

## **Open access and Scopus: a new approach to scientific visibility from the standpoint of access**

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### **Abstract**

The last few years have seen the emergence of several Open Access (OA) options in scholarly communication, which can broadly be grouped into two areas referred to as gold and green roads. Several recent studies showed how big the extent of OA is, but there have been few studies showing impact of OA in the visibility of journals covering all scientific fields and geographical regions. This research shows the extent of OA from the perspective of the journals indexed in Scopus, as well as influence on visibility, in view of the various geographic and thematic distributions. The results show that in all the disciplinary groups the presence of green road journals widely surpasses the percentage of gold road publications. The peripheral and emerging regions have greater proportions of gold road journals. These journals pertain for the

most part to the last quartile. The benefits of open access on visibility of the journals are to be found on the green route, but paradoxically this advantage is not lent by the OA per se, but rather of the quality of the articles/journals themselves, regardless of their mode of access.

**Keywords:** Open Access; Bibliometric analysis; Impact; Journals; Scopus

## **Introduction**

The scientific community is a key platform for research activity, and publishing is the formal mechanism through which researchers make contributions to the body of scientific knowledge. Thus, the documents configuring the bibliographic dimension of a discipline can also be seen as systems of production and divulgation of knowledge (Keresztesi, 1982). Journals and databases are the protagonists in scientific communication. Their value and implications for science go beyond purely bibliographic relevance, as they become the main focus of bibliometric studies, and enable researchers and policy-makers to assess developments and trends within the realms of science (Borgman, 2002).

In view of the tremendous volume of articles currently published worldwide, journal quality is a main criterion for researchers aiming to report their research findings. Indeed, journal quality may be even more important than free access or visibility (Warlick and Vaughan, 2007).

Journal quality depends largely upon compliance with editorial standards for the presentation and organization of contents so as to ensure the scientific rigor of all articles published, and thereby fortify the journal's standing. Yet quality cannot be expressed by one simple number; there are aspects impossible to quantify, which are linked to the peer-review process. The specialists in a field, or peers, establish thresholds for the reliability of reported results, and by filtering out sound research articles amid the vast number of journals in the information market, they determine the inherent quality of publications.

Visibility, or “impact”, is in turn determined by how avidly published work is received by the academic or scientific community. Here is where bibliometrics comes in as a useful extrinsic tool, complementing peer review, or recounting what peers have validated. Visibility is therefore an indirect means of appraising the quality of publications.

Which leads to the matter of how to best measure visibility. Traditionally, the impact of publications was measured literally, through citations received considered as the observed impact, or else in terms of anticipated impact, or the journal impact factor (IF). According to Harnad (2004), impact measures the extent to which the results of research findings are read, used, cited and applied in future research efforts. It is a gauge of progress and productivity that has implications for the career of the researchers in question (salary, project financing, recognition, awards...) and for the institutions they belong to, which will likewise benefit from financing or prestige. The funding agencies also obtain returns from such investment.

For decades now, experts have been calling for the combined use of indicators to shed light on scientific productivity and its impact (Martin, 1996; Moed, et.al., 1999; Rousseu and the STIMULATE 8 Group, 2009). Current initiatives may entail recounts of downloaded documents or social network analysis. Some of them, such as the projects COUNTER or MESUR, try to weigh aspects of use that will complement already defined factors of publication quality. MESUR analyses 39 aspects of impact or visibility to see how they are interrelated and how precise and comprehensive they are in representing scientific impact. The results come to reconfirm that the concept of quality//visibility is multidimensional\_and cannot be gauged by any single indicator or initiative. Complementary elements are needed to provide relatively objective and reliable information (Bollen, et al., 2009).

Along these lines, full-text access of articles is considered to be one factors influencing the odds of consultation, retrieval and citation of a document (Hajjem, Harnad and Gingras, 2005; Moed, 2007; Norris, Oppenheim and Rowland, 2008; Davis, 2008).

The open access initiative regarding scientific literature (OA) proposes free access to publications as an alternative to the traditional model of distribution and access by subscriptions, which was the mainstay of journals for some 300 years. OA allows users to read, download, copy, distribute, print out, search or link to the complete texts of the articles, without any economic, legal or technical barriers other than those intrinsic to Internet (BOAI, 2001). The sole restriction for reproduction and distribution in the realms of OA is that authors hold control of the integrity of their work and the right to be properly acknowledged and cited.

In the BOAI Declaration (Budapest Open Access Initiative), two routes are established for achieving open access: the golden road, or publication of articles in open access journals; and the green road, which consists of the self-archive or deposit of all articles published in traditional journals, on authors' web pages, or in institutional/thematic repositories that are open accessed, either before (pre-print) or after (post-print) their publication. These repositories, then, are archives of academic-scientific material available on the web, containing the articles published by researchers of a given institution or from a given field of knowledge (Chan, 2004). A variant of these models is the hybrid journal. They may require subscription, but the author is given the possibility of paying an established tariff so that the article will be available to readers. One such example is the journal P.N.A.S. Proceedings of the National Academy of Sciences, USA. Others allow free access to articles only after a period of embargo (Abad, 2006).

In an aim to increase visibility and promote the use of gold road journals, the *Directory of Open Access Journals*, or DOAJ, was created (<http://www.doaj.org/>). This directory takes in all the international journals that ascribe to the OA movement, a number that grows by leaps and bounds—from 1,400 titles in early 2005 to 5,138 as of June of 2010. Yet this figure represents just 20% of the total number of academic-scientific peer-viewed journals currently put out worldwide (*Ulrich's International Periodicals Directory*, <http://www.ulrichsWeb.com/ulrichsWeb/>).

Harnad (2004) argues that the green road is the only option that would lead to 100% OA in the near future, as it does not require complete restructuring of the system of scientific publication; and he urges institutions to create repositories according to the OIA protocol. The green road also offers incentives —promotions or funding— for authors who deposit their research results and harvest positive impact. Thus, authors can continue to publish their articles in the journals they choose (even if payment is involved) while at the same time providing free access to their work through the version in the repository. The permission for self-archiving should be granted by the journal publishers. Information about journal editorial policy and copyright with respect to the self-archive of some 700 publishing companies can be obtained through Sherpa/Romeo ([www.sherpa.ac.uk/romeo.php](http://www.sherpa.ac.uk/romeo.php)).

Meanwhile, the choice of data sources for carrying out macro-level studies of the situation and impact of OA on the publishing industry and on the scientific community is still an area of controversy. Jacsó (2006) insists that the open-access sources do not replace the traditional bibliographic databases, but complement them. Traditionally, the source of information used for bibliometric studies was the joint set of databases pertaining to the Web of Science (WoS) of Thomson Reuters: the Science Citation Index (SCI), the Social Science Citation Index (SSCI) and the Arts and Humanities Citation Index (A&HCI). One of their strong points is their multidisciplinary and international nature. These databases contain information from some 10,000 scientific journals, and have become tools of world reference for information retrieval and for studies evaluating science. However, the appearance on the market of the SCOPUS database, by Elsevier, with a coverage of over 17,000 journals, together with the development of new tools for bibliometric analysis based on this source, such as the SCImago Country & Journal Rank (SJR, 2007) developed by the SCImago group, has helped complement and broaden analyses drawn from other sources.

Ever since its early days, the SCOPUS database has been a subject of analysis (Codina, 2005; Fingerman, 2005; Jacsó, 2005, 2009; La Guardia, 2005), with comparisons of coverage,

accessibility, usability and price between this tool and the WoS (Deis and Goodman, 2007; Fingerman, 2006); or comparing these two products with Google Scholar (Bakkalbasi, et al., 2006; Bosman, et al., 2006; Falagas, et al., 2008). We shall avoid exhaustive mention of the profuse literature surrounding SCOPUS, and simply point out that certain limitations (Jacsó, 2008a, 2008b, 2008c, 2010) accompany the tremendous endeavor undertaken by *Elsevier*. There are still journals with important gaps regarding coverage and the country of affiliation. Such weaknesses must be remedied, since they may have broad repercussions. For instance, the *Organisation for Economic Co-Operation and Development* (OECD), uses SCOPUS as its main source of data for research into research, to foment a Strategy of Innovation to help governments raise their level of innovative production (Tomizawa 2008). Similarly, since February 2009 the *Australian Research Council* has been using this database for citation studies at its universities in the framework of the ERA program -Excellence in Research for Australia- (Australian Research Council, 2009).

