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Scientific potential of European fully open access journals

Abstract

The scientific potential of European countries measured by their participation in publication of all peer-review journals as well as open access journals (OAJs) is significant. In this paper we focus on European fully open access journals (OAJs) as a potentially optimal channel of communication in science. We explore fully OAJs (n=1201) indexed by Scopus with several bibliometric indicators: quartile rankings, SJR (SCImago Journal Ranking) and h-index. As countries in our focus have entered EU at different times and have diverse backgrounds, we divide them into three groups: A (members before 1995), B (became members in 2004-2013 period) and C (EU candidate countries). Analysis across country groups is complemented with analysis across major subject fields. Quartile rankings indicate that journals in Q1 dominate in group A, followed by journals in Q2. In the remaining two country groups, journals belonging to Q3 have more than 50% of the share. Analysis by different scientific fields stresses that life and health sciences have the highest shares of OAJs in Q1. In physical sciences the highest share of OAJs is in Q3 while combined shares of Q2 and Q3 are above 50%. Only 10% of all European OAJs in social sciences is in Q1. Furthermore, we find the least difference between journals in group A and groups B and C in social sciences, both in respect to coverage and quality indicators. In all scientific fields median SJR indicators is, in the case of groups B and C, higher for OAJs than non-OAJs as opposed to group A.

Keywords

Open access journals, bibliometric analysis, h-index, SJR, quartiles, EU countries

Introduction

Academic journals, as the main communication channel in science ever since the 17th century, base their existence on researchers' intrinsic need to communicate research results to the rest of academic community. That is consistent with the basic ethos of science which includes openness and building on the work of others (Björk, 2017: 6). Yet, scientific information communicated through various channels, including journals are not always easily accessible for every member of research community and, in particular, not under the same conditions. Publishing of academic journals requires adequate institutional conditions, including professional competencies and stable funding. Historically, first publishers of scientific journals were academic societies which in some countries continue to have important role in publishing process. However, nowadays the most important role belongs to professional publishers. It is in particular the behaviour of professional publishers since the 1970s, when they had started to continuously increase subscription fees for scientific journals, that forced academic community to use the advantage of new technologies (in particular internet) and initiate open access (OA) (Björk et al., 2010; Schöpfel, 2015). As stated by Pisoschi & Pisoschi (2016), in that way the free access to scientific information has become the challenge of 21st century.

In fact, the first OA journals appeared in the 1990s and were predecessors of the formal beginning of OA initiative.[2] Nowadays, there is a number of different variations and hybrids of the basic, gold and green models[3] (e.g. delayed open access, open choice/author choice, etc.) that coexist in different subject fields (Houghton, 2009). According to Tennant et al. (2016) open access has become such a global phenomenon that it is crucial for all involved in scholarly publishing - policymakers, publishers, research funders, governments, academic societies, librarians, and academic communities in general - to be well-informed on the history, benefits, and drawbacks of OA. The OA initiative is rather widely defined. It relates to OA to individual publications on different platforms (from webpages to institutional repositories), OA of all articles in a journal as well as accessibility of various other types of research-related publications (including open data), and is nowadays usually covered by the term *open science* (Choudhury et al., 2014).

In 2012 European Commission released "Recommendation on the access to and preservation of scientific information" confirming the importance of OA initiative. The "Recommendation" emphasises the need for open access to results of all publicly-funded research. Such policies are intended to reduce duplication of efforts and minimise time spent on searching and accessing information (EC, 2012: 3). It is expected that these policies will speed up the scientific progress and allow for easier cooperation across and beyond the EU. The Commission stressed that as of 2014, all publications resulting from projects undertaken with the funding from the Horizon 2020 Programme will be accessible through OA (Pisoschi & Pisoschi, 2016). The largest European scholarly publishing countries strongly support open access initiative (Butler, 2016; Geismar & Küchler, 2014).

[2] The formal beginning of the OA movement is associated with the Budapest Open Access Initiative (2002) that was followed by two additional declarations: the Bethesda Statement on Open Access Publishing (2003), and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003).

[3] The gold route refers to direct payments by authors (who may be subsidised by research grants, university, etc.) to publishers to cover the costs of publication and distribution. The green route, supported by most publishers, permits authors to make available the final, accepted, but unbranded or copyedited version of the article through an institutional repository (Geismar & Küchler, 2014).

Due to multi-dimensional aspects of OA initiative, we focus in this paper only on *fully OA scientific journals* published in EU member and candidate countries. These are journals whose publishers provide immediate free access to the entire content of the journal, thereby avoiding any reliance on subscriptions or subscriber-only access (Walters & Linvill, 2011). Total number of fully OA journals (OAJ), without predatory journals (Beall, 2016) is significantly higher than the number registered in publicly available sources such as, for example, DOAJ and DOAR, or in bibliographic and citation databases like Web of Science (WoS) and Scopus. This can be illustrated by national journal portals of European countries.[4]

Although, by definition, OAJs are more accessible and consequently should be more often used than subscription-based journals, their visibility can actually be measured only after they are indexed in bibliographic and citation databases (Scopus, WoS). Significant part of research results published in OAJs that are not indexed in publicly available databases, and in particular in prestigious citation databases, remains unnoticed for international audience especially if they are not written in one of the worldwide-used languages. Visibility of these journals can potentially be accessed by altmetric indicators (Wilson, 2016), that show usability through number of *visits* or *downloads*, or in their correlation with number of citations (for example, Google Scholar). However, altmetrics is not in the focus of this paper.

An important indicator of any journal's vitality is its age. Continuous publishing of OAJs, regardless of whether they are digital-born or converted to OA, requires stable funding. Scientific fully OAJs secure continuous publishing and quality through various funding models such as APC (Article Processing Charge) model, government funding (ministries, foundations, etc.), funding through academic institutions, scholarly societies, charities, etc.). One of the goals of this paper is to see which funding model prevails in publishing and dissemination of European fully OAJs and whether different models affect the status of OAJs measured by bibliometric indicators.

More generally, our motivation aims at determining the acceptance and recognition of European fully OAJs in the academic community measured by the bibliometric indicators. The share of journals from European countries indexed in Scopus is 49% (16,426 journal titles). The fact that almost one half of all journals indexed in Scopus come from countries in our sample indicates promising scientific potential. Additionally, number of fully OAJs indexed in Scopus from countries in the sample compared to fully OAJs from the rest of the world is also relatively high and amounts to 41%.

The characteristics of European fully OAJs will be explored through the analysis of bibliometric indicators across different groups of countries, subject fields and types of publishers. We use SJR (SCImago Journal Rank), h-index and quartiles (Q) as indicators. Results of analysis should give better insight into the potential of European fully OAJs and to what extent they are accepted by academic community. Although, as the literature review in the next section shows, a number of analysis on this topic have been undertaken, comparative analysis of different bibliometric indicators through several-year-period are rare.

[4] For details, see national OAJ portals for: Croatia http://hrcak.srce.hr/?lang=en; Hungary http://www.open-access.hu/magyar_oa_folyoiratok; Poland http://pon.edu.pl/index.php/czasopisma-w-owartym-dostepiees; Slovakia http://www.cvtisr.sk/en/support-of-science/open-access/list-of-scientific-slovak-origin-open-access-journals.html?page_id=5175; Slovenia http://www.dlib.si/results/?query=%27keywords%3dSlovanske+revije%27&pageSize=25;Spain http://www.accesoabierto.net/dulcinea/?idioma=en (accessed October 11, 2016).

The paper is structured as follows. After introductory notes, second section reviews the literature followed by the description of data and methodological approach in the third section. Fourth section brings the discussion of empirical results followed by conclusions in the fifth section.

Literature review

Literature related to the OA initiative, and in particular to OAJs, can be traced back to 2001. In Scopus database we have found 537 documents whose titles include „open access journal(s)“ phrase. Among these documents over 50% are scientific articles and reviews, while about 30% are editorials, which implies strong interest of journal editors from different fields towards OA initiative. In 2001-2016 period, average annual growth rate of documents that incorporate OAJ term in their titles, amounted to over 30% (Figure 1). Such strong increase requires a more detailed literature review which will cover three main topics dominating in the literature: acceptance of OAJs in the academic community; importance of stable funding and various funding models; as well as advantages and disadvantages of OAJs.

