total number of journals in the discipline, denoted by  $J_i$ . The likelihood for a given university to publish in an open-access journal is then the weighted average of disciplinary open access likelihoods, weighted by the university's share of publications in each discipline, expressed as a percentage:

$$OAL = \sum_{i=1}^n \left( \frac{P_i \cdot OAJ_i}{\sum_k P_k \cdot J_i} \right) = \frac{\sum_{i=1}^n P_i (OAJ_i / J_i)}{\sum_{i=1}^n P_i}$$

OAL represents the expected percentage of publications in open access journals given differences between disciplines and the university's research profile if publications were randomly assigned to journals. Note, however, that OAL does not take size differences between journals into account.

The Table 1 presents an example of the calculation of the indicator:

**Table 1** – Example of the calculation of the OAL indicator.

Field of knowledge	Publications (%)	OA journals (%)	OAL
Agricultural sciences	10	30	3
Biology & biochemistry	20	10	2
Chemistry	30	20	6
Clinical medicine	40	40	16
OAL sum	.....	.....	27

Note: the values of the artificial field 'Other fields (mainly humanities)' are not included in the calculation of the indicator.

Source: Developed by the authors (2021).

The value of OAL for the university is 27, the sum of the partial OAL values for each field of knowledge.

The partial value of OAL for Agricultural Sciences (3) is calculated as the percentage that the percentage of publications in that field (10) represents with respect to the % of OA journals available in that field (30), *i.e.*, the 10% of 30.

The indicator ranges from 0 to 100. 0 indicates that the unit of analysis counts with publications only in fields with 0 availability of OA journals. 100 indicates that the unit of analysis counts with all the publications published in fields where the availability of OA journals is 100%.

The indicator is not intended as a performance indicator, but rather a proxy descriptor for the availability of OA journals for a unit of analysis (universities in this case) given its past distribution of outputs by fields. Also, the indicator is not intended to present predictive capacity over other variables. Finally, it is acknowledged that taking into account Bradford's Law, a Pareto distribution is expected in the scattering of articles in journals for any given field: for this reason as well as for the unknown influence of factors affecting the choice of journals by authors (such as OA mandates and regulations), the indicator is intended to be a proxy of an initial situation of OA availability given a certain distribution of outputs by field of knowledge, instead of an exact measure.

In order to process the information regarding the funding, we used the field tagged as 'FU' in WoS downloaded registers, crossing this data with the OA status of the entry.

