

Measuring compliance with a Spanish government open access mandate

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Abstract

Open access (OA) mandates are policies that require researchers to provide free, unrestricted access to their published research by including it in OA journals (gold OA) or depositing in freely available disciplinary or institutional repositories (green OA). This paper measures the degree of compliance with a Spanish government OA mandate two and a half years after its implementation. A total of 58.4% of articles resulting from publicly funded research had at least one OA copy available a year after publication. Of these, 23.8% were in gold OA, 21.8% in green OA and 12.8% in grey OA, i.e. posted on websites and social networks. Most of the green OA articles were in two disciplinary repositories: arXiv and PubMed Central. Just 14.4% of the articles resulting from publicly funded research were available in institutional repositories, although more than 90% of the articles in the dataset were the result of projects carried out at institutions that have such an archive. There is great potential for growth in green OA, since over two-thirds of the articles that were not available as OA were published in journals whose publishers allow a preprint or a postprint copy to be deposited.

Introduction

Open access (OA) mandates are policies that require researchers to provide free, unrestricted access to their published research by including it in OA journals (gold OA) or depositing in freely available disciplinary or institutional repositories (green OA). As of May 2014, a total of 458 OA mandates had been implemented worldwide, mostly by research institutions (261) and

to a lesser extent by research funders (87). One hundred and ten of the mandates were related to thesis deposits (ROARMAP, 2014).

OA advocates are hopeful that mandates will raise the amount of OA published research, especially the number of articles deposited in digital repositories. In the words of Harnad et al. (2004), “the adoption of official university OA self-archiving policies will help to maximize the number of such archives, as well as the number of articles in them”. Otherwise, the proportion of OA research output is still low, considering the relatively liberal policies of publishers that generally allow accepted manuscripts to be deposited in institutional repositories (79.9% of articles) and personal webpages (78.1%), although they are more reluctant to accept deposits in subject repositories (32.8%) (Laakso, 2013).

Overall, studies that assess the availability of OA-published research show a small, though continuing, proportional growth in OA publications in recent years. An investigation of 1,837 journals in 2008 found that 20.4% of the articles were available in OA: 8.5% in gold OA and 11.9% in green OA (Björk et al., 2010). A further longitudinal study found an average annual growth rate of OA articles of 30% between 2000 and 2009, with articles in OA journals representing 7.7% of all those published in 2009 (Laakso et al., 2011). Another study based on a stratified sample of 787 journals indexed in the Directory of Open Access Journals (DOAJ) indicated that the proportion of gold OA, which included full immediate OA, hybrid OA and delayed OA of up to 12 months, had increased to about 17% of the article volume indexed in Scopus in 2011 (Laakso & Björk, 2012). Gargouri et al. (2012b) studied a sample of 1,300 articles per year between 2005 and 2010 in 14 disciplines. They found that 24% of the articles were available in OA, with green OA (21.4%) greatly exceeding gold OA (2.4%) in both proportion and growth rate. More recently, Archambault et al. (2013) assessed the OA availability of a set of 20,000 Scopus articles and found that 48% of the articles published in 2008 were available for free in December 2012. The authors attributed the larger share of OA articles obtained with respect to previous studies to the use of a searching strategy to maximize recall.

An alternative approach to investigating OA consists of surveying academics’ awareness and attitudes. Surveys combining questionnaires with focus groups and interviews suggest that although researchers are familiar with the OA movement, there is much less awareness of repositories and considerable differences among disciplines in researchers’ willingness to deposit articles (Creaser et al., 2010; Kim, 2010; Spezi et al., 2013). Interestingly, an

international survey of nearly 1,700 researchers (Nicholas et al., 2012) showed that around three-quarters of those who had deposited in a digital repository had made additional arrangements to provide access to their publications via their personal or institutional websites. Nicholas et al. (2012) note that in the debate about gold and green OA what they call “grey OA”, i.e. websites, is often overlooked. Actually, grey OA is usually encompassed in a broad definition of green OA which includes both repositories and websites. In the present article we distinguish between both OA routes and use the term “grey OA” to refer exclusively to OA copies of articles available in websites and social networks.