Notwithstanding, the levels of chronological, geographic and thematic coverage attained by WoS and SCOPUS are indeed sufficient for guaranteeing relevant and reliable findings (Braun, Glänzel and Schubert, 2000; Moya et al., 2007). Both Thomson Reuters and Elsevier state that they have no restrictions in their selection policies with respect to electronic journals, and apply the same quality criteria as for the traditional journal. Moreover, their use of these sources — which feature inclusion of bibliographic references and institutional affiliations of all the authors— facilitates extensive posterior bibliometric analyses.

Elsewise, some studies look at the coverage of these sources in terms of the economic model of the journals, and of their value and implications for detecting research trends in different fields of knowledge. In 2004 Harnad et al. found that 10% of the OA journals were gold road ones, and 90% were green road. However, just 10-20% of the articles were self-archived. This suggests a lack of balance in the influence of OA on the publishing industry and on the scientific community.

A study by the Pontificia Universidad de Valparaíso de Chile (2009) found that of the total journals registered under the Journal Citation Reports, Science and Social Sciences Editions (Thomson Reuters), just 5% were OA.

Björk et al. (2008) estimate that in 2006 the total number published was approximately 1,350,000. Of this number 4.6% became immediately openly available and an additional 3.5% after an embargo period of typically one year. Furthermore usable copies of 11.3% could be found in subject-specific institutional repositories or on the home pages of the authors. Thus the total OA was 19.4 %.

In a more recent article, Björk et al. (2010) look at the availability of OA articles, whether published in open access journals (gold road) or else from repositories or websites (green road) over a sample stratified by disciplines, of 1.837 articles from the year 2008 selected from the SCOPUS database. The availability of open access articles was 20.4% (8.5% in OA journals and 11.9% in repositories and websites). A breakdown by discipline revealed that in Medicine, Medicine-related areas, Biochemistry, and Molecular Biology the gold road surpasses the green one, in fact nearly doubling the figures (14% vs 8%, 14% vs 6% and 11% vs 5%, respectively). Yet in other thematic areas the situation is reversed: noteworthy for their use of auto-archiving are the Earth and Environmental Sciences (25.9%); Physics and Astronomy (20.5%), the Social Sciences, Arts and Humanities (17.9%) and Mathematics (17.5%).

Still other studies describe the influence of OA on citation. A pioneer in this direction is Lawrence (2001), who showed that the greatest percentage of citation of computer\_science articles corresponded to work freely available on the Internet, to a much greater extent than works with limited access. Later studies authors arrived at the same finding in fields such as Physics (Hajjem et al., 2005), Astrophysics (Kurtz, 2005), Ecology, Applied Mathematics, Sociology and Economics (Norris, 2008). A recent article in *Molecules* covering the journals of Molecular Diversity Preservation International (MDPI) announced a steady increase in their

Impact Factors throughout 2009 and the inclusion of some in the Thomson Reuters databases as a result of their OA policy established at the beginning of 2007 (Rordorf, 2010).

Still other authors find that open access yields no benefits regarding citation in Physics-Condensed Matter (Moed, 2007), Conservation Biology (Calver and Bradley, 2010), and certain other fields. Two recent review articles clearly spot contrasting results to this respect (Swan 2010; Wagner, 2010).

Eysenbach (2006) affirms that open access holds great potential for accelerating the acknowledgement and diffusion of research findings, but that its effects on the impact of contributions is quite a different and controversial matter. A similar conclusion was traced by Moed (2007), who underlines that OA has immediate effects on citation due to the prompt availability of online articles, not because of open access per se. Davis et al. (2008) found that OA articles reached a greater audience and showed a higher number of downloads than those accessed by subscription, yet this did not entail an increase in citation the year after publication; in other words, OA citation may be due to other causes, for instance an increase in readership not stemming from the academic world, and who therefore do not cite, period. It may be that open access use is highly influenced by the website interface of the publishers or their full-text access policy (Davis and Price, 2006), or simply depends on whether an article is hung on the webpage of a more prestigious publishing company or else on personal or institutional pages, as stressed by Eysenbach (2006). Meanwhile, authors such as Bessemer (2006) or Turk (2007) dispute the methodology used to compute citations, arguing that a reasonable period of time should elapse in order to accurately evaluate impact and avoid short-term, categorical analyses.

Authors Craig et al. (2007) also point out methodological difficulties in evaluating the impact of the OA using different factors. Firstly, citation may be conditioned by the age of articles and the effects of accumulated citation received by the older articles. Secondly, when comparisons are made grouping journals of different geographic sources and situations with respect to OA, the results can be erratic. And thirdly, not all disciplines use journals as the main channels of

communication of research findings, and they may have different citation behaviours. Harnad (2007) reports four independent factors that contribute to greater citation in the field of biomedicine, ranging from the time since publication, the Impact Factor of the journal where the article appears, the number of authors, and OA status. Yet the results of a recent study based on a sample of 27,197 articles published in 1,984 journals in the period 2002-2006 shows that the advantage of OA over citation is independent of factors such as the age of the article, the journal's impact factor, the number of authors, references or pages, the country of institution, and the type of article; the advantage is causal and depends on the quality of the articles (Gargouri et al., 2010). Eysenbach (2006), taking into account the number of authors, the country of origin and the discipline, found OA articles to be cited twice as much; but when a journal wields great prestige, such as PNAS, the results could not necessarily be extrapolated to other journals. In short, journal prestige still stands as a quality brand name for the contents of an article, and persists as one key behind citation.

### **Objectives and hypothesis**

This research is intended to complement previous studies by incorporating a new analytical approach toward the open access movement, from the perspective of the economic model of the journals registered in SCOPUS, as well as OA influence on visibility, in view of diverse geographic and thematic distributions.

As specific goals we set forth:

- Determining the coverage of the SCOPUS journals with regard to the open access movement (gold road and green road), on the global level as well as by disciplinary groups.
- Identifying the distribution of journals by geographic region, in order to corroborate if they largely coincide with either the green or gold road.

- Assessing the influence of the OA movement in citation behaviour in the different scientific disciplines and geographic regions.

The present study explores these premises: 1- there is a stronger gold road in the social sciences and humanities, and 2- there is a greater proportion of gold road journals in emerging economic regions and 3- that these journals are not the most relevant and are for the most part from the last quartile (Q4).

## **Material and methods**

### *Data sources*

We based our study on four key data sources:

A- The list of titles in SCOPUS as of April 2010, on their official webpage: [http://www.info.scopus.com/documents/files/scopus-training/resourcelibrary/xls/title\\_list.xls](http://www.info.scopus.com/documents/files/scopus-training/resourcelibrary/xls/title_list.xls).

This list gives all publications registered in the database: 27,861. Of these, we selected the journals active in the categories “Journal” and “Trade Journal”. We excluded inactive titles or documents of the type “Book Series” or “Conference Proceedings”. Our source corpus then amounted to 17,284 journals. We should add that when the list was downloaded, the page “Content Coverage of Scopus” (<http://info.scopus.com/scopus-in-detail/facts/>) indicated coverage of 16,500 journals, a discrepancy that might be explained by the delay between updating the source and the information actually published on the website. From this source we took editorial data regarding each journal: title, ISSN, publisher, country where published, and thematic classification.

B- The Directory of Open Access Journals (DOAJ) of Lund University Libraries (<http://www.doaj.org/>), a repertory of international reference in the register of “gold road” journals, which when consulted (June 2010) harboured a total of 5,138 titles.

C- The web page of project ROME0, developed by the SHERPA group (Securing a Hybrid Environment for Research Preservation and Access) of the University of Nottingham ([www.sherpa.ac.uk/romeo.php](http://www.sherpa.ac.uk/romeo.php) self-archiving policies established by more than 700 academic/scientific publishers worldwide).

