2011

The high cost of science journals: a case study and discussion

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PREPRINT

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Final version published in *Journal of Electronic Librarianship,* Vol. 23(3) 2011, pp. 219-2141,
DOI:10.1080/1941126X.2011.601225

Acknowledgements

This paper is based on my submission to an essay contest sponsored by the American Chemical Society (Rose-Wiles, 2010). I thank Tony Grimaldi (Elsevier) and Dr. Nicholas Snow (Seton Hall University Department of Chemistry & Biochemistry) for discussion and helpful insights.

Abstract

Abstract: Like many libraries, Seton Hall University Libraries has suffered budget cuts that forced a reduction in serial subscriptions. As science librarian, I report on my efforts to streamline subscriptions and to address the question "Why are science journals so expensive?" Our science journals are significantly more expensive than journals in other areas. Our commercially published science journals are 25% more expensive than those from non-profit publishers, although the difference is not statistically significant. I discuss the reasons for the high cost of science journals, which involve a complex interaction between supply and demand and academic culture.

Introduction

Flat or reduced budgets coupled with rising costs pose a major challenge for most academic libraries. Journal subscriptions and online databases typically account for a substantial part of the materials budget. Science journals are particularly expensive, especially compared with the price of social science and humanities journals (Cross, 2010: Weir, 2010). Those pricey science subscriptions offer a tempting target for the budgetary axe - especially at smaller universities without a strong science focus. In this paper, I describe our attempts to streamline science journal subscriptions for Seton Hall University, compare the cost of science information resources with resources in other disciplines, and examine the question 'why are science journals so expensive?'

Seton Hall University is a private, Catholic diocesan university located in South Orange, New Jersey. It is the oldest diocesan university in the United States. Classified as a doctoral research university with balanced arts and sciences/professions, SHU has an enrolment of 8,164. This includes 4,871 undergraduates (88% full time) and 3,293 graduates (33% full time). The majority (82%) of freshmen have on-campus housing. The university's Walsh library is used intensively, especially since 24/7 library service was launched in 2005 (Bao, 2009). A National Endowment for the Humanities grant has permitted the purchase of print resources in the humanities since 1990, but we rely on a largely static or decreased general budget for all other information resources. A substantial increase in the library budget was finally approved for 2008-9, but almost 30% was subsequently clawed back due to the economic crisis, followed by a further 5.8% cut. The materials budget was most affected, although a further 5.1% cut to library budget in 2010 resulted in reductions in library hours and staff as well. As databases and serials account for over 70% of the materials budget, these came under intense scrutiny as we sought to cut costs and yet continue to meet our mission to provide "an ever flourishing wealth of resources for knowledge building" (Seton Hall University Libraries Mission Statement).

Literature Review

In 2009, a survey of 835 libraries worldwide was conducted by the CIBER research group at University College London, in conjunction with the Charleston Conference, YBP Library Services, and ebrary (CIBER, 2009; McKiel, 2010). The survey found that 39.4% of academic libraries had received no budget increase over the previous year, 16.8% had cuts of up to 10%, and 27% had experienced cuts of more than 10%. A follow-up report (Nicholas *et al .,*2010) found that 43.8% of academic libraries had experienced or would be facing cuts of up to 10% of their annual budgets. The Library Resource Guide Benchmark Study on 2011 Library Spending Plans found that for fiscal year 2010, 38% of academic libraries reported budget decreases, and 15% reported cuts of 10% or more. Although the author suggests that "the recent economic pinch has bottomed out" and "prospects are brighter for the year ahead" (McKendrick, 2011, p. 3), 38% of respondents expected no budget increase in 2011, and 22% expected a budget decrease. Bosch *et al*., (2011) report that 34% of 450 libraries surveyed experienced budget cuts for 2011. These authors not only found little sign of economic recovery for libraries, but describe the state of library funding as "dire".

