Accepted version, Current Science, September 2016

Should Indian researchers pay to get their work published?

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Abstract

We raise the financial and ethical issue of paying for getting papers published in professional journals. Indian researchers have published more than 37,000 papers in over 880 open access journals from 61 countries in the five years 2010-14 as seen from *Science Citation Index Expanded*. This accounts for about 14.4% of India's overall publication output, considerably higher than the 11.6% from the world. Indian authors have used 488 OA journals levying article processing charge (APC), ranging from INR 500 to US$5,000, in the five years to publish about 15,400 papers. More than half of these papers were published in just 13 journals. *PLoS One* and *Current Science* are the OA journals Indian researchers use most often. Most leading Indian journals are open access and they do not charge APC. Use of OA journals levying APC has increased over the four years from 242 journls and 2557 papers in 2010 to 328 journals and 3,634 papers in 2014. There has been an increase in the use of non-APC journals as well, but at a lower pace. About 27% of all Indian papers in OA journals are in 'Clinical Medicine,' and 11.7% in 'Chemistry.' Indian researchers have used nine mega journals to publish 3,100 papers. We estimate that India is potentially spending about US$2.4 million annually on APCs and suggest that it would be prudent for Indian authors to make their work freely available through interoperable repositories, a trend that is growing significantly in Latin America and China, especially when research is facing a funding crunch. We further suggest bringing all Indian OA journals on to a single platform similar to SciELO, and all repositories be harvested by CSIR-URDIP which is already managing the OA repositories of the laboratories of CSIR, DBT and DST. Such resource sharing will not only result in enhanced efficiency and reduced overall costs but also facilitate use of standard metadata among repositories.

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More than two decades ago Harnad posted his subversive proposal to a mailing list in which he called on researchers "to make copies of all the papers they published in scholarly journals freely available on the internet."[1,2] Many researchers now make their papers freely available either by publishing them in open access (OA) journals or by placing them in repositories or websites. Indeed, a 2013 report asserted that by 2011 "free availability of a majority of papers has been reached in general science and technology, in biomedical research, biology, and mathematics, and statistics," and that the number of open access papers has been growing by about 2% a year.[3]

Journals make papers open access in two ways: OA journals make all papers open access immediately on publication, and hybrid OA journals make selected papers open access. Most OA journals listed in the *Directory of Open Access Journals* (*DOAJ*) do not charge to make a paper open access. *Current Science* is such a journal. Many OA journals – about 26% according to Solomon and Björk[4] – and all hybrid OA journals levy an article processing charge (APC) to provide OA to a paper. However, according to Crotty,[5] the majority of OA papers are published by paying an APC. The APC levied by journals used by Indian researchers is in the range INR 500 (~US$8) - US$5,000.

OA journal publishing, particularly by commercial publishers and in the field of biomedicine, is growing rapidly. According to *DOAJ* there are 9,192 OA journals as of 2 September 2016 published from 130 countries and one can access more than 2.27 million articles. Currently, *DOAJ* is growing at the net rate of 6 titles per day.[6] The *Directory of Open Access Scholarly Resources* (*ROAD*) lists 14,031 OA journals published from some 140 countries.[7]

Repositories, where full texts of research publications are deposited and made available online, are of two kinds: central repositories, such as *arXiv*, and distributed (or institutional) repositories, such as the University of Southampton institutional research repository, <eprints.soton.ac.uk>, the first of its kind.

Here we are concerned only with the open access journals which make all content open access immediately on publication. Further, our interest is in papers from India that are published in journals levying APC. The question we are particularly interested in is, 'is paid open access affordable for India?' And, even if it is affordable, should we go for it?

We assessed the current status of the use of OA journals by Indian researchers using bibliometric analysis of data gathered from *Web of Science – Science Citation Index Expanded* (*SCIE*). We used this analysis to find out the number of papers Indian researchers have published in OA journals charging APC, leading to an estimate of the amount the country as a whole would potentially have spent on APC costs, and to see if publishing in paid OA journals led to higher levels of citations.

Methodology

We searched for articles, letters, proceedings papers and reviews from India in OA journals

indexed in *SCIE* in the five years 2010-2014. The search made on 11 January 2016 resulted in 37,122 papers. Of these, 44 papers resulting from five international collaborations (CMS, ATLAS, ALICE, STAR and FAITH), and appearing in journals such as *Physics Letters B*, *New Journal of Physics*, *Nuclear Physics B* and *BMC Musculoskeletal Disorders*, had a very large number of authors (running to several hundreds). We removed them from the data set as they hindered processing the data. Thus we considered 37,078 papers. We downloaded full bibliographic data for all these and analysed the data using Visual FoxPro and found that Indian researchers have used 881 OA journals in which to publish these papers. We visited the web site of each of these journals during January- February 2016 to find out information on APCs levied by them. Also we classified the journals into 22 major field categories following the *Essential Science Indicators* (ESI) classification. This classification does not allocate journals to multiple fields. We identified papers in which at least one author was from a country other than India.