D- SCImago Journal & Country Rank (<http://www.scimagojr.com/>), developed by the SCImago group (<http://www.scimago.es>), which publishes indicators of output, visibility, and collaboration of the journals included in SCOPUS.

### ***Levels of Analysis***

For thematic analysis we resorted to the scheme of *Subject Area Categories* by SCOPUS ([http://help.scopus.com/robo/projects/schelp/h\\_subject\\_categories.htm](http://help.scopus.com/robo/projects/schelp/h_subject_categories.htm)), which classified journals in just four broad areas: Physical Sciences, Health Sciences, Life Sciences, and Social Sciences. Then, to facilitate comparison, we adopted the specific thematic groups proposed by Björk et al., 2010.

Geographic analysis called for grouping the journals' countries of origin into five regions: Europe, North America, Asia, Latin America and the Caribbean (LAC), Oceania and Africa.

### ***Preparation of the sources and crossing data***

#### ***1- Identification and inventory of the gold road journals***

We compared the lists of sources A and B with reference to the journal ISSN, to derive a list of SCOPUS journals that were also registered in DOAJ; that is, the number of gold road SCOPUS journals. Although the source A list includes a column with data about the economic model adopted by each journal (OA vs No-OA), early ventures made us aware that this information was not up-to-date, as the number of OA journals from source A located within source B is vastly greater than that reflected by the listing.

## *2- Identification and inventory of the green road journals*

Based on information from the web page of the ROMEIO Project by SHERPA, we created source C, in which each publishing company is identified with a colour that symbolises the type of policy adopted regarding self-archive. A green tone indicates that the authors can self-archive the pre-print, the post-print or the PDF version of the editor. The blue tone represents publishers that allow for self-archiving of the post-print (and post-peered) versions or the editor's PDF version. The yellow tone indicates permission for self-file of the pre-print versions, before peer review. And finally, white represents the editors who do not permit self-archiving or no information is available. The former three groups, then, are the editors adhering to the open access movement via the green route.

If we compare the list of editors from sources C and A and we normalize their means of entry so as to allow us to cross data, each editor of source C can be associated with one or more journals from source A, and we identify the source A journals associated with the colours that symbolise each type of editor from source C. Using these data we can calculate the amount of journals that permit some form of self-archiving and which we include in the green road group.

## *3- Identification and inventory of the non- OA journals*

Having finalized processes 1 and 2, we configure the group of non-OA journals, gathering up the set of titles that were not on the gold road or the green road.

Note also that Sherpa has explicit conditions of some 700 publishers. This means that for quite a big share of the journals in SCOPUS, especially publishers publishing only one journal and particularly publishers outside the English language, there is no available information. However there are many small journals that don't even have copyright stuff on their sites and that they do not require authors to sign away the copyright. Hence there is a risk in interpreting of non-OA journals.

## *4. Calculating the impact indicators*

Finally, we consulted the total list of journals included in the SJR. We selected the year 2008 as the criterion of selection for calculating the indicators, and downloaded the data in a grid (source D). Then we compared the journals from sources A and D and normalized the titles that presented variations in their denomination. In the SJR we found some journals that were not on the SCOPUS list, and vice versa. Considering the fact that this could be due to some delay in updating the sources, we opted to calculate indicators of impact only for the journals present in source A, as the predominating source of our study. We placed the journals into the groups identified in stages 1 through 3: gold road, green road, and non-OA. For each group we calculated the number and percentage of journals, the average value of the SCImago Journal Rank (SJR) indicator and of the citations per document for a chronological window of two years (Cites / Doc. (2 years)). The SJR indicator expresses the number of links that a journal receives through the weighted citation of its documents in relation with the number of documents published per year for each publication. Weighting of citations was done in terms of those received by the citing publication. The SJR indicator considers journal impact in terms of the citations received, also taking into account the quality of the citing journals. (González-Pereira, Guerrero-Bote and Moya-Anegón, 2010). The indicator Cites / Doc is the mean number of citations per document in two years. To calculate this indicator, we bear in mind the number of citations received in the two previous years and the number of documents published in the year selected (SCImago, 2007). These indicators were calculated for the entire volume of journals from each group, and then again for the groupings by theme or geographic region.

##### *5. Analysis*

Analysis was global, by theme and by geographic aggregates, depending on the economic model adopted (gold road, green road, and non-OA) to compare journal distributions. We proceeded to put our first hypothesis to the test, using the chi-squared test to determine significant differences in the different disciplinary groups, and regions, with regard to the open access movement. The visibility of the groups of journals was compared according to the

underlying economic model, and finally, visibility of the journals was analysed grouping them by quartiles, on the basis of the SJR indicator from the source SCImago Journal & Country Rank.

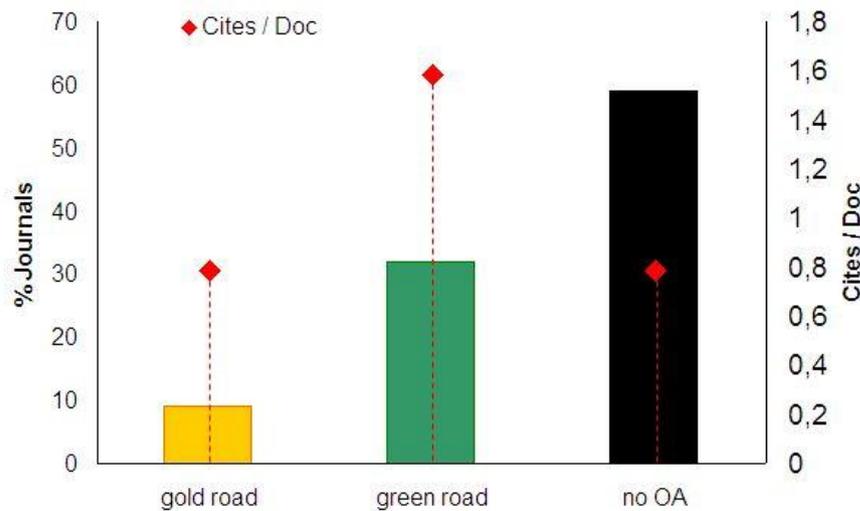
## **Results**

### **SCOPUS coverage in relation with the economic model of the journals**

From a general standpoint, SCOPUS journal ascription, somehow or other, to the OA movement amounts to 41% (9% gold road journals, and 32% green; **Figure 1**). Despite the limitations of indicators regarding visibility and sets of journals in heterogeneous disciplinary domains, it is fairly clear that in general the journals that comply with self-archive receive, on the average, more citations per document than those published in open access journals (gold road) or traditional pay-to-subscribe journals (non-OA), which present no relevant/significant differences in the values for this indicator.

These results converge with those of other studies (Harnad, 2004; Moed, 2007; Gargouri, 2010); and as we mentioned earlier, one possible explanation is that well consolidated journals of great prestige, such as *Nature*, *Cell* or *Science*, are not integrated in the *open access* movement because they wield very high visibility and subscriptions are economically beneficial for them. Open access might afford some advantage along the green road, but certainly not on the gold route.

Figure 1. Distribution of the journals according to the open access movement



### Thematic distribution of journals

The thematic distribution of SCOPUS journal is quite well balanced. The main thematic divisions *Health Sciences*, *Physical Sciences* and *Social Sciences* share presences near 30%, *Life Sciences* lagging close being with 20% (**Figure 2**). This comes as somewhat of a surprise, as bibliographic databases —first the *Web of Science* and later on of *Scopus*— are often accused of lacking coverage in the social sciences, not only because of different publication habits well known to all, but also because of the lack of proportion is their coverage with respect to the other fields. The importance of journals in the Social Sciences owes mainly to the incorporation of journals from the *European Science Foundation's European Reference Index for Humanities* (ERIH) since June 2009. This means that we are dealing with a multidisciplinary, international tool, and with an expanding area of social studies and humanities, which will permit us to branch out and revise earlier studies in which the thematic coverage in this direction was seen as deficient (Moya et al., 2007).