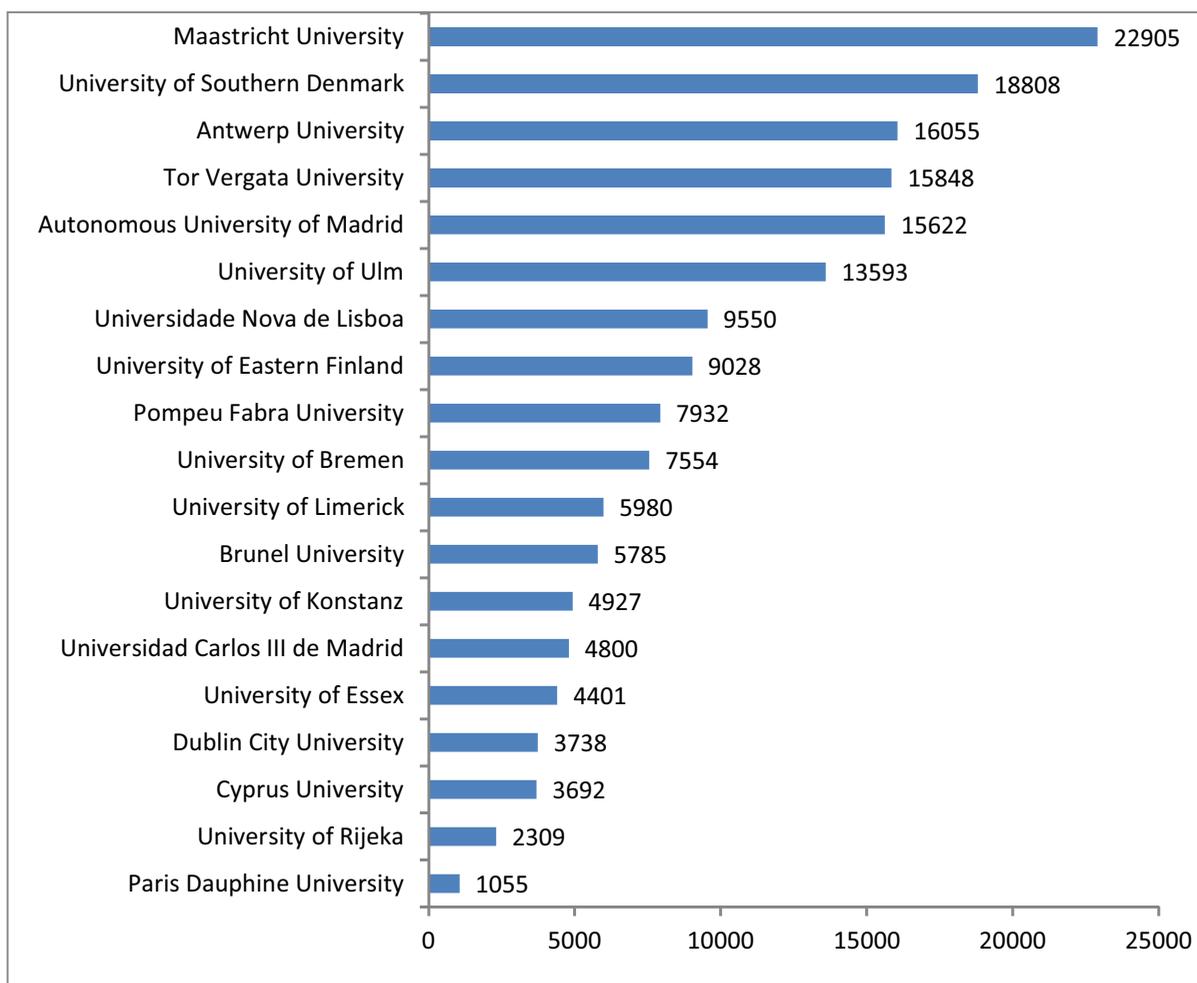
## General overview

### Total output

Figure 1 presents the total number of publications by university for the period 2016-2020. The volume of publications presents a wide range, between 1055 articles for Paris Dauphine University to 22905 for Maastricht University.

