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The split between availability and selection

Business models for scientific information, and the scientific process?

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Abstract. The *Berlin declaration on Open Access to Knowledge in the Sciences and Humanities* has resulted in a strong impetus in the discussion on business models, and in particular the model of open access. A business model is defined as just the organisation of property. Consequently, business models for scientific information are discussed on the premise that any such business model should primarily produce added value for the scientific process next to commercial value for the research institution or intermediary acting as publisher. Furthermore, any business model should be sustainable. Scientific information is thus considered an integral part of the scientific process. It is not an end product but an intermediary product subject to scientific scrutiny. The final goal is to integrate the information into the scientific process. To this end, scientific information should be widely available for selection by the user as common property.

Two basic business models emerge: one with the focus on added value as selection by the user known as the 'subscription model'; and another one with the focus on wide availability known as the 'open access' model.

Both in the subscription model as in the open access model it is the scientific community that invests. In the subscription model scientific information is more considered as external to the scientific process in a consumer type model, while in the open access model scientific information is more seen as internal, as necessary acquisition costs for the scientific process. In the subscription model there is less incentive for broad availability of information whereas in the open access model there is less incentive to develop and maintain added value services to facilitate the selection by the reader. The organisation of property is a condition sine qua non. Although common property, the information is owned by the author claiming this property by the act of publication. Core to this claim of property is peer review being therefore core to any business model. The author is interested in protecting his moral rights against plagiarism; the publisher is interested in protecting the added value against commercial abuse. It is suggested that open access repositories could boost if repository management would guarantee protection of the moral rights of the author. In this way, the protection to the two main infringements could be split over different stakeholders. This would also allow separating the responsibility for availability coupled with peer review as a basic service from added value services coupled to selection at an optional charge.

In the end, any business model has to fulfill the basic idea that scientific information is not there just for the record as a commodity, but is there to be used in research and teaching: scientific information has no value in itself.

Keywords: Scientific process and scientific information, intellectual property, integration of scientific information, business models (subscription model, open access model)

1. Introduction

The *Berlin declaration on Open Access to Knowledge in the Sciences and Humanities* [2] has resulted in a strong impetus in the development of and the discussion on business models, and in particular the model of open access. Open access is not new. We may wonder why open access is especially now again in the picture. This may be due to the fact that open access seems with respect to habits and ethics more acceptable for the scientific community than the subscription model. The open access model values the

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production of scientific output more as intrinsic acquisition costs of the scientific process. Furthermore, the present internet technology allows more advanced applications of the open access model than in the past. Against this background, this article will discuss options for business models for scientific publishing.

Before dealing with any business model we need to address the position of scientific information in the scientific process, and the conditions authors and readers do expect with respect to scientific information and its business model.

Following a brief introduction to these issues the paper will discuss the vision guiding scientific information, report on some pertinent developments in scientific information, report some relevant research data on the use of digital services in the Netherlands, will discuss some pertinent issues related to intellectual property before turning to business models and an outlook on market developments.

Some remarks on the position of scientific information in the scientific process seem appropriate as these are related to the use of scientific information. In this paper the view is taken that scientific information is an integral part of the scientific process. Merton [4] extensively describes this scientific process and this description is still largely valid, albeit that Gibbons et al. [3] and Ziman [13] have made important contributions since then. For this discussion it is relevant to realise that science should be universal implying that nobody should be excluded from the scientific process and that scientific knowledge is common property or otherwise does not exist. Scientific information is not an end product. It is an intermediary product accepted by the scientific community as being worthy of further scientific effort and scrutiny [5]. The information must therefore be shared and thus must be available and it should be possible to 'falsify', using the original terminology of Popper, the knowledge in the future scientific process [6]. The author no doubt has a vested interest that this contribution to the scientific process is of such quality that the author wants it to be subjected to scientific scrutiny. Summarising, the primary purpose of scientific information and knowledge is to create value in the scientific process.