When we analyse journal distribution of the SCOPUS journals according to the economic model for each one of the four major areas (**Figure 3**) it becomes apparent that OA journals are not predominant in all fields. The green road is clearly the strongest modality of OA, and in relative

terms the distribution is quite similar in all the fields. For the gold road, in contrast, *Life Science* and *Health Sciences* clearly dominate over *Physical Sciences* and *Social Sciences*.

Figure 2. Thematic distribution of the journals in SCOPUS

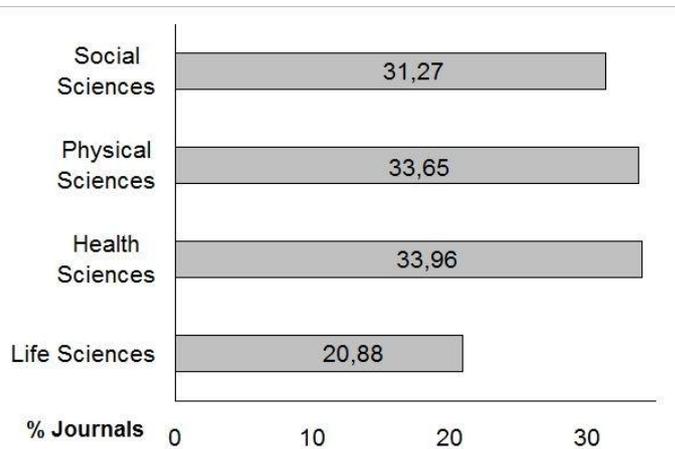
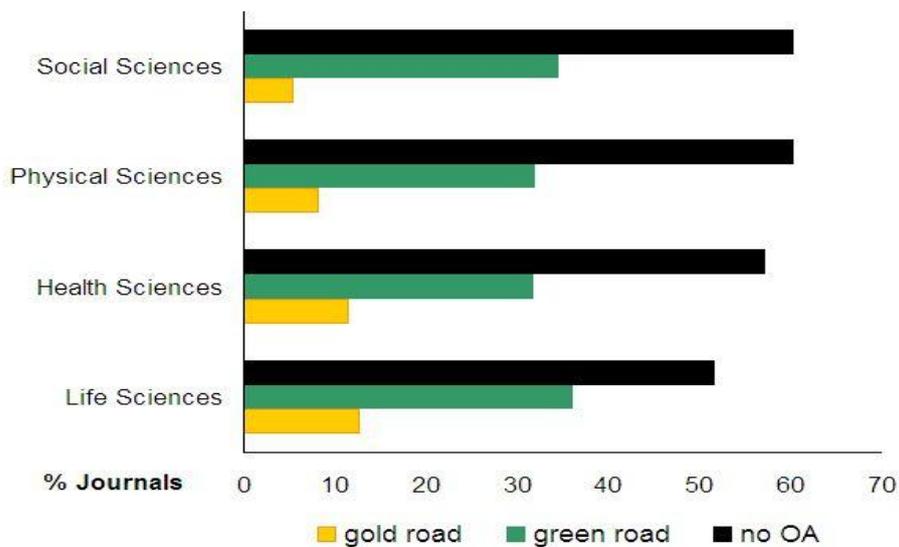


Figure 3. Thematic distribution of the journals in SCOPUS by economic model



Now, if we take as point of reference the thematic distribution of the gold road journals, comparing sources SCOPUS y DOAJ, we see our first hypothesis partly confirmed. From the perspective of the international directory DOAJ, the *Social Sciences* have the greatest percentage (39%) of gold road journals, ahead of *Health Sciences* (24%), *Physical Sciences*

(20%) and *Life Sciences* (14%). In contrast, SCOPUS shows a lesser presence of the gold road in all the fields, reaching just 12% of the journals in *Life Sciences* and in *Health Sciences* (**Table 1**).

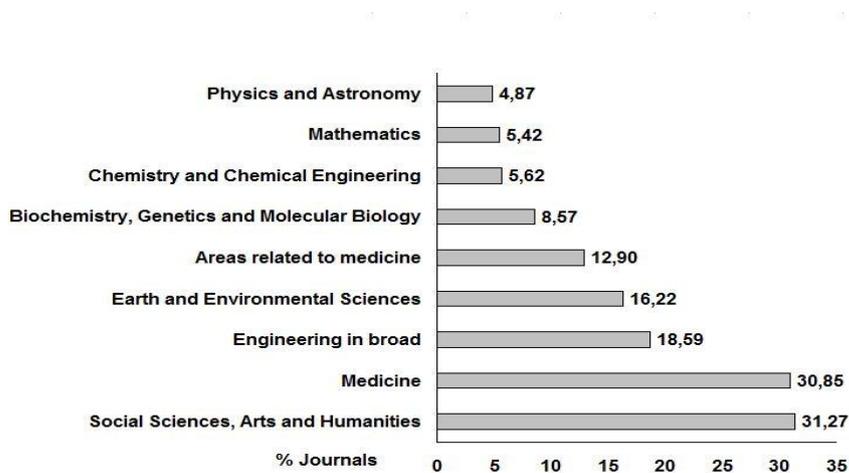
Table 1. Comparative thematic distribution of the gold road journals between Scopus and DOAJ

	% SCOPUS	% DOAJ
Social Sciences	5.4	39.1
Health Sciences	11.4	24.4
Physical Sciences	8.2	20.5
Life Sciences	12.6	14.2

If we descend a level and segregate these fields into more specific thematic areas, we find that the percentage of journals in *Social Sciences, Arts and Humanities* (SSA&H) comprises 31% of the total database. This figure lies well above the rest, including Medicine (**Figure 4**).

Another of the strong points of SCOPUS is its coverage in Engineering and Technologies, where it by far outdoes the percentage of journals in Ulrichs' Web (Moya et al., 2007). The results show that over 18% of the journals belong to this category. At the other extreme, Physics and Astronomy take in just under 5% of the journals, and Chemistry and Mathematic are over 5%.

Figure 4. Percentage-wise distribution of SCOPUS journals by thematic category



Which leads us to the question: in which thematic categories are the OA journals most concentrated, regardless of whether they pertain to gold or green road? **Figure 5** shows the breakdown by economic model and category to the left; and to the right, the percentage of journals of each thematic area in the database.

At first glance one notes a fairly balanced distribution among the disciplinary groups with respect to the journal access. The percentage that somehow ascribe to OA is near 50% in most cases. The discipline showing best adhesion to OA is Biochemistry, Genetics and Molecular Biology, with over 52% of the journals, followed at some distance by Mathematics, Physics and Astronomy and Areas related to Medicine. At the other extreme, the least adherence is seen for Engineering, with 36%, followed by Social Sciences, Arts and Humanities and then Earth and Environmental Sciences. In all the disciplinary groups, the green road widely surpasses the percentage of gold road access, with a difference close to 30% in nearly all cases. In Medicine, Earth and Environmental Sciences and Engineering the differences are less remarkable (20%, 16% and 24%). In the first two cases, they coincide with the discipline having a greater percentage of journals in the gold route (12%); contrariwise, in the latter case, it is the field with the least percentage of journals (40.8%) adhering to the OA movement. We confirm that among the disciplinary groups there are significant differences with regard to the economic model of the journals ( $\chi^2(16) = 392.6$   $p < 0.001$ ).

By weighting the percentage of journals according to the economic model with respect to the total percentage of journals in the database in each thematic category, we are able to see that the gold road predominates in *Medicine*, in the first place, followed by *Earth and Environmental Sciences*, and in third place *SSA&H* (**Figure 6**).