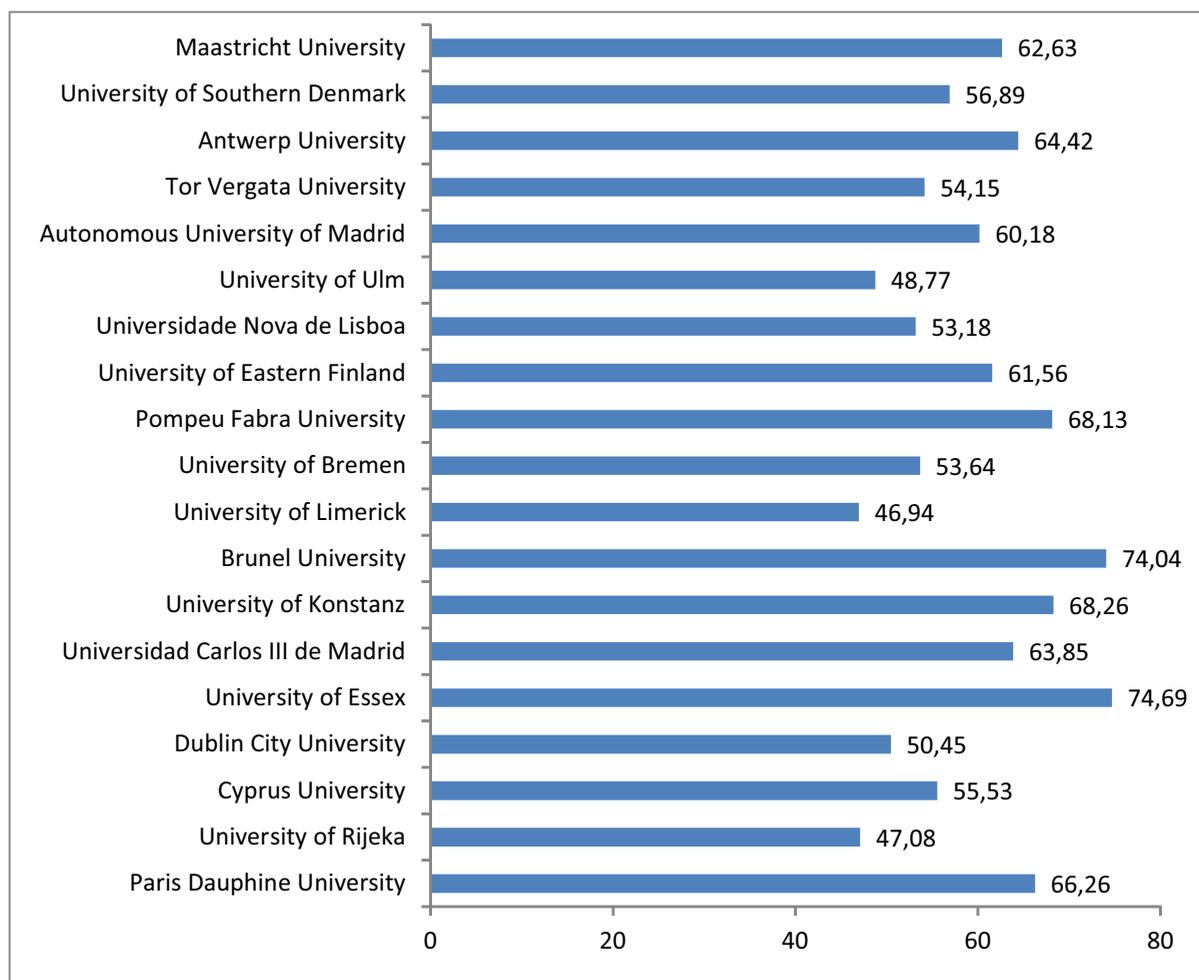
### % of OA publications

The total percentages of OA publications by university show a smaller range than the total output, which varies from 46.94 in the case of the University of Limerick to 74.69 in the case of the University of Essex (Figure 2).



**Figure 1** – Total output by university (2016-2020).

Source: Developed by the authors (2021).



**Figure 2** – Percentages of OA publications by university (2016-2020).

Source: Developed by the authors (2021).

## Types of OA by university

Table 2 presents the percentages of OA by university and OA type for the period 2016-2020; in bold are the percentages over the mean for the column. The percentages do not add to 100 because there is overlap between the various types of OA (i.e., the various types of Green OA). Of particular interest are the percentages of publications in the Gold-Hybrid route, which implies the payment of APCs and ranges from 6.33% for Universidad Carlos III of Madrid to 29.56 in the case of Maastricht University.

## Specialization

### Gini Index

The Gini Index indicator ranges from 0 to 100, indicating full equality (i.e. all outputs are equally distributed across fields) and full inequality respectively. Of particular interest for this research are the smaller values: a greater

**Table 2** – Distribution of percentages of OA types by university. Values in bold represent percentages that exceed the mean of the column.