In looking at the market and business models we should thus keep in mind that scientific information is an integral part of the scientific process and that scientific publishing should serve the primary processes in science: research and teaching. Both primary processes need appropriate management information coupled to the research and teaching information. For science, the primary objective of scientific information is to make use of the information for scientific purposes as outlined above and this means integration of this information into the everyday scientific working processes. This is the purpose that repositories among others will serve; they are not primarily built to generate direct revenue from this information. Integration of scientific information into the scientific process means that scientific information can be merged, mingled, manipulated and used in new or existing settings like, e.g. worldwide collaboratives or collaboratories. Also in this sense scientific information and knowledge is common property or else loses its proper function. Next to sharing these results with the scientific community to be subjected to scientific scrutiny, these results will also be used in innovative change. In this way science will serve society and industry and vice versa will researchers be driven by innovation goals. To that end universities or research institutes should have the right to exploit the findings of their employees in a competitive environment and this implies the full use of these findings under conditions to be determined by these universities and the scientific community. The alternative would be that scientific information is only there for the record, and this would erode its value.

This article will discuss business models for scientific publishing on the premise that these business models will only be successful if they meet the following conditions:

- they should allow value creation for the scientific process;
  - any model must cope with the natural growth of scientific information that is a result of scientific progress and is essential for the scientific process.
- they should allow commercial value creation;
  - publishing will be outsourced by the academic community to external partners if and only if this outsourcing results in additional value creation for the scientific process. Value creation in this context may mean, e.g. efficacy or efficiency of the sharing of scientific information, etc.

2. Developments of the scientific information market

The scientific information market has developed over a period of more than 300 years characterised by a steady growth of information. This market was faced by an almost disruptive technology, the internet technology, promising new options of sharing scientific information that are more commensurate to the scientific habits as discussed above. In particular over the past 10 years this internet development has resulted in considerable changes in the scientific information world. It is among others for this reason that universities and publishers have both invested in technological innovation.

With respect to publishers these investments have forced an ongoing clustering of publishers resulting in ever fewer publishers, with each of the remaining publishers controlling an expanding market share of published papers. This development has strengthened the strategic position of the publishers and as a consequence their negotiation positions vis-à-vis the scientific world, i.e. the universities. This development is contrary to the expectations at the outset of the development of internet; internet was initially seen as a major instrument to empower authors and readers, and consequentially the universities.

What kind of strategies will universities develop and implement to their benefit? Only if science can build a strong position and will be a strong partner in the value chain, will it be possible to create a transparent market, i.e. based on comprehensive information for all stakeholders. Just complaining about high prices is simply not sufficient. In many countries universities now create 'repositories of information' with the aim to integrate the information required for research, education and the management thereof in an in-house system to make the scientific process more effective and efficient. These repositories also give them opportunities for public relations activities as needed nowadays in an era of growing worldwide competition between universities. And not least, the development of repositories also provides universities with the opportunity to strengthen their joint position in the value chain versus the other stakeholders, in particular the publishers. Indeed, these repositories of information allow universities to make scientific information widely available. This feels as scientific production coming back home to the alma mater.

The creation of e-science makes the above discussion on strategies related to the value chain of scientific information even more relevant. E-science essentially means the sharing of scientific information in a federated network of research and higher education institutions. E-science means a further step towards the goal of full availability of scientific results, comprising also the primary results and other pertinent data, and thus a further step towards full integration of information into the scientific process. This development is probably even more important for the smaller and medium sized institutions. It is key to them to fully participate in research that is nowadays organised in a more and more programmatic approach

in a national or international setting. Only when firmly embedded in e-science these institutions may be able to effectively and efficiently participate in projects of that scale.

E-science means sharing of information at all levels in the scientific process, at the informal and formal level. Next to this demand for general availability, the demand for power of selection remains and this means a demand for services provided by other service providers as publishers and other intermediaries.