Figure 5. Percentage-wise distribution of the gold road, green road and non-OA journals by thematic category

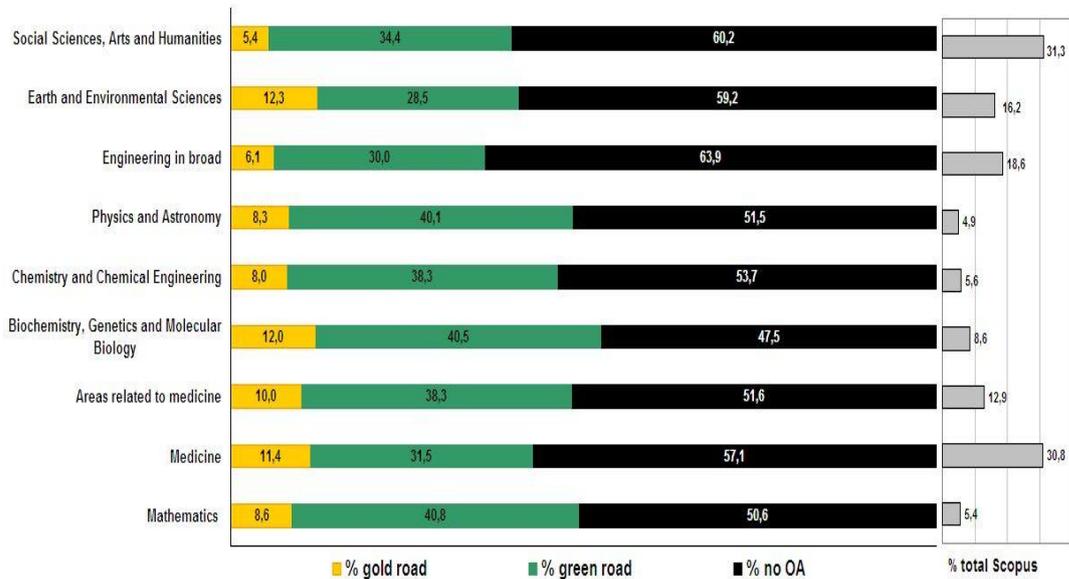
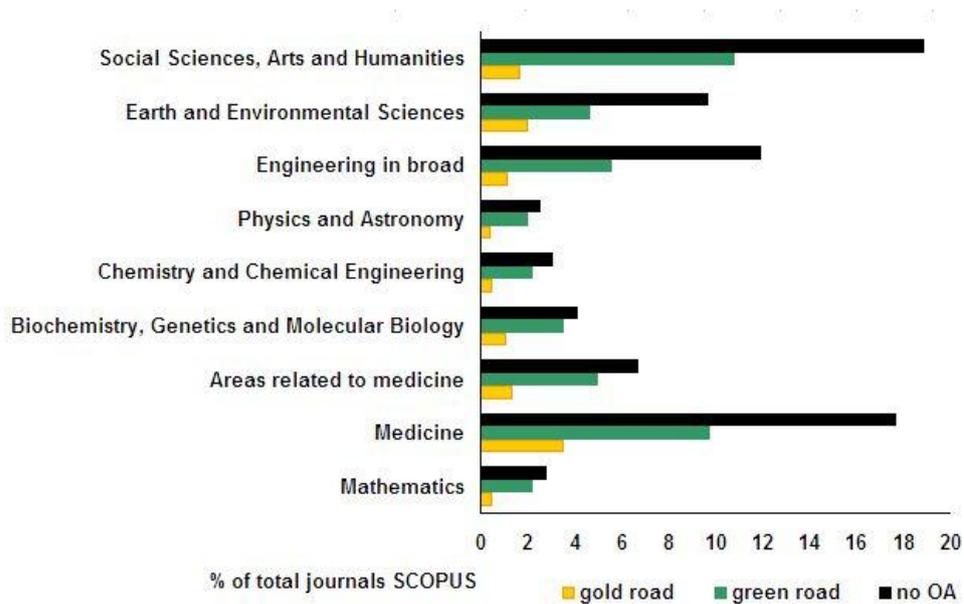


Figure 6. Percentage of gold road, green road and non-OA journals with respect to total SCOPUS journals by thematic category



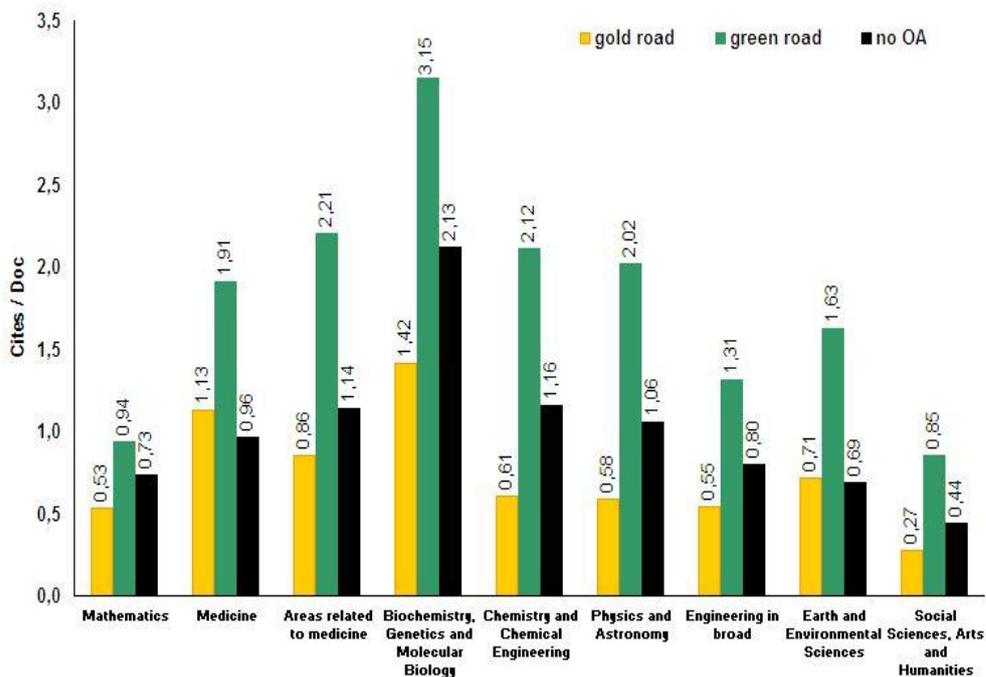
The surprising finding by Björk et al. (2010) —that gold road articles surpass by far the green road ones in Medicine, Areas related to Medicine, and Biochemistry, Genetics and Molecular

Biology, is not seen in our study, where the green road prevails in all the disciplinary groups. This finding reveals that from the standpoint of the journals themselves, the green road has a great potential for expansion that is perhaps not being taken advantage of by the authors. This is a finding of relevance for authors as well as for the persons responsible for repositories and institutional policies.

### **Visibility**

**Figures 7 and 8** show the average visibility achieved by the journals in each thematic category according to the economic model, using the indicators Cites / Doc (2 years) and SJR. These two units of measure give information on different facets of visibility/impact/use that have to do with popularity and prestige, and they are highly correlated (González-Pereira, Guerrero-Bote and Moya-Anegón, 2010). The SJR indicator considers journal impact in terms of the citations received, also taking into account the quality of the citing journals. This has implications that go beyond popularity (citations per document), and the use of the information in question. Accounting for the origin of citations grants an added value to appraisal of its use, and has much to do with the prestige of the journal, not just the citation-based indicators. Due to the variability of impacts among disciplines, the SJR is not directly comparable for the different thematic areas. Figures 7 and 8 are meant to reveal the differences in impact between gold road, green road and non-OA journals within each disciplinary grouping.