University	Gold (%)	Gold-Hybrid (%)	Free to Read (%)	Green Published (%)	Green Accepted (%)	Green Submitted (%)
Maastricht University	30.45	<b>29.56</b>	<b>20.88</b>	66.39	13.23	21.11
University of Southern Denmark	34.09	14.2	2.29	<b>60.91</b>	13.29	<b>36.18</b>
Antwerp University	30.39	14.03	<b>13.72</b>	<b>55.61</b>	<b>45.3</b>	31.97
Tor Vergata University	<b>39.03</b>	13.15	1.71	<b>61.58</b>	21.65	<b>50.98</b>
Autonomous University of Madrid	<b>42.42</b>	13.02	<b>14.03</b>	58.87	28.24	52.43
University of Ulm	<b>38.63</b>	<b>19.08</b>	<b>24.39</b>	<b>60.52</b>	13.06	27.36
Universidade Nova de Lisboa	<b>48.91</b>	12.52	12.52	<b>64.44</b>	20.75	<b>42.65</b>
University of Eastern Finland	33.07	<b>20.08</b>	<b>16.93</b>	<b>62.27</b>	21.39	27.94
Pompeu Fabra University	<b>39.91</b>	13.05	<b>16.71</b>	<b>63.05</b>	3.07	<b>35.81</b>
University of Bremen	<b>40.89</b>	<b>19.99</b>	13.1	50.02	19.42	<b>42.89</b>
University of Limerick	25.44	11.15	<b>18.1</b>	46.17	23.98	4.06
Brunel University	28.44	<b>29.23</b>	7.21	<b>55.99</b>	<b>36.26</b>	<b>56.08</b>
University of Konstanz	29.47	<b>17.93</b>	12.76	<b>56.08</b>	12.88	<b>55.49</b>
Universidad Carlos III de Madrid	29.53	6.33	8.19	35.82	<b>34.49</b>	<b>47.21</b>
University of Essex	20.14	17.16	8.61	32.7	<b>85.52</b>	28.81
Dublin City University	27.57	10.92	11.72	43.43	<b>34.36</b>	<b>38.23</b>
Cyprus University	<b>40.93</b>	<b>17.76</b>	11.61	<b>60.73</b>	<b>41.12</b>	<b>60.1</b>
University of Rijeka	<b>57.02</b>	8.11	<b>16.22</b>	<b>54.32</b>	11.51	<b>36.36</b>
Paris Dauphine University	10.01	11.16	<b>16.74</b>	14.45	8.73	<b>81.69</b>
Mean percentage (for all YERUN output)	35.47	17.62	13.19	53.19	24.59	35.16

Source: Developed by the authors (2021).

specialization in a limited number of fields implies a greater sensitivity to the availability of OA journals in those fields, considering the unit of analysis as a whole. The values of the Gini Index for the distribution of articles across fields by university (2016-2020) range from 0.66 for the Autonomous University of Madrid to 0.77 for Paris Dauphine University (Mean=0.71, SD=0.03).

## Open Access availability

The Figure 3 provides an overview of the different proportions of OA journals available in the various ESI fields. These range between 5.54% in Economics and business and 41.67% in multidisciplinary (31.01% in Microbiology). In other words, a WoS-indexed journal in Microbiology is 5.6 times more likely to be OA than one in Economics & Business.