Although there is a relatively large amount of research on OA availability, there is much less data on compliance with OA mandates. What little evidence is available suggests that mandates are not highly effective. When Nicholas et al. (2012) asked researchers who had deposited in OA about their reasons for doing so, only 21.6% of them stated that they were responding to an institutional mandate, whereas a much lower 3.5% replied that they were responding to a mandate from a research funder. Regarding the OA availability of publications subject to funder mandates, an article in *The Times Higher Education* (Jump, 2012) cited the head of digital services at the Wellcome Trust, who indicated that the compliance rate was 55% six months after publication of papers produced with Wellcome funding; a rate he qualified as “simply not acceptable”. Van Noorden (2012) further reported that of the 55% of researchers who complied with Wellcome’s mandate, 85% did so by means of gold OA. Elsewhere, Poynder (2012) reported that the US National Institutes of Health (NIH) had a 75% level of compliance.

Regarding the OA availability of publications subject to institutional mandates, Gargouri et al. (2010) compared depositing behaviour at mandated and non-mandated institutions for articles published from 2002 to 2006, and considered deposits up to 2009. According to their results, mandates triple the baseline green OA depositing rate, with a mandated deposit rate of 60% compared to a self-selected deposit rate of 15–20%. An analysis by Xia (2012) of 349 implemented and planned mandates showed that depositing rates rose in many repositories after the implementation of an OA policy. However, institutional, sub-institutional and theses mandates had a more positive effect than funders’ OA policies, in terms of the number of documents deposited. A study carried out by Gargouri et al. (2012a), based on data from the Registry of Open Access Repositories Mandatory Archiving Policies (ROARMAP) and the Registry of Open Access Repositories (ROAR), found that deposits in institutional repositories

correlated with mandate strength, i.e. the stronger of the mandate, the more deposits, with the strongest mandates generating deposit rates of up to 70% within two years of adoption. The main limitation of these studies is that deposit rates refer to the total number of items deposited, including other content in addition to green OA copies of journal articles.

In July 2011, a new Spanish Law on science, technology and innovation came into effect. This law included an article on OA dissemination that stated that scientists whose research is mainly publicly funded have to make public a digital version of the contents that have been accepted for publication in scholarly journals as soon as possible and no later than twelve months after the official date of publication. This period is longer than the six months allowed by most funder mandates (Xia, 2012). The law states that the electronic version of the articles should be deposited in disciplinary or institutional repositories.

The aim of this paper was to measure the degree of compliance with this mandate in the first quarter of 2014, two and a half years after its implementation. Specifically, the study was driven by the following research questions:

1. What proportion of journal articles resulting from Spanish government research funds is available in OA a year after publication?
2. How do researchers make these outputs available in OA?
3. Do authors posting copies of articles on the web comply with publishers' depositing policies?
4. Are there any differences in OA availability across disciplines and according to journal impact?

Methods

In December 2010, the Spanish Ministry of Science and Innovation published its annual call to fund research projects as part of the National Programme of Fundamental Research Projects. An initial resolution with a list of 2,871 funded projects published in October 2011 was supplemented with an additional resolution including 477 projects in December 2011 (Ministerio de Economía y Competitividad, 2011). Altogether 3,348 research projects were funded with a total of 384 million euros for a three-year period, from January 2012 to December 2014.

A random sample of 810 of these projects (95% confidence level, $\pm 1.5\%$ margin of error) was obtained. In December 2013, the outputs from these projects were retrieved from the Web of Science by searching the Grant Number field. The search was limited to documents published in 2012, i.e. the first year the project had been active. A total of 839 articles from 299 projects were found, but a search for 511 projects resulted in 0 results. Twenty-one articles were duplicates, i.e. funding from two projects was acknowledged in the articles, and were therefore removed from the final dataset of 818 articles.

A limitation of the study lies in the fact that the retrieval of the scholarly output resulting from publicly funded research projects depends on the accuracy of the authors in acknowledging their sources of income and on the Web of Science listing all grant numbers in its records. In Spain, authors funded with public funds are required to acknowledge their grants but we do not have empirical evidence of the degree of compliance with this requirement or the completeness of records in the Web of Science.