Using the same strategy as used for Indian publications, we recorded the number of papers published by 12 other countries and the proportion of OA papers (data gathered on 29 January 2016).

Results

We present here the key findings. Details of our bibliometric analysis are available from the authors and will soon be presented in a report.

Use of OA journals by researchers – In the five years considered, SCIE had indexed 6,460,105 papers, of which 748,127 (or 11.58%) were in OA journals. In Fig. 1**,** we present the share of proportion of journal publications which have appeared in OA journals in 13 countries in the 5-year period 2010-2014. Brazil has the highest proportion (close to one in three papers), with India coming a distant second (one in seven papers). That Brazil leads is not surprising. Long before the OA movement began, the funding community led by the São Paulo Science Foundation (FAPSEP) and the information community led by the Latin American and Caribbean Center on Health Sciences Information recognized the need for strengthening the visibility of the Brazilian journals, and initiated the SciELO movement in the state of São Paulo, Brazil, in 1997, which later spread to Chile and the rest of Ibero-America and South Africa.[8] As Vessuri et al.[9] have pointed out, a strong sense of public mission among Latin American universities, coupled with the realization that OA improves the presence and impact of Latin American research publications led Latin America to develop its own knowledge exchange mechanisms on its own terms.

Estimates of the proportion of open access papers vary widely depending on the source used and when the estimate was made. For example, by analysing journals indexed in *Scopus* we found that 4,231 of the 22,460 active titles (as of 6 February 2016) were OA (as seen from *DOAJ* on September 2015) and were listed in either or both of *DOAJ* and *ROAD*.[10] Of the more than 12,000 journals covered by *Web of Science,* 1,313 journals are OA as of October 2015 as listed

by *DOAJ*.[11] Analyzing data from *Google Scholar*, Jamali and Nabavi showed that more than 61% of papers were accessible in full text.[12]

Use of journals charging APC - In 2010, Indian researchers had published their work in 479 OA journals, of which 237 did not charge APC. The number of OA journals used by Indian researchers to publish their work is increasing (Table 1). It has risen from 445 in 2009[13] to 611 in 2014. More than half of the 611 journals levy APC.

Not all journals charging APC have a fixed APC. There are many models. Of the 881 *SCIE*-indexed OA journals which Indian researchers have used, 488 charge a fee: 437 charge a fixed APC, 49 levy page charges, and two charge a non-refundable submission fee. Contrary to Crotty's observation that the majority of OA papers are published by paying an APC,[5] Indian authors publish a larger number of papers in non-APC journals. However, papers published in journals levying APC are cited a larger number of times on average.

The APC OA journal used most often by Indian researchers in the five-year period is *PLoS One* with a total publication count of 2,404 and average cites per paper (CPP) of 7.32. Starting with 78 papers in 2009,[13] the number increased to 724 papers from India in 2014. Indeed, *Current Science*, which comes next in the list with 2,334 papers with a CPP of 1.74, was the leader until 2011.

Overseas collaboration - All authors are from India in 30,152 of the 37,078 papers published by Indian researchers in the 881 OA journals; this includes papers in which all authors are from the same institution as well as papers with authors from more than one Indian institution. These papers have been cited 78,722 times for a CPP of 2.61. There are 6,926 papers with at least one author from an address outside India, and these have been cited 39,031 times for a CPP of 5.63. Indian researchers have collaborated with authors from some 115 countries. Collaborators are mainly from USA (2,191 papers), UK (815 papers) and Germany (708 papers).

Country of journal publication - Indian authors have published in OA journals from 61 countries. More than half (18,781) were published in 48 Indian journals, six of which charge APC. As one would expect, US and UK journals followed Indian journals in the number of papers published: 7,647 papers were published in 149 US journals of which 107 charge APC, and 2,834 papers were published in 172 UK journals of which 162 charge APC. Indian researchers have published 675 papers in 54 Brazilian OA journals of which nine levy APC, 229 papers in 9 Chilean OA journals of which two levy APC, 231 papers in 14 journals published from China of which five charge APC in the five yeras. In these five years Indian authors have published 652 papers in seven Nigerian APC journals. Of these, all but one were delisted from *Web of Science* after a few years of coverage. Such delisting is all too common. Of the 881 journals studied here, only 263 have been used by Indian researchers in all five years.

