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Scholarly Journal and Digital Database Pricing: Threat or Opportunity?

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2.1 Introduction

For over three centuries, scientific scholarly journals have demonstrated remarkable stability. A large number of studies performed during the past few decades have shown their continued use, usefulness, and value. However, two phenomena have evolved over the last thirty years that have the potential either of destroying the scholarly journal system or substantially enhancing its considerable usefulness and value. These two phenomena are the maturation and integration of communication technologies and the economics of the journal system, particularly pricing of traditional journal subscriptions and access to digital full-text databases through site licensing and package “deals.” Certainly, the new technologies should, if deployed with care, enhance the journal system (e.g., Tenopir, et al. 2003) but contemporary pricing policies have been a greater threat to the journal system. Up to the mid-1990s rapid, and little understood, price rises posed a significant threat to the system, and then, more recently, policies of site licensing and negotiated journal packages have become commonplace even though little is known as to their sustainability.

The early pricing policies resulted in substantially reduced personal subscriptions, increased reliance on library access, library prices raised far higher than inflation or increased journal sizes would warrant, and libraries and scientists having to rely more heavily on obtaining separate copies of articles through interlibrary loan, document delivery, preprints, reprints, and photocopies or electronic copies from authors and colleagues. Recently, most academic libraries in the U.S. and many other types of libraries have negotiated licenses with individual publishers, library consortia, and other vendors to obtain access to multiple journals. While there are appreciable benefits to both publishers and libraries of such arrangements (King and Xu 2002), there are considerable concerns as well (Frazier 2001). One concern is that negotiation seems to vary from deal-to-deal, and it is not clear that long-term revenue to publishers will be sufficient. In this chapter, we discuss the early pricing policies and why prices spiraled upward, and we show that problems leading to this dilemma are also inherent to the current licensing policies.

This chapter provides some insights gained from analysis of over 15,000 responses from readership surveys of scientists; cost analysis of publishing, library services and scientists' communication patterns; tracking of a sample of scholarly journals from 1960 to 2002; and review of over 600 publications dealing with scientific scholarly journals. This chapter will attempt to dispel some myths concerning communication costs, system participants' incentives, and reasons for increased prices. It will also present perspectives on pricing that might help in an electronic age and provide some suggestions concerning subscription pricing, site licensing, and online access to separate copies of articles.

2.2 Are Scientific Scholarly Journals Worth Saving?

Over the years there have been a number of skeptics regarding the use, usefulness, and value of scientific scholarly journals. However, since the 1950s, there have been over twenty studies that show that scientists in general rely more on journals than any other source for their information, although this is not true for engineers or “technologists” (Tenopir and King 2004). Consider evidence from surveys of scientists conducted by King Research from 1977 to 1998, the University of Tennessee School of Information Sciences in 2000 and 2001, Drexel University 2002, and University of Pittsburgh 2003. A 1977 national survey of scientists showed that they averaged 105 readings of scholarly journals per scientist per year, and a follow-up survey in 1984 revealed about 115 readings per scientist; several surveys in organizations from 1993 to 1998 yielded combined estimates of 120 readings; and surveys in 2000-2003 resulted in a weighted average of 134 readings, thus suggesting that amount of reading might have increased over the

years.¹ Extrapolated to the entire population of scientists and articles published, these data indicate that the average readings per article was about 640 readings per article in 1977 and about 900 readings in the late 1990s. Three studies in the 1960s and 1970s estimated the amount of reading per article by asking sampled scientists to indicate which articles listed on recently published tables of contents they had read. Average readings per article, extrapolated to the population of scientists sampled, showed that psychology articles averaged 520 readings per article (Garvey and Griffith 1963), economic articles averaged 1,240 readings (Machlup and Leeson 1978), and Journal of the National Cancer Institute articles averaged 1,800 readings per article² (King, McDonald, and Olsen 1978), or 756,000 readings for the entire volume of 12 issues. Thus, there is ample evidence that scientists read many scholarly articles and that journals are well read.³

Scholarly articles are read for many purposes ranging from supporting specific research projects and teaching to administrative purposes. They are also read by people wanting to keep current in their disciplines. A number of studies have shown the importance of scholarly articles for these and other purposes. Our recent surveys of university scientists show that readings for teaching purposes are rated high in importance (5.10 on a scale of 1-- not at all important to 7 -- absolutely essential) while readings for research are rated even higher (5.32). One-third of the readings are said to be “absolutely essential” to the teaching or research. Similar results are observed in surveys of non-academic scientists, who individually read fewer articles than university scientists, but totally account for about three-fourths of all reading due to the overwhelming number of these scientists.

Machlup (1979) defines two types of value of the information provided by scholarly journals: purchase value and use value. Purchase value is what scientists are willing to pay for the information in monies exchanged and time expended in obtaining and reading the information. The purchase value expended on scholarly journal information exceeds \$5,400 per year per scientist, most of which involves their time spent obtaining and reading the information. In fact, the price paid in scientists’ time tends to be five to ten times the price paid in purchasing journals, separate copies of articles, and other journal-related services. Of twenty studies by various researchers that provide estimates of time spent reading, the median time spent is 9.0 hours per month or about 108 hours per year per scientist. Our recent surveys show that scientists annually spend about 130 hours reading scholarly articles, up from 80 hours in 1977. Also, scientists are spending more time obtaining articles because they more often use library-provided articles than their own personal subscriptions (more is said about this later).

Use value involves the outcomes or consequences of using scholarly journal information. Examples of use value from our surveys include evidence of producing work with greater quality, faster, or at a lower cost in time or money. Several studies, dating back to the 1950s, have shown

¹ Surveys involved national probability samples of scientists (1977, 1984), audiences of *Science* and the *Journal of the National Cancer Institute*, and samples of scientists in organizations such as the National Institutes of Health, AT&T Bell Labs, Oak Ridge National Lab, The Johns Hopkins University, University of Tennessee, Drexel University, University of Pittsburgh, and American Astronomical Society members. There may be some bias in organization surveys because the organizations are self-selected.