Figure 7. Cites per document of journals: gold road, green road and non-OA

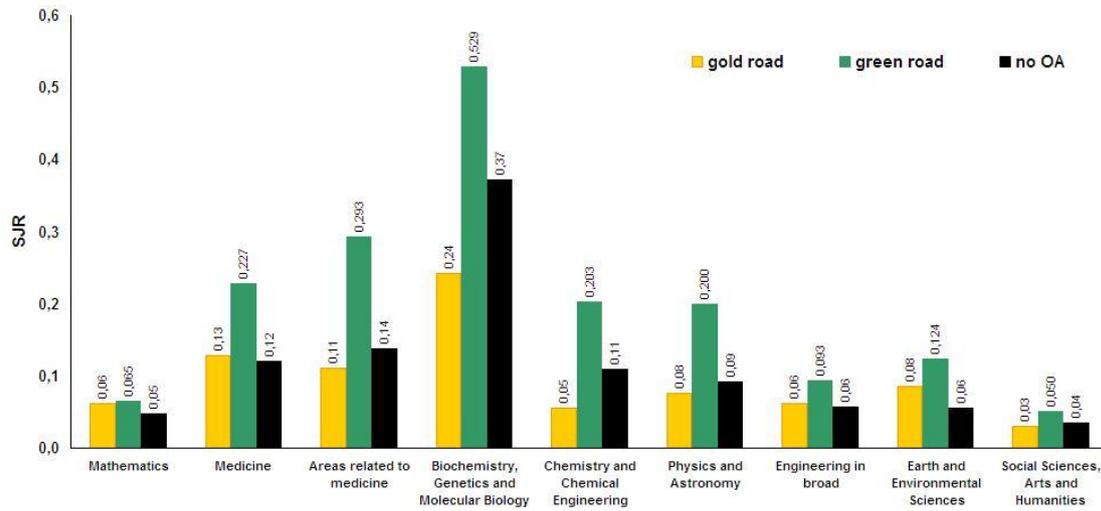


Given these considerations, we may say that in terms of citation per document or popularity in all the disciplinary groups, the green road achieves the highest values, followed by the non-OA journals, with the gold ones taking last place except in Medicine, where they are slightly higher than the average cites per document of the non-OA journals. In Earth and Environmental Sciences, the visibility of the gold road journals and the non-OA journals is basically the same. Finally, deserving mention is the fact that the greatest number of citations per document in the green route is seen in the category Biochemistry, Genetics and Molecular Biology followed by Areas related to Medicine, Chemistry and Physics and Astronomy; the least cited are SSA&H and Mathematics (**Figure 7**).

Utilizing the SJR indicator now, we observe the same phenomenon: the green road journals are the most prestigious. Although there are thematic areas in which the differences among the three groups are minimal —the case of Mathematics SSA&H, for example— there is hardly any difference in visibility and prestige between the gold road and the non-OA journals. Yet it is

noteworthy that Engineering in broad and Earth and Environmental Science house gold road journals with higher prestige than the non-OA ones. We therefore agree entirely with Harnard (2008) in that the green route is the only option leading to 100% OA in the future.

Figure 8. SJR average of the journals, according to the economic model



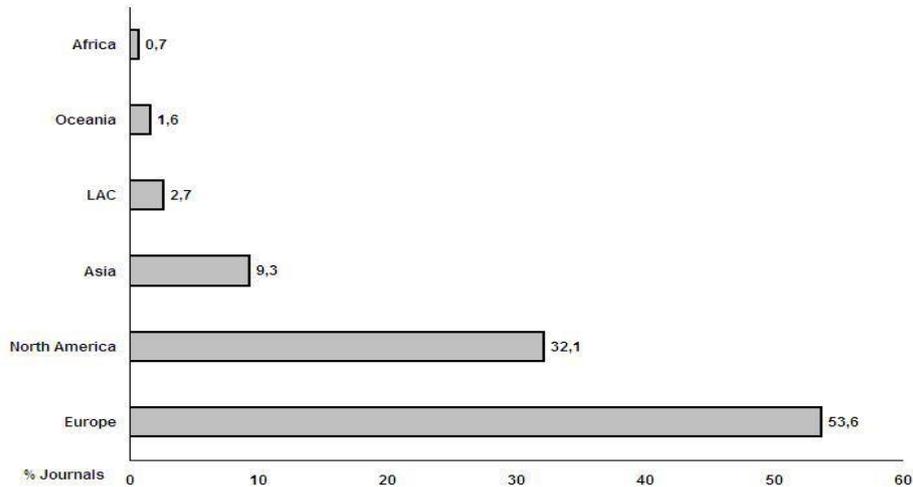
### Coverage of journals in SCOPUS by geographic region

**Figure 9** displays the percentage-wise distribution of SCOPUS journals by geographic region of origin. Europe produces 54%, and North America 32%. These are followed, at some distance, by Asia (9%); Latin America and the Caribbean (LAC) with 2.7%, Oceania (1.6%) and Africa (0.7%). This distribution is similar to the one observed regarding scientific output on the worldwide level: three regions concentrate over 80% of world production (Moya et al., 2009).

When the regional distribution is further broken down by economic model (**Figure 10**), the differences between Europe and North America are less pronounced. Now these are the regions with a greater adhesion of green road access, respectively representing 38% and 35%. The pattern seen in LAC is very distinct: 74% of the journals of this region included in SCOPUS are

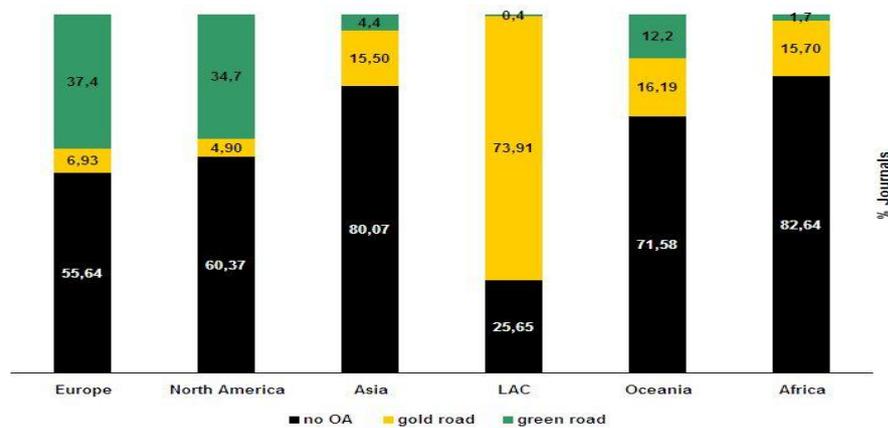
gold road ones, and there are practically no green road journals registered. Excepting LAC, there is a high percentage of non-OA journals overall.

Figure 9. Distribution of journals by geographic region



We could also speak of three well differentiated groups or consolidated regions of the scientific world in which more than 35% of the journals allow for self-archiving; regions that are traditionally peripheral (from the standpoint of scientific output and their editorial presence in major databases) with very little green road presence, such as Africa and LAC; and finally there are emerging regions, namely Asia and Oceania, where over 15% of the journals are gold road ones, and the green route percentage is very different.

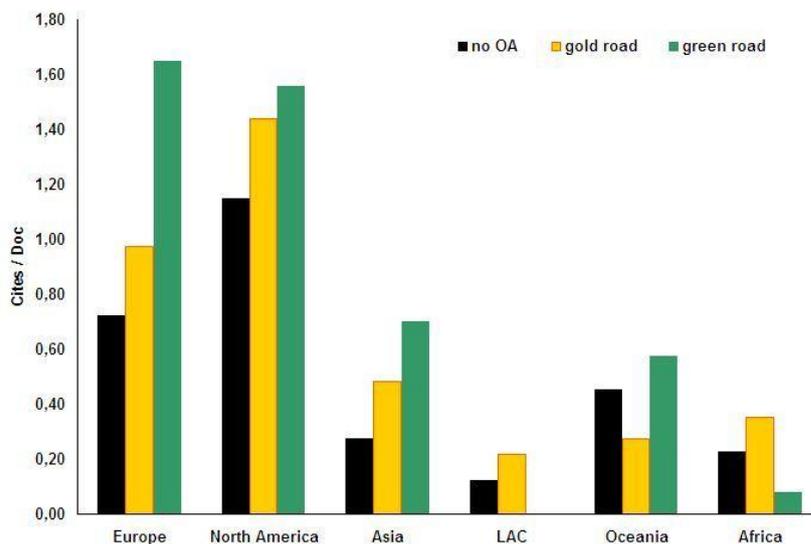
Figure 10. Distribution of the journals according to economic model and geographic region



The case of LAC is remarkable. One reason could be that publishers in this region do not establish clear policies regarding self-archiving. Moreover, they feature some unusual initiatives such as the projects *Scientific Electronic Library Online* (SciELO) ([www.scielo.org](http://www.scielo.org)) and the *Red de Revistas Científicas de América Latina y el Caribe, España y Portugal* (Redalyc) ([redalyc.uaemex.mx/](http://redalyc.uaemex.mx/)), digital libraries that offer full-text access of journal articles, but do not have all the characteristics of repositories. In other words, there are certain ways in which this region is fomenting the green road, but unlike the way it is developing in the rest of the world.