The increasing cost of academic journals has long outpaced the growth of library budgets (e.g. Bergstrom, 2001; Johnson, 2004; Harnad *et al*., 2008), and the widespread cuts to library budgets in recent years have simply intensified a chronic problem. Databases and journals represent the biggest slice of the shrinking materials budget: the 2009 CIBER survey reports that they account for an average 65% of the materials budget at academic libraries. The distribution between print and online subscriptions is more variable. The Library Resource Guide Benchmark Study on 2011 Library Spending Plans reports an average of 35% of the materials budgets spent on online collections and 29% spent on print journals (McKendrick, 2011). The Association of Research Libraries (2009) reported that the median ARL university library spent 57% of its materials budget on electronic resources. Meantime, the costs of most journals – whether print or electronic - have steadily increased by an average of five to ten percent per year. Some databases and e-journal bundles have increased even more, although true 'per title' prices can be difficult to determine due to what one vendor tactfully calls "the varied nature of publisher pricing in the electronic era" (Ebsco Serials Price Projections for 2011). According to *Library Journal*'s Periodicals Price Surveys, the <u>rate</u> of price increase for dropped from 7.6% for 2009 to 4.4% for 2010, but increased back to 5.2% for 2011 and is predicted to increase close to previous levels for 2012 (Henderson & Bosch, 2010; Bosch *et al*., 2011). Unfortunately, even a 'modest' 4-5% increase would require a corresponding budget increase just to maintain existing subscriptions. The recent trend toward publisher and vendor mergers is particularly disturbing because mergers have been estimated to cause a 20-30% increase in journal prices (Edlin & Rubinfeld, 2004). As Bosch *et al*. (2011) observe: "Libraries are no longer in a position of having to cut low-use journals in order to make room for high-use ones; instead they are being forced to cancel heavily used, even essential subscriptions" (p.30).

The high and ever-increasing cost of science journals has long been a concern for scientists and librarians (e.g. Tenopir & King, 1997; Bergstrom, 2001; Taylor *et al*., 2008; Galin & Latchaw, 2010). Edlin & Rubinfeld (2004) report a 615% increase in the price of physical science journals between 1984 and 2001, along with a 479% increase in medical journals and 205% in law journals. The disproportionate rise in science journals seems to be associated with the early migration of science journals to electronic format, increasing concentration of ownership to a small number of large commercial publishers, and the bundling of journals into packages that create a "strategic barrier to entry" for possible competitors (Edlin & Rubinfeld, 2004, p. 121). In 2004, the Labor, Health and Human Services and Education Subcommittee expressed concern "that there is insufficient public access to reports and data resulting from NIH-funded research. This situation, which has been exacerbated by the dramatic rise in scientific journal subscription prices, is contrary to the best interests of the U.S. taxpayers who paid for this research" (Wallace, 2004).

Data from annual surveys of periodical prices clearly show that science journals are more expensive than social science or humanities journals, with average United States subscription costs for 2011 reported at $1,636, $572 and $172 respectively (Table 1). Chemistry, physics and biology have the most expensive journals at $4,044, $3,499 and $2,167 respectively. These data include online prices, but data based on print list prices gave similar results for 2010 (Henderson & Bosch, 2010). In 2009, chemistry, physics and engineering came in as the three most expensive disciplines, with each showing a 40% or more increase in prices since 2006 (van Orsdel & Born, 2009). In a case study of actual library subscriptions, Weir (2010) reported that the average cost of science and engineering journals at Murray State University was nearly seven times that of humanities journals ($2,245 versus $339). Weir also reported that the average increase for science journals was 9% annually, compared with 5% for journals in the English department.

Academic libraries have employed various strategies to help reduce subscription costs, but when cutting titles becomes inevitable, print serials and standing orders are often the first targets. Bosch *et al.* (2011) report that 80% of librarians surveyed in 2010 and 2011 indicated that they were likely to move to print and online or online only subscriptions. Some disciplines have a reputation for using older literature and traditional print resources more than others (Brown, 2007*),* but print usage typically declines once electronic access is established (Borelli *et al.,* 2009). A survey of faculty reading patterns at five US universities found that although many read their personal subscriptions in print, faculty read most library-provided articles in electronic form (71% electronic vs. 28.8% print) and read very few articles (5.4%) in the library (King *et al*., 2009). A 2009 survey revealed "increasing approval among faculty members in the science disciplines for the cancellation of print subscriptions in favor of increased electronic access" (Wolverton & Davidson, 2011, p. 69).