² Estimates of readership of articles by this survey method are in fact biased on the low side because they miss readings that take place after the survey responses, they do not include readings of separate copies of articles (over 100 million currently), and they miss other article distribution means.

³ All uncited data come from: Tenopir, C. and D. W. King, 2000, *Towards Electronic Journals: Realities for Scientists, Librarians, and Publishers*, Washington, D. C.: Special Libraries Association; or are new unpublished results.

that amount of reading is correlated with productivity. Our surveys established that amount of reading is positively correlated with five indicators of productivity (i.e., outputs and input time measured in five ways) (Griffiths and King 1993). Another indicator of use value is that scientists whose work has been formally recognized through awards, special assignments, or designated by personnel department (for our survey purposes) tend to read more than others.⁴ This was observed in the 1960s (Lufkin and Miller 1966) and was invariably observed in 21 of our surveys. Thus, there is also abundant evidence of the purchase and use values of scholarly journals, and one must conclude that any changes in the future should ensure that the use, usefulness, and value of scholarly journals be retained.

2.3 Scholarly Journals Examined from a Systems Perspective

In the late 1970s King Research performed a series of studies for the National Science Foundation on scientific and technical information communication, with particular emphasis on scientific scholarly journals.⁵ As part of these studies we identified and characterized all the principal functions performed in the journal system, participants who performed the functions, and hundreds of detailed activities necessary to perform the many functions. For each activity we established quantities of output and amount of resources required (with dollar amounts placed on the resources). We traced the flow of messages transmitted among participants, which, in 1978, numbered in the billions. We also examined all of the activities in terms of the introduction of evolving technologies to assess when comprehensive electronic journals were likely to become commonplace.

As a result of our 1978 systems study we indicated that:

“Recent technological advances, which were developed largely independently of the scientific and technical communication, provide all the components of a comprehensive electronic journal system. Such a system would provide enormous flexibility, particularly because individual articles can be distributed in the most economically advantageous manner. Much-read articles may still be distributed in paper form, and infrequently read articles can be requested and quickly received by telecommunication when they are needed “ (King, McDonald, and Roderer 1981).

We went on to say that:

“This comprehensive electronic journal system is highly desirable and currently achievable. It is believed that within the next twenty years, a majority of articles will be handled by at least some electronic processes throughout but not all articles will be incorporated into a comprehensive electronic journal system.”

At that time (1978), some communications researchers scoffed at this “pessimistic” view of when electronic journals would become widespread, and some at NSF were disappointed because other studies forecast much quicker implementation of electronic journals.

⁴ Of course, it may be that intelligent professionals read more *and* get more recognition for their work, but the latter for their intelligence, not necessarily because they read a lot. Regardless, it shows that this resource is important to them.

⁵ For example: King, D.W., D.D. McDonald, N.K. Roderer, and B. Wood. 1976. *Statistical Indicators of Scientific and Technical Communication*. (1960-1980): Vol. 1 A Summary Report. GPO 083-000-00295-3 and King, D.W. and N.K. Roderer. 1978. *Systems Analysis of Scientific and Technical Communications in the U.S.: The Electronic Alternative to Communication Through Paper-Based Journals*. NTIS: PB281-847.

One aspect of the systems analysis done at the time was to sum the resource costs applied to all the activities identified in order to establish an overall journal system cost in the U.S. In 1975 we estimated the total amount of resources expended that year on scientific journals to be \$5.05 billion (or about \$15.6 billion in 1998 dollars, considering increases in resource costs). The corresponding total system cost in 1998 is estimated to be about \$45 billion.⁶ This systems approach ignores the amount of money exchanged between participants, such as the price paid by scientists and libraries for subscriptions purchased, the price paid for online bibliographic searches, fees paid for document delivery services, and so on. Including such transfer payments would only duplicate the costs of system resources applied by publishers, online vendors, and document delivery services. Thus, the additional cost to the U.S. economy (or scientific community) for processing and using scientific journals was another \$5.05 billion in 1975 (or \$15.6 billion in 1998 dollars) and \$45 billion in 1998. The \$15.6 billion (1998 dollars) comes to about \$7,000 per scientist or about \$67 per article reading. In 1998 we estimated the comparable system cost to be about \$7,100 per scientist or \$59 per reading.

The 1998 total system cost per scientist (\$7,100 per scientist) is sub-divided as follows: authors (\$640), publishers (\$500), libraries and other intermediaries (\$420), and readers (\$5,540). Thus, scientists' time spent writing and reading dominates the total system costs (i.e., 87% of the total costs). The costs per scientist of authorship, publishing, and libraries and other intermediaries have all decreased over time, but readers' cost per scientist has increased. The reader increase in cost per scientist is attributable to an increase in their time spent acquiring and reading articles. The number of personal subscriptions of scientists has decreased by over one-half, with nearly all prior reading from personal subscriptions replaced by reading from library-provided journals. Thus, scientists spend more time obtaining articles, and they also appear to spend more time reading an article (due perhaps to an increase in size of articles as shown later). The decrease in cost per reading is due to relative decreases in library and publishing resources expended.

The relative resource expenditures of libraries (and other intermediary services) are down, whether calculated by cost per scientist or cost per reading. The library cost per scientist is down because of relative reduction in library budgets, but also because of efficiencies due in part to library automation, resource sharing (King and Xu 2002), and replacement of print journals by electronic versions (See section 2.9). The library cost per reading is down due in large part to the increase in the amount of reading from library-provided journals resulting from the shift from personal subscriptions to library-provided articles. For example, from 1977 to the current era, the number of personal subscriptions declined from 5.8 to 2.4 and number of readings from library collections increased from 15 to 66 readings per scientist.

