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Jean-Philippe Rennard

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WORKING PAPERS

OPEN ACCESS: TOWARD A NEW ECONOMIC MODEL OF SCHOLARLY PUBLICATIONS

Jean-Philippe RENNARD

Grenoble Ecole de Management

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Pour plus d’informations :
For further information:

François Thérin
Grenoble Ecole de Management
12 Rue Pierre Sémard
38003 Grenoble Cedex 01
francois.therin@grenoble-em.com
Open Access: Toward a New Economic Model of Scholarly Publications

Jean-Philippe Rennard
GEM
12 Rue Pierre Sémard, 38003 Grenoble, France
jean-philippe.rennard@grenoble-em.com

ABSTRACT: The mean price of scholarly journals is now three times higher than it was in the mid-1980s. In the meantime, the development of Internet and of informal exchanges between researchers progressively led to the Open Access Initiative which aims at freely disseminating scientific publications. This article introduces to the consequences of this evolution and presents the path toward a new economic model of scholarly publications.

"If I have seen further it is by standing upon the shoulders of giants." The famous statement of Sir Isaac Newton demonstrates that the progress of science relies on the dissemination of discoveries and scientific knowledge. Even though scientific progress is not strictly cumulative (Kuhn, 1970) information sharing is the heart of this progress. Nowadays, scientific knowledge is mainly spread through scholarly journals, that is, highly specialized journals where quality controls and certifications are achieved through peer-review.

The first section of this article will present the specificity of the current economic model of scientific publications. The second section will introduce to the open access movement and to its emerging economic model. The third section will point out the potential contribution of Open Access to developing countries.

THE ECONOMIC MODEL OF SCIENTIFIC PUBLICATIONS

The growing complexity of modern science induces a growing need of knowledge dissemination media. The number of academic journals is very difficult to estimate, but according to the "Ulrich’s International Periodicals Directory" (http://www.ulrichsweb.com) there were about 164,000 scientific periodicals in 2001 in all disciplines (see Figure 1).

The largest publishers like Elsevier-Reed, Blackwell or Wiley own most of these journals. Over the last twenty years, commercial firms -especially the largest ones- have raised prices at a rate which cannot be justified by cost or quality increase (McCabe, 2000). The evolution of the median cost of serials is summarized in Table 1; it is now three times higher than it was in the mid eighties. Former president of the University of California recently stated: "University librarians are now being forced to work with faculty members to choose more of the publications they can do without." (Atkinson, 2003, p.1, original emphasis). As a consequence, Figure 2 shows that, in the USA, acquisition expenditures have tremendously grown and that part of the budgets had to be reallocated from monographs to journals. The rise of journals prices has a multiple origin, one of the most important being provisions to invest in electronic publications (Chartron & Salaun, 2000). Paradoxically, electronic publication, which should reduce costs, is one cause of cost increase. These provisions are nevertheless insufficient to explain the current prices. Elsevier-Reed gross-profit margin is estimated 32% (Wellen, 2004). Such "Microsoft like" margins are very unusual and demonstrate the inefficiency of the scientific publication market. There are four main reasons to this inefficiency:

- Researchers publish to popularize their works and to improve peers recognition (which has a great impact on their careers). They are "giveaway authors" (Harnad, 2001) and do not receive any royalties or fees. Furthermore, they do not have to pay to access to scientific information since all the expenses are paid by academic libraries. Authors are then not concerned with the price of journals, they only consider the reputation and the citation impact of the journals they publish in.
- The demand is price-inelastic (that is prices have few impact on the volume of the demand) since prices are not important for researchers and journals are not easily substitutable.
- Libraries evolve on a commercial market but do not have any commercial approach. They buy up to their budget limit and not according to any price equilibrium.