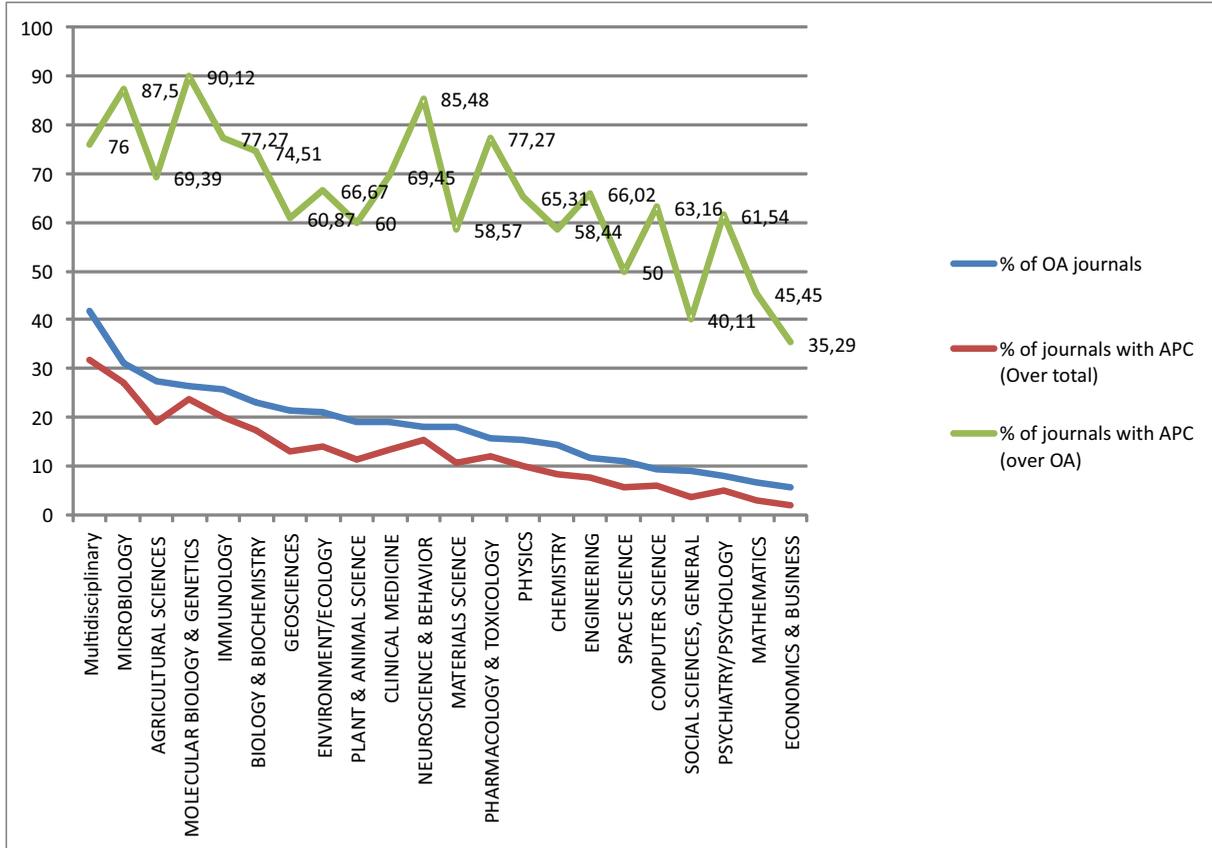
The Pearson correlation between the % of OA journals and the % of journals with APCs is 0.71. This implies that, in general, the fields with greater proportions of OA journals also represent greater proportions of journals with APCs. The mean value of OA by field is 18.11 (SD=8.89).

It is important to mention that the volume of APC journals in ESI fields is 65.38, in clear contrast with the 28.7% in DOAJ<sup>5</sup>. The proportion of APC journals in WoS seems to be significantly greater than among the OA journals in general (assuming the large coverage of DOAJ).

## Specialization and Open Access availability by field

The Table 3 shows the values of OAL for the YERUN universities. These range from 9.25 for Paris Dauphine University with 9.25 to 18.49 for the University of Eastern Finland. The indicator shows a proxy of the effective

<sup>5</sup> This value has been obtained from the publicly available DOAJ metadata, downloaded in August, 2021.



**Figure 3** – Distribution of the % of OA journals, % of journals with APC (over total), and percentage of journals with APC (over OA) for the ESI fields.

Source: Developed by the authors (2021).