In summary: *'authors want to publish more, readers want to read less'* [10], is equally if not even more valid in the future than in the past. It states that in scientific information the author, after claiming intellectual property for the work, wants wide exposure for this work, and the reader wants for reasons of efficacy and efficiency to have the power to select him/herself the information relevant for his/her work. This selection depends on the reader's ability of assessing the relevance and the quality of the information for his work. It also states that author and reader are both (end-)users. The author might even be considered the principal end-user. Availability and selection are thus the relevant parameters in creating added value and therefore crucial parameters for any business model, where availability evidently is a prerequisite to selection. As expressed in the title of this paper and as will be expanded upon below, availability and selection may well each lead to separate and sometimes even opposite requirements on business models of scientific information.

In a previous paper [11] the following vision for scientific information was identified:

> *The scientific information market will in future be based on a federated network of repositories of scientific information that conform to open standards, and an accommodating architecture that allows users the easiest and fastest possible access to information in all of these repositories.*
> *The information available by such a network will not only comprise of scientific information material, but also of management information relating to this information.*
> *The market is the scientific community. This federated network will be an open and global network.*

This vision is not new; the language is just adjusted to the present technological opportunities. The vision describes the general desire and need of the users for full availability of scientific information. The overall aim is to share the information in the interest of the progress of science and in the interest of the author and the reader. This desire and need are of all times, and independent of technical, business or other considerations. The creation of the scientific journal in 1665 can be seen as an early expression of this vision,[1] the idea being that a world wide communication vehicle for all science was needed and created as soon as technology allowed it.

Next to demands on general availability and effective and efficient selection, this vision states that users of scientific content will always strive to integrated access to information in a particular domain and will demand that the information can be seamlessly searched irrespective of the mode of access.

3. Growth of scientific information and its consequences

On a worldwide scale, scientific information is growing at about 5% on an annual basis and has already been growing at roughly this rate for a period of several centuries. Such growth is well-known as exponential growth and results in a doubling of the worldwide annual scientific output every 10–15 years. This growth has primarily been the result of a growth in the number of scientists worldwide; on balance the productivity per scientist has not changed much [7]. Scarceness of the available human resources will exhaust this growth in a natural way. Growth in scientific output can then only be the

[1] See the archives of the Royal Society, Bodleian Library, Oxford.

result of an increase in efficacy and efficiency in the scientific process. This efficacy and efficiency in the process depends on the efficacy and efficiency of the information transfer, i.e. of the scientific information system. An effective and efficient scientific process is in turn indispensable for innovation and our modern society is nowadays particularly dependent on the success of innovation.

This growth of scientific information has given rise to a debate on 'information overload', suggesting exorbitant growth of information. As we have seen this 'information overload' is the result of the steady growth of scientific output as witnessed already for centuries and as is needed to sustain scientific progress. Slower than exponential growth will lead to diminishing returns hampering the rate of scientific progress. The solution to this 'information overload' is evidently not to hamper scientific progress with the only objective to reduce the availability of information, but to find ways to deal more effectively and efficiently with this ever-growing pile of information. If we want to sustain or enhance the rate of scientific progress or innovation, this calls for continuous innovation of the power of selection by the reader. Selection is, as we have seen before, dependent on the reader's ability of assessing the relevance and the quality of the information for his work. Steady enhancement of the selection options is the right response to the steady growth of scientific information. Technology can and will help us here in providing an instrument for the reader to effectively and efficiently manage the selection process.

The volume of available information will therefore continue to grow and as a consequence the costs for availability will continue to grow in some more or less commensurate way. This means roughly a doubling in annual costs every 10 years or so for availability only, irrespective of other factors such as costs arising from additional added value, profits or inflation. Other issues to be considered in relation to availability are that dated information may not always be available in digital sources or simply not generally available while not visible, such as with some grey and black information. This autonomous growth of scientific information has resulted in more and more journals to cover the expansion in research areas and existing journals have grown in volume. This makes them more expensive as part of the costs of journals is related to the volume of articles. The overall system will become more expensive if we want all this growing information to be widely available for science.