Figure 1. Number of periodicals published worldwide ('000s) 1998-2001. (Source: Ulrich’s International Periodicals Directory)
Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Serial Unit Cost US$</th>
<th>Annual percentage changes</th>
<th>Cumulative percentage changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>89.77</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>1988</td>
<td>117.25</td>
<td>10.94%</td>
<td>30.60%</td>
</tr>
<tr>
<td>1990</td>
<td>134.09</td>
<td>4.18%</td>
<td>49.36%</td>
</tr>
<tr>
<td>1992</td>
<td>173.67</td>
<td>13.93%</td>
<td>93.46%</td>
</tr>
<tr>
<td>1994</td>
<td>200.85</td>
<td>6.67%</td>
<td>123.72%</td>
</tr>
<tr>
<td>1996</td>
<td>222.89</td>
<td>3.95%</td>
<td>148.28%</td>
</tr>
<tr>
<td>1998</td>
<td>245.05</td>
<td>-1.97%</td>
<td>172.96%</td>
</tr>
<tr>
<td>2000</td>
<td>303.19</td>
<td>12.30%</td>
<td>237.73%</td>
</tr>
<tr>
<td>2001</td>
<td>282.54</td>
<td>-6.81%</td>
<td>214.72%</td>
</tr>
<tr>
<td>2002</td>
<td>296.50</td>
<td>4.94%</td>
<td>230.27%</td>
</tr>
<tr>
<td>2003</td>
<td>283.08</td>
<td>-4.53%</td>
<td>215.32%</td>
</tr>
</tbody>
</table>


- The multiplication of mergers among publishers has strongly contributed to the increase of prices (McCabe, 2000).

Moreover, commercial publishers now have a growing aggressive commercial attitude with, for example, journal bundling that obliges libraries to buy journals they do not need if they want to subscribe to prestigious "must-have" journals. The "Big Deal" (Frazier, 2001) - an online aggregation of journals - is so expensive and restrictive that prestigious universities like Stanford or Cornell created sensation in late 2003 by canceling their "Big Deal" (Wellen, 2004).

Symptomatic of this evolution, the new CEO of Elsevier-Reed previously worked in firms operating in highly competitive markets like Procter & Gamble or Guinness (Wellcome-Trust, 2003).

In this context, public research institutions pay twice for scientific knowledge. They pay researchers who publish freely, and publishers to have access to journals (Anderson, 2004).

The growing conflict between researchers, who aim at disseminating their works as widely as possible, and libraries, which have a limited budget on the one hand and publishers who mainly have financial objectives on the other hand, gave rise to an accelerated development of the practice of open access to electronic publications. Governments concerned about research budgets are more and more interested in that movement and try to support it. At the end of January 2004, OECD ministers "(...) recognized that fostering broader, open access to and wide use of research data will enhance the quality and productivity of science systems worldwide. They therefore adopted a Declaration on Access to Research Data from Public Funding." (OECD, 2004). One of the principles of this declaration is to promote "Openness", that is open access to public-funding researches.

THE OPEN ACCESS MOVEMENT

In the Gutenberg Era researchers had no alternative, publishers were the only way to reach readers. In the PostGutenberg Era, digital networks offer a powerful alternative which can lead in the long term to a new organization of scientific publications (Harnad, 1999). Preserving quality controls and certifications through peer-review, this organization should be based on open access to electronic publications. Beginning with self-archiving and repositories, the open access movement is now moving towards free electronic publications.

Self-archiving

From the very beginning, scientists have exchanged information, consulted peers about a given idea or tested colleagues’ reactions to an innovative concept. Up to the second half of last century, the main transmission tool was private correspondence via postal mail. With the development of Internet and electronic communications, informal exchanges have exploded since it is now easy and very common to contact a researcher by e-mail to ask him for a copy of a given work.

In order to ease informal exchanges and to increase their visibility, many researchers have used Internet for a long time to self-archive their works, that is to make either preprints (before refereeing) or postprints (after refereeing) available on their own (personal or institutional) web site.

Due to the pressure of the open access movement, the copyright policy of journals and publishers has changed a lot over the last years. The Project RoMEO (Rights Metadata for Open archiving, http://www.lboro.ac.uk/department/ls/disresearch/romeo/) lists publisher’s copyright transfer agreement. Figure 3 shows that 83% of the 10,673 journals listed in September
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2004 now accept at least preprint archiving. This percentage was only 55% in 2003. Self-archiving undoubtedly increases visibility but, since these archives can only be found through usual search engines, their access is very difficult without the knowledge of the existence of a given work.

Repositories

The success of self-archiving and the difficulty to find self-archived works led Paul Ginsparg, then physicist at the Los Alamos National Laboratory, to initiate in 1991 the arXiv archives (http://www.arXiv.org). It aimed at centralizing and easing access to free electronic publications. Researchers were asked to directly archive their works in the repository. With such tools, publications are no longer dispersed among many web sites and are available at once. There are now more than 275,000 articles in arXiv with a submission rate of about 3,500 papers per month.