Citations to papers published in journals levying APC – Number of papers by Indian researchers in 57 journals charging APC and publishing at least 10 papers from India and has a CPP of not

less than 10 are listed in Table 2. Table 3 lists the 10 journals that do not levy APC and have been cited at least 10 times on average in the five years. Three journals, viz. *Nucleic Acids Research*, *PLoS Neglected Tropical Diseases*, and *BMC Genomics*, all of which charge an APC of well over US$2,000, have published more than 100 papers from India. In all three journals, CPP of Indian papers are less than CPP of the journal as a whole, and there is a big difference between the CPP of papers written solely by Indian authors and that of those written in collaboration with foreign authors. For example, *Nucleic Acids Research* has published 138 papers from India (CPP 14.09) out of a total of 6,614. The journal's average CPP for the 5-year period is 25.29 as against India's CPP of 14.09. The 80 papers entirely written by Indian researchers has a CPP of less than 10, and the CPP of the 58 papers with foreign collaborators is more than 22.

As many as 92 papers have appeared in 10 OA journals which do not charge APC, none of which are from India, and these have been cited more than 15 times on average. Of the 92 papers, 41 were published in the *Bulletin of the World Health Organization* at a CPP of about 12.5. In contrast, the CPP of the 478 papers published in the journal during the five years is above 15.

Use of mega journals- Indian authors have published 3,100 papers in nine mega journals where the papers are accepted without applying the usual standards of strict peer review if they are perceived to be technically sound (Table 4).

Papers classified by field - It is in Clinical Medicine that Indian researchers have published in the largest number of OA journals (208) as well as contributing the largest number of papers (10,036). They have published in 88 journals in the field of Plant and Animal Science, but have published a much larger number of papers in both Chemistry and Biology & Biochemistry in a smaller number of journals.

Discussion

Over 14.4% of the 37,122 papers from India as seen from *SCIE* have been published in OA journals. The actual number of OA papers from India will be much larger since, for example, *Scopus* is likely to have indexed a larger number of such papers. Additionally, there are papers published in hybrid OA journals and papers published in non-OA journals that are made open access by placing them in institutional or central repositories or freely available through author websites, which indicates that there is a welcome growing awareness of the need for making one's work OA. Our earlier study[13] has revealed that some 16% of Indian papers were pulished in OA journals indexed in SCIE 2009, but in that study we had considered all categories of papers from OA journals collected comprehensively from various sources.

Potential spend on APC seen in perspective

We estimated the total APC for all 14,293 papers published by Indian authors in OA journals charging a fixed APC (leaving out 7% of all OA papers charging variable APC). We found there

is an average cost of ~ US$1,173 per paper. We compared this figure with the costs on APCs incurred by institutions elsewhere.

From a survey of a large sample of journals listed in DOAJ carried out in 2014, Morrison *et al*. reported an average APC of US$964.[14]

The Wellcome Trust, which supports payment of charges incurred by their grantees, reported a total spend of about £4.7 million paid for 2,556 papers, published in OA or hybrid journals, in 2013-14 at an average APC of £1,837. Close to 60% of these papers were published in the journals of the five leading publishers, and of these 68% were in hybrid journals. In 2014-15, the Charity Open Access Fund, comprising the Trust and five other funders, had paid more than £5.6 million towards APCs for 2,942 papers at an average cost of £1,914.[15]

In its report dated March 2015, RCUK indicated an average APC of £1,600, based on APC paid for 6,504 papers from 55 universities during the two years 2013-14 and 2014-15. The average APC paid varies from university to university, from £778 for the School of Oriental & African Studies to £2,248 for Durham University.[16] Over the 15-month period April 2013 – July 2014, Leeds University alone had paid publishers a little over £270,000, of which about £10,000 was for colour and page charges. For the 166 RCUK funded papers for which APCs were paid during the review period, the average cost of APC was £1,626.74.[17] University of Cambridge spent £936,000 towards APC in 2014. For the 495 RCUK funded papers the average cost was £1,891.[18] Besides this, the university has also supported payment of page and colour charges and has paid for researchers to join memberships that offer a discount for APCs out of the RCUK fund. There is a growing concern in the university if they should be spending so much money on APCs.[18]

Björk and Solomon, in their report submitted to a consortium of European funding agencies in March 2014, had estimated the average APC from a study of journals indexed in *Scopus* for at least two years to be US$ 1,418.[19]

Gerritsma reported that in 2013, the Netherlands had spent €4 million towards 3,314 papers published in OA journals charging APC and in hybrid journals, and indexed in *SCIE*, at an average APC of €1,220.[20]

In 2015, the Austrian Science Fund (FWF) spent over €418,000 on APCs for 288 papers in Gold OA journals (average €2,376) and €2.38 million on APCs for 913 papers (average €1,453). In addition FWF incurred an expenditure of €273,600 on other costs.[21]

The variation is to be expected, as the sampled journals vary and in the case of India a substantial number of low-APC journals would have been used. Wang et al. have found that the level of APCs varies with the region. European and North American APC OA journals have average