The relative cost of publishing has apparently also decreased. For example, the cost per page published is down, due in part to use of technologies, increased efficiencies, and increased sizes of journals. The cost per scientist is down, due in part to the factors mentioned above, but also the fact that there is an average of over three fewer subscriptions circulated per scientist. The publishing cost per reading is also down due, in addition to the factors above, to a greater amount of reading. This discussion of the systems perspective causes us to ask this question: ***Why have average prices risen by a factor of nearly nine over a period of time during which the relative cost of publishing has actually decreased?***

⁶ The increase in total cost is largely attributable to an increase in estimated number of scientists who are active in research, teaching, and/or other endeavors that involve reading scholarly journals, i.e., 2.23 and 6.38 million scientists in 1975 and 1998, respectively. It is emphasized that estimates of the number of scientists are inexact (see *Science and Engineering Indicators* 2000, p. 3-3 to 3-5).

2.4 To Understand Price One Must Understand Publishing Costs

While there have been literally hundreds of articles written about the price of scholarly journals in recent years, very little has been written about the cost of publishing journals. To understand why prices are what they are, one must know about the cost of publishing journals. One reason that costs are not often discussed in the literature is that publishers do not want their competitors to know their costs. Also, costs vary a great deal among journals, depending on the characteristics of journals such as manuscript rejection rates, number of articles, number of pages, number of issues, and circulation, and the type of resources used such as location and experience of editors, technologies applied, and quality of paper. With that concern in mind, we decided to develop a cost model of journal publishing in order to analyze effects of circulation, changes in characteristics of journals over time, and how such factors might affect the price of journals. We formulated a cost model using data we collected for the 1978 journal systems analysis and more recent pieces of information gleaned from the literature. The model has been reviewed by staff from different types of journal publishers, who found it reasonable with the caveats mentioned above. We also compared our model data with other published data and found them a good source of validation.⁷

The cost model consists of five functions or groups of activities as follows:

- Article processing including manuscript receipt processing, initial disposition decision-making, identifying reviewers or referees, review processing, subject editing, special graphic and other preparation, formatting, copy editing, processing author approval, indexing, coding, redaction, and preparation of master images.
- Non-article processing including many of the same activities involving editorials, letters to the editor, brief communications, and book reviews. It also includes preparation of issue covers (for paper versions), tables of contents, and indices.
- Reproduction involving printing, collating, binding of issues, and printing for reprints (all of which activities are not necessary for electronic versions).
- Distribution of paper versions involving wrapping, labeling, sorting by zip code, and mailing; distribution of electronic versions including storage and access. Subscription maintenance is required of both versions.
- Support activities including marketing and promotion, rights management and other legal activities, administration, financing, and other indirect activities.

In 2002 the average U.S. Science journal characteristics were estimated to be 10.8 issues, 154 articles, 213 manuscripts submitted, 1,910 article pages, 397 special graphics, 2,215 total pages, and 4,800 subscriptions.⁸ The cost model estimates for these functions are: \$255,897 for article processing, \$22,957 for non-article processing, \$215,392 for reproduction and distribution, and \$197,908 for support, for a total of \$692,154. The article processing cost per article is \$1,660 per

⁷ (e.g., Halliday and Oppenheim 2003, Holmes 1997, Marks 1995, and Scott 1998)

⁸ The cost model also included 20 fixed and variable cost parameters such as setup costs associated with each issue and printing cost per impression.

article and the reproduction and distribution cost per subscription is about \$45 per subscription (without allocation of support costs).

By holding all other journal characteristics and cost parameters constant, we can assess the effects of journal characteristics on the total and unit cost. For example, we find that the cost per hypothetical subscription varies substantially by number of subscribers (see Table 2.1).

Table 2.1:

Publishing Unit Cost Per Subscription by Various Numbers of Subscribers: 2002 Dollars

Subscribers	Cost per Subscription
500	\$993
1,000	\$519
2,500	\$235
5,000	\$140
10,000	\$93

Note: These are data estimated for this chapter.

The price necessary to recover costs at 500 subscribers is at least \$993 per subscriber, but it decreases sharply at the 2,500 – 5,000 subscription range, at which point the unit costs decrease slowly approaching an asymptote (which is the incremental reproduction and distribution costs). At 500,000 subscribers the cost is \$2 above these costs. Of course, in reality the journal characteristics and cost parameters among journals vary. For example, large circulation journals tend to publish more issues, have expensive photos and graphics, reject more manuscripts, and use more expensive covers and paper. Spinella (2004) makes this point in discussing publication of large circulation journals, such as *Science*. However, by holding non-circulation characteristics and cost parameters constant we get a good picture of the effect of size of circulation. Halliday and Oppenheim (2004) present similar results as above, but expand by showing effects of varying overhead and profit levels (which we call support above).

Similarly, by varying the number of articles published from, say, 50 to 200, we find that cost per subscriber increases from \$77 to \$172 (at 4,800 subscribers). The direct article processing costs per article do not vary much, \$1,747 per article with 50 articles and \$1,651 per article with 200 articles in a journal, but the difference in cost per article is substantial when non-article processing, reproduction and distribution, and support functions are included (\$7,375 vs. \$4,130). Similarly, the cost per article received by subscribers decreases from \$1.54 per article with a 50 article journal to \$0.86 per article for a journal with 200 articles. The phenomenon of the cost per article decreasing with larger journals may be the reason that publishers have steadily increased the size of journals over the years; that is from an estimated average of 85 articles per title in 1975 to 154 in 2002.