Following this pioneer, other high-level archives emerged. Some of the most important being:

- Cogprints (http://cogprints.ecs.soton.ac.uk) specialized in cognitive sciences.
- PubMed Central (http://www.pubmedcentral.gov/) specialized in life sciences.
- Repec (http://www.repec.org/) and WoPEc (http://netec.mcc.ac.uk/WoPEc.html) specialized in economics.
- NCSTRL (http://www.ncstrl.org/) and CiteSeer (http://citeseer.ist.psu.edu/) specialized in computer science.

The development of repositories and self-archives led to a standardization need, notably to build services permitting to search across multiple repositories. Repositories also needed capabilities to properly identify and copy articles stored in other repositories (Lynch, 2001). These needs, identified by Herbert van de Sompel, led to the Open Archives Initiative (http://www.openarchives.org) initiated by P. Ginsparg in 1999 with "The Santa Fe Convention of the Open Archives Initiative". The Open Archives Initiative designed specific metadata tagging standards (standard format of keywords) to make archives easily harvestable. Even though the Open Archives Metadata Harvesting Protocol is mainly used by free repositories, it is also employed by servers housing commercial products (the term Open refers to the technical architecture, not to the fact that the content should be free).

Specific directories like OAIster (http://www.oaister.org) or Eprints.org (http://www.eprints.org) now provide lists of OAI-compliant archives. This initiative knows a tremendous success. In May 2005 OAIster managed nearly 5.4 million records originated from more than 450 institutions.

Online journals

Publishers could not ignore the progress of electronic publication and distribution. Considering the quick development of knowledge dissemination through Internet, many among them have thus decided to make their journals available online. Apart from their usual paper edition, those journals so try to improve their diffusion and reputation.

Some publishers or institutions also decided to adopt a more radical solution: purely electronic journals. Considering the prices of printing and postal diffusion, electronic publications can reduce the cost of journals (Wellcome-Trust, 2003). Publishers only have to support the organization of the review process and the cost of diffusion tools (software and hardware).

The access to electronic articles originated in classical or electronic journals is usually reserved to subscribers, but a growing number of them are now free on certain condition (such as time-delayed release). In May 2005, the Directory of Open Access Journals (http://www.doaj.org) listed more than 1,500 journals in all disciplines.

One of the reasons of the growing success of open access journals is that open access articles have a greater citation impact than others. Studying 119,924 conference articles in computer science and related disciplines, Lawrence found that the number of citations of open access articles was 2.6 times greater than the number for offline articles (Lawrence, 2001). A recent study based on the ISI CD-ROM citation database concluded that for the year 2001, the citation impact in all physics fields was 5.5 times higher for open access articles (Brody et al., 2004).

THE SEARCH FOR A NEW ECONOMIC MODEL

The transition to electronic journals reduces the costs but is of course insufficient to economically validate the open access model. Apart from subsidy-based free journals, a growing economic model is based on the payment by the authors’ institutions. An author-pays model is substituted to the classical subscriber-pays system.

A recent study by the Wellcome Trust tries to compare the costs of classical subscriber-pays journals and of electronic author-pays journals (Wellcome-Trust, 2004). The results are summarized in Table 2. The structure of fixed costs is similar for both types of journals (editorial costs, review...
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Table 2
Estimates of journal costs.

<table>
<thead>
<tr>
<th>Cost element</th>
<th>Subscriber-pays journal Cost in US$</th>
<th>Author-pays journal Cost in US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-copy costs per article</td>
<td>1500</td>
<td>750</td>
</tr>
<tr>
<td>Fixed-costs per article</td>
<td>1650</td>
<td>825</td>
</tr>
<tr>
<td>Variable costs per article</td>
<td>1100</td>
<td>600</td>
</tr>
<tr>
<td>Total costs per article</td>
<td>2750</td>
<td>1425</td>
</tr>
</tbody>
</table>

^1Source: (Wellcome-Trust, 2004).
^2eight articles reviewed for each article accepted.
^3two articles reviewed for each article accepted.

Advantages of Open-Access Journals: Open-access journals offer several advantages over traditional subscription-based journals. One of the main advantages is that they make scientific research freely available to anyone who accesses them, thereby increasing the visibility and impact of published articles. Additionally, open-access journals can attract a wider audience, leading to higher citation rates. They also provide researchers with more autonomy in the publication process, allowing them to choose the most suitable platform for their work. Furthermore, open-access journals often have streamlined submission processes, reducing the time and effort required for authors to get their research published.