The following step consisted in checking the availability of copies of these articles in OA journals (gold OA), repositories (green OA) or on the web (grey OA). In order to do this, a Google search for the titles of the articles was carried out in the first quarter of 2014. A delay of slightly over one year after publication was introduced because of the twelve month embargo period allowed by Spanish law. As a result, most of the article search was conducted between February and March 2014. The search term was the full article title without quotation marks, which allowed for slight differences such as the way mathematical symbols were typed. The documents that were found on Google were retrieved and downloaded to check the contents, since sometimes they were just PowerPoint presentations with the same title as the article. All documents other than the article were dismissed, and only the first ten hits in Google were used for the results.

All the articles were classified as follows:

1. Not available: if the full text was only available via subscription or not available at all online.
2. Gold OA: if the full text could be openly accessed at the journal website. These articles were further classified as:
 - 2.1 Published in journals that charge article processing charges (APCs)
 - 2.2 Published in journals free of charge to authors and readers

- 2.3 Delayed OA: articles in subscription journals available in OA on the publisher's website at the end of an embargo period
- 2.4 Hybrid OA: individual author-paid OA articles in subscription journals
- 2.5 Complementary OA: articles in subscription journals made OA by the publisher
- 3. Green OA: if the full text was available in a repository. When metadata were available in the repository but access to the full text was restricted, the records were not considered. These publications were further classified as available in:
 - 4.1 Disciplinary repositories
 - 4.2 Institutional repositories
- 4. Grey OA: if the full text could be accessed at any other website. These publications were further classified as available on:
 - 4.1 Social networks: Academia.edu, ResearchGate, etc.
 - 4.2 Websites: personal, departmental, etc.

When there were several hits to OA versions of the articles in the first page of Google results, the information was compiled for all the copies available. However, only locally hosted files were considered. For instance, if an article was available both on the server of a researcher's personal website and at a repository, two OA copies were counted. However, if the personal website just linked to the copy in the repository, a single copy was considered.

Finally, alignment with publishers' policies regarding depositing was analysed in two ways. First it was considered whether the publisher allowed self-archiving. If it did, the second aspect to be examined was stipulations about the deposited copy. At this point, the level of compliance proved very difficult to assess. Publishers' policies, as described in SHERPA/RoMEO, use the terms "preprint" and "postprint" to refer to stages of manuscripts prior to peer review (preprints) and after peer review (postprints). However, if there is no clear statement in the manuscript, it is difficult to distinguish between preprint and postprint versions. As a result, two kinds of copies were considered in this study: "submitted manuscripts", which are manuscripts that still need to be copyedited, and "accepted manuscripts", which are publishers' PDFs with the complete page layout. Publishers' policies regarding the possibility of depositing manuscripts were obtained from SHERPA/RoMEO.

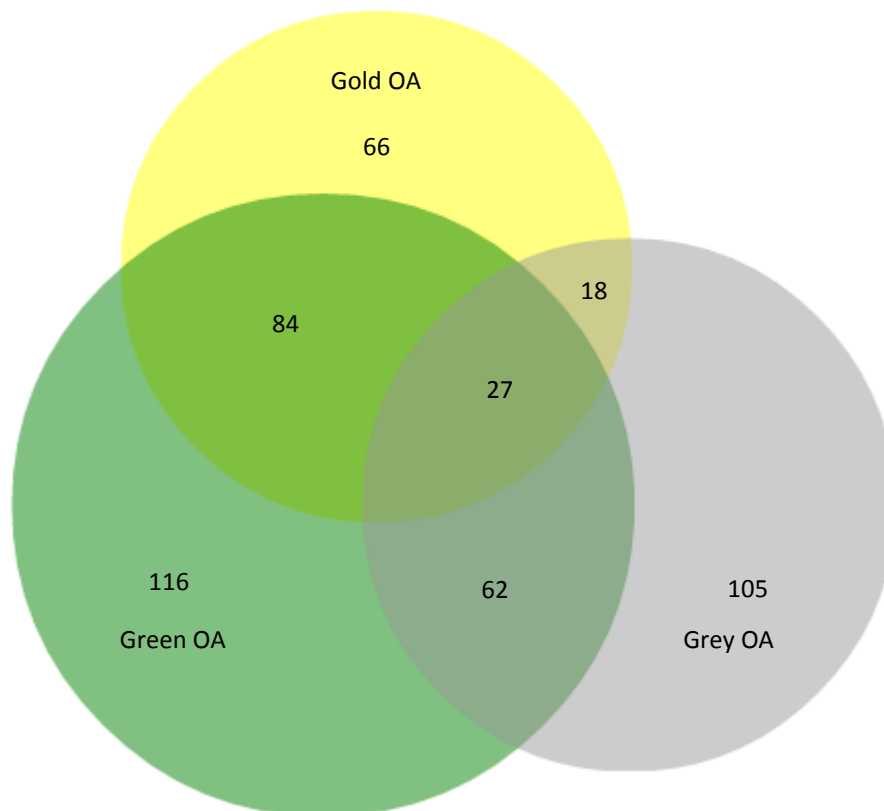
The impossibility of clearly identifying submitted and accepted manuscripts introduces a certain degree of inaccuracy in terms of measuring compliance with the Spanish government