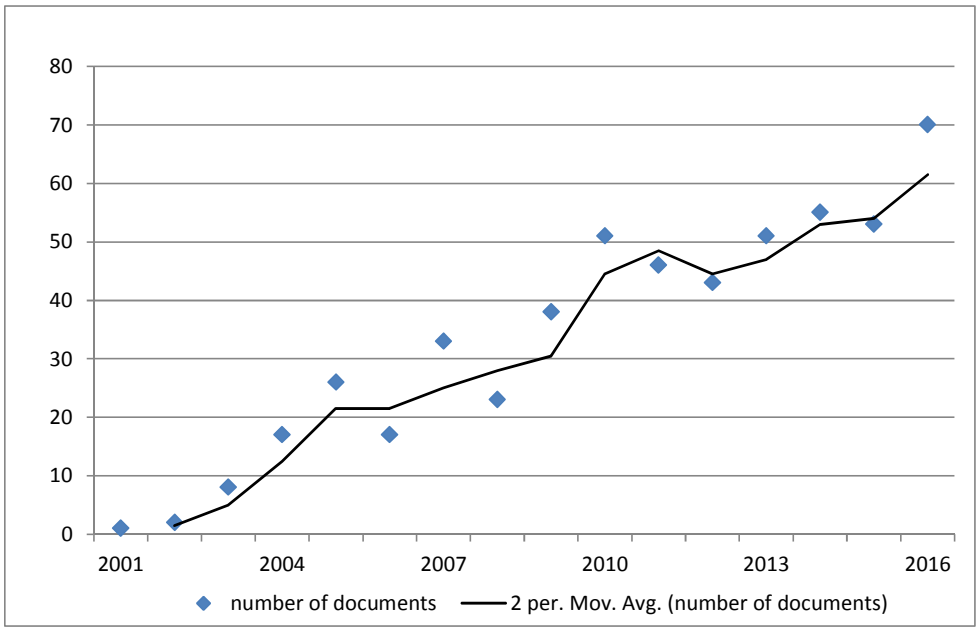


Figure 1 Scopus documents with „open access journal“ phrase in the title
Source: Scopus.

The acceptance level of OAJs is strongly affected by statements, recommendations and declarations borne within the academic community or by government bodies (Ghane & Niazmand, 2016; Arunachalam, 2008; Lawrence, 2017). Swan & Brown (2004) were among the first to explore the acceptance level of OAJs within the academic community, which depends on familiarity with the concept or with the specific OAJs in their subject field (Talja et al., 2005; Eger et al., 2015; Hrynaszkiewicz, 2016; Andreoli-Versbach & Mueller-Langer, 2014). While Sotudeh & Horri (2007) analyse the performance of OAJs in terms of expected citation rates and find that OAJs are widely recognised by academic community, McCullough (2009) claims that OAJs in economics are often perceived as having a second-class status compared to the traditional journals.

According to Frandsen (2009a) authors from developing countries are usually more likely to perceive OA positively than authors from developed countries. At the same time, authors from developing countries do not cite articles from OAJs more often than those from developed ones. As Frandsen (2009b) notes, the development of OAJs is not just a matter of number of OAJs in a certain scientific field but also depends on the extent to which they are cited in non-OAJs as well as OAJs. We agree with Frandsen, but since the OA initiative has been launched more than 15 years ago, number of OAJs still presents one of the valuable signs of OAJs' acceptance in the academic environment. Spain is in this context an outlier with as much as 48% of all Spanish journals being OAJs (Abadal et al., 2015).

Despite concerns that OAJs may be of lower quality (Jeon & Rochet, 2007), Gaulé & Maystre (2011) claim that some of them have established themselves as prestigious ones (Björk & Solomon, 2012). However, Migheli & Ramello (2014) suggest that authors that publish in OAJs and those that cite their work in OAJs are usually „weaker" members of academic community (women, or researchers at the start of their careers). Findings for the sample of Chinese researchers indicate that they are often confused and believe that OAJs are neither properly peer-reviewed nor published by reputable publishers (Xu et al., 2016). Kieńć (2017) states that in the last 3 years, 83% of authors from the developing countries published in gold OAJs, compared with only 64% from the developed countries. Wider acceptance of OA journals as well as open science movement requires for more active participation of all key stakeholders including research managers, publishers, information professionals, national university library consortia, policy setting players, funding bodies and other institutions (Gunasekaran & Arunachalam, 2014; Schöpfel, 2015; Björk, 2017; Lawrence, 2017).

Despite the fact that OA means that scientific publications are freely available without any access restrictions, such system is not sustainable without credible funding. There are a number of different funding models (Frandsen, 2009b). Willinsky (2009) identifies 10 such models. Most of the literature on funding of OAJs is related to the model of the article processing charge (APC) (Hrynaszkiewicz, 2016). The APC business model for OAJs has grown rapidly (Solomon & Björk, 2012) as well as prices. According to Pinfield et al. (2016) APCs of articles and journals indexed in DOAJ have had an average APC per article amounting to US$ 906 for 2010. Laakso et al. (2016) compare APCs and non-APCs OAJs. They conclude that many journals switch to OA, without APCs, by implementing one of two main strategies: society or institutional subsidy and cost reductions through voluntary labour and low-cost infrastructure. In many European countries, central government research funders have traditionally provided subsidies to national scholarly journals with the aim of supporting research in local languages or with national/regional content. Such journals, especially in the social sciences and humanities, are prime targets for conversions.

Third important topic in the literature on OAJs relates to its advantages and disadvantages. In the literature on advantages of OAJs, primarily through bibliometric indicators that are used as proxy for quality, seminal was paper by Lawrence (2001) indicating higher citation of open online documents compared to those offline. Swan (2010) reviews findings of 27 various studies and concludes that allowing OA to research results has beneficial effects on citations metrics. Björk & Solomon (2012) indicate that OAJs with APCs are on average cited more than other OAJs. Xia (2012) finds that some OAJs have been ranked as high as the best traditional journals. According to Gumpenberger et al. (2013) gold OAJs' impact factor (IF) is generally increasing, and 30% of newly launched journals are indexed in JCR (Journal Citation Report database, Thompson Reuters) after just one year. These are mainly the UK and US OAJs. Numerous studies, using different methodologies, have suggested a citation

advantage for open access articles (Wohlrabe & Birkmeier, 2014; Koler-Povh et al., 2014; Atchison & Bull, 2015; Hrynaszkiewicz, 2016). Tennant et al. (2016) give a detailed review of literature examining citation metrics of OA publications. Out of 70 studies analysed, in 46 the rise in citation metrics is confirmed; in 7 studies neither rise, nor decline was present, while in 17 studies positive trend could not be confirmed.

A part of the studies related to scientific impact and quality of OAJs measured by citation and bibliometric indicators has not confirmed neither significant advantages nor disadvantages of OAJs (Frandsen, 2009b; Gaulé & Maystre, 2011); Björk & Solomon, 2012; Solomon et al. (2013); Pisoschi & Pisoschi, 2016). Studies that indicate weaker status of OAJs in relevant databases compared to subscribe-based journals include Giglia (2010), Miguel et al. (2011), Mccabe & Snyder (2014), Salisbury et al. (2017). Additionally, Gunasekaran & Arunachalam (2014) stress that many journals from developing countries, especially from Latin America and India, have improved their visibility and impact by adopting OA, but their IFs are still lower than for subscription-based journals.

In conclusion, we could agree with Tennant et al. (2016) that there is a general lack of consensus regarding the advantages and disadvantages of OAJs at multiple levels. We expect that our contribution will give an initial insight on the status of *European* fully OAJs, measured by bibliometric indicators as a proxy for quality, and level of acceptance in the academic community.

Data and methodology

In our empirical analysis initial population comprised of 1,486 fully OAJs (October 2016) indexed in Scopus and published in one of 28 EU member countries and 3 countries of former Yugoslavia - with perspective of becoming EU members in foreseeable future: Bosnia and Herzegovina, Macedonia and Serbia. In the remaining part of the text these countries together are labelled as "European countries". Under the notion of *fully OAJ s* (Walters & Linvill, 2011) we perceive journals whose publisher secures free immediate access to the entire content of the journal, thereby avoiding any reliance on subscriptions or subscriber-only access.