An initial approach to regional visibility according to the economic model of the journal sheds light on some significant details that differentiate regions. In spite of having similar figures for green road journals, visibility is much greater in Europe than in North America, and the differences regarding the gold road are even greater. In Oceania, the non-OA journals surpass the gold road ones in popularity, whereas in Africa, the gold road is higher in visibility than the non-OA journals and the green road journals. A similar trend can be seen for LAC, yet involving only the non-OA journals, as there is no visibility at all of green road publications.

Figure 11. Average cites per document by region, according to the economic model of the journals



### **SCOPUS coverage by geographic region and thematic area**

The results shown in **Figure 11** are gross, and do not account for important factors bearing on visibility, such as the different thematic specialization of each region. Hence, **Figure 12** presents the distribution of journals according to the economic model in the three major thematic areas of SCOPUS: Life Sciences, Health Sciences, Physical Sciences and Social Sciences.

Europe and North America exhibit more or less balanced distributions of the journals ascribing to some form of OA (gold plus green road) against the no self-archive. In all four areas the percentage of green road journals lies in the range 35%-46%, except Physical Sciences within North America, where the percentage is somewhat reduced (30%). The gold road journals are under 10% in all cases.

Asia and Africa present similar patterns insofar as the considerable proportion of non-OA journals, over 70% in all cases; the gold road journals take second place. In Asia, outstanding areas are Life Sciences and Health Sciences, in which the gold road figure is nearly 25%. In Africa, this open access mode is noteworthy in the case of *Life Sciences* and in Physical Sciences, with respective proportions of 28% and 21% of journals.

Deserving special mention is Oceania: even though most of the journals it puts out are non-OA, the rest are essentially half-and-half, gold or green. The main distinction would be in the area of Health Sciences, where the gold road figure is twice that of the green road figure (27% vs 13%). LAC marks the exception to the rule. Aside from the unexpected finding that most of its journals are gold road ones, we also discern that this holds true in all four areas, in a quite balanced way, though the field Social Sciences stands out with its 81% of the journals. Another point worth mentioning is that there is absolutely no green road representation in Life Sciences or Health Sciences, and it is very scanty in the other two areas.

Figure 12. Distribution of the journals by geographic region and thematic area



In order to determine if there are significant differences in the economic models adopted by each geographic region with respect to the thematic areas covered by the journals, we calculated the chi-squared value (**Table 2**). The results gave ( $X^2$  (6),  $p < 0.001$ ) meaning that the regions Europe, North America and Asia exhibit significant differences with regard to the model adopted by the journals in each thematic area; yet there were no significant differences found in

Oceania. For the regions LAC and Africa we were not able to calculate this indicator because the expected frequencies were under 5 and statistically it isn't worth to calculate because are not relevant.

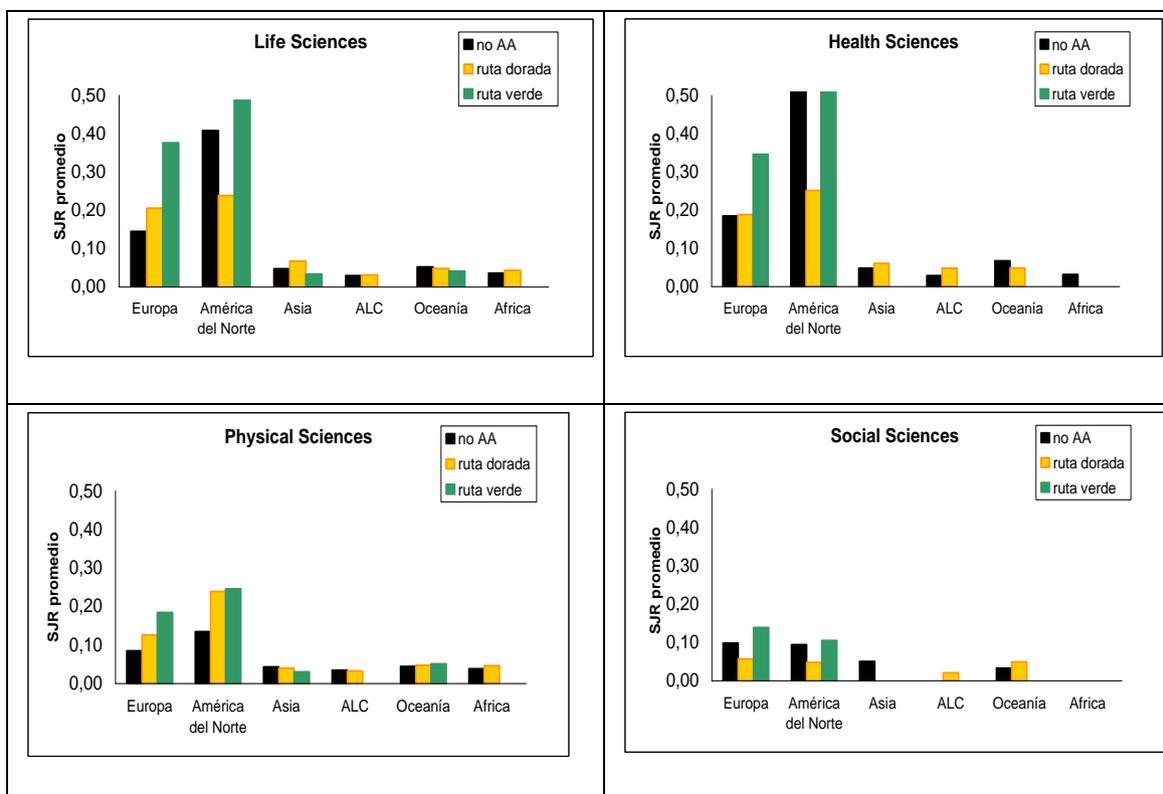
Table 2. Chi-square test of the distribution of journals according to geographic region and thematic area

<b>Region</b>	<b><math>\chi^2</math></b>
Europe	188.9
North America	56.7
Asia	111.4
LAC	no relevant
Oceania	8.0
Africa	no relevant

The mean visibility as measured by the SJR indicator leads us to affirm that in Europe and North America, the green road attains higher average impact than the gold road or the non-OA journals in all four thematic areas. We might also underscore that in North America, in the impact reached by the green road journals in Health Sciences is similar to that seen for non-OA publications.

In the other regions, the mean impact of the journals is much lower than in Europe and North America. The green road exists in terms of impact in Asia and Oceania only in the areas Life Sciences and Physical Sciences. Furthermore the green road does better than the gold one in impact in Oceania, within the area Physical Sciences.

Figure 13. SJR averages by thematic area and geographic region



In LAC, the gold road surpasses, on the average, the impact of the non-OA journals in Health Sciences alone; but not in Physical Sciences, where the greatest relative impact corresponds to the non-OA journals. In Life Sciences there is a draw; and in Social Sciences, we only find gold road journals, with no impact values obtained for the other two models. Then again, we should bear in mind that this region produces virtually no green road journals, and in the two areas where there is indeed some greenery (Physical Sciences and Social Sciences) there is no impact from the standpoint of the SJR indicator for 2008. Perhaps the recent incorporation of these in the database is to blame, and we should wait a few years for them to begin to make these data available to the general public, as occurred with the Journal Citation Report of Thomson Reuters.

Finally, we analyzed the gold road journal distribution by geographic region, into quartiles, based on the SJR values. The results support our working hypothesis in that the gold road journals of the peripheral and emerging countries pertain to Q4 (**Table 3**). We can further state

that this is also true for Europe and North America, and conclude that the gold road offers the least visibility in any region.