OA mandate, which requires the accepted version to be deposited, and compliance with publishers' policies, which normally use the terms preprint and postprint copies. This should be acknowledged as a limitation of the study.

Results

At least one OA copy was obtained for 478 (58.4%) of the 818 articles in the dataset. Several copies of some articles were available through different OA routes, as shown in Figure 1. Thus, out of the 195 articles published in OA journals, 84 were also available in a repository, 18 on a website, and 27 both in a repository and on a website (Figure 1).

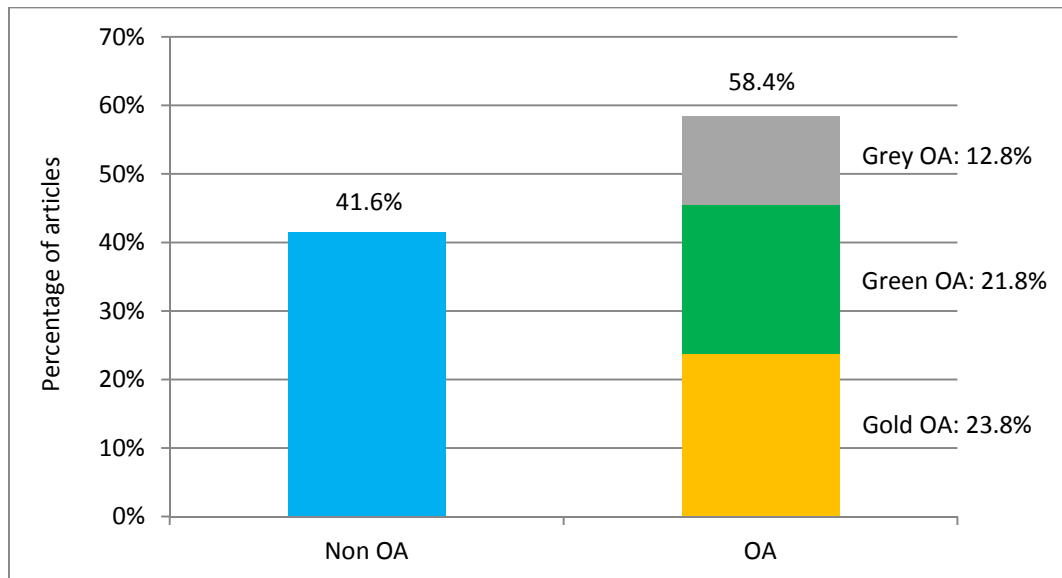
Figure 1. OA copies of articles



Repositories were the main source of OA copies of articles (35.3% of the articles were in such archives), followed by websites (25.9%) and OA journals (23.8%). However, once duplicate copies had been removed from the dataset (i.e. copies of gold OA articles found in repositories and on websites, and copies of green OA articles found on websites), a total of 23.8% of the articles had been published in OA journals, a proportion similar to that of articles available in

repositories (21.8%), whereas 12.8% of the articles were only available in OA through websites (Figure 2).

Figure 2. Availability of articles



For 340 articles (41.6%) no OA copy was found. However, according to information provided by SHERPA/RoMEO, 72.1% of these articles were published in journals whose publishers allow a preprint copy (i.e. pre-refereeing) to be deposited. Authors of these articles would not necessarily be complying with the mandate, which requires the accepted manuscript to be deposited, but this barrier does not exist for 62.9% of the articles, which were published in journals whose publishers allow a postprint copy (i. e. final draft post-refereeing) to be deposited.