From a library budget viewpoint, print journals generate handling and maintenance costs on top of actual subscription costs, and consume valuable shelf space. Moving to online access whenever possible can reduce costs and save space (Henderson & Bosch, 2010; Derven & Kendlin, 2011; Schonfeld, 2011), and makes sense in terms of users increasing expectation to have content delivered electronically. However, simply switching from print to online format does little to alleviate rising subscription costs, and many academic libraries have been forced to cut online journals and databases as well as print subscriptions (Matlak, 2010; McKendrick, 2011). Also, while canceling print often makes sense from a budget and space perspective, relying on electronic journals provided through databases or bundled packages – choices that Frazier (2001) referred to as the 'Big Deal' – leaves libraries vulnerable to having these titles dropped, often without warning. Finally, although these bundles provide access to many more journals than the purchase of individual titles, the escalating cost increasingly limits the funds available for books, monographs and journals not available in bundles, distorting library choices and collections (Edlin & Rubinfeld, 2004, p. 121).

A common response to reduced subscriptions is increased dependence on interlibrary loan, with a concomitant commitment to improve ILL efficiency and service (Walton, 2008; Buchanan, 2009). However, if all libraries independently followed this strategy, we run the risk of having no one left to borrow from, especially given the stringent copyright restrictions on fulfilled article requests per title that many publishers impose on loaning libraries. In addition, some contracts expressly forbid libraries to provide document delivery for articles journals available through online databases or bundles (Frazier, 2001). Joining or forming consortia and other forms of cooperative resource sharing can help address some of these problems (French, 2003; Tong & Kisby, 2009; Bock & Burgos-Mira, 2010), but may not offer much relief to library budgets, especially if consortia impose membership and/or processing fees. There are also some widely-recognized problems with shared electronic collections, notably "interdependency, problems with new titles, and de-selection" (French, 2003, p.50). An additional problem is that prices for shared collections may be based on some form of combined or average full time enrolment (FTE), which can prove more expensive for smaller institutions.

Whether purchasing individually or through consortia, most academic libraries attempted to renegotiate package deals in an effort to keep existing resources in the face of budget cuts. If unsuccessful, many simply cancelled expensive databases and bundled e-journals, often substituting individual orders to highly used titles or those required for accreditation. Other libraries explored alternate pricing models such as patron-driven acquisition and pay-per-view articles (Anderson, 2010; Carr & Collins, 2009; Throumoulos, 2010), or even fee- based library services (Brooks, 2010). Bosch *et al*., (2011) report that nearly 40% of librarians who responded to a recent Ebsco survey said they would likely break up Big Deal packages and renew only the most used individual titles. Interestingly, 25% of publisher respondents also believed that Big Deal packages will be unbundled in the future (Ebsco Serials Price Projections 2011). From a library perspective, it seems that warnings about the Big Deal voiced by Frazier (2001) have now been realized: no matter how attractive the original price, an annual price increase of 7% will double the cost of the Big Deal licenses within a decade. From a publisher perspective, the threat of anti-trust actions (Edlin & Rubinfeld, 2004) may be a concern, but the driving factor is likely realizing that the logic of "pay a bit more to get access to lots more" fails when library budgets are flat or in decline.

It has been argued for some years that open access publishing has the potential to change the 'market dysfunction' under which the price of information resources needed by faculty and students far exceeds library budgets (Johnson, 2004; Liu, 2005). However, Henderson & Bosch (2010) argue that OA initiatives have had little effect on the publishing industry, and that OA journals are not yet considered 'mainstream' publishing venues. Liu (2011) describes OA as being "in its infancy". While 10% of peer-reviewed journals are now open access (double the 5% reported by Harnad *et al*., 2004), Henderson & Bosch (2010) estimate are that only 2% to 4.6% of total articles published are OA.