Scopus has been chosen as main database due to its relevance (De Moya-Anegón et al. 2007; Miguel et al., 2011; Solomon, 2013; Chinchilla-Rodríguez et al., 2015) which is reflected in balanced thematic and regional representation of journals, credible selection procedures, and adequate bibliometric indicators.[5]

Throughout the analysis every journal has the same weight. We use descriptive statistics with mean being often replaced or complemented by median in order to avoid the effect of outliers. As a benchmark in the analysis we use the population of subscription-based journals (non-OAJs) extracted from Scopus (October 2016). These are only active Scopus journals published in European countries (approximately 11 thousand).

In order to get an insight into the status and scientific potential of European fully OAJs, we focus on the following bibliometric indicators: quartiles and SJR (SCImago Journal Rank) for the period 2012-2015 as well as h-index for 2015. It is important to mention that we initially collected data for SNIP (Source Normalized Impact per Paper) and IPP (Impact Per Paper)

[5] Authors' access to Scopus database was allowed by Croatian Ministry of Science and Education.

indicators. While preliminary analysis confirmed that correlations among SJR, SNIP and IPP indicators for each year in the period 2012-2015 are high, for further analysis and interpretation we have chosen SJR as the most appropriate indicator for the purpose of this research.

Data for these indicators are taken from SCImago Journal & Country Rank portal (October 2016) and its source for the relevant bibliometric indicators is Scopus database. Quartile (Q) rankings are the simplest indicator of journals' status. In our case they are defined depending on the values of SJR indicator for individual subject fields. The SJR indicator considers journal impact in terms of the citations received, taking into account the quality of the citing journals (González-Pereira et al. 2010). Scopus SJR may be perceived as more sophisticated indicator compared to WoS IF (Impact Factor), although it is not radically different (Ennas & Di Guardo, 2015). SJR is calculated as the ratio of the number of citations received by the prestigious journals in the current year and the total number of papers published in the last three years. The use of the SJR indicator allows for the estimation of a journal's impact, reducing the effect of self-citations (González-Pereira et al., 2010).

Value of h-index is analysed for 2015, the latest year for which the data was available in October 2016. H-index indicates visibility of a journal in relevant academic community taking into account number of articles and number of their citations in a certain time period. Journal has index *h* if *h* of his papers have at least *h* citations each (Jokić, 2009). Out of initial 1,486 European fully OAJs extracted from Scopus for 2015 only 1,201 journals had quartile rankings which was the prerequisite for a journal to be included in our analysis. The rest of the journals, some 20%, are to a lesser extent inactive, while most of them are newly indexed in Scopus (less than 3 years) and consequently bibliometric indicators could not be calculated. It is important to note that all journals included in this study in period 2012-2015 do not have values for all indicators. Main reason is short period of presence in Scopus.

Since EU is diverse in historical, political, economic, social and cultural dimensions, in order to get more precise picture of status and potential of fully OAJs, above-mentioned indicators are analysed across groups of countries, which are defined according to the year in which they entered EU. First group includes 14 old EU members[6] classified as group A. Group B comprises of 11 countries that entered EU from 2004 to 2013.[7] Group C includes 3 countries that are either EU potential candidate or candidate countries.[8] Countries in three groups differ substantially according to the main development and science indicators. For example, an average country in group A has almost 40% higher GDP per capita (expressed in purchasing power parities) than an average country in group B and 70% higher than an average country in group C. As for the total R&D expenditures they amount to 2.1% of GDP on average in group A, 1.2% in group B and 0.5% in group C, respectively.[9]

[6] Group A includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Luxemburg is not included as it does not have a fully OA journal indexed in Scopus.

[7] Group B comprises of Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. Note that Cyprus and Malta would belong to this group but Cyprus does not have a single fully OA journal indexed in Scopus while Malta has only one and therefore these two countries are not included in the analysis.

[8] Group C includes 3 former Yugoslav countries and candidates for EU membership: Bosnia and Herzegovina, Serbia, and Macedonia. Montenegro is not included as it does not have a fully OA journal indexed in Scopus.

[9] Data referes to 2015 (except for group C where it refers to 2014 for R&D expenditures) and originates from Eurostat.

In order to get insights across scientific fields we analyse specific characteristics of fully OAJs of European countries in life sciences, health sciences, physical sciences and social sciences. As we believe that status of fully OAJs depends on the publishers' type, which is indicated by earlier research (Walters & Linvill, 2011; Solomon, 2013; Ennas & Di Gardio, 2015; Björk et al., 2016), we also analyse the relation between publishers' type and status of fully OAJs. Our publisher classification resembles to the Solomon's (2013). Due to specific characteristics of European publishers we have divided them into seven groups: academy, foundation, research institute, professional publisher, society, university and other.

Results and discussion

During the first half of the 1990s the share of European fully OAJs in the total number of journals indexed in Scopus was below 1% (Laakso et al., 2011). With an average annual growth close to 15%, it increased to approximately 9% over the last two decades. As Figure 2 indicates, journals in our sample are predominantly published in group A. This group includes countries that are either leaders or, among leaders, in R&D and innovation performance as well as countries with strong scientific publishing industries. Consequently, group A has the share of over 70% in our sample of European OAJs. At the same time share of OAJs from group A compared to the total number of their journals is 6%, lower than the average for all European countries (9%), or all countries in the Scopus database (11%). Group B journals have the share of 9% in the sample of European journals while their share in European OAJs is approximately 25%. Potential candidate and candidate countries participate with 0.5% in all European journals while their share in the total number of European OAJs is about 4%. Note that more than half of group C journals' content is actually freely available.

In order to more accurately illustrate importance of OAJs across these three groups of countries that are substantially different in population size, achieved development stage, R&D output and many other aspects, number of published journals has been adjusted by the number of full-time researchers. While left panel of Figure 2 shows original proportions, right panel is based on adjusted values.[10] There are 9 journals per thousand full-time researchers in group A, 6 in group B and 3 in group C. However, the ranking is just the opposite when we consider OAJs. While group A has 0.5 OAJ per thousand full-time researchers, it amounts to 1 in the case of group B and close to 3 in the case of group C. This leads to conclusion that OAJs have much higher relative importance in groups B and C than in group A.

[10] In alternative versions adjustment was done by population size and GDP generating similar results.

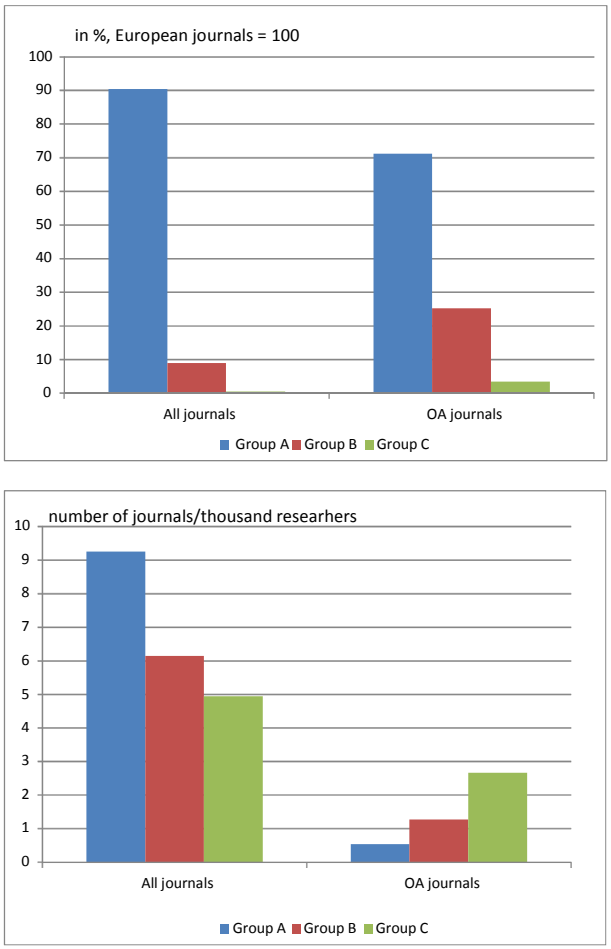


Figure 2 European journals – comparisons across country groups, 2015
Source: Scopus for journal data and Eurostat for data on full-time researchers.