2.5 What do Average Prices Mean?

Prior to discussing reasons why journal prices have increased so much, it is worth noting that there are several ways in which one can measure average price. In the literature, average price is nearly always calculated as the average price per title. That is, the prices of a set of journals are summed and divided by the total number of journal titles in the set. This average has specific meaning. For example, it makes sense for an individual library to estimate the average price for their collection in this way, particularly for comparison over time. However, from a total systems perspective it makes more sense to measure average price by the price per subscription. That is,

one takes the total price of all journals circulated and divides by the total circulation. This average price is much lower than the average price per title and has a much different meaning. The point can be made through a simple arithmetic example, taking into account that low circulation journals have higher prices due to relatively higher fixed costs. In 1995 we observed the following equal number of journals in four ranges of circulation (i.e., quartiles) and the average circulation observed in each quartile as shown in Table 2.2.⁹ In the table we also present the price necessary to recover publishing costs at the average circulation and with the other characteristics and cost parameters mentioned in the previous section held constant.

Average price per journal can be roughly estimated by summing the four sets of prices of all journals in each quartile (e.g., \$747 x 1,693) and dividing the total of the four quartiles by 6,772 journal titles (recognizing that this estimate is below the real average). As shown, the average cost/price per journal title is \$315.

Table 2.2: Circulation Quartiles of U.S. Scholarly Journals, Average Circulation, and Price Necessary to Recover Publishing Costs: 1995

Circulation	No. of Journals	Avg. Circulation	Price
< 900	1,693	520	\$747
901 – 1,900	1,693	1,310	\$316
1,901 – 5,700	1,693	3,290	\$145
> 5,700	1,693	18,100	\$ 53
ALL	6,772	5,805	\$315

Note: Source: Tenopir and King 2000

The average price per subscription is estimated by summing the four sets of prices of all subscriptions in each quartile (e.g., \$747 x 1,693 x 520) and dividing the total of the four quartiles by the total number of subscriptions in 1995, which is about 39.3 million (i.e., 6,772 journal titles x 5,805 subscriptions per title). The average price per subscription is \$96—far less than the price per journal title (\$315). Thus, it is clear that the highly skewed distribution of journal circulation means that large circulation journals dominate average price calculated in this way. Yet this measure of average price is more meaningful when considering the impact of price on the U.S. economy or in terms of examining price trends to the entire scientific community, not just to individual libraries.

2.6 Reasons Why Journal Subscription Prices Spiraled Upward

There is overwhelming evidence that individual scholarly journal prices increased dramatically from 1960 to 1995. For example, we sampled 430 U.S. scientific scholarly journals and tracked them from 1960 to 1995.¹⁰ In this sample, prices rose from an average of \$8.51 per title in 1960 to \$284 in 1995. One particular concern is that the rate of increase accelerated, even in constant dollars. There are many reasons that prices increased in this manner. Okerson (1989) provides an

⁹ We use 1995 data in Tables 2.2, 2.3, and 2.4 because we had better data on circulation in 1995. Also, introduction of licenses and negotiated packages of journals has diminished the meaning and count of circulation. In 2002 we estimate journal circulation to be about 4,800 subscriptions.

¹⁰ The tracking process took into account births, deaths, and splitting of journals into two or more journals.

excellent discussion of some reasons for this phenomenon, and below we present some numeric examples as to why prices per title increased so much.

Some of the high increases in price over these two decades can be explained by inflation and increase in the size of journals. Referring back to the publishing cost model above, one can establish an indication of how much an increase in size of journals has affected prices over time. As mentioned earlier, the average number of articles published in science journals has increased from 85 to 154 articles per title from 1975 to 2002. Other journal characteristics (e.g., number of issues, pages, special graphics) increased in size as well. By substituting 1975 and 2002 characteristics in the cost model and keeping number of subscriptions and cost parameters at 2002 levels we estimate that the cost per subscriptions for the 1975 size journal is about one-half that of the 2002 journal. Thus, there is evidence that the increased size of journals has resulted in a substantial increase in journal publishing cost, and therefore, the necessity to increase prices accordingly.

A more subtle factor is that the estimated number of scientific scholarly journals increased from 4,447 in 1975 to 6,772 in 1995. Most of the new journals had a small circulation and, therefore, must have a higher-than-average price per title. Consequently, the continued addition of new journals had the effect of increasing average price both per title and per subscription. In fact, journal prices increased at a rate greater than inflation since at least 1960, when there were only 2,815 scientific journals provided by U.S. publishers (Tenopir and King 2000).

This phenomenon can be documented by examining the 1975 number of journals in the quartile ranges shown for 1995 above and applying the same calculation of average price per journal title and per subscription as shown in Table 2.3. One can see that in 1995 there were more of the smaller-circulation journals and fewer larger ones.

Table 2.3: 1995 Circulation Quartiles of U.S. Scholarly Journals and the Number and Proportion of Journals in the Ranges in 1975 and 1995

Circulation	No. of Journals		Proportion of Journals (%)	
	1975	1995	1975	1995
< 900	880	1,693	19.8	25
901 – 1,900	805	1,693	18.1	25
1,901 – 5,700	1,579	1,693	35.5	25
> 5,700	1,183	1,693	26.6	25
ALL	4,447	6,772	100.0	100

Note: Source: Tenopir and King 2000

In order to make unbiased comparisons, we again assume that all cost parameters remain the same and that average prices in the four ranges do as well. We find that the average price per journal title of 1975 journals with their circulation would be about \$270 per title compared with \$315 in 1995. Thus, this average price per journal would have increased about 17 percent due only to the change in distribution of circulation. A much smaller increase is observed in the average price per subscription, from \$91 per subscription for 1975 circulation to \$96 in 1995.¹¹

¹¹ There is a small distortion in the 1975 average circulation in that calculation from the data gives 6,300 subscriptions per title, but the average calculated from the sampled journals was 6,100.

Note that the average circulation per title did not decrease much from 1975 to 1995, from 6,100 to 5,800 subscriptions, but the median dropped from about 2,900 to 1,900 subscriptions.