More and more expensive journals result in cancellations of these journals as libraries cannot afford to subscribe anymore due to budget ceilings. This in turn results in loss of revenues for the publishers and in return these publishers raise prices additionally to compensate for this loss. This process has launched a pricing and cancellation spiral, and is known as the 'serials' crisis'.[2] This serials crisis endangered and still endangers the full availability of information. As stated above the author wants wide exposure for this work, while the reader wants (pre)selection. Wide exposure means wide availability of information and availability in turn is a prerequisite to selection. Availability is thus a basic service in the interest of the author. Sharing of information is an indispensable function in the scientific process.

Selection can be viewed much more as an added value in the interest of the reader and readers may well have different demands to this added value. These considerations result in different requirements for availability and selection on the business model of scientific information. The demand for full availability of scientific information and concomitant power of selection drive change in the system. Availability is

[2]This serials' crisis commenced in the 1970's as a consequence of growth in scientific publications and journals volume, decreasing libraries' budgets, inflation, space constraints [1]. Moreover the dollar devaluation and increasing subscription costs of scientific journals contributed to this phenomenon. Subscription costs have started to raise continuously already in 1963. That caused the cancellation of scientific journals by libraries on the basis of use by scientists and the cancellation of multiple subscriptions [12]. Publishers started to compensate this attrition of revenues in the journal price finally resulting in an avalanche of price increases: the serials' crisis was born.

crucial to empower the users of scientific information, and such empowerment is a necessary condition for integration into the everyday working processes of the scientists.

4. An illustration of recent developments

A limited experiment on the enhancement of the availability of scientific journals has been carried out in the Netherlands in 2003/2004. The Dutch university libraries and the Royal Library, the publishers Elsevier and Kluwer Academic, and 'Surf ICT in research', jointly carried out this research as part of agreements that allowed the university libraries to offer their users access to complete journal collections in electronic form, e.g. from ScienceDirect and Kluwer Online [8]. In this way full availability to the users for at least these journal collections was realised and this is a condition for comparative research.

As the cooperation with the publishers allowed access to the log files of the journals a study was made of the number of articles downloaded from the publisher platforms. In October 2001 the users downloaded on average 1 in 14 articles of these databases, in October 2003 this number had increased by more than 30% to an average of 1 in 10. This increase can be attributed to the fact that articles can comfortably be downloaded by the reader, but some part of this increase will be the result of multiple downloads.

The number of downloads per journal varies substantially, from just a few downloads per month to more than a thousand downloads per month. From the Fig. 1 below we see that 20% of the journals do cover about 80% of the downloads, 40% of the journals is good for more than 90% and 60% of the