APC of more than US$2000, while Asian, African and South American APC OA journals have average APC of less than US$1000.[22]

If we assume that APC was paid in full for all the 14,297 papers (4,775 with foreign collaborators and 9,522 by exclusively Indian authors) published by Indian authors in OA journals charging APC, the total expenditure would be around US$16.75 million. This figure does not include the APC for the other 7% of papers published in journals charging APC on the basis of number of pages, submission fee, and so on. Nor does it include the expenditure on OA papers published in hybrid journals. These journals usually charge much more than journals with fixed APC. According to Björk and Solomon (2014), the average APC for publication charged by hybrid journals published by subscription publishers (such as Elsevier and Wiley) is US$ 2,727, almost double that chaged by fully OA journals published by non-subscription publishers (such as PLoS), US$ 1,418.[19] It is possible that APCs for many papers jointly authored with foreign collaborators might have been paid by the other party. Also, in some cases authors might have been granted either a fee waiver or a discount. Allowing for these possibilities, we may assume that the sum spent would still be very high, more than ~US$12 million, or an average of US$2.4 million a year. This amount is in addition to the national expenditure on its academic and research library budget. Data releaesed early this year as part of the Natioanl Institutional Ranking Framework (https://www.nirfindia.org/Ranking) exercise reveal that the academic and library budget is by no means small.

Author pays model has failed

In the initial years of the 'author pays' OA journals, the hope was that OA publishing would be cheaper than subscription publishing. Eisen claimed that APC would go down "and will continue to do so, asymptotically approaching zero."[23] What we see in reality, however, is that the APC charged by *PLoS One* has gone up from US$1,250 when it was founded in December 2006 to US$1,450 now. The APC charged by *PLoS Biology* and *PLoS Medicine* has increased from US$1,500 at launch in 2003 to US$2,900 in 2012, a rise of 93% in nine years.[23] The situation at BioMed Central is no different. Comparing the APC levied by the 165 BMC titles between 2010 and 2016, Wheatly has shown that for many titles there has been a substantial rise.[24] Neylon, a former employee of PLoS had recently conceded that "no functional market is emerging and it (APC model) might be the wrong economic model."[25]

When the high energy physics community and librarians from more than 20 countries negotiated with publishers to make key journals OA, it resulted in a contract with 11 publishers that would ensure they could make 10 journals OA immediately on publication and, in return, continue to make the profits they were making earlier with the subscription model. From its inception in January 2014, SCOAP^3 is making papers available on an OA basis and it charges an average APC of US$1,165.[26] According to Morrison,[6] "SCOAP^3 nearly doubled in size this past year (87% annual growth) for a total of 4,690 documents," and "the Electronic Journals Library added

3,612 journals that can be read free-of-charge in the past year, for a total of 52,000 journals, a 7% growth rate."

As early as 1999, Rosenzweig[27] pointed out that the world of knowledge was being "kidnapped and held for ransom" by commercial publishers who have "turned renegade, exiling themselves from the academic enterprise, and focusing entirely on making the most money for their stockholders" and in the process "restricting the flow of knowledge." Laakso and Björk have pointed out that today commercial publishers are the most common publisher of OA papers and the number of papers published by them jumped from 13,400 in 2005 to 119,900 in 2011.[28] Björk and Solomon[19] have shown that "among the established OA publishers with journals listed in *Scopus*, the average APC grew by about 5% a year over the two years 2012 – 2013." Taking such increases into account, India's APC bill is bound to grow far beyond the US$2.4 million in the future. These cost increases are unpredictable, making it difficult for organizations willing to pay APC to make appropriate provisions in their budgets.

Affordable OA publishing

Concerned about the high subscription costs and audience-limiting access rules of many traditional journals and the high levels of APCs charged by OA journals, many editorial boards broke away from publishers of such journals 'in order to launch a comparable journal with a friendlier publisher or less-restrictive access policy.'[29] The most recent example is the *en masse* resignation of Rooryck and the other members of the editorial board of *Lingua* to start *Glossa*.[30] An early example was the resignation of the editor of *Evolutionary Ecology* along with many members of the editorial board to start *Evolutionary Ecology Research* in 1998.[29] Suber maintains a list of such 'Journal declarations of independence.'[29] Gowers, a strong opponent of publishers making tall claims about the value they add to publications and the huge subscription prices they charge, has launched an *arXiv* overlay journal called *Discreet Analysis*, owned by a group of researchers, in which the overall cost per article will be well below $30.[31] His idea is to demonstrate that "in the internet age, and in particular in an age when it is becoming routine for mathematicians to deposit their articles on the *arXiv* before they submit them to journals, the only important function left for journals is organizing peer review."[31] How will these journals survive? Initially, the Association of Dutch Universities and The Netherlands Organization for Scientific Research will fund *Glossa* so it can be completely free for both authors and readers, and the Open Libraries of the Humanities will take over the funding after five years.[32] Seed money from the University of Cambridge will see through *Discreet Analysis in* the first five years.[31]

"It's important [that these alternative models] acquire a reputation and prestige that people can feel it's okay to submit to them — rather than the more established traditional journals — without damaging their careers," Gowers says.[32] "We need an alternative, cheap system sitting there — at which point the commercial publishers will become redundant."[33]

Should Indian researchers spend a large sum on APCs?