The shifts in the distribution of circulation are attributable to more than the influx of new, small-circulation journals. Increased prices had a spiraling effect. As mentioned above, the average number of personal subscriptions per scientist dropped more than 50 percent over a twenty-year period. Had the average remained constant, there would be about 19 million more personal subscriptions than there actually were in 1995. Even at modest personal subscription prices, publishers undoubtedly lost billions in annual revenue from cancelled personal subscriptions, in which case they probably tried to recover the lost revenue through exceptionally high price increases to libraries. They would have been able to do this because library demand is much less sensitive to price changes than personal subscription demand.¹² Both personal and institutional (library) prices jumped dramatically in the late 1970s due to high inflation, fluctuating international exchange rates, and other factors. When this happens, subscriptions can decrease even though the number of scientists interested in a discipline continues to increase. With small-circulation journals, decreases in circulation result in an accelerated increase in cost per subscription. For example, if circulation decreases by 100 subscribers from a 2,500 level, the cost to publishers at 2,400 subscribers would be \$6 more per subscriber. However, a 100-subscriber decrease from 500 to 400 subscribers would require an increased cost of \$186 per subscriber in order to recover costs. Examples of required cost increases are outlined in Table 2.4:

Table 2.4: Required Publishing Cost Increases at Various Decreases in Circulation: 1995 Dollars

Circulation Decrease	Required Cost Increase
2,500 to 2,400	\$6
2,000 to 1,900	\$8
1,500 to 1,400	\$18
1,000 to 900	\$41
500 to 400	\$186

Thus, the accelerated publishing cost increases can result in corresponding price increases and further decreases in circulation, leading to higher costs and in turn, by necessity, to spiraling prices. Since personal subscriptions are much more sensitive to price changes than library subscriptions, the spiraling effect was initially observed with personal subscriptions.

Even with these reasons for the price increases of the past few decades, other factors must contribute as well. One explanation is that publishers have grown substantially in terms of the number of journals published. Some of this is due to publishers starting new journals and splitting journals into two or more when they increase in size, although the trend in recent decades has been to let them grow in size. Another factor has been growth through mergers. McCabe (2004) provides evidence that such growth results in higher prices of journals due to market power. We believe that size of labor-intensive organizations such as publishers, tend to have relatively higher support costs as they grow in size. In our cost model for 2002, we estimated support costs to be about \$198,000 or 29% of all costs. Others have speculated that commercial journal publishers are making an exorbitant profit by increasing prices, although this has yet to be proven for all commercial publishers. Furthermore, net revenue may also be positive for some society and other non-profit publishers. Case (2004) emphasizes the importance of competition among publishers in order to minimize the potential for monopolization of the system.

¹² See Tenopir and King (2000) for detailed evidence of this phenomenon.

2.7 Factors That Affect Demand

Clearly, demand for scientific journals is affected by price, but other factors affect demand as well. Scientists are willing to pay more for better journal attributes such as special electronic journal features, quality, speed of publishing, comprehensiveness and relevance of articles, and reputation of authors. In fact, studies in the 1970s suggest that such attributes were more important at that time than price. Our studies have shown that availability and relative cost of alternative sources of information determine to a large degree whether or not scientists and libraries will purchase journals. For scientists there are three types of alternative information sources. One alternative, discussed in Odlyzko (2004), involves information from other research that has led to the research reported in an article or from near equivalent research done by others. A second alternative source exists because research results are often reported via a number of different channels, such as discussions, presentations, conference proceedings, technical reports, patents, and books, in addition to journal articles. A third alternative source involves the many distribution means and media in which journal articles are found. Alternative distribution means from which scientists can choose include personal subscriptions, library subscriptions, and separate copies of articles such as preprints, reprints, interlibrary loans and document delivery, and copies provided by colleagues, authors, and others. These distribution means can be in paper, electronic, or microform. The point is that numerous combinations of distribution means and media are used by scientists based on their assessment of availability and relative access costs.

Sources of articles that are read have changed dramatically over the years as shown by the proportion of readings from three sources in Table 2.5:

Table 2.5: Proportion of Readings of Articles by Source of Articles Read: U.S. 1977, 1993-1998, 2000-2003

Source of Article	Proportion of Readings by Years of Observation		
	1977	1993-1998	2000-2002
Personal Subscriptions	68.4%	27.5%	31.7%
Library-provided	14.7%	55.0%	52.7%
Other	16.9%	17.6%	15.6%
Total	100%	100%	100%

Note: Source: Tenopir and King 2000, University of Tennessee, Oak Ridge National Lab, Drexel University, and University of Pittsburgh.

Clearly, scientists are reading less from their personal subscriptions, which undoubtedly is due to their subscribing to fewer journals (5.8 per scientist in 1977 to 2.4 in 2000-2003). Library-provided articles have been the alternative source of choice. The proportion of readings from other sources (e.g., shared department collections, colleagues, and authors) has remained consistent over the years. Few of these readings are currently from author websites or preprint archives.

Our cost studies show that there is a break-even point in the amount of reading over which it is less costly to subscribe to a journal and below which going to the library or another source is less expensive. The break-even point, of course, is higher with higher prices. By knowing the distribution of sources among journals, we have determined the sensitivity of demand to personal subscription prices. We have also shown that scientists' time is an important component in the cost equations, and that scientists generally behave in an economically rational manner in

deciding whether or not to purchase a journal. For example, distance to the library also affects the break-even point and the purchase of journals. As corroborating evidence, we have observed that

- Scientists close to libraries purchase fewer personal subscriptions than those further away (e.g., 1.8 subscriptions per person for those less than ten minutes away versus 2.6 for those further away).
- Scientists close to libraries and shared department print collections read more from these sources than from personal subscriptions (e.g., 91 percent of readings by those less than 5 minutes away; 65 percent for those 5 to 10 minutes away; 43 percent for those more than 10 minutes away).
- Even with the availability of electronic personal subscriptions, most scientists prefer to subscribe to print versions. This may be because they have observed that it takes them less time to browse current print journals than electronic versions. However, when library journals are available online, scientists prefer to browse these journals online because it saves time nearly 15 minutes per reading by not having to go to the library to browse or obtain older articles.