Galin & Latchaw (2010) suggest that one reason that publishing models have been slow to change is that "academics and publishers alike are too fixated on the products of intellectual work rather than the processes of use" (p. 212). In addition, the promotion and tenure system continues to favor publication in conventional, long-established and especially high-impact journal. Although Harnad *et al.* (2008) demonstrate that making articles openly accessible by publishing in open access journals and/or self-archiving increases citation rates, Staley & Malenfant (2010) note that "collegial culture continues to value tradition over anything perceived as risky" and as librarians "tend not to sit on tenure committees, there is little we can do except preach to faculty until the tenure system changes" (p. 18). The reality is that until the potential of open access publishing is realized, and/or the economic plight of academic libraries dramatically improves, librarians must continue to make painful decisions in terms of which resources to cut.

It is widely recommended that cuts to information resources, especially serials, be made strategically, consulting usage statistics and other metrics, impact factors, accreditation requirements, and especially faculty (Throumoulos, 2010, Weir, 2010; Derven & Kendlin, 2011). Libraries have a long tradition of employing usage statistics such as the number of times a journal is accessed and/or the number of articles downloaded to evaluate library collections (Rathemacher, 2010), although the challenges and limitations of usage statistics have been often noted (e.g. Morrison, 2005; Milman, 2006; Medeiros, 2007; Matlak, 2010; Rathemacher & Vocino, 2010; Stewart, 2011). Weir (2010) advises that developing a strategic plan and effective communication with all resource stakeholders are critical components of any budget reduction process.

<u>The Seton Hall Experience</u>

1. <u>Streamlining subscriptions</u>

Our single greatest subscription expense is the database *ScienceDirect*, which accounts for over 20% of our total materials budget. By comparison, at Cornell University Library, *ScienceDirect* claims over 20% of the *serials* budget (Edlin & Rubinfeld, 2004). We subscribe to *ScienceDirect* through a consortium (VALE), which allows each participating library to access a common pool of titles known as the Uniform Title List (UTL). The subscription paid by each library is fixed, with built-in annual increases, but the titles to which we each subscribe are flexible. In fall 2008 I examined our *ScienceDirect* journal subscriptions in terms of usage and duplication with other consortium members. I canceled 32 low use titles that at least two other member libraries subscribed to and added 86 new titles to our package for January 2009. In summer 2009 there was a similar but more comprehensive revision, with librarians from most participating libraries working together with our Elsevier representative. The goals were to have only one library keep a subscription to a given journal; to discontinue high cost, rarely-used titles, and to use the 'savings' to add new content. Overall the consortium cancelled 118 titles and added 112 for January 2010. Our library was a very active participant, dropping 45 titles and adding 59 for the January 2010 contract. Although this did not result in any cost saving, we benefited from a title list that is a better fit for our institution.

In 2009 I also began examining our subscriptions for individual science journals in preparation for January 2010 renewals. I contacted department chairs and faculty from chemistry, biology, math and physics and asked if we could cut some high-cost/low-use titles in order to purchase more urgently needed resources. All agreed to cooperate in this endeavor. I used journal costs and usage statistics to generate a 'cost per download' for all existing subscriptions in each subject area, consulted accreditation requirements and recommendations when these were available, and held further discussions with each department. The math and computer science department chose to cancel many of individual serial subscriptions (almost all print) in order to purchase the ACM digital library. Physics provided a list of journal titles to cancel and add that were of about equal price. The chair of Chemistry asked each faculty member to provide a short list of essential journal, which we used to create a new set of subscriptions that included the ACS journal package. Biology was more complicated, largely because of resource overlap with our extensive and diverse School of Health & Medical Sciences, but we were able to exchange a few titles. Everyone agreed to change print or "print plus online" subscriptions to online-only access wherever possible. After price increases for 2010 were factored in, we had a net saving of over $20,000. We also cancelled 45 journals that were available in multiple databases or through open access, which enabled us to reinstate our subscription to *Nature* journals as many faculty members had requested.