Higher relative share of journal content that is freely available in groups B and C compared to group A might be explained by several reasons. One of them relates to different funding models of peer-reviewed journals in these countries. Groups B and C comprise of post-socialist countries where journals have traditionally been financed by government bodies such as ministries, foundations, public academic institutions, etc. (Radosevic & Lepori, 2009) and consequently it should not be a surprise that their content is publicly available. Additionally, most of the publishers in these two country groups are of academic descent and are not professional publishers. However, there might be some other reasons for different importance of OA concept in country groups of our interest.

We turn our attention now to scientific fields. Earlier studies (for example, Frandsen, 2009b) have shown that OAJs have a larger uptake in some scientific fields than the others. Figure 3 shows the distribution of European journals across four major scientific fields and across three country groups. Kozlowski et al. (1999) point out that post-socialist countries have inherited certain disciplinary structure of science with substantial bias towards physical sciences. Therefore, instead of comparing distribution of journals across scientific fields compared to the European average, we use the European subscription-based journals (or so-called non-OAJs) as a benchmark. Our results confirm earlier findings. Common heritage of post-socialist countries in terms of disciplinary structure seem to be still present. As Figure 3 indicates, share of journals in physical sciences in group B and, in particular, in group C is substantially higher than the European average. Additionally, journals in health sciences have

lower share in group C than in other country groups. Nevertheless, distributions across scientific fields for non-OAJs and OAJs do not indicate pronounced differences. For the European journals as a whole (due to group A), health and life sciences are relatively more represented in OAJ group than among subscription-based journals.

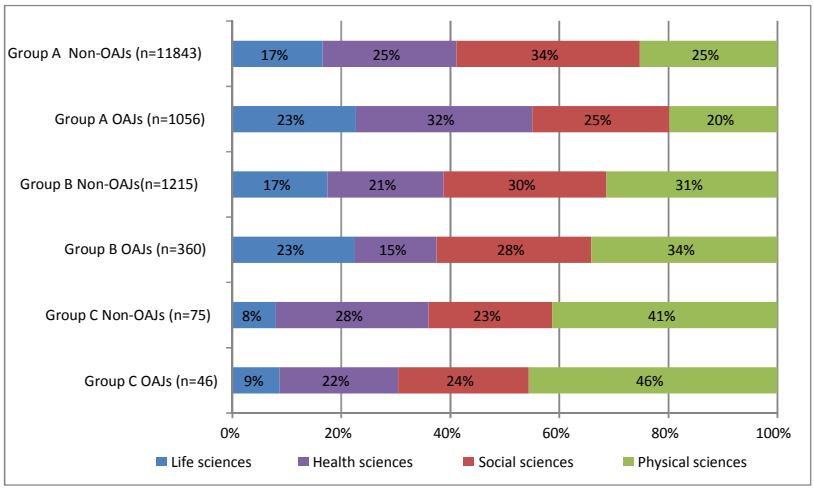
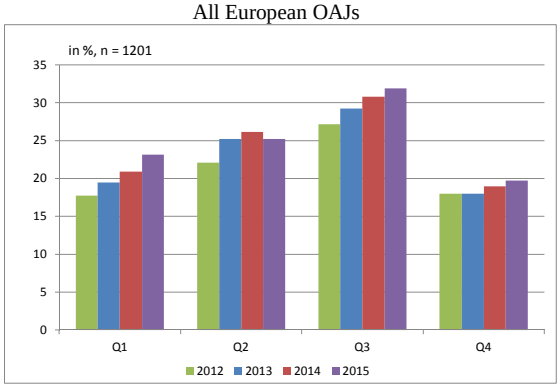


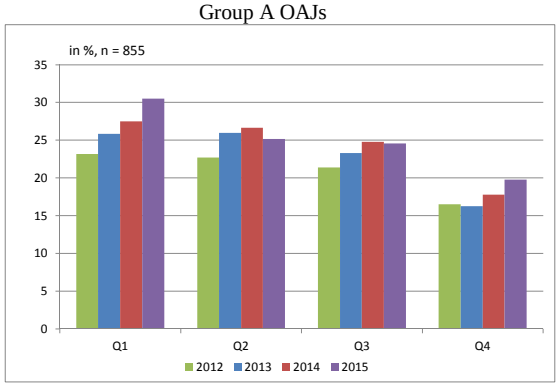
Figure 3 Distribution of EU journals across scientific fields, 2015
Note: A journal may be attributed to more than one scientific field.

In the remaining part of the analysis we use bibliometric indicators as a proxy of journal's quality. We start with quartile rankings that are in Figure 4 shown for European fully OAJs as a function of publisher's location over the 2012-2015 period. Four panels of Figure 4 indicate substantial differences among OAJs in different country groups. While in group A dominate journals in Q1, followed by journals in Q2, in group B latest trends are positive and towards higher quartiles, while that cannot be observed in group C where share of journals in Q3 has been on the rise.