It is clear that the relative cost of alternative sources is important and that scientists' time is an essential component of cost that must be kept in mind. Now that scientists can obtain some copies of articles online, the choice is complicated somewhat. However, as will be discussed later, amount of reading from a journal and scientists' time both remain dominant factors in the decision.

Libraries are faced with similar choices between purchasing (in paper or electronic media) or relying on obtaining separate copies of articles. The amount of reading of specific journals, their price, and the cost of obtaining separate copies are all important factors which should play a role in decision-making.¹³ Over time, scientists pretty well know how much they will read a journal, but it is more difficult for libraries to establish the extent to which individual journals are used, particularly with electronic journals. With print versions, common practice is to ask library users to leave journal issues and bound volumes on the table to be counted when re-shelved (or to use circulation bar codes). A weakness in this method of observation is that use of an issue (or bound volume) may involve reading of several articles and **all** readings should be counted when deciding between purchase or obtaining separate copies of articles. However, reasonable adjustments can be made to the use data.

2.8 What Are We Really Buying?

We mentioned earlier that scientists consider journal attributes to be important in their decision-making process and that availability and relative costs of alternative sources of information are important as well. Another perspective is that scientists are buying two product components: (1) the information contents and their attributes and (2) combinations of distribution means and media. With traditional scientific scholarly journals (and articles) the information contents and

¹³ Detailed examples of economic break-even points are given for decisions with personal subscriptions vs. use of the library and library subscriptions vs. obtaining separate copies in Tenopir and King 2000.

attributes remain the same regardless of combination of distribution means and media used.¹⁴ Furthermore, article processing cost required to provide the information contents is essentially the same regardless of distribution means and media. That is, regardless of where scientists obtain articles – from personal subscriptions in paper or electronic medium, library-provided articles in paper or electronic medium, or in separate copies from a database, colleague, or author – the article processing cost is about the same for all distribution alternatives. Thus, one can ignore the article processing costs and focus on the costs of the alternative distribution means and media.

First, just a note of clarification concerning the article processing costs. In the literature one finds widely varying estimates of these costs, say, from \$400 per 20-page article (Harnad, quoted in Halliday and Oppenheim 2004) to \$8,000 per article in mathematics journals (Odlyzko 1995a). The lower estimates tend to be made by those publishing exclusively electronic journals and who are strong advocates for doing away with the paper medium. Yet, in a sense, making such cost comparison is a moot point because journals in which costs are as low as \$400 per article could just as easily be distributed in paper issues at the additional cost of reproduction and distribution (i.e., about \$40 to \$50 per subscription). Thus, in order to at least break even, the price that publishers charge would have to recover two components of their cost: (1) article processing to provide information content (i.e., anywhere between \$400 to \$8,000 per article) and (2) the cost of distribution means/media of the version preferred by users. Obviously, distribution cost by electronic media is negligible, whether through access by subscription or by separate copy of articles. Paper distribution of subscriptions tends to be in the \$40 to \$50 per subscription range and compared with paper distribution by interlibrary loan or document delivery, which tends to be in the \$15 to \$30 per article range (see also Spinella 2004).

Thus, based on the added \$40 to \$50 per subscription of paper distribution, it might seem that electronic distribution would always be the alternative of choice. However, when amount of reading and costs to users other than the price paid are taken into account, the choices are not so clear. For example, most of the readings of current articles are identified through browsing for the purpose of keeping up with the literature. Assuming the \$50 paper distribution cost and that a scientist reads 50 articles from a year's subscription, the distribution component of the price would cost the scientist only \$1 per reading versus near zero cost for electronic access. Yet when the cost of scientists' time for browsing and equipment are included, it appears that the paper version costs less per reading or is very close to that of the electronic version. Other aspects, then, of the two versions could prevail in decision-making which may explain why scientist overwhelmingly choose print over electronic personal subscriptions, but electronic over print for use of library collection.

Similar arguments can be made for library decisions concerning purchase of paper or electronic subscriptions or access to separate copies of articles. Here the unit cost per reading paper distribution can also be negligible because reading is in the hundreds for some journals. Thus, again, libraries can choose one or both versions depending on factors other than cost to them of the price paid and the cost of processing electronic or print issues.

Of course, publishers do not distinguish between the information content and distribution components of price. However, Harnad and others have suggested that authors or their funders pay for the information content (i.e., article processing) and then journals would be "free," since

¹⁴ Of course, there are some attributes achievable through technology, such as links to back and forward citations, searchable databases, numeric data sets, moving graphics, and so on (Tenopir, et al. 2003, Halliday and Oppenheim 2004).

articles would be distributed electronically (Halliday and Oppenheim 2004). This suggestion ignores the potential desirability of the paper distribution medium that might be less expensive to some users and/or preferred for some other reason.

The point is that there is some merit in distinguishing between the information content and distribution components of costs/prices. The article processing costs have remained relatively stable or perhaps decreased some over the years, and these costs are now recovered primarily by library budgets versus an earlier combination of lower library payment and payment by scientists through subscription albeit often from discretionary funds provided by their employers. This transfer of cost recovery from scientists to libraries resulted in publishers being publicly criticized or blamed for spiraling prices, libraries paying more for less information, and scientists paying more in the scarce resource of their time. Funders of the scientists and libraries are questioning the whole process, even though in fact they may be paying less in cost per reading considering all resources expended.

One can make a strong argument for author funders paying the information content costs since they already pay for authors' time. The 2003 survey at the University of Pittsburgh yielded an estimate of 95 hours of scientists' time per article authored. Thus, their funders appear to pay far more than the cost to publishers in processing articles. At least two initiatives are trying this approach to publishing. The Public Library of Science proposes to charge \$1,500 per article (not too different from our \$1,660 article processing model cost above), and BioMed Central proposes a \$500 per article fee (with some institutional membership alternatives). However, for such initiatives to be widely accepted by all system participants, they must be convinced of the economic incentives involved. We believe that this can be achieved by understanding the flow of funds among the participants. For example, a preliminary analysis of the flow of funds from sources (e.g., government, universities, industry, etc.) to organizational R&D performers and then to authors and readers suggests that author sources of funds come roughly from the following sources: industry (25%), government (33%), foundations (7%), and solely universities (35%). However, readership sources of funds are not nearly equally allocated (i.e., solely university [20%]; universities funded through external sources [4%]; and solely non-university [76%]).