Why do authors choose to publish in certain journals? Scientists want their work not only to be seen and read but also to be appreciated and cited. For them publications are the culmination of their research and a means of achieving prestige and visibility. Moreover, the journals in which authors publish play an important role in the way the global community of scientists and funding agencies evaluate a scientist. Authors choose journals that would bring them maximum visibility, prestige and citations. Although there have been many discssions in recent times about the place of citations in scholarly communication and the undue importance paid to journal impact factors,[34] scientists of all age groups look forward to their papers being cited repeatedly and quickly, and journals proudly advertise their impact factors on their cover pages. Scientists do not really care if a journal is OA or if it charges APC (as long as their institution or funder is ready to cover the costs), nor surprisingly are they chary of surrendering all rights to their paper to the publisher. Many journals charging APC satisfy authors'expectations to a lesser or greater extent and authors are able to find the ones that would accept their papers. In addition, many of the journals run by major commercial publishers are run professionally and their unified graphical appearance gives them an identity. As scholarly communication moves from print to online, these publishers take advantage of emerging technological tools and standards to offer the research community ever better ways of presenting their content and they also energetically market their journals. PLoS, which was started with a view to fighting the commercial publishers, has spent US$3 million on software development in 2013-14 and more than US$413,000 on marketing and advertising in addition to expenses on promotion.[35]

The question, from the point ofview of authors, is, "is it all right to spend huge sums for getting papers published in OA journals?" No, says Balaram, former director of Indian Institute of Science. He believes that Indian researchers should not use government funds – money given for research - to subsidize non-Indian journals, and that the money spent on APCs could be better spent on research per se or on libraries.[36] Williams-Jones and colleagues belive that "for many sectors of academe, 'paying to publish' is ethically suspicious.[37] Such an ethical concern has also been raised by Wilson and Golonka.[38] There are other voices from the global South opposed to OA through APC. Babini of the Latin American Social Science Council asserts that paying huge sums as APC could increase the overall costs of research and financially undermine a nation's research and scientific publishing ecosystem.[39] Nilsen says paying to publish represents a new apartheid system, and that "we need to move away from a system where someone decides who should have access to what."[40] For the sake of the global public good, Nilsen recommends that we should abandon the discriminative APC-based publishing practice and adopt open access through repositories.

The APC model of OA is not serving the true purpose of OA, which aims to create a level playing field for access to research. The APC levied by *PLoS Biology* and *PLoS Medicine* is roughly equal to half of a month's salary for an assistant professor in the United States, but more than two months of salary for an assistant professor in India.

Moreover, at a time when science is facing a funding crunch, it would be prudent for Indian researchers and research institutions to refrain from paying APCs to journals. A few months ago, both Rao and Swaminathan lamented the shortage of funds for research,[41,42] and more recently the Ministry of Human Resource Development announced some budgetary cuts for Indian Institutes of Technology[43] and the Ministry of Science & Technlogy has told the CSIR laboratories to fund reseach by themselves and to convert ongoing projects into for-profit ventures.[44]

What is the alternative model for making research OA?

What is the alternative to publishing in paid OA journals? Balaram suggests that the authors could publish their papers without paying APC and still make them open through interoperable institutional repositories.[36,45] Joshi has explained the advantages of depositing one's papers in such repositories.[46] Authors may wonder if making a paper available through such a repository is equivalent to publishing in an OA or hybrid OA journal. The answer is yes, very nearly. Journals may insist on an embargo and they may let the author deposit only the author postprint (the refereed version). Experts such as Harnad would recommend the adoption of OA through repositories worldwide so that institutions could cancel subscriptions and use the savings to pay for the much lower-priced, affordable, sustainable OA journals.[47] Use of repositories is picking up around the world. According to Morrison,[6] "Bielefeld Academic Search Engine (*BASE*) repositories collectively added more than 4.7 million documents this quarter for a total of just under 89 million documents," and "the number of journals actively participating in *PubMed Central*, making all content immediately freely accessible, and making all content open access, continues to grow." *arXiv* grew by over 107,000 documents to over 1.1 million documents during the last year.[6]

What is happening in India?