Gold OA

A total of 195 articles (23.8%) had been published in an OA journal. Nearly half of these articles (47.7%) had been published in an OA journal whose business model consists in applying article processing charges (APCs) to authors. *PLOS ONE* was the most popular of these journals, as 33 of the 93 articles in this model had been published in it. On average, authors were charged 1,565 USD (SD=524) per article published (Table 1).

Table 1. Ranges of article processing charges (APCs)

	Journals	% of journals	Articles	% of articles
Less than 1,000 USD	4	12.9	7	7.8
1,000 USD to 1,499 USD	9	29.0	44	48.9
1,500 USD to 1,999 USD	6	19.4	15	16.7
2,000 USD to 2,500 USD	10	32.3	22	24.4
More than 2,500 USD	2	6.5	2	2.2
Total	31	100.0	90	100.0

Three articles published in journals whose fees depend on the number of pages were excluded

One third (35.9%) of the articles available in OA journals had actually been published in a subscription journal that allowed delayed free access to its online edition after an embargo period. In most cases (25.1%) the embargo period was 12 months. In a few cases it was 6 months (9.7%). One journal applied a longer embargo period (18 months) and one journal had a shorter one (2 months).

Slightly over one tenth of the articles (12.3%) were published in journals that are free of charge both to authors and readers. Finally, four articles had been published through a hybrid OA model, whereas four more articles were freely available due to publishers' complementary OA (Table 2).

Table 2. Location of gold OA articles

	Articles	%
APC journals	93	47.7
Delayed OA	70	35.9
Free of charge journals	24	12.3
Hybrid OA	4	2.1
Complementary OA	4	2.1
Total	195	100.0

Green OA

A total of 289 articles were available in repositories: 71.3% in disciplinary repositories and 40.8% in institutional repositories. In order to determine OA availability, we have to take into account that 35 articles were available simultaneously in both a disciplinary and an institutional repository and that 111 articles in repositories were copies of articles published in OA journals. Once these duplicate copies were excluded, we found that 178 articles (21.8%)

were only available through green OA: 123 articles (15.0%) in disciplinary repositories and 73 articles (8.9%) in institutional repositories.

Two disciplinary repositories were the main sources of articles: arXiv (142 articles, 69%) and PubMed Central (63 articles, 31%). Just one article was available in a different disciplinary repository (SSRN). In the case of arXiv, this source provided access to articles that would hardly be OA otherwise, since just 18.3% of the articles in arXiv had been published in an OA journal. In contrast, in the case of PubMed Central, most of the contents (90.5%) were already available through delayed OA at the publisher's website.

Before we addressed availability in institutional repositories, we had to consider whether the authors' institutions had such a repository. We observed that 68.5% of the articles in our dataset resulted from projects with funds awarded to 45 universities and 22.5% of the articles resulted from projects with funds awarded to the Spanish National Research Council (CSIC). We confirmed that 43 of the 45 universities and the CSIC have an institutional repository. Just 8.9% of the articles resulted from projects with funds provided to other institutions (research centres, research institutes and public and private foundations). Altogether, over 90% of the articles in the dataset resulted from projects with funds awarded to institutions that had an institutional repository. However, just 118 articles (14.4%) were available in archives of this kind. In fact, most of these articles were concentrated in just a few repositories. Thus, 44.9% of the articles available in institutional repositories were deposited in the CSIC repository, although the CSIC was responsible for just 22.5% of the articles in the dataset. The distribution of articles in repositories was asymmetrical: 80% of the articles were deposited in just nine repositories.

Two thirds (66.9%) of the articles found in institutional repositories were publishers' PDFs, whereas the remaining 33.1% were submitted manuscripts. In most cases, the publisher's version of the article could be archived. According to SHERPA/RoMEO, only eight articles could not be archived in the publishers' version.

Grey OA

A total of 212 articles were posted on different websites. Again, some of these copies were duplicates of articles available in OA journals and/or repositories. Once 107 duplicates had

been removed, we found that the remaining 105 articles (12.8% of the output) were only available in grey OA.