Despite the 2010 budget cut, we were able to maintain most of our remaining science subscriptions. The required reductions were made by cutting print book orders by over 65%, canceling various standing orders and print subscriptions, and most significantly by discontinuing our subscription to Wiley Interscience. The latter was a loss, especially for chemistry, but the inflexible conditions imposed after the Wiley-Blackwell merger would have meant a substantial cost increase coupled with loss of access to shared consortium titles, and virtually no ability to reduce or change the 28 titles that we subscribed to. Many of these titles did not receive much use. Based on access to all shared titles, the average cost per full text article downloaded for July 2009-June 2010 was $20.40, but the average cost per article based only on our 28 subscribed journals would have been $168.90 (excluding 3 journals with no downloads; range $2.49 - $1,479, standard error $61.48, based on 2009-10 prices). After consultation with faculty, we cancelled all but seven high-use / high-demand titles, and added two titles from the consortium list that were specifically requested. As an experiment, we kept both an electronic and print subscription to the European chemistry journal *Angewandte Chemie International Edition* and placed the print issues in the chemistry reading room rather than the library. The aim is to see whether promoting this extremely expensive journal and making it readily available in print affects its electronic usage rates. I will be reviewing the results at the end of this summer.

We still had more than a year remaining on our *ScienceDirect* contract through VALE, but I did consider "unbundling" titles and retaining only the most highly used, or moving to a pay-per-view model. Discussions with science faculty suggested that there would be strong opposition to losing *ScienceDirect*, and examination of our usage since 2008 generated a per article download cost of $5-$6 – considerably less than the least expensive pay-per-view options. However, if our budget does not improve next year we will be forced to revisit our options, especially if the proportion of our materials budget that *ScienceDirect* consumes exceeds the current 20%.

2. Examining the cost of science journals

The high cost of science journals has frequently been noted and discussed (e.g. Tenopir & King, 1997; Bergstrom, 2001; Edlin & Rubinfeld, 2004; Taylor *et al*., 2008; Cross, 2010; Weir, 2010). In order to help assess this issue in our own library, I conducted a brief cost analysis. All statistical analyses were performed using Microsoft Office Excel 2007. All t-tests were based on unequal variances. Significance was set at $p \leq 0.05$, and all p-values provided are 2-tailed.

In 2009-10, databases and journals accounted for 64.8% of our acquisition costs, while books and monographs accounted for 29.5% (Figure 1). This is very close to the average for academic libraries reported in the 2009 CIBER study. However, 76% of the books ordered (73.7% of book expenditure) were for the Humanities. Only 4.35% of the books ordered (5.6% of book expenditures) were for the sciences. This difference is partly due to the greater dependence on articles versus books in the sciences in conjunction with a strong humanities focus at SHU, but it also reflects the high cost of science information resources relative to shrinking library budgets. The bottom line is that once science databases and bundles and then individual journals have been purchased, there is very little money left over for books or other resources.

I used our 2010 renewal statement from Ebsco Electronic Journal Services to compare the cost of science journals in relation to other disciplines. There were 329 individually-priced journals, including 53 science journals (Table 2). This excludes journals purchased in packages, such as the American Chemical

Society's Web Editions, and standing orders. Although only 16% of our individually-priced journal titles were science or primarily science oriented, these accounted for 45% of our invoice renewal (Figure 2). I found that our science journals are on average six times more expensive than humanities journals (average \$2,212 vs. \$356, $t = 5.627$, $p < 0.001$), three times more expensive than health & nursing journals (\$2,206 vs. \$699, $t = 4.493$, $p < 0.001$), and four times more expensive than all non-science journals combined (average \$2,206 vs. \$529, $t = 5.130$, $p < 0.001$). These results are similar to those of Weir (2010), who reported that at an average cost of \$2,245 per year, science journals were about seven times the price of humanities journals. The 20 commercially published journals that we subscribed to were about 25% higher than the 32 journals from nonprofit publishers (average \$2,550 versus \$2,039; Table 3) but the difference was not significant ($t = 0.683$, $p = 0.500$).