There are many OA journals in India, and 337 have been listed in *DOAJ* (as on 3 September 2016). These include journals published by leading Academies, societies and government organizations such as CSIR-NISCAIR, DESIDOC, ICMR, and ICAR, and these are free to authors and readers. MedKnow, although part of a private publishing group, publishes a large number of OA titles, most of which again are free to both authors and readers. But not all Indian OA journals are on a single platform like SciELO. Apart from a few exceptions like MedKnow journals, others do not offer all the web features and metrics that leading publishers offer, which is surprising considering the wealth of technological skills available in the country.

Another platform specifically designed to provide open access to journals published in developing countries is Bioline International, a not-for-profit partnership committed to providing open access to quality research journals and reducing the South to North knowledge gap. Bioline currently supports 36 journals from 16 countries. The download statistics of Bioline journals (http://www.bioline.org.br/stats) are very impressive. Kirsop, a founding member of Bioline International, told us "Within a single month in 2016, some 1.5 million full text articles were downloaded – equivalent to approximately 18 million per annum – showing the value

attached to publications resulting from research carried out in regions of the global south, often referred to as 'the missing science', but nevertheless essential to achieve a global understanding in such areas as health and the environment." (Personal communication, 13 April 2016).

Organizations such as CSIR, DBT and DST have already adopted a policy of making research produced in their own laboratories, as well as research they support in other institutions, open access through placing the accepted papers in institutional open access repositories.[48,49] CSIR-URDIP, Pune, has set up a central platform for OA repositories and harvesting from all three organizations and these could be accessed at http://www.csircentral.net/ and http://sciencecentral.in/. Unfortunately, many laboratories under these apex bodies have not taken the OA policy seriously, nor there seems to be any will on the part of the apex bodies to implement the policy forcefully.These repositories are interoperable and have adopted the best international practices. ICAR also has an open access policy, but it does not seem to have much traction.[50] There are also many institutional repositories (listed in http://roar.eprints.org/), some of them well populated, but others are languishing, largely due to the indifference of scientists.

By contrast, China seems to have made considerable progress. It was only in 2014 that the Chinese Academy of Sciences (CAS) and the National Natural Science Foundation of China (NSFC) issued open access policies.[51] By mid-March 2016 , the Open Repository of the NSFC included 135,000 research papers published between 1998 and 2015 by authors from 1,305 institutions. These research papers have already been downloaded more than 669,000 times. CAS now has two OA portals, namely the Institutional Repository Grid of Chinese Academy of Sciences, with content from 102 repositories, and the China Open Access Journal Portal, with content from hundreds of journals.[52]

Latin America has witnessed the emergence of strong cooperative scholarly publishing ventures, such as SciELO (www.scielo.org) which hosts about 1,250 journals, and Redalyc (www.redalyc.org) which hosts, 1,095 journals. Of these more than 2,300 journals, 1,300 do not charge APC and others charge only a modest fee.[53] A SPARC report says, "SciELO and Redalyc do raise the visibility and accessibility of the journals they host, particularly with their local communities. These types of networked meta-publishers allow for central governance of policies, procedures and controls, but are intentionally decentralized to support the development of local capacity and infrastructure ensuring greater sustainability and alignment with local policies and priorities."[54] With these efforts, Latin America has become a model for affordable OA journal publishing.

Even so, researchers in Latin America continue to publish a very large proportion of their papers in non-OA journals. For example, as shown in Table 1, in the five years 2010-14, more than 65% of papers from Brazil were published in non-OA journals. The simplest way to make the large volume of non-OA papers freely available is to set up many institutional repositories and populate them quickly. Efforts are already under way in several countries and indeed a network

of repositories from nine countries is coordinated by *La Referencia* (http://lareferencia.redclara.net/rfr/), and there are legislations in place in Argentina, Mexico and Peru to make publicly funded research freely available through repositories.[55]

What needs to be done?

Compared with developments in Latin America and China, India is clearly lagging behind in making her research freely accessible. How can this be changed? We believe that making all research freely accessible through interoperable OA repositories is the ideal solution. According to Houghton and Swan, [56] till the time we reach an all Gold OA (OA through journals) world, Green OA (OA through repositories) may well be the most immediate and cost-effective way to support knowledge transfer and enable innovation across the economy. We suggest the following actions.