There are other important aspects of the flow of funds as well. For example, where do publishing research and development funds come from—government, foundations, commercial investor, and so on? What is the international “balance of information” determined by authorship and reading? For example, the 2003 University of Pittsburgh survey shows that 69 percent of articles read by these scientists are authored by U.S. scientists, 24 percent by non-U.S. scientists, and seven percent are collaboration by U.S. and non-U.S. scientists.

2.9 Era of Site Licensing and Package Arrangements

The previous sections have dealt largely with the traditional journal system and pricing policies. We have tried to describe the journal system environment and what led to spiraling journal prices in this environment. Recently, however with the growth of electronic publishing, publishers and libraries have taken a new approach to their participation in the system through site licenses involving multiple journal packages over an extended period of time, say up to five years. This is a form of economic bundling. The multiple journal packages are sometimes negotiated directly between a library and a publisher, but more often libraries have formed or used existing library consortia to negotiate arrangements between groups of libraries and publishers, or libraries have made arrangements through vendors. Such arrangements have proven to be beneficial in many ways to both libraries and publishers not the least of which because libraries can plan their

budgets more accurately (often with lower prices) and publishers can build a steadier revenue flow (King and Xu 2002).

An example is given below concerning the many sources of journals used by libraries in electronic journal acquisition. In 1998, the medium-sized W.W. Hagerty Library (Drexel University) had gone through a phase in which many of its high price core journals had been cancelled and its' acquisition decreased to about 1,700 titles averaging a price of \$120 per title. The new Library Dean, Carol Montgomery and the university administrators decided to migrate to a nearly all-electronic journal collection. In fact, by 2002 the Library acquired only 370 print journals and 8,600 unique electronic journal titles (Montgomery 2000, Montgomery and King 2002). The Library made several different arrangements that are categorized as follows:

- **Individual subscriptions** which are almost always purchased from a subscription agent (i.e., Wiley titles, speciality design arts titles).
- **Publisher's packages** which may or may not be a part of a consortium or from the publisher directly (e.g. Science Direct, Kluwer titles).
- **Aggregator journals** which came from vendors that provide access to different publishers' journals. The aggregators do not drop content, only add (so far). The collections started as full-text content and added searching (e.g., JSTOR, MUSE).
- **Full-text database journals** that provide access to electronic journals from different publishers but do not make title or issue level access available (except ProQuest). Examples are WilsonSelect and Lexis/Nexis. Titles are added or removed regularly according to the database vendor's contracts with publishers. They often have an embargo on current issues of six months or more. There is considerable overlap among the journals in these collections and between the full-text database journals and the other two types.

This example demonstrates the complexity resulting from site licensing and the various kinds of arrangements that can be made.

These arrangements meant that there was an overlap in electronic titles acquired (e.g., 13,500 total titles, but only 8,600 unique titles in 2002). As a result, many acquired electronic journals are not used and some of the cancelled high price journals have very high use (for other observations see Davis 2002, Nicholas and Huntington 2002, and Sanville 2000). The price per title varied among the four types of arrangements made: \$432 per title for individual electronic subscriptions; \$134 per title for publisher's packages; \$60 per title for aggregator journals; and \$6 per title for full text database journals. However, the migration to electronic journals has affected library costs in many more ways than the price paid for the journals (Montgomery and King 2002; King, Boyce, Montgomery, and Tenopir 2003). The Library operational costs and staffing patterns have shifted. For example, the electronic journal collection has required higher costs for collection development for negotiation, training of staff and users, reference support, and equipment and systems. On the other hand, print input processing and space costs are down, as are reshelving, photocopying, and directional reference costs. On balance, overall operational costs are less for the electronic journal collection than for the print collection.

A particularly revealing way to examine the effects of an electronic journal collection is to compare the cost per use of the alternative collection services; that is, access to electronic, current periodicals and bound volume collections. Drexel obtained publisher and vendor online use statistics and maintained their own server use counts by journal title. They also observed reshelving counts for the current periodicals and bound volume collections. However, there are

well documented the flaws in these data, and the electronic use is not the same as reshelving use. We also obtained estimates of amount of reading from user surveys that, while flawed as well, at least provide a common measure of use for the three access services (King and Montgomery 2002). The costs per reading (including price paid and operations) are: \$2.00 per reading of the electronic collection; \$3.90 per reading of current periodicals; and \$23.50 per reading of bound volumes. One particularly important cost is to users who may save as much as 24 hours per year per person by having external access to library journals.

The Drexel situation is unique in that they migrated to a nearly all-electronic collection. Most libraries are not doing this, but rather depend on some duplication of print and electronic collections due to concern of the viability of long term archives. The problem with large duplication is that electronic collection use dominates (i.e., over 80% of library use in Pittsburgh and Drexel). Thus, the cost per use increases substantially for print collections. In fact if Drexel had also continued its' core print collection it probably would cost about \$7.80 per reading versus \$3.10 under the strategy chosen by Drexel. While there are journals in the large electronic collection that are infrequently read, the overall subscription and processing costs of the electronic collection is less than the cost had Drexel continued its core print collection and not acquired an electronic collection.