**Table 3** – OAL indicator by university.

University	OAL
Paris Dauphine University	9.25
University of Essex	12.33
Universidad Carlos III de Madrid	12.41
Brunel University	13.78
Cyprus University	13.83
Dublin City University	13.91
University of Rijeka	14.09
University of Limerick	15.23
University of Konstanz	16.6
Universidade Nova de Lisboa	16.68
Autonomous University of Madrid	16.97
Tor Vergata University	17.08
University of Bremen	17.09
University of Southern Denmark	17.57
Antwerp University	17.6
Maastricht University	17.83
University of Eastern Finland	18.49
University of Ulm	18.5
Pompeu Fabra University	18.6

Source: Developed by the authors (2021).

availability of OA journals in combination with the relative specialization of the universities, but no significant correlation has been found between this indicator and the percentages of OA publications, except in the case of Green Published ( $Rho=0.506$ ). This lack of generalized intense correlations is, nevertheless, expectable taking into account the role that OA mandates and other regulations play in the total volume of OA outputs, together with other factors affecting the choice of journals by researchers.

## Open Access availability by fields

For the universities studied, the number of fields for which the OA availability is below the mean, from the 10 fields in which the university has more published articles ranges from 5 (University of Eastern Finland, Antwerp University, and Pompeu Fabra University) to 9 (Cyprus University). This is indicative of important differences in the availability of OA journals in the fields of specialization for the different universities.

The specialization profiles of all YERUN universities are available as an interactive chart at: <https://public.tableau.com/app/profile/huber7925/viz/ICHReport/Hoja1?publish=yes>. Clinical Medicine is one of the most frequent fields of specialization for the YERUN universities, although a notable exception is the Université Paris Dauphine, which strongly specializes in Mathematics (with only 6.55% of OA journals) and Economics & Business (with 5.54% of OA journals), which partially explains its low OAL values.

## Funding and Open Access

The percentages of funded research range from 52% in the case of the University of Essex to 72.5% in the case of the University of Bremen. The differences in the percentages of OA in funded research and non-funded research are congruent with those found in the literature (Table 4).

**Table 4** – Percentages of funded research and OA in funded and non-funded research by university (2016-2020).

University	Funded research (%)	OA in funded research (%)	OA in non funded research (%)	Difference in OA % (funded-non funded)
University of Bremen	72.51	83.16	28.61	54.55
University of Konstanz	72.49	82.44	32.12	50.32
University of Ulm	56.98	74.5	25.48	49.02
University of Eastern Finland	74.27	82.92	35.86	47.06
Pompeu Fabra University	76.13	85.06	38.11	46.95
Autonomous University of Madrid	73.37	80.77	35.72	45.05
University of Antwerp	61.79	73.84	29.46	44.38
Cyprus University	61.76	76.49	34.31	42.18
Dublin City University	62.67	71.88	30.43	41.45
Universidad Carlos III de Madrid	77.34	79.75	38.95	40.8
University of Southern Denmark	62.54	73.52	34.82	38.7
Universite Paris-Dauphine	56.52	61.54	25.55	35.99
Universidade Nova de Lisboa	71.69	75.12	39.29	35.83
Tor Vergata	50	64.03	30.87	33.16
University of Limerick	48.21	64.1	32.52	31.58
University of Rijeka	54.17	64.48	36.1	28.38
Maastricht University	53.11	63.47	42.77	20.7
Brunel University	58.28	63.23	48.9	14.33
University of Essex	52.07	60.79	55.71	5.08

Source: Developed by the authors (2021).

## Discussion and Conclusions

OA mandates often directly present overarching objectives such as the achievement of a certain percentage of OA publications, or indirectly, are intended to increase the volume of OA publications in the case of publicly funded research. In other cases, compliance with the regulations applicable to research funded by public funds implies the OA publication of the research results produced. Nevertheless, the results of this research underline one of the major difficulties researchers might encounter when trying to comply with the mandates: the different availability of OA journals in the different fields of knowledge.

The variability in the percentages of OA publications of the different universities is, by themselves, evidence of the different starting points of the institutions when dealing with the compulsory publication of part of their research in OA. The reasons for the different OA output can be numerous, including institutional regulations, national laws, and volumes of publicly funded research subject to the obligation of OA publishing but represent, in any case, different initial states of the publication output. Such initial percentages ought to be taken into account when designing any OA policy, mandate, recommendation, or strategy.