1. Populate OA repositories that are already there, as empty and sparsely populated repositories will not reflect well on the research community.
2. Set up repositories in institutions where one does not exist. Academic and research librarians can play an important role in setting up and populating repositories.
3. Academic and research organizations (at the state and central levels, as well as apex bodies), which do not have an OA policy, should adopt a policy similar to those of DBT, DST and CSIR and implement the same.
4. As part of the implementation, funding agencies and heads of organizations should have a compliance monitoring mechanism that would reward those who deposit their papers, and persuade those who do not.
5. If the policies of all agencies are aligned, it would bring about many advantages such as ease of compliance, optimization of workflow, and sharing of data and best practices.[57]
6. All organizations may join the CSIR-URDIP effort so that a nation wide platform could emerge for OA repositories. Such resource sharing will not only result in enhanced efficiency and reduced overall costs but also, as demonstrated by HAL, France, facilitate "coherent meta-data description, connection to national authority files, quicker take up of new technologies (e.g. visualisation and data mining) and better connection with international initiatives."[58]
7. Funding agencies and research organizations that are so far unconcerned about their funds being used to meet APCs should stop supporting this practice.
8. A cadre of scholarly communication workforce should be developed for building institutional repositories and persuading researchers to upload materials.

Conclusion

If India and China follow the Latin American model of hosting all or most of their journals on a single decentralized platform and make as many journals as possible OA, and if India, China and Latin America vigorously promote a culture of OA repositories and encourage researchers to self-archive their publications, that would have a great impact on making science and scholarship open, not only in these regions but around the world. All of this can happen only with the willing

participation of the scientific community. As Harnad would say, 'Self-archive unto others as you would have them self-archive unto you'.[59]

If, instead, researchers continue to pay publishers exorbitant APCs, as Poynder points out, there will soon be a crisis over the cost of APCs, which would hit research the world over, but research in the developing world will be hit harder.[60] As long as we continue to use APC based journals, we cannot expect to make access to research affordable to all.

Acknowledgement
We are grateful to Peter Suber and Ms Barbara Kirsop for their valuable comments.

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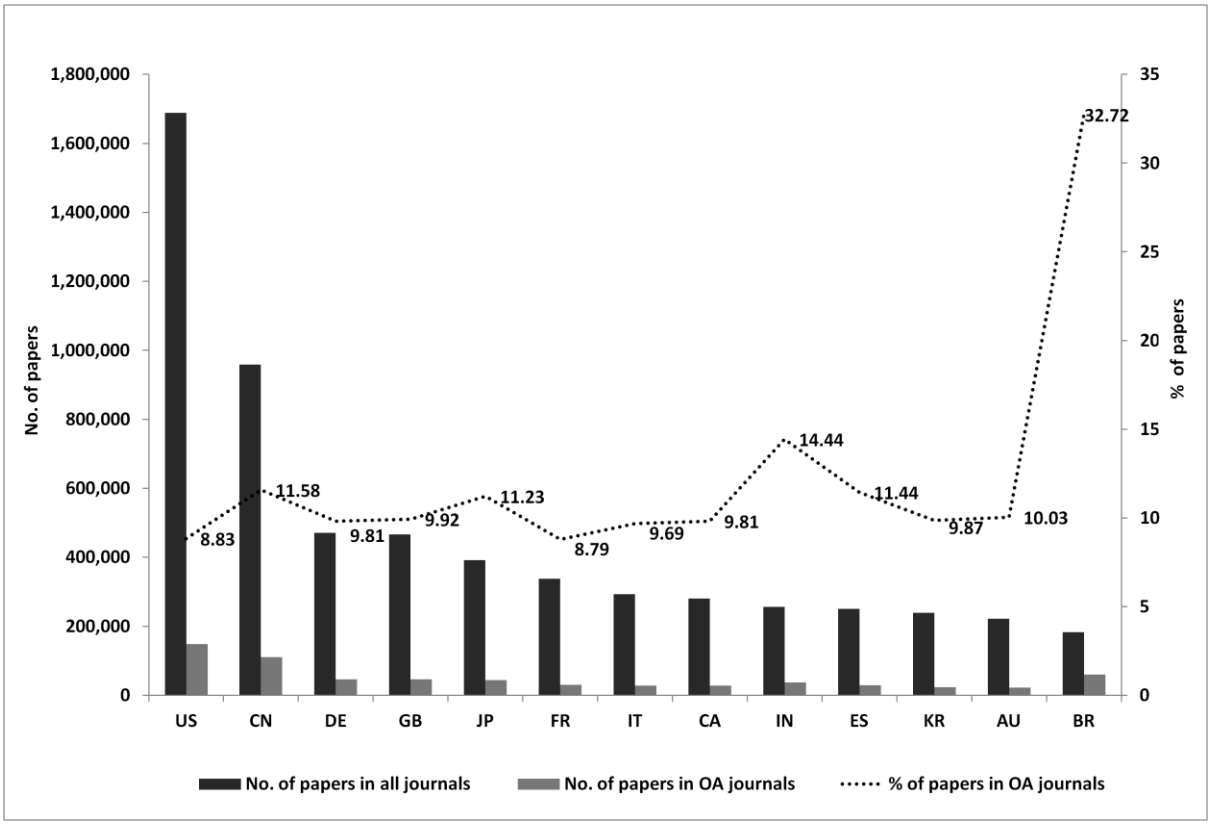

Figure 1. Share of papers published by different countries in open access journals indexed in *SCIE*, 2010-2014.* Data gathered on 29 February 2016. Great Britain includes England, Scotland, Wales and Northern Ireland.