What is clear from the overall panorama is that the best positions in terms of visibility are held by the traditional journals that have explicit policies in favour of some form of self-archive in repositories. It is likewise manifest that the advantages of OA upon visibility are mainly due to the green road, not the gold one; and that Europe together with North America are at the forefront, as the regions with greater percentages of green road journals, with which they harvest greater impact.

Table 3. Percentage-wise distribution of gold route journals in quartiles, according to their visibility, by geographic region

Region	Q1	Q2	Q3	Q4
Europe	0.7	4.4	11.7	25.3
North America	0.8	1.5	3.5	12.5
Asia	0.0	0.3	2.4	12.3
LAC	0.0	0.0	0.8	20.9
Oceania	0.0	0.0	0.3	1.5
Africa	0.0	0.0	0.0	1.0

In contrast, in the peripheral regions where the green road is virtually inexistent, and the gold road is relatively abundant, it did not achieve better levels of impact than the non-OA journals. The exception to be highlighted here is *Health Sciences* in LAC. The reason would be the strong promotion of open access by means of the initiatives and projects mentioned earlier, and in the case of Brazil, BIREME/OPAS/OMS and other such inter-governmental bodies.

## Discussion and conclusions

SCOPUS offers a thematic coverage of journals that can be said to have a good balance in general terms. It has become the international multidisciplinary source of data with the greatest

percentage of journals in the Social Sciences and Humanities, aside from Engineering and Technologies, overcoming a limitation of bibliographic databases in the past. However, there is still room for improvement in aspects that may affect bibliometric analysis, such as comprehensive coverage of journals and inclusion of the countries of affiliation of all authors. Regarding open access, it provides more homogeneous coverage among the thematic areas than the other outstanding source of information, the DOAJ.

The percentage of journals adhering to in some form to the self-archiving trend in SCOPUS ranges from the 50% we obtained for Biochemistry, Genetics and Molecular Biology and the 36% seen in Social Sciences, Arts and Humanities. In all the disciplinary groups, the presence of green road journals widely surpasses the percentage of gold road publications.

The peripheral and emerging regions have greater proportions of gold road texts and the publication in green journal is almost inexistent. In broader terms, a possible explanation could be that the scientists –as-readers in peripheral countries are served equally well by Open Access, and for the scientists in poor countries, provided the internet connections are available with the rise of OA. This is the argument most often put forth to justify creating new OA journals or archiving peer-reviewed articles in suitable repositories. On the other hand, scientists-as-authors may discover that getting an article accepted in an OA journal located in a “central” country is just as difficult as being accepted in a toll-gated journal, and perhaps even more difficult if they have to plead for funds to pay the publishing charge. Therefore, if getting into a core OA journal is as difficult as being published in a core, toll-gated journal, creating an OA journal on the periphery, is a good deal easier. The cost of creating an OA journal and making it work in the sense that it is recognized, used and cited is lower than the cost of creating a new, toll-gated journal. The fact that it can be made visible and accessible from all over the world, and the fact that it can be included in lists such as DOAJ or Open J-Gate ensures a certain level of impact. (Guédon, 2008).

The gold road journals have no visibility, and pertain to the fourth quartile. This finding could be the key to a paradox mentioned in the literature involving the inclusion of national journals in international databases and an ensuing drop in “impact per capita” of the country, or a difficulty in making impact grow (Zitt and Bassecouard, 1998). The change from national to transnational model, in which so many authors and editors participate with sound publishing practices in order to enhance their international visibility (Zitt et al., 1998), makes necessary a continual revision of the habits behind divulgation of the results of scientific activity, to move away from the periphery and closer to the centre of the publishing arena (Bekayac, Petrak and Buneta, 1994).

Thus, while open access may facilitate use, this use of data can be affected by factors that do not necessarily contribute to greater visibility. Such factors include publication in a language other than English, that is, in the mother tongue of the country in question (Puliselic and Petrak, 2006); a high degree of self-citation on the part of authors or journals; and a low percentage of international collaboration (Morillo, Fernández and Gómez, 1999; Engels, Ruschenburg and Weingart, 2005; Chinchilla-Rodriguez, et al., 2010). Furthermore, beyond the issue of OA publishing, it would appear that authors and editors need to exert themselves more in evaluating their habits. Certain practices which may have been common in the past are no longer recommendable, and if they affect the content of articles, they will ultimately hinder journal quality and visibility.

In general terms, and from the standpoint of SCOPUS coverage, there is no noteworthy presence of the gold road in Social Science and Humanities... except in LAC and other peripheral regions. The gold road has a greater proportion of work in journals pertaining to Medicine, Biochemistry, Genetics and Molecular Biology, Areas related to Medicine, and Earth and Environmental Sciences. The first three coincide with the areas where Björk et al. (2010) found more gold articles than green ones. There would appear, however, to be a greater

presence of the gold road in Social Sciences according to the DOAJ, an OA source of worldwide reference. This comes to partly confirm our first working hypothesis.

We arrived at significant differences among the different disciplinary groups with regard to the economic model underlying the journals, and also in the regions Europe, North America and Asia. The trend in Oceania is unique. Meanwhile, in LAC and Africa we could not determine this because of the small sample of green journals. The green road publications outdo the other two types in most of the thematic areas and geographical regions, so that the ratio gold road versus OA is not very clear. At the thematic level, these results are in line with those of Norris (2008).

The gold road journals pertain for the most part to the Q4, regardless of the geographic area of origin. The peripheral regions were found to produce greater output in gold road journals, confirming our second working hypothesis. These results also reveal a phenomenon holding true for both Europe and North America, permitting us to conclude that the gold road is the one with the lowest visibility in any region.

On the regional level, Latin America shows atypical behaviour. The fact that LAC is hardly present in green road journals attests to its recent incorporation into the publishing market, where journals have since taken the high (gold) road. In addition to the scarce presence mentioned earlier in the literature of Latin American output in the main stream means that it is scarcely any green route production. While the green road yields better results insofar as visibility, with the gold open access road, the boundaries between these two bias are not well defined. This may be giving rise to some conflicts in the publishing world. Revision of the overriding policies could help orient future recommendations for researchers, institutions, and information managers.

To sum up, the results of our study make manifest that the benefits of open access in terms of impact are to be found on the green route. Paradoxically, this advantage is not lent by the OA per se, since even though the green road journals are the ones with the highest levels of impact,

previous studies reveal that the percentage of articles placed in repositories or hung on websites does not surpass, on the average and for all the thematic fields, 12%. Notwithstanding, there are important differences in the different disciplinary groups. The area with the greatest presence (Earth Sciences) just barely reaches 26% (Björk et al, 2010). In other words, most articles published in green journals continue to be non-OA, one good reason why it is not possible to attribute their high visibility to free access. In this sense, and in agreement with the indications of previous authors (Norris, Oppenheim and Rowland, 2008; Gargouri et al., 2010), we believe it stands demonstrated here that the greater visibility of green road journals is not a consequence of OA, but rather of the quality of the articles/journals themselves, regardless of their mode of access. It has also been shown that the guaranteed access afforded along the golden road is insufficient for attaining more citation, because citation depends, in the final analysis, on the quality of articles.

So why do the green road journals attain higher visibility than the non-OA ones? What is the determinant difference between these two groups and their respective impact or success? It may be that the editors of the more prestigious journals were the first to jump on board the OA movement via the green path, establishing some sort of self-archiving policy for their articles. As Eysenbach (2006) and Moed (2007) claim, open access is a great vehicle for accelerating the divulgation and acknowledgement of research results, with immediate effects for citation. And the quick availability of articles online can enhance quality, which the editors of the most prestigious journals have harvested wisely.

It would seem that the recommendation to make visible the results of research through repositories, be they institutional or thematic, increases the probability that they be read sooner, and therefore cited earlier, but there is no guarantee of such. Open access certainly offers more possibilities. Nonetheless, it is the quality of contents, the prestige of the journal and of the author and institution, what ultimately determine explicit quality in the form of citation. We should therefore not treat open access and visibility as if they were a pair of cufflinks, but rather

view them as signs of wise publishing practices with distinctive roots in the generation of scientific knowledge.

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