Thus, the impact of site licensing and multiple journal arrangements appear to be highly advantageous to libraries and their users. However, the long term advantages to publishers are not as clear. Ultimately, as with single subscriptions, publishers must recover the high cost of processing articles and any other related activities. Generally, decline in reproduction and distribution costs of print journals have been counter-balanced with extensive computer and systems costs so that large costs still must be recovered. The question then becomes whether the many, varied license arrangements can produce sufficient revenue over time to cover these costs. While long-term licenses help reduce revenue volatility, there is no guarantee that the license policies provide the solution to the library and publisher problems.

2.10 Some Alternative Pricing Policies

One way in which the two cost/price component approach can be addressed is with site licenses. We have suggested one possible scheme to achieve this type of site license, as detailed below:

- The license would cover the price paid for all journals provided to the organization by the publisher, regardless of whether the organization's library, department, or any employee subscribes to the journal.
- The library and publisher would establish the current subscription cost of all print subscriptions to the publisher's journals in the organization.
- The library would estimate the total readership in the organization of the currently purchased journals and estimate the subscription cost per reading (i.e., current revenue divided by total readings).
- The first annual access cost would be this current total subscription amount.
- Any electronic access to currently purchased print journals would be free. Electronic access to any other journals available from the publisher would be at the calculated cost

per reading plus some allocated support costs.¹⁵ Distribution of paper issues from any of the journals would be at the reproduction, distribution, and allocated support costs.¹⁶

- During the first year, each access to the articles would be counted electronically and used as a basis for future charges on a cost per reading basis.¹⁷
- The publisher must agree to ensure future access to all the journals covered by the term of the agreement, thus permitting the library to discard all relevant paper issues.¹⁸

This type of site license provides advantages to every participant. While libraries and their constituents pay the same amount to publishers as they do now, they achieve considerable savings in input processing, storage and maintenance (e.g., approximately \$90 per subscription for a large library and \$125 for a small one). They also save an estimated \$1.43 per reading by avoiding current reshelving, directional reference, and photocopying costs which, for a frequently-read journal, can be as much as the subscription price. Libraries also save on interlibrary borrowing or document delivery costs from journals in the publisher's database that they did not purchase. Finally, the library has the option to retain certain current periodicals or department collections in paper. These savings can exceed any advantages that might have been achieved from reduced electronic journal prices.

Publishers have the advantage of retaining any cost savings they might obtain from electronic publishing, plus they receive additional revenue from distribution of electronic separates either from their digital databases or royalties from document delivery services that previously took place outside of their control.

Readers benefit by having the choice of obtaining articles in paper or electronic versions, both at substantial savings in their time and to their parent organizations. In other words, by this kind of negotiation, publishers win, libraries win, readers win, and funding sources win.

This kind of agreement, of course, may have downsides, but it is given to demonstrate the need to arrive at arrangements that can be beneficial to all participants in order to end the adverse effects of traditional pricing strategies.

Another pricing approach is to extend current price differentiation to reflect potential readership by purchasers. Varian (1996) argues that small niche markets, which accurately describe most scholarly publishing, are generally not well served if the producer is required to charge a uniform, single price. As mentioned earlier, purchasers/users always have alternative sources available to them if cost per reading is too high. Thus, amount of reading serves as a useful means for identifying classes of purchasers for differentiation. In fact, negotiating "bundles" of journals can achieve this objective. Furthermore, electronic journals provide a useful vehicle for charging on a transaction or potential transaction basis.

¹⁵ Support costs vary greatly among publishers. Our average is 29% above direct article processing costs Halliday and Oppenheim (2004) present other amounts.

¹⁶ We have observed allocated support costs of about 15% on direct reproduction and distribution costs.

¹⁷ Of course, one must establish what constitutes a "reading" based on electronic use as pointed out in Odlyzko (2004).

¹⁸ The question of archiving journal articles is a contentious one between libraries and publishers, but it must ultimately be resolved. Some are proposing institutional archiving (see, for example, Harnad's September Forum).

In another vein, Getz (1999) has suggested that readers be given personal debit accounts with libraries to access separate copies of articles. This would permit scientists to order separate copies from services depending on attributes of speed, image, quality, and accessibility that are provided at appropriate prices. This interesting notion, of course, can be extended to subscriptions in print or electronic media and other related services as well. Getz feels that such an account would end up serving users more effectively and relieve libraries of some clerical activities. The examples given involve academic libraries but are even more feasible in a special library environment.

Several alternative approaches to distribution that will require careful pricing policies that are presented by others in this book. For example Halliday and Oppenheim (2004) discuss three alternative models: one that follows traditional print, without the reproduction and distribution of print; one suggested by Harnad in which authors bear the article processing cost by producing and archiving the articles and providing them free of charge on the web (although recently he advocates institutional archiving); and a free-market model suggested by Fishwick and colleagues. Hunter (2004) and Gazzale and Mackie-Mason (2004) explore results of the PEAK experimentation. Hunter presents some innovative approaches to pricing and their advantages and disadvantages. Gazzale and MacKie-Mason examine three access products, how they are used, and what they cost users. Case (2004) discusses the SPARC initiative and argues its merits.

All of these and other approaches warrant detailed examination, but one must keep in mind that the scholarly journal system has been successful because it has achieved certain minimal objectives, including

- serving as a means of communication of new, peer-reviewed, and edited information. Thus, the information should be trustworthy and, to the degree possible, supported by other research findings;
- being readily available to readers and accessible to an unlimited audience beyond the author's primary or immediate community;
- providing permanent, locatable, and retrievable archives for the information since many articles are read years after they are published;
- continuing to provide alternative distribution means and media so that authors and readers can choose from alternatives that satisfy their specific needs and requirements, particularly to minimize their time and effort;
- protecting against plagiarism, copyright ownership violation, and unauthorized modification or altering of the record of ideas, discoveries, and hypotheses tested;
- properly conveying the concept of prestige and recognition for authors, their research, and their institutions.

Any proposals for changes in pricing policies or other modifications in the scholarly journal system should take such desirable objectives into account. Then the system use, usefulness, and value will be maintained and future pricing can be an opportunity and not a threat.

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