All European OAJs



Group A OAJs



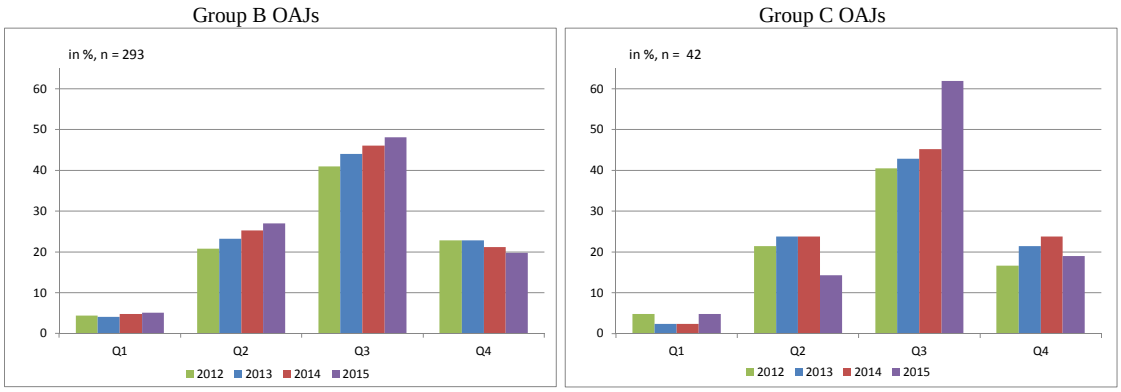


Figure 4 Quartile rankings of European OAJs across country groups

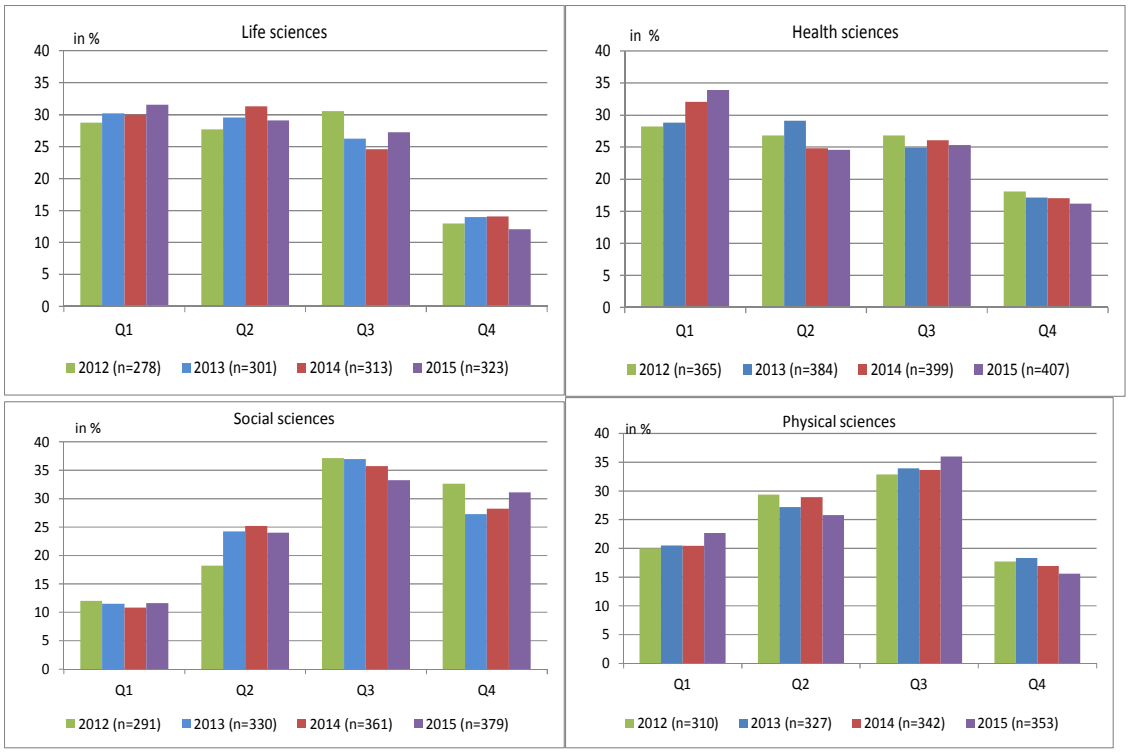


Figure 5 Quartile rankings of European OAJs across scientific fields
Note: A journal may be attributed to more than one scientific field.

In Figure 5 quartile rankings for European fully OAJs are shown across scientific fields. From earlier research we know that publication and citation behaviour of researchers in various scientific fields differ. In two fields, life and health sciences, the highest shares of OAJs are in Q1 suggesting that in these two fields OAJs have gained prestigious position. In physical sciences the highest share of OAJs is in Q3 while combined share of Q2 and Q3 is above 50%. Figure 5 also suggests that only in social sciences, the OA concept is less accepted, as out of all European OAJs in social sciences, only 10% is in Q1 while close to 70% of journals are positioned below SJR median (e.g. in Q3 and Q4). Additionally, in social sciences the smallest share of OAJs is in Q1 while in the remaining three scientific fields smallest shares of OAJs are in Q4.

We now combine the information from Figures 4 and 5 in order see whether there are some significant differences across four scientific fields in three country groups of our interest

(Figures 6-9). In the case of life and health sciences approximately 40% of OAJs in group A are in the highest quartile while close to 70% has SJR above the median. In the case of groups B and C the majority of OAJs is in the Q3, with very small number of journals, if any, in Q1. In the case of physical sciences about a half of all journals are equally distributed between first two quartiles in the case of group A, while in the case of two other country groups Q3 dominates (around 50%). Looking at the quartile rankings across scientific fields and country groups, social sciences seem to be different from other scientific fields. Namely, in social sciences the distribution of journals across quartiles between group A on one and groups B and C on the other side is more similar than in the case of any other field. In all three country groups the share of journals in Q3 is dominant with more than 50% of journals below SJR median. Additionally, in all three groups the share of journals in Q1 is the smallest.