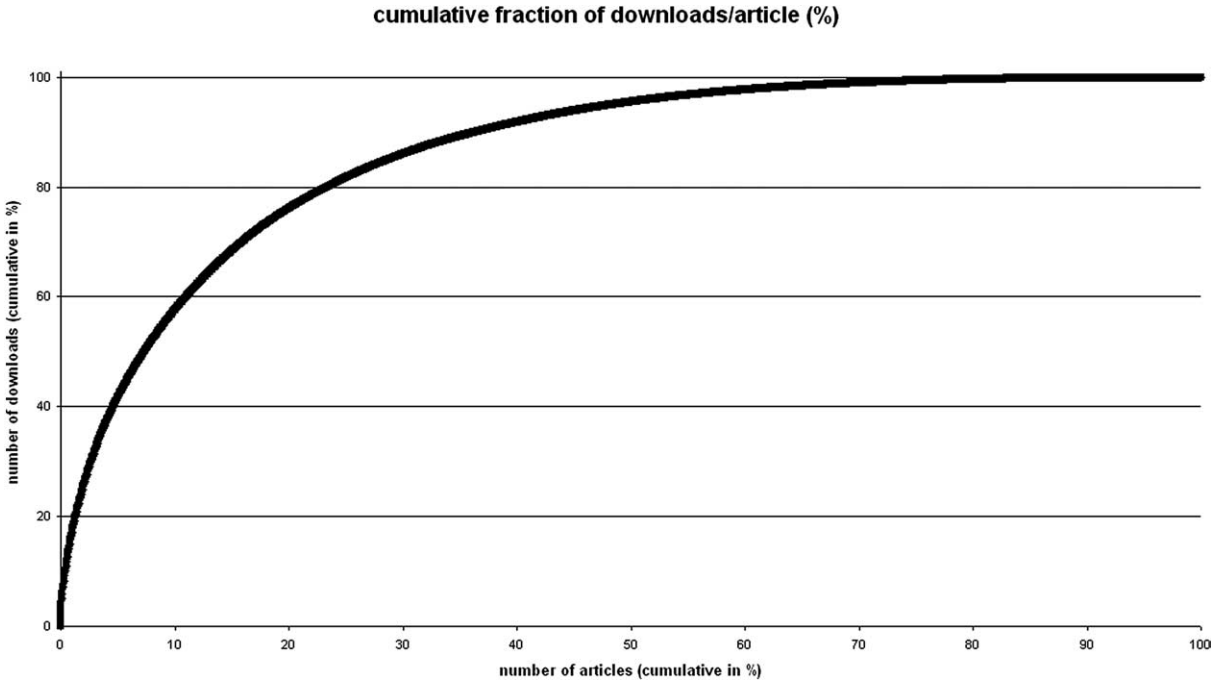

Fig. 1.

journals even for more than 95% of the downloads. This download behaviour follows nicely the '80/20' rule or the 'Pareto' distribution as was to be expected.[3]

An interesting observation is that according to a sample of interviewed scientists electronic journals do offer additional advantages for performing interdisciplinary research: the comfort at which one can inspect many different articles, e.g. by using specific search terms, allows scientists to find yet unknown sources and new angles that were not evident before. Research is also expected to speed up as the required information from disparate sources can be collected and integrated much faster. This will be an impetus to a more effective and efficient information system as it allows a stronger integration over different disciplines. Again, full availability is required for enabling this.

Overall, this research confirms the relevance of full availability and concomitant power of selection. Scientists appreciate full availability as the most important property of electronic journals: journals must be available at any desired moment and it should be possible to consult them at the working place and from home, via the university network. In the eyes of the scientists access to scientific information by the desktop has become the rule. Availability of scientific information is taken for granted.

This experiment confirms that availability and selection are the crucial parameters for any business model. Experiments focusing on the balance between availability and selection with the aim to optimise this balance could be worthwhile.

5. Issues of intellectual property

Availability and selection are seen to be crucial parameters in the scientific information market as the market of sharing scientific information, of sharing of intellectual property. The organisation of property is evidently a conditio sine qua non in any business model in any market. As noted in the Introduction intellectual property is at the nucleus of the scientific process. In this chapter we will touch upon those issues of intellectual property that are strongly interrelated to the scientific process. We will not touch upon the issue from a legal point of view but take the view that law should follow society, in this case the scientific world.

As discussed above, scientific knowledge is common property or otherwise does not exist. For the scientist, scientific information is not an end product but an intermediary product. The information is to be shared. Again, the primary purpose of scientific information and knowledge is that it will be used in the scientific process. To this end, the information must be generally available. Scientific information also requires added value, e.g. specific services to disclose the information effectively and efficiently. These added values are not common property and can be owned on a proprietary basis by service providers such as universities and publishers.

Scientific knowledge while being common property is nonetheless owned by the author. The author claims the property of the 'invention' by publishing this 'invention'. The author retains always the rights to the personal expression and this personal expression is protected. The author retains the 'moral rights'. These moral rights are the paternity and the integrity rights. The author can transfer the exploitation rights, integrally or partially, to a third party, be this a university operating as an institutional repository, a university publisher, a non-commercial or a commercial publisher. In exchange to these exploitation rights the service provider provides added value in terms of services leading to among others visibility of the work of the author and protection of the moral rights of the author.