Examples of Open-Access Journals: Some prominent examples of open-access journals include PLoS Biology and ResearchGate. PLoS Biology is an open-access journal that focuses on publishing high-quality research in all areas of biology. It is one of the leading journals in the field, with a strong emphasis on promoting transparent and reproducible research. ResearchGate is a platform that allows researchers to publish their work and share it with the global scientific community. It provides a unique opportunity for researchers to receive feedback and collaboration from peers worldwide.

Challenges and Issues: While open-access journals offer numerous benefits, they also face several challenges and issues. One of the main challenges is the financial sustainability of open-access journals. The traditional subscription model relied on revenue from libraries and institutions buying subscriptions to journals. In contrast, open-access journals must rely on alternative funding sources, such as article processing charges (APCs), grants, and sponsorships. This shift can be particularly challenging for authors in developing countries, who may have limited access to funding.

Another issue is the potential for predatory journals that may exploit the desire for open access by charging exorbitant fees or offering subpar-quality publications. Researchers must be cautious and verify the credibility of open-access journals before publishing.

Conclusion: Open-access journals provide a valuable resource for the scientific community, offering increased visibility, accessibility, and collaboration. While they face financial challenges, ongoing efforts are being made to support and sustain these initiatives. The future of scholarly publishing is likely to continue to evolve, with open-access models becoming increasingly prevalent and recognized as a crucial component of the academic landscape.
marginal. In 2000 India published less than 2 percent of world scientific articles; China’s share was about 3 percent and Brazil 1 percent (OST, 2004).

The importance of education, research and innovation for economic growth is well known at least since Schumpeter (Schumpeter, 1912). According to Jones (Jones, 2000), between 1965 and 1990, 35 percent of the U.S. growth can be attributable to the rise in educational attainment and 40 percent can be attributable to the rise in worldwide research intensity. From the 1980s, researches and investments in ICT have played a leading role in productivity growth (OECD, 2003). Most developing countries have been unable to be part of this movement, and the tremendous education and research gap between advanced and developing countries has never ceased to expand. Figure 4 summarizes this gap in development (R&D) expenditures as well as ICT diffusion are strongly correlated to wealth (GDI per capita).

Researchers belonging to regional communities could also benefit from these networks. Even though high level researches will still require the acquisition of some specific works, free publications are now sufficient to do the groundwork.

**VISIBILITY AND REGIONAL NETWORKS**

The development of free journals and repositories stimulate the visibility of researchers and academic institutions (Lawrence, 2001). Regional communities are fully aware of it and are more and more involved in that movement. In South America for example, the project Scientific Electronic Library Online (http://www.scielo.org) is now gathering Brazil, Chile, Cuba and Spain. In Africa, the African Journals OnLine (http://www.ajol.info) promotes African publications and already proposes free abstracts.

Since many institutions and laboratories in developing countries are highly specialized in very specific fields like rural development, tropical diseases or agriculture, the implementation of regional repositories could promote these specific researches and give them a better visibility. The constitution of specific local networks could thus ease the development of works in fields that are considered marginal in developed countries.

Furthermore, the constitution of free access tools to local language literature would help local engineers communities to be aware of recent developments in their field and ease the elaboration of specific solutions.

Implementing a repository is technically relatively easy (Crow, 2002) and specific freely available tools have been developed to help their creation, mainly:

- **Eprints** (http://www.eprints.org) developed by Southampton University.
- **DSpace** (http://www.dspace.org) developed by MIT libraries and Hewlett-Packard.
- **CDSware** (http://cdsware.cern.ch) developed by the CERN.

Such tools allow the quick development both of specific or general repositories and of institution-based self-archiving. Specific regional repositories can then easily be implemented. Sharing the hardware costs between regional institutions could permit to create original exchange systems that would have been impossible to set up before Internet. Existing initiatives like for example CARINDEX (http://www.mainlib.uwi.tt/), which indexes the content of 70 West Indian Journals, or LATINDEX (http://www.latindex.org/) which promotes Latin America scholarly publications, could initiate at relatively low cost such regional repositories.

Regional institutions could also benefit from the realization of electronic journals. Such journals are cheaper than paper publications and have a greater impact. *PLoS Biology* provides a significant demonstration of the growing reputation of these journals.