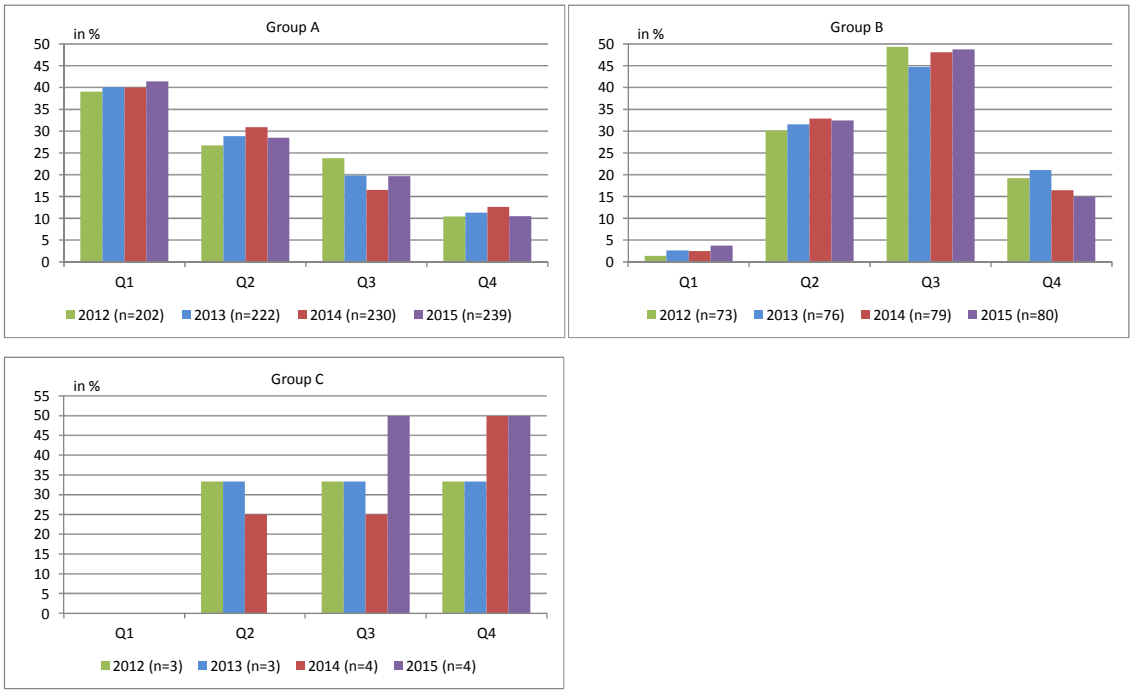


Figure 6 Quartile rankings of European OAJs in life sciences

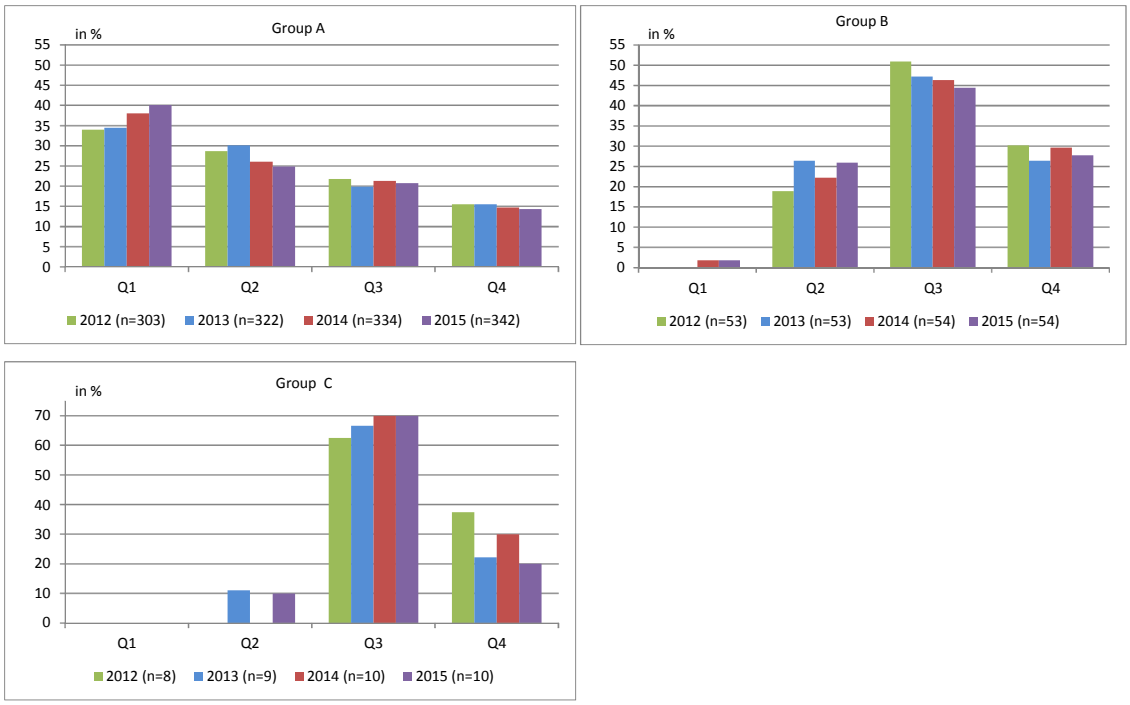


Figure 7 Quartile rankings of European OAJs in health sciences

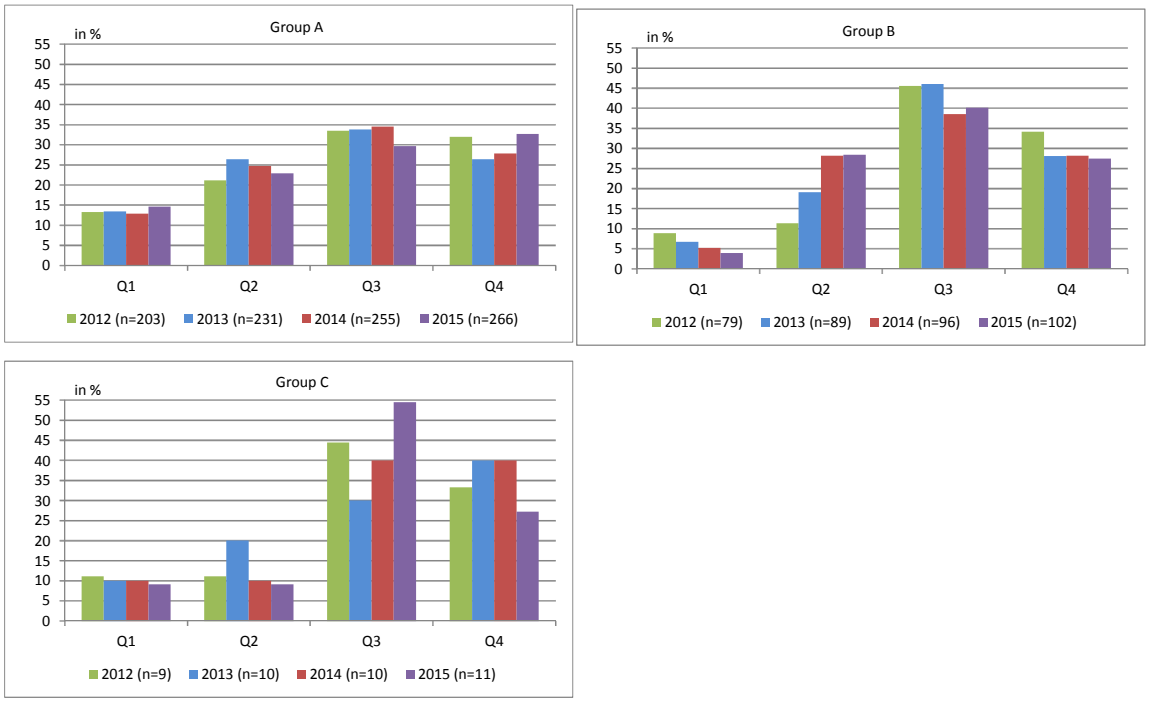


Figure 8 Quartile rankings of European OAJs in social sciences

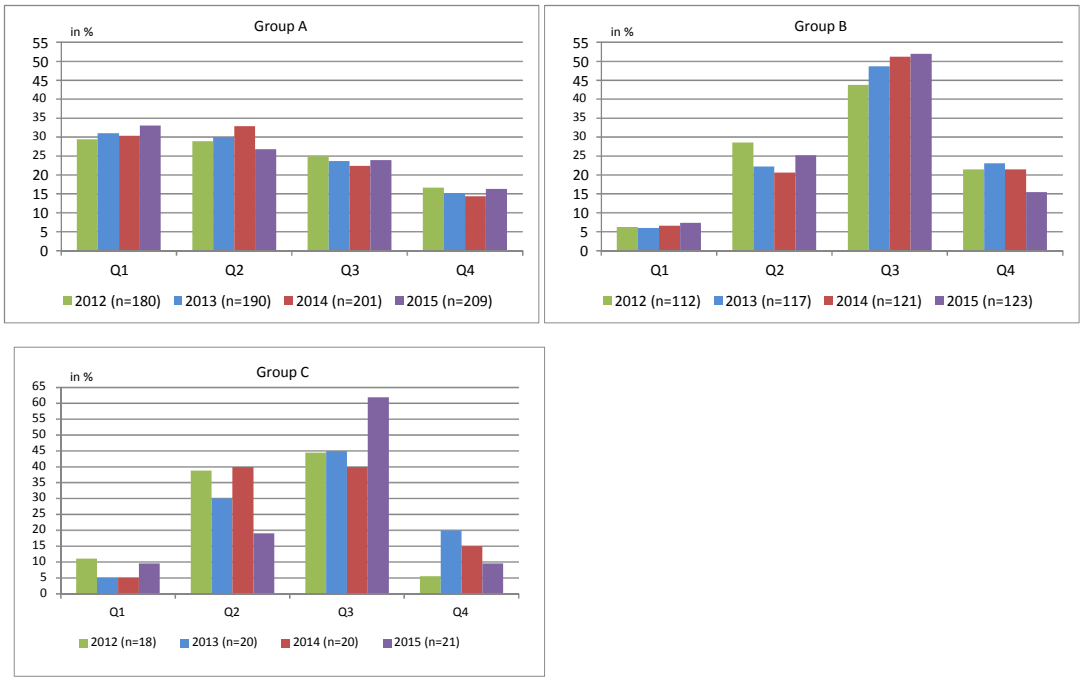
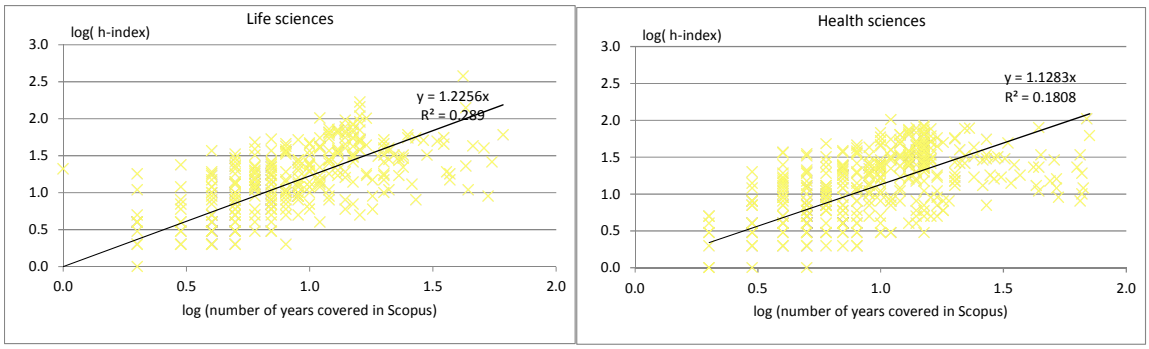


Figure 9 Quartile rankings of European OAJs in physical sciences

In order to check previous results we use h-index for 2015. In Figure 10 h-index of an individual journal is plotted against its age, e.g. number of years the journal has been covered in Scopus database. Coverage in Scopus is used as a proxy of journal's age as it in addition to other factors such as number of articles, language, self-citations etc., substantially affects the value of h-index. In order to have straightforward interpretation, values of h-index and number of years are expressed in the logarithmic form which allows for the estimated regression coefficients to be interpreted as elasticities. Figure 10 presents all European OAJs across four scientific fields.[11]



[11] In order to spare space, we are presenting results for all European OAJs and not for each country group separately.