*Only articles, letters, proceedings papers, and reviews are considered.

Table 1. Distribution of research papers published by Indian scientists in open access journals by publishing year

[Data gathered on 11 January 2016]

Year	OA journals (APC)			OA journals (non-APC)			All OA journals		
	No. of journals	No. of papers	Sum of citations	No. of journals	No. of papers	Sum of citations	No. of journals	No. of papers	Sum of citations
2010	242	2557	17550	237	4131	16301	479	6688	33851
2011	263	3067	17367	244	4280	12645	507	7347	30012
2012	308	2800	15715	251	4157	9276	559	6957	24991
2013	326	3335	12635	268	4457	6257	594	7792	18892
2014	328	3634	6950	283	4660	3057	611	8294	10007
Total		15393	70217		21685	47536		37078	117753

Table 2. OA journals charging APC in which Indian authors have published at least 10 papers that have been cited not less than 10 times on average in the five years

Journal	Publishing country*	No. of papers	Sum of citations	CPP	APC
Nucleic Acids Research	GB	138	1945	14.09	$2,770
PLoS Neglected Tropical Diseases	US	126	1409	11.18	$2,250
BMC Genomics	GB	123	1330	10.81	$2,145
International Journal of Nanomedicine	NZ	94	1555	16.54	€1,843
Atmospheric Chemistry and Physics	DE	65	1116	17.17	€25#
BMC Plant Biology	GB	44	579	13.16	$2,145
PLoS Pathogens	US	42	781	18.60	$2,250
Molecular Cancer	GB	34	540	15.88	$2,145
International Journal of Molecular Sciences	CH	28	298	10.64	CHF1,600
Molecules	CH	28	300	10.71	CHF1,800
PLoS Computational Biology	US	25	342	13.68	$2,250
PLoS Medicine	US	25	721	28.84	$2,900
DNA Research	GB	24	542	22.58	$750
PLoS Genetics	US	24	354	14.75	$2,250
Biogeosciences	DE	23	294	12.78	€25#
International Journal of Environmental Research and Public Health	CH	22	278	12.64	CHF1,600
Journal of Translational Medicine	GB	15	238	15.87	$2,145
Marine Drugs	CH	14	256	18.29	CHF1,800
Journal of Neuroinflammation	GB	12	179	14.92	$450
Science and Technology of Advanced Materials	GB	12	181	15.08	$1,600
BMC Medicine	GB	11	374	34.00	$2,785
Remote Sensing	CH	11	125	11.36	CHF1,600
Cryosphere	DE	10	112	11.20	€25#
Progress in Electromagnetics Research-PIER	US	10	128	12.80	$200
Articles in 33 other journals with CPP > 10		117	1930	16.50	
Total		1077	15907		

*ISO 3166 country code

#Page charges

Table 3. Non-APC journals in which Indian authors have published their papers that have been cited not less than 10 times on average in the five years

Journal	Publishing country*	No. of papers	Sum of citations	CPP
Bulletin of The World Health Organization	CH	41	515	12.56
Journal of Pharmacy and Pharmaceutical Sciences	CA	14	173	12.36
Environmental Health Perspectives	US	10	188	18.80
Journal of Machine Learning Research	US	10	118	11.80
Materials Today	GB	4	81	20.25
Earth System Science Data	DE	3	88	29.33
Revista Mexicana de Astronomia Y Astrofisica	MX	3	181	60.33
Revista Mexicana de Ciencias Geologicas	MX	3	41	13.67
Folia Neuropathologica	PL	2	23	11.50
Upsala Journal of Medical Sciences	GB	2	20	10.00

* ISO 3166 country code

Table 4. Mega journals used by Indian researchers

Journal	Publishing country*	No. of papers	Sum of citations	CPP	APC
PLoS One	US	2404	17587	7.32	$1,495
Scientific Reports	GB	222	1523	6.86	£990
AIP Advances	US	196	645	3.29	$1,350
Springer Plus	CH	170	235	1.38	$1,290
BMJ Open	GB	56	148	2.64	£1,350
FEBS Open Bio	GB	21	86	4.10	$1350
PeerJ	GB	13	33	2.54	$695
Biology Open	GB	9	9	1.00	$1,495
G3 - Genes Genomes Genetics	US	9	83	9.22	$1,950
		3100	20349	6.56	

* ISO 3166 country code