[3]The law was first presented in details in V. Pareto 'Cours d'economie politique', 1897, 2: 299–345.

Whatever the business model the author, as we have seen above, claims the intellectual property to the work by publishing this work. Publishing in an acknowledged medium of publication, be this an institutional repository, a book, a journal or any other accessible medium is for the author the only way of claiming this intellectual property. Moral rights are part of the copyright and the author will retain these moral rights in perpetuity. Which commercial or exploitation rights are exactly transferred is just a matter of negotiation between the author and the publisher. If the information is published on the university's repository, the university can also support or even act on behalf of the author in negotiating the further exploitation rights for the work.

A common infringement of these moral rights is plagiarism; a common infringement of the exploitation rights is commercial abuse of the information. Plagiarism is of direct relevance to the author as it affects the paternity and integrity rights of the author and it is here that the author needs protection. Commercial abuse is not an issue directly relevant to the author as the author is primarily interested that the work will be available to the scientific community, but instead highly relevant to the publisher. It is therefore in principle possible to split these different responsibilities. The above argument means that the protection to these two main infringements does not need to be in one hand, but could easily be split over different stakeholders. The university, possibly as the employer of the author or if the work is published on the university's repository, might just as well guarantee protection against plagiarism; in fact the university has to guarantee this if the repository is freely accessible. The publisher could take responsibility for the commercial abuse, as this is in the publisher's interest. Needless to state that the university can also be the publisher.

6. Business models for scientific information

We have seen that the scientific process demands that scientific information must be widely available, and in perpetuity. This is generally valid, but it is in particular valid for information that has been accepted for publication in scientific journals after having been subjected to the peer review process. Within the general condition that any business model for scientific information should be commensurate with the scientific process the above leads to the following basic requirements for any business model:

- the model should account for wide availability anyhow, anywhere and anytime,
- the model should account for the power of selection by the reader. This power of selection should ever continue to advance with technology;
- the model should be commensurate with the specific demands on intellectual property inherent to the scientific process.

Two prototypical models emerge:

- the emphasis on selection leads to the subscription model;
- the emphasis on availability leads to the 'open access' model.

Here we use the concepts of availability and selection as introduced before. Selection is the selection as done by the reader and does not include selection of information on scientific and/or editorial criteria, such as peer review. Peer review is coupled to availability as it is the determinant of which information is worthy of being published. In other words which information qualifies as scientific information or as scientific knowledge being worthy of further scientific effort and scrutiny, and thus as common property?

In the widely used business model, the subscription model, it is the library that pays on behalf of the researcher as reader. The basic idea is that the overriding added value for which is paid is the power of

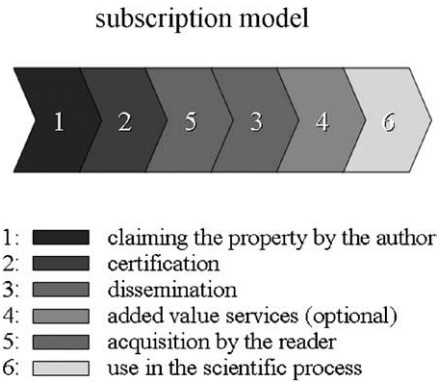

Fig. 2.

selection by the reader. The model aspires to maximum availability which is then bounded by selection. Selection is in this way used as an ordering principle to create this bounded availability. Limited availability adds to this. Selection as ordering principle was no doubt relevant with printed journals as here selection is to a large extent based on title choice. With electronic information, digital searching means searching over more than one title and over different products with the concomitant result that one can and will find new sources and new angles. This makes the journal title less important as a selection tool, albeit that the journal and thus its title will remain important to the reader for the scientific and editorial policies it represents. As such the journal title represents the flavour of the journal, the title is the brand. The subscription model puts the total financial responsibility and burden, for selection and availability, on the reader. The challenge for the subscription model is to create a higher or even full availability at an affordable price.