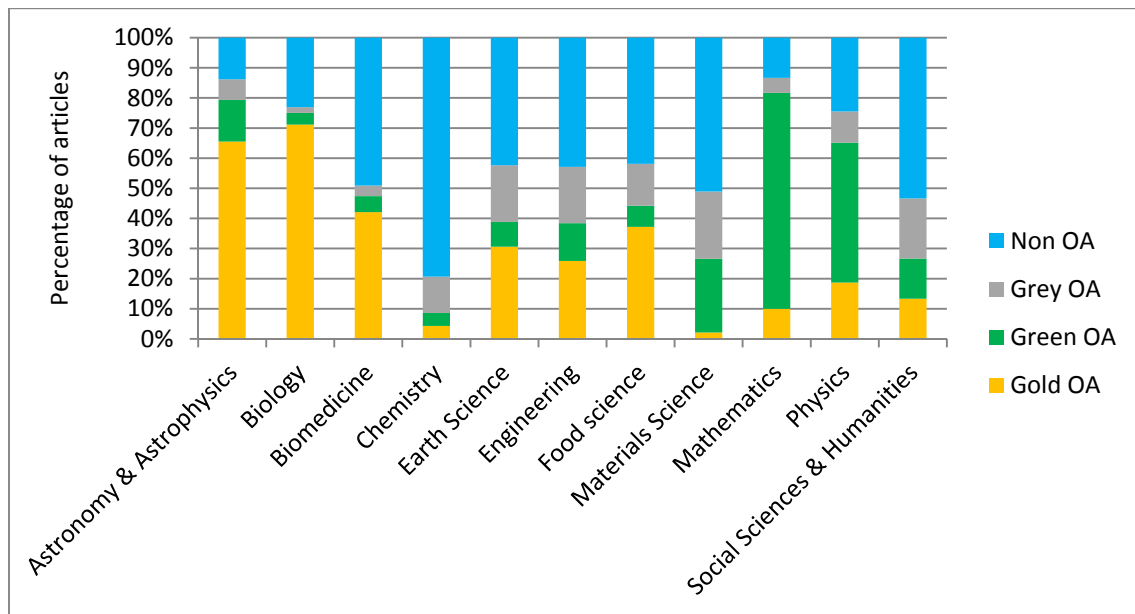
These articles were posted on two kinds of sites: social networks (48.6%) and websites (45.3%). A total of 6.1% of the articles were available both on a social network and on a website. The most popular social network for sharing articles was ResearchGate (50.9% of the articles) and, to a much lesser extent, Academia.edu (3.8% articles). In the case of websites, copies were mainly hosted on departmental and personal websites.

Of the 212 copies in grey OA, 70.3% were publishers' PDFs and 29.7% were submitted manuscripts. In most cases, researchers broke the publishers' policies. According to data provided by SHERPA/RoMEO, in the case of more than half (56.4%) of the articles whose PDF had been posted on a social network or a website, the publisher did not allow this.

OA availability across disciplines

Articles in the dataset were classified by discipline, according to the field in which the initial project had been funded. Mathematics (86.7% of articles), astronomy & astrophysics (86.2%), biology (76.9%) and physics (75.7%) were the fields with the highest percentages of OA availability. In the case of astronomy & astrophysics and biology, this was due to the high number of articles in gold OA journals, whereas in mathematics and physics it was related to the high number of articles available in green OA, especially at arXiv.org. Biomedicine, earth science, engineering, food science, materials science and social sciences and humanities had intermediate percentages of OA availability, in all cases between 46% and 58%. Finally, at the other extreme, chemistry was the field with the smallest share of OA availability (20.7% of articles) (Figure 3).