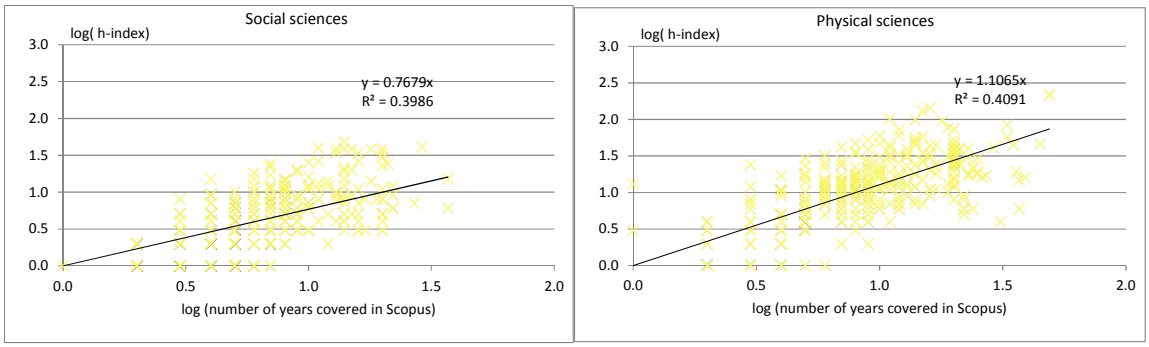


Figure 10 European OAJs: h-index vs. journal's age
Note: H-index related to 2015.

Results verify earlier conclusions regarding life and health sciences where OA concept seem to be more accepted than in other two scientific fields. In the case of life sciences one additional year of coverage in Scopus increases h-index by 1.2 point, while in case of health and physical sciences by 1.1 point. However, due to the specifics of publication and citation behaviour in physical sciences, h-index in this field is on average lower than in life and health sciences. Finally, in case of social sciences additional year of journal's age brings on average 0.8 point of h-index, lowest among all scientific fields. Additionally, the values of h-index are the lowest among four major scientific fields. These results were expected and are related to the specifics of scientific communication within the social sciences (Nederhof, 2006).

Detailed information on coverage of European OAJs, their h-index (2015) and SJR (2012, 2013, 2014, and 2015) indicators across scientific fields and country groups are given in Table A1 in the Appendix. In all scientific fields except social sciences, the mean coverage by Scopus database is longest for journals in group B. This data could speak in favour of awareness of OA concept in this country group but it could also be a consequence of the publication paradigm and type of funding of scientific journals in post-socialist countries. The reasons why social sciences are exception should be further explored but orientation towards national topics (instead international), various types of publication outlets (beside journals that dominate in other fields) as well as more individually than team-authored publications certainly are a part of the explanation (Nederhof, 2006). As for the h-index and SJR indicators, in case of life, health and physical sciences journals in group A have much higher values than in two other groups. At the same time, indicators for groups B and C do not differ much. The least difference both in respect to coverage and quality indicators between group A and groups B and C is present in social sciences.

We continue by comparing bibliometric indicators for OAJs against the benchmark, e.g. subscribe-based journals (non-OAJs). Table 1 presents combined results for SJR indicator over 2013-2015 period for both OAJs and non-OAJs. The median SJR indicator for life sciences is in group A slightly higher for non-OAJs than for OAJs while in the case of health sciences median SJR indicator is higher for OAJs than for non-OAJs. Although SJR indicators suggest, as expected, much lower quality of the journals in B and C groups for life and health sciences than in the case of group A, OAJs indicators are for these two groups higher than for non-OAJs which is in line with our previous observations. Moreover, in all scientific fields (except in group B in physical sciences where they are almost equal) median SJR indicators are in the case of groups B and C higher for OAJs than non-OAJs. In social sciences, life sciences as well as physical sciences we find in group A higher median SJR indicator for non-OAJs than for OAJs.

	Non-OAJs			OAJs			Non-OAJs vs. OAJs
	SJR, 2013	**SJR, 2014**	**SJR, 2015**	**SJR, 2013**	**SJR, 2014**	**SJR, 2015**	
Group A- life sciences							
Median	**0.85**	**0.86**	**0.86**	**0.75**	**0.73**	**0.77**	>
Observations	1867	1888	1926	222	230	239	
Group B- life sciences							
Median	**0.23**	**0.28**	**0.26**	**0.26**	**0.29**	**0.30**	<
Observations	204	207	208	79	80	80	
Group C- life sciences							
Median	**0.24**	**0.20**	**0.20**	**0.24**	**0.20**	**0.20**	≤
Observations	5	6	6	3	4	4	
Group A- health sciences							
Median	**0.52**	**0.52**	**0.54**	**0.57**	**0.61**	**0.66**	<
Observations	2747	2804	2845	322	224	342	
Group B- health sciences							
Median	**0.15**	**0.15**	**0.15**	**0.18**	**0.19**	**0.22**	<
Observations	256	256	259	53	54	54	
Group C- health sciences							
Median	**0.16**	**0.14**	**0.16**	**0.17**	**0.14**	**0.17**	≤
Observations	20	21	21	9	10	10	
Group A- social sciences							
Median	**0.27**	**0.27**	**0.25**	**0.16**	**0.16**	**0.15**	>
Observations	3639	3777	3870	231	255	266	
Group B- social sciences							
Median	**0.14**	**0.14**	**0.13**	**0.15**	**0.17**	**0.16**	<
Observations	298	329	347	89	96	102	
Group C- social sciences							
Median	**0.19**	**0.20**	**0.18**	**0.21**	**0.20**	**0.18**	≤
Observations	14	14	16	10	10	11	
Group A - physical sciences							
Median	**0.63**	**0.63**	**0.61**	**0.42**	**0.46**	**0.47**	>
Observations	2819	2871	2932	190	201	209	
Group B - physical sciences							
Median	**0.25**	**0.26**	**0.25**	**0.24**	**0.26**	**0.25**	=
Observations	358	366	373	117	121	123	
Group C- physical							

sciences							
Median	**0.26**	**0.29**	**0.26**	**0.27**	**0.30**	**0.27**	<
Observations	28	28	30	20	20	21	

Table 1 Non-OAJs vs. OAJs: SJR (2013-2015) indicator

In order to fully understand the results of the analysis some additional aspects of the publication process are analysed. Important actor in that process that affects the status of European fully OAJs are publishers (Walters & Linvill, 2011; Solomon, 2013; Ennas & Di Gardio, 2015; Schöpfel, 2015; Björk et al. 2016; Hrynaszkiewicz, 2016) in addition to the type of funding of scientific journals. For this purpose, we have collected preliminary data on publisher's type (Figure 11) of European OAJs.

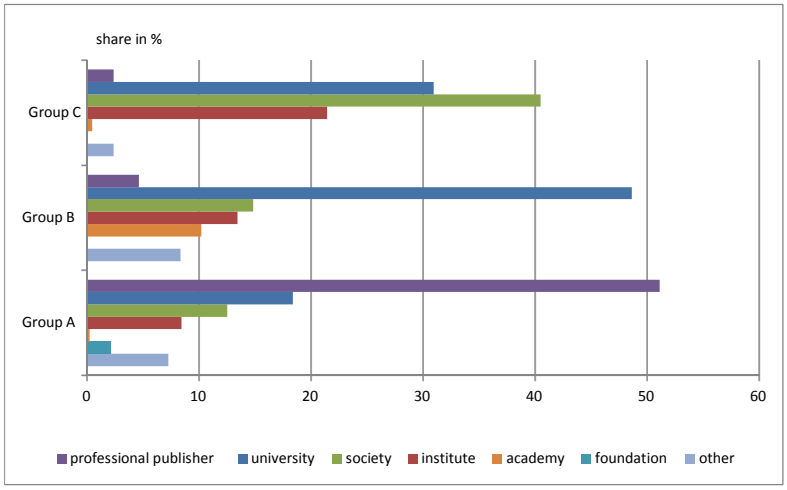


Figure 11 European OAJs and publishers' type

Professional publishers are most often present in country group A. Non-professional publishers are categorized as an academy, foundation, research institute, scholarly society, university or other publishers and they prevail in groups B and C. If we look at the importance of each publisher's type in our three country groups, it may be noted that professional publishers publish around 50% of fully OAJs in group A. Universities, scholarly societies and research institute are also important publishers of OAJs in this country group. On the contrary, in groups B and C, professional publishers publish small number of journals (10 out of 216 in group B and 1 out of 42 in group C). Foundations are not at all present in these two country groups while the largest share of OAJs in group B is published by universities and in group C by scholarly societies (about 50%). Having in mind outcome of bibliometric analysis, these results suggest that the publisher's type has an effect on the status of OAJs (Björk and Solomon, 2015). However, more detailed analysis is needed to verify the causal relationships.