International institutions and non governmental organizations working with developing countries are more and more aware of the importance of open access, and

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**Figure 4.** Gross Enrolment Ratio in Tertiary Education 2000/2001. (Source: UNESCO)

The evolution toward open access could contribute to scientific progress in developing countries in at least two ways. It could enlarge the available information base and strengthen regional networks as well as regional organizations visibility.

**INFORMATION BASE**

We have pointed out the fact that even rich universities cannot afford access to many scholarly journals. This problem is obviously far more intense for low budget institutions particularly in developing countries.

The development of free online journals, of repositories and self-archiving could allow any laboratory in the world to access to some of the most recent publications. Over a million research articles were freely available on the web in 2001 (Lawrence, 2001) and this figure has never ceased to grow. By encouraging specific training for graduate and undergraduate students, teaching them how to access to these free publications, universities in developing countries could both reduce the need of journals subscriptions and enlarge their information base.
Table 3
Selected R&D and ICT Indicators, 2001. (Compiled from selected UNESCO and World Bank data)

<table>
<thead>
<tr>
<th>Continent</th>
<th>Countries</th>
<th>Researchers per million inhabitants</th>
<th>Expenditure for RD in million of US$</th>
<th>Expenditure for RD as percent of GDI</th>
<th>Personal Computers per 1,000 people</th>
<th>Internet users per 1,000 people</th>
<th>GDI per capita (2002)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>7</td>
<td>104</td>
<td>1,350</td>
<td>0.24</td>
<td>23</td>
<td>20</td>
<td>1,000</td>
</tr>
<tr>
<td>South and Central America</td>
<td>13</td>
<td>221</td>
<td>9,000</td>
<td>0.34</td>
<td>62</td>
<td>53</td>
<td>3,000</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>14</td>
<td>1,634</td>
<td>8,000</td>
<td>0.79</td>
<td>55</td>
<td>49</td>
<td>3,500</td>
</tr>
<tr>
<td>Asia †</td>
<td>11</td>
<td>1,211</td>
<td>30,500</td>
<td>0.75</td>
<td>30</td>
<td>48</td>
<td>5,500</td>
</tr>
<tr>
<td>Oceania</td>
<td>2</td>
<td>2,818</td>
<td>7,000</td>
<td>1.28</td>
<td>495</td>
<td>353</td>
<td>16,000</td>
</tr>
<tr>
<td>Western Europe</td>
<td>17</td>
<td>3,142</td>
<td>180,000</td>
<td>2.04</td>
<td>315</td>
<td>327</td>
<td>23,500</td>
</tr>
<tr>
<td>North America</td>
<td>2</td>
<td>3,538</td>
<td>305,000</td>
<td>2.37</td>
<td>609</td>
<td>489</td>
<td>29,000</td>
</tr>
</tbody>
</table>

† Japan excluded

could help financing initial set-up costs. The United Nations already contribute to disseminate scientific works in developing countries with initiatives like HINARI (http://www.healthinternetwork.org/), which provides free or very low cost online access to the major journals in biomedical sciences to non-profit institutions in developing countries. Some non governmental organizations like the International Council for Science which set-up the International Network for the Availability of Scientific Publications (http://www.inasp.info), also give a great importance to the scientific information gap and could participate to regional electronic journals financing.

CONCLUSION

Open-access is by no way a panacea. It is not economically viable yet and it could have important undesired effects. Nevertheless, the pressure induced on commercial publishers is now very high and they cannot ignore this movement any more. It is now very difficult to imagine that in a decade or more, commercial publications will disappear and be replaced by free publications, but the open-access movement will undoubtedly brake the exploding dynamic of prices.

The Journal of Comparative Neurology cost 18,000 US$ a year; Brain Research cost about 21,000 US$ and Nuclear Physics A and B more than 23,000 US$ (Guterman, 2004). Such exploding prices explain the growing conflict between academics and publishers. The development of the open-access movement is then not the mere consequence of the diffusion of Internet, but also a clear symptom of the inefficiency of the current market and the future equilibrium will inevitably associate commercial and open-access publications. The debate on free publications remains very passionate and is not always rational, but it has the merit to raise a real problem. By modifying the balance of power between researchers and publishers, the success of the open access movement will ease scientific knowledge dissemination, reduce the information gap between wealthy and low budget institutions and help the advent of an efficient market.

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