Figure 3. Availability of articles across disciplines

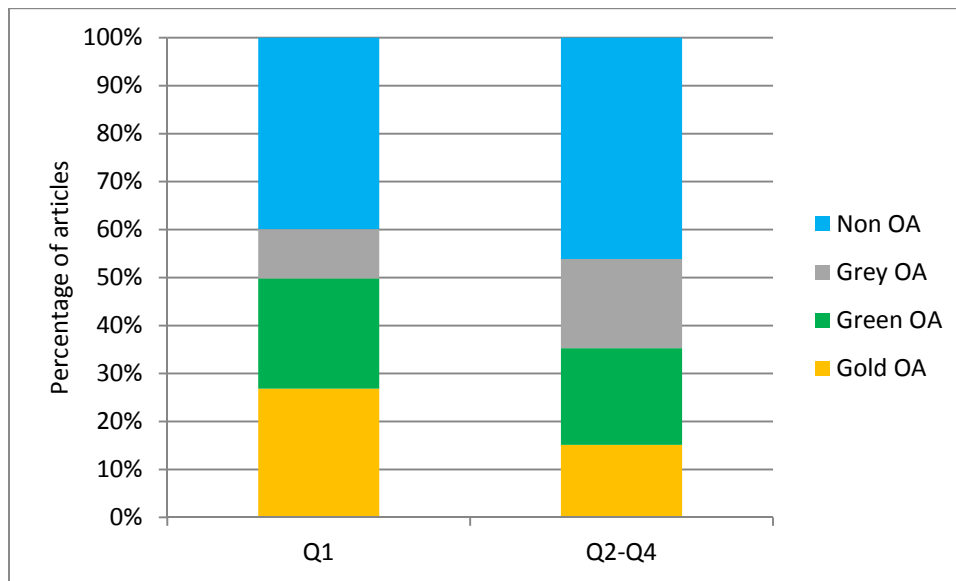


OA availability according to journal impact

Articles were classified in quartiles according to the journal impact factor. Quartile scores are derived for each journal according to which percentile of the impact factor distribution it occupies. If a list of journals in a subject category ranked from highest to lowest impact factor is divided into four equal parts, then each part is a quartile. Journals with the highest impact factor fall in the first quartile, those between the top 50% and the top 25% in the second quartile, and so on.

We found that two-thirds of the articles (66.5%) were published in journals in the first quartile of its subject category. There was a higher percentage of OA articles in the first quartile (60.1%) than in lower quartiles (53.9%), due to the larger number of articles in gold and green OA. This was partially compensated for by the higher number of articles published in lower impact factor journals on websites (Figure 4).

Figure 4. Availability of articles by impact factor



Discussion and conclusions

The Spanish Law on science, technology and innovation mandated scientists who carry out publicly funded research to make a digital version of their articles available to the public. Two and a half years after the implementation of this law, nearly six out of every 10 articles resulting from projects funded by the Ministry of Science and Innovation were available in OA within a year of publication. However, not all these versions comply with the mandate which requires accepted manuscripts to be deposited in disciplinary and institutional repositories.

This percentage of OA availability is higher than previously described in the literature (Björk et al., 2010; Laakso et al., 2011; Laakso & Björk, 2012; Gargouri et al., 2012b), but similar to that obtained by Archambault et al. (2013). These latter authors used a strategy to maximize recall to retrieve any OA version available and found OA copies of 49% of a sample of articles published by Spanish authors four years after publication. The reasons for the discrepancy between our results and those previously published in the literature may lie in our broad definition of gold OA, which includes articles available in journals that offer delayed access to contents after an embargo period, and the inclusion in our study of grey OA, i.e., copies of articles posted on the web. The consideration of delayed OA in our study also helps to explain the balance between gold OA and green OA, whereas most previous studies found a larger proportion of green OA. Despite these data, there is still huge potential for growth in green OA, since publishers allow the depositing of submitted or accepted manuscripts (the latter

being the version required by the mandate) of around two-thirds of the articles that are not currently available in OA.

Nearly a quarter of the articles resulting from publicly funded research in Spain are disseminated through OA journals. Of these, nearly half are published in journals requiring APCs. This figure is consistent with that observed by Laakso & Björk (2012), who found that OA journals requiring APCs published nearly half (49%) of all OA articles in 2011. These results call for action from Spanish research funders and institutions to implement mechanisms for funding APCs for researchers who are willing to publish in this model, as is happening elsewhere (Björk & Solomon, 2014). On average, the authors in our study were charged 1,565 USD per article, a figure that is well above the average 904 USD calculated by Solomon and Björk (2012) for journals in the Directory of Open Access Journals. The discrepancy is possibly due to the fact that Solomon and Björk's population included journals that are published in developing countries and have lower prices, whereas our study focused on Web of Science journals with higher prices.

As Laakso & Björk (2013) point out, the subset of delayed OA journals was generally overlooked in previous studies of OA availability, due to the lack of a comprehensive index of such journals and the debate about whether this is a valid form of OA. However, our results show that this is a remarkable route that provides access to a large segment of the literature. In addition, the main benefit of delayed OA is that the archived version is provided directly by the publisher, and surveys have shown that most researchers are rather conservative in their citation practice and try to track down the published version of the articles they want to reference (Fry et al., 2009).