Conclusions

European scientific potential measured by the share of peer-review journals indexed in Scopus database amounts to 49%. Additionally, out of all OAJs in Scopus database, 41% is published in European countries. Through its policy initiatives and recommendations European Commission strongly supports the idea that all research that is publicly financed should also be publicly available through various channels without any restrictions. Fully OAJs are one of them. This analysis has shown an average annual growth close to 15% of

OAJs over the last two decades. Consequently, the share of European fully OAJs compared to all European peer-review journals indexed by Scopus has increased to 9% compared to less than 1% in 1990s (Laakso et al., 2011).

In order to measure to what extent OAJs are accepted in the academic community, we have used main bibliometric indicators (quartiles, SJR, h-index), which are perceived as a proxy for quality. Because of differences in scientific communication, OAJs have been grouped in four subject fields: life sciences, health sciences, social sciences and physical sciences. In two fields, life and health sciences, the highest shares of OAJs are in Q1 suggesting that in these two fields OAJs have gained prestigious position. In physical sciences the highest share of OAJs is in Q3 while combined share of Q2 and Q3 is above 50%. In social sciences, the OA concept is less accepted. Out of all European OAJs in social sciences, only 10% is in Q1 while close to 70% of journals are positioned below SJR median.

Additionally, as countries in our focus have different social, cultural, economic, and research potentials, we have divided them into three groups according to the time they entered EU: group A (member states before 1995), group B (countries that become members in 2004-2013 period) and group C (candidate and potential candidate EU countries). In the case of life and health sciences approximately 40% of OAJs in group A are in the highest quartile, while close to 70% has SJR above the median. In the case of groups B and C the majority of OAJs is in the Q3, with very small number in Q1. In the case of physical sciences above 50% of journals are equally distributed between first two quartiles in the case of group A, while in the case of two other groups Q3 dominates (around 50%). In the case of social sciences quartile distribution among different country groups is more similar than in the case of any other field. Namely, in all three country groups the share of journals in Q3 is dominant.

Comparison of median SJR indicator for individual years in period 2013-2015 between OAJs and non-OAJs implies that in group A only in the case of health sciences the indicator is consistently higher for OAJs than for non-OAJs. For life sciences the difference is very small but in favour of non-OAJs, and that is also the case for physical and social sciences. In case of two other country groups quality indicators are substantially lower but with SRJ indicator for OAJs being higher than for non-OAJs. This indicates the importance of OA concept in these two groups of countries which is undoubtedly related to the model of funding of scientific journals as well as the fact that majority is published by non-professional publishers.

This paper presents initial results in the analysis of the scientific potential of European fully OAJs. In order to get an overall picture of the acceptance of OA in academic and EU policy framework it is necessary to define appropriate methodological framework (probably altmetrics). Macro perspective taken in this paper can give only a limited insight into the performance at lower aggregation levels while bibliometric indicators could *only* be perceived as a proxy for quality. Therefore, qualitative analysis would add important additional information.

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Appendix

	Number of years in Scopus	H-index, 2015	SJR, 2012	SJR, 2013	SJR, 2014	SJR, 2015
Group A-life sciences						
Mean	10.5	28.7	0.9	1.2	1.2	1.2
Median	8.0	19.0	0.6	0.7	0.7	0.8
Min.	1.0	1.0	0.1	0.1	0.1	0.1
Max.	51.0	379.0	6.4	9.6	10.0	9.9
Stan.dev.	8.0	34.3	1.0	1.3	1.3	1.4
Obs.	239	239	202	222	230	239
Group B-life sciences						
Mean	13.5	13.8	0.3	0.3	0.3	0.3
Median	9.0	9.5	0.2	0.3	0.3	0.3
Min.	2.0	2.0	0.1	0.1	0.1	0.1
Max.	61.0	61.0	1.0	1.0	0.8	0.9
Stan.dev.	12.0	12.8	0.1	0.2	0.2	0.2
Obs.	80	73	76	79	80	80
Group C-life sciences						
Mean	6.5	11.0	0.3	0.3	0.2	0.2
Median	7.0	12.5	0.3	0.2	0.2	0.2
Min.	3.0	3.0	0.2	0.2	0.1	0.1
Max.	9.0	16.0	0.3	0.3	0.3	0.2
Stan.dev.	2.3	5.1	0.0	0.0	0.1	0.0
Obs.	4	4	3	3	4	4
Group A-health sciences						
Mean	11.6	23.5	0.6	0.8	0.8	0.9
Median	10.0	18.5	0.5	0.6	0.6	0.7
Min.	2.0	1.0	0.1	0.1	0.1	0.1
Max.	71.0	105.0	6.3	9.6	10.0	8.9
Stan.dev.	9.5	19.9	0.6	0.9	0.9	0.9
Obs.	342	342	303	322	224	342
Group B-health sciences						
Mean	17.6	11.9	0.2	0.2	0.3	0.3
Median	10.0	8.0	0.2	0.2	0.2	0.2
Min.	2.0	2.0	0.1	0.1	0.1	0.1
Max.	65.0	43.0	0.4	0.7	0.7	0.8
Stan.dev.	15.9	10.0	0.1	0.1	0.2	0.2
Obs.	54	54	53	53	54	54
Group C-health sciences						
Mean	24.6	8.1	0.1	0.2	0.2	0.2
Median	11.0	9.5	0.1	0.2	0.1	0.2
Min.	3.0	2.0	0.1	0.1	0.1	0.1
Max.	67.0	12.0	0.2	0.2	0.3	0.3
Stan.dev.	24.8	3.8	0.0	0.0	0.1	0.0
Obs.	10	10	8	9	10	10

Group A-social sciences						
Mean	7.8	6.9	0.3	0.3	0.3	0.3
Median	6.0	4.0	0.1	0.2	0.2	0.1
Min.	1.0	0.0	0.1	0.1	0.1	0.1
Max.	37.0	15.0	0.3	0.4	0.3	0.5
Stan.dev.	5.6	8.4	0.3	0.3	0.4	0.3
Obs.	266	266	203	231	255	266
group B-social sciences						
Mean	7.4	4.8	0.2	0.2	0.2	0.2
Median	6.0	4.0	0.1	0.2	0.2	0.2
Min.	2.0	1.0	0.1	0.1	0.1	0.1
Max.	9.0	19.0	0.5	0.8	1.2	1.0
Stan.dev.	4.7	3.8	0.1	0.1	0.2	0.1
Obs.	102	102	79	89	96	102
Group C-social sciences						
Mean	6.8	4.2	0.2	0.2	0.2	0.2
Median	7.0	4.0	0.2	0.2	0.2	0.2
Min.	2.0	2.0	0.1	0.1	0.1	0.1
Max.	9.0	9.0	0.2	0.3	0.4	0.3
Stan.dev.	2.2	2.2	0.0	0.1	0.1	0.0
Obs.	11	11	9	10	10	11
Group A-physical sciences						
Mean	10.7	22.5	0.7	0.8	0.8	0.9
Median	8.0	14.0	0.4	0.4	0.5	0.5
Min.	1.0	0.0	0.1	0.1	0.1	0.1
Max.	37.0	31.0	1.4	1.9	1.5	1.1
Stan.dev.	8.4	28.9	0.8	1.1	1.2	1.2
Obs.	209	209	180	190	201	209
Group B-physical sciences						
Mean	11.4	12.3	0.3	0.3	0.3	0.3
Median	9.0	9.0	0.2	0.2	0.3	0.3
Min.	2.0	1.0	0.1	0.1	0.1	0.1
Max.	25.0	19.0	0.5	0.4	0.6	0.8
Stan.dev.	7.0	9.8	0.2	0.2	0.2	0.2
Obs.	123	123	112	117	121	123
Group C-physical sciences						
Mean	8.9	12.5	0.4	0.3	0.3	0.3
Median	8.0	10.0	0.3	0.3	0.3	0.3
Min.	2.0	2.0	0.2	0.1	0.1	0.1
Max.	20.0	47.0	0.8	0.8	0.8	0.8
Stan.dev.	4.5	10.0	0.2	0.2	0.2	0.2
Obs.	21	21	18	20	20	21

Table A1 Coverage, h-index and SJR indicator of European fully OAJs across scientific fields and country groups