The discussion about the business models can be illustrated using the value chain. Figure 2 presents the chain of added values in the subscription model. The essence of the subscription model is that the acquisition, thus first selection of scientific information precedes its dissemination.

As we have seen, the costs for availability will continue to increase in the foreseeable future, as there will be no end to the steady growth of worldwide scientific output. And indeed, such an end is not desirable from the point of view of the scientific process.

An alternative to the subscription model is the ‘open access’ model. In this model availability is the overriding added value for which is paid. Basically, it means that the authors pay a one-time lump sum for the publication and perpetual availability of their work, and the journals will be freely accessible for the readers. But at the end of the day, it is always the scientific community that pays for the publication, in the subscription model the reader channel is used via library funds and in this open access model the author channel via research funds. This open access model is not new, but recently reintroduced as a possible new solution. A premise to the open access model is that authors can dispose of funds to cover these costs, be this directly or via the institution in the form of a publication budget. This may require a transfer of funds from the library budget to a publication budget. This is in principle possible as the library budget would be freed from subscription responsibilities.

Not for long, most American journals used to have a somewhat similar system of ‘page charges’: authors paid to cover the fixed costs connected to a publication. In this model, the variable costs were covered by subscription costs paid by the reader. However, pressure of mainly non-American authors forced many journals to abandon this system largely or partially in the seventies as these authors could not afford these page charges. In some research areas, such as economics, review charges are being

levied as separate payment covering the costs of the reviewing process. In this way, the costs for the reviewing process are made independent from the revenues from subscriptions. However, the reviewing process is still coupled to the submission of an article to a journal as scientific and editorial frame of reference.

Technology allows any institution to make scientific information available via repositories of information. The university can also support or even act on behalf of the author in negotiating the exploitation rights for the work. Scientific quality control by peer review next to power of selection is then a clear separate added value for which independent segmentation or branding, e.g. by journal titles or other editorially controlled scientific information collections, is vital.

While it remains to be seen if authors will accept the model of 'open access' and if this model will prove to reduce total costs, this model has one clear weakness: there is no real incentive to warrant an optimal power of selection for the reader. Optimal power of selection means that its continuous innovation using the latest technology will be guaranteed in future. Open access is commensurate with the intrinsic scientific demand for availability. Alternatively, the subscription model is seen to be strong with respect to selection but weak on availability.

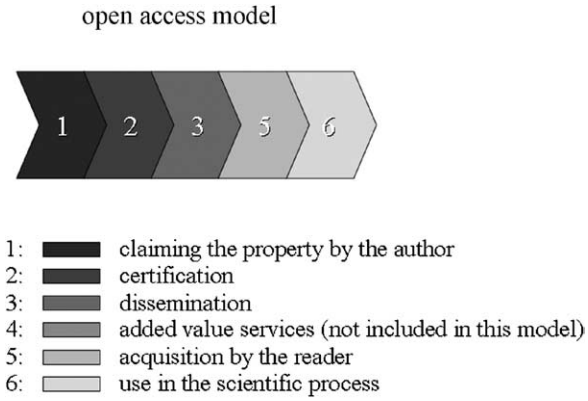

Fig. 3.

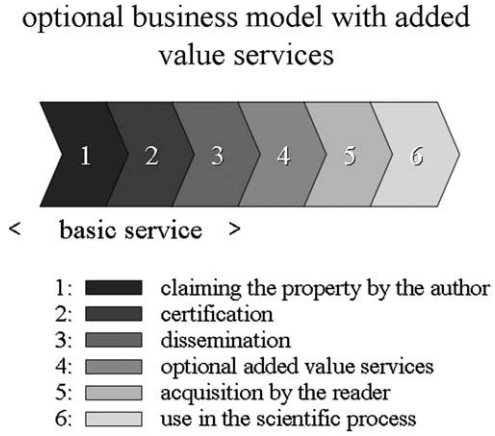

Fig. 4.

The 'open access' model is presented in Fig. 3. The basic idea of the open access model is that scientific information is available for the reader who acquires the information either with or without added value services (e.g. sophisticated search software, appropriate metadata, alerting systems, mailing lists, etc.).