The percentages of OA journals in the various ESI fields range from approximately 5 to 41, which in terms of choice of journals by researchers is a significant difference. It is important to mention here that the different impact factors of the journals in OA and non-OA are not being taken into account in this research, but might be another conditioning factor for researchers when choosing to publish their research in OA journals. The differential availability of OA journals in the various tiers of impact factor, citation counts, and other impact or visibility indicators is particularly important if both journal or article impact and its OA status are being taken into account in evaluation processes.

The sensitivity of some universities to the availability of OA journals is also patent taking into account the Gini indexes. Their range evidences that some of the YERUN universities are highly specialized in a small number of fields. The greater or smaller OA availability of OA journals in those fields is more conditioning, in terms of compliance with OA mandates or regulations, for the highly specialized universities than for those with an ample variety of fields of knowledge. The conditioning can affect the initial position of the specialized universities in both directions: facilitating the OA publication if the fields of specialization present high levels of OA journals or making it more difficult for the specialists in those fields to publish in OA if the availability of OA journals is comparatively low.

The different starting positions of the different universities taking into account their specialization are also patent when we look at the number of fields (from the 10 with a greater volume of outputs) in which the availability of OA journals is below the mean for the 22 ESI fields. The values range from 5 to 9, showing that there is considerable variability in the initial conditions of the various universities when complying with any OA policy that does not take into account the different specialization profiles of the universities.

Although the study of the Gold-hybrid route of OA is not among the aims of this research, the observation of the important difference between the percentages of journals with APC in the ESI fields and DOAJ (65 and 28% respectively) might be related to the 'initial' availability of OA journals in the various fields. It can be hypothesized that not distinguishing the initial percentages of OA journals in different fields of knowledge in OA mandates might increase the demand for OA publications (but not necessarily OA journals) in fields where the availability of non-hybrid OA journals is limited, and contribute to an increase of Gold-hybrid publications as the expectable market reaction to such growing demand.

The differences in the share of funded research among universities imply also a different starting position concerning their total OA output. In a general conclusion, the availability of OA journals in the various fields presents important differences. At the same time, the specialization profiles of the universities studied here imply

that they depart from substantially different initial conditions for the accomplishment of OA mandates. Equal initial conditions are not realistic or always necessary for the development of research policy. Nevertheless, not considering such differences in the development of OA policies, strategies or mandates could reduce its feasibility, and might have undesirable side effects (such possible growth in Gold-Hybrid publications, that in turn would increase the expenses of OA publications covered in most cases by public research funds).

The recommendation that stems from the evidence gathered in this article consists of the analysis of the availability of OA journals (and their types) in national or regional Current Research Information Systems (Pölönen *et al.*, 2020), and international databases such as WoS or Scopus when designing OA policies, mandates or strategies in order to maximize the feasibility of their goals and minimize the foreseeable undesirable side-effects.

Limitations of this study: This research presents some caveats that, without significantly changing the conclusions, ought to be reflected here. On the one hand, the use of the Web of Science as the main source of data for this research makes it participate of its well-known biases towards the fields outside the Social Sciences and the Humanities and the publications in English. This limitation is acknowledged, but for the purposes of this research, the availability of the OA information at the article level is a very important feature that the Scopus, being the alternative source for this study, has included only recently and with a data structure that does not allow some of the analyses carried out in this research. Another source of unknown variability in the OA information of Web of Science is the fact that some institutional repositories of the YERUN universities are listed as sources on Unpaywall<sup>6</sup> whereas others are not (see Appendix I): this might affect the volume of OA articles that are then included in WoS, but the variance of this factor in the total count of OA articles is unknown.

## Contributions

J. Mañana Rodríguez has downloaded and analyzed the data, and prepared an initial draft of the manuscript. R. Guns has provided a mathematical description of the indicator and its interpretation, together with an extensive review of the initial research plan and the article draft, contributing to the inclusion of central elements of the manuscript.

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<sup>6</sup> This information was obtained from the public list of OA sources used by Unpaywall, available at <https://unpaywall.org/sources>.

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