Interestingly, 12% of gold OA articles were available in subsidized OA journals that are free of charge to authors and readers. Recent research (Rodrigues and Abadal, 2014) has shown that countries like Brazil and Spain have achieved a high proportion of OA scientific journals without requiring payment from authors. Instead they are helped by governments, universities and associations that provide economic, technical and political support. This would be an alternative to the funding of APCs by research funders suggested above in order to support researchers willing to publish in OA journals. In contrast, the share of hybrid OA is negligible, as observed by Björk (2012); those authors found that only between 1% and 2% of eligible authors use this OA option, due mainly to the generally high charge.

Repositories host approximately one third of articles resulting from publicly funded research in Spain. However, many of these files are just copies of articles available in gold OA journals. When these items were removed, the proportion of green OA was about 22%; which is similar to the rate described in the literature (Björk et al., 2010; Gargouri et al., 2012b). Disciplinary repositories and, specifically, arXiv and PubMed Central, concentrate most of the outputs, but our research reveals that the coverage of both repositories is quite different. Whereas most of the contents in PubMed Central are also available on the publisher's website, since most publishers open their electronic archives after an embargo period, arXiv.org provides access to research articles published in subscription journals that would not be openly available otherwise.

The level of coverage of institutional repositories is very low. Just 14.4% of articles resulting from publicly funded research are in institutional repositories. However, over 90% of these articles resulted from projects in which the funds were awarded to institutions that have a repository, and most publishers allow deposits (Laakso, 2013). In addition, it should be noted that deposits in an institutional repository may be carried out for reasons other than compliance with a mandate. The high number of documents in just a few institutional repositories and the fact that many of these items are copies of articles published in OA journals suggest that some librarians are very active in the implementation and population of their repositories.

Regarding the behaviour of users, our results uncover some questions that call for further research. Although previous studies suggest that authors are willing to disseminate their research in OA, they seem to prefer disciplinary repositories or posting copies of articles on the web to institutional repositories. Although the terms green OA and self-archiving are often used interchangeably, the author is not the only person who can be involved in the process of depositing, and deposits in institutional repositories are often mediated, for instance by a librarian. Our results suggest that authors may feel more comfortable self-archiving on a website, without the involvement of a librarian. This may be due to the restrictions of publishers' policies for archiving publishers' versions. Our results show few articles in institutional repositories deposited in contravention of publishers' policies, a problem much more apparent in the case of copies posted in websites and social networks.

Our results are consistent with those of Covey (2009), who observed that authors prefer to self-archive publishers' PDFs. Publishers are aware of these practices, as shown by the several takedown notices sent by Elsevier in late 2013 to universities and social networks requesting the removal of published editions of articles from Elsevier journals posted on their domains because of alleged copyright infringement (Peterson, 2013). We have observed that authors based at institutions where an institutional repository is available to them seem to prefer disseminating copies of their articles in personal websites, social network profiles, etc. A possible explanation for this behaviour is that, in this way, they avoid the intermediation of libraries which may imply delays or a strict corroboration of the publishers' policies, since librarians would not allow these versions to be placed in institutional repositories if this action is not permitted by the publisher, but authors can overcome this barrier by posting on websites and social networks. However, another possible explanation may simply be ignorance of the existence of the repository. This issue calls for further research which we aim to conduct through participative methods like questionnaire surveys and interviews. Finally, it seems that even if authors place their work in a repository, they also self-archive copies of the same article in different places, maybe, as suggested by Xia, Myers & Wilhoite (2011), because they believe that multiple access points may increase citation impact.

This is the first study to provide comprehensive measurement of compliance with an OA research funder mandate. Our results show that the Spanish policy has little impact, since the proportion of OA availability is not much greater than that observed in previous studies once the definitions of OA in each study have been considered. Changes do not happen spontaneously and encouragement is needed from policy makers, funding agencies, universities and repository managers to exploit the potential for OA growth. A stronger mandate, more investment in researchers' training and assistance, and incentives to publish OA would probably increase the rate of OA compliance.

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