Combination of these two basic elements of availability and selection in one hand is seen to result in a painful split: either there will be problems with full availability or problems with less effective and efficient power of selection for the reader.

This leads to a business model as presented in Fig. 4 comprising of a basic, no frills service of sheer availability coupled with peer review as the major value proposition required and with optional value added services as the reader might desire. This model is further discussed in the conclusions below.

7. Conclusions and outlook

Would it then not be desirable to separate the costs and pricing for availability from the costs and pricing for selection? From a business point of view this is not new. There are nowadays many examples where services are being separated from the infrastructure needed to provide these services, such as the internet and the providers, the UK and Dutch trains and railway systems, etc.

Following the above arguments on the different aspects of availability and selection as core added values of scientific information and the different roles they therefore play in the business model it follows to consider, at least from a theoretical point of view, two separate suppliers: one for availability and a second for the selection by the reader. These suppliers can be both universities and publishers. This is even more interesting as we have seen that availability and power of selection represent different types of added value. Availability can be seen as a basic need directly coupled to the notion that scientific information is common property whereas power of selection can be seen as a proprietary added value that needs be tailored to the desires of the reader.

Peer review can be seen as a separate added value and as seen above is strongly coupled to availability. It will in principle be possible to make the costs for peer review a clear transparent, and possibly non-remunerable, part of the availability costs. In connection to this notion of peer review being a separate added value in the process it may be noted that peer review is a scientific process carried out by scientists as a scientific duty and is not an added value provided by the publisher. Peer review is a service to the author and it is an added value for the reader when assessing the relevancy of the information. Although, as it is sometimes claimed, peer review may not always be required in scientific disciplines such as, e.g. physics or chemistry, peer review is definitely needed when uncertainty is high, e.g. in interdisciplinary studies. Publishers play an important role in assisting in this process of peer review, but the key players are the editors of a journal and the referees. Peer review results in the scientific conditions under which the paper can be published in a certain editorial collection such as a journal. If these conditions require the author to rewrite the paper it is still the author deciding to do so in order to claim the 'invention'. By this act, the author then creates a new personal expression superseding the previous one that thereby cedes to exist, or rather has never existed. It is this negotiation with the scientific community that has brought the author to take this decision, and such a decision is an integral part of the scientific process.

Market segmentation with independent pricing for both forms of added value of availability and power of selection can increase the transparency of the market. Enhancing the transparency in the market requires strong partners and we have seen that universities, albeit somewhat hesitantly, are nowadays strengthening their strategic position by building repositories and investing in e-science. This development allows universities to assume a key role in providing the availability of scientific information.

A transparent market also requires transparency for all stakeholders in cash flows, tariffs, revenues and all, also hidden, costs. As a first step to support this development proactively and to bring the investments in repositories and e-science to fruition the cash flows between research, education and information within the university will have to be transparent. Such a development seems, however, still far away.

More generally, further developing the digital scientific information market requires developing and testing new value chains different from the present ones, and consequently new business and distribution models. A prerequisite for the acceptance of new models is that they provide sustainable solutions.

Sustainability requires that a new value chain for the scientific information market should be jointly developed between universities and the other partners like publishers and other service providers. A new value chain should be able to support a variety of value chains for the information market representing different organisational, legal and business models. The individual stakeholders will need this flexibility to effectively compete with their information products. This process has begun with the experimentation of new license models, but these models can only be considered as a beginning of a long process still ahead of us.

In considering new business models it remains important to realise what was stated before: scientific information is an integral part of the scientific process and scientific publishing should serve the primary processes in science: research and teaching. The primary objective of scientific information is to make use of the information for scientific purposes in everyday scientific working processes. Scientific information and knowledge is common property or else it loses its function. The latter would mean that scientific information is only there for the record, and this would erode its value. But at the end of the day scientific information has no value in itself, but is there to serve in teaching, and research and development.

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