Science journal packages had a lower average price of \$1,246 per title. The average price for science journals in commercial packages was 51% higher than offered by non-profit publishers (average \$1,417 vs. \$941 per title). Average prices for the four major packages were: Wiley Interscience (which we have since dropped) \$2,006, *ScienceDirect* \$1,780, Nature \$1,537 and American Chemical Society \$1,126. If we consider the total titles that we can access as a result of our VALE consortium agreement, the average cost per *ScienceDirect* title would be \$243. However, *ScienceDirect* includes social science and some humanities titles as well science journals. Also average title costs for Big Deals and other packages are not really meaningful because they include many titles that we would not otherwise subscribe to and/or that are rarely if ever used. On the other hand, subscriptions costs include access to the publisher's platform with all of its embellishments and supplementary material. Increasingly it seems to be the platform and its search capabilities that are being marketed as much as the content.

Assessing journal costs for interdisciplinary databases is even more problematic. In addition to the issues stated above, pricing may vary according to "full time enrolment" (FTE), the number of subscribing libraries, the number of products purchased from a vendor, and/or individual negotiations. Also, title lists provided by vendors often include titles for which the full text is not available, and for discontinued or embargoed titles. For example, Ebso's listing for Academic Search Premier indicates "8,553 journals & magazines indexed and abstracted" of which 4,658 (54%) are "available in full-text" (http://www.ebscohost.com/academic/academic-search-premier). However, only 1,384 journals (30%) of the 'full-text" journals have *current* full-text. The rest have either ceased publication, been dropped or withdrawn from the database, or have a publisher's embargo, usually of 12 months. The latter is an increasingly common practice through which publishers force libraries to purchase individual subscriptions to important journals.

3. Why **are** science resources – especially journals - so expensive?

The crux of what Harnad *et al*., (2008) term the "journal-affordability problem" is that "journal prices keep rising and library budgets are limited" (p. 36). But why are science journals in particular so expensive? Many librarians and researchers simply attribute the high cost of science journals to profit-hungry publishers. The disparities between commercial and nonprofit journals and between individual subscriptions and library subscription are particularly striking in science disciplines. Some also recognize an academic system that largely bases tenure, promotion and research grants on publication and citation in prestigious, high-impact journals (e.g. Bergstrom, 2001, Taylor *et al*., 2008; Beaudouin-Lafon, 2010; Staley & Malenfant, 2010). There are, however, networks of factors and perspectives that can be considered.

Publishers typically argue that science journals are expensive to produce: they include numerous figures or tables and often supplementary data; require high-quality graphics, color images and/or require specialized type-setting, and most significantly contain more articles per issue and have longer articles than non-science journals. An early study (Tenopir & King, 1997) identified number and length of articles as the most significant factors accounting for increases in the cost of science journals. An additional factor is that many publications in the sciences are aimed at very specialized audiences and have a relatively small number of sales or subscriptions. Also, publishers have overheads, production and labor costs, and other indirect expenses which roughly double the cost per article. Tenopir & King (1997) calculated an average 'first copy' cost of $2,000 per article in direct costs, and $4,000 with indirect costs. Most commercial publishers are also answerable to share-holders who expect profits, and are generally are not exempt from taxation. Nonprofit publishers, by contrast, may have sources of external funds such as membership fees, donations, and advertizing that subsidize journal operations (Chressanthis & Chressanthis, 1994). For commercial publishers, high prices ensure profits; for non-profit societies they cover production and distribution costs. The sluggish economy and crisis in library funding has affected most publishers badly as well.

In my analysis, commercially published journals were on average about 25% more expensive than those produced by non-profit societies, but the difference was not significant. This contrasts earlier findings for science journals (Chressanthis & Chressanthis, 1994; Tenopir & King, 1997; Bergstrom, 2001; Frazier, 2001; Bergstrom & Bergstrom, 2004; Taylor *et al.,* 2008) and similar findings for business journals (Liu 2005, 2011). In some studies, commercially published journals were more than ten times the average price of nonprofit titles (Edlin & Rubinfeld, 2004). The difference in our collection may be because our library subscribes to very few of the most expensive commercial titles, but the $2,212 average cost of our science journals is similar to the $2,245 reported by Weir (2010) and higher than the $1,636 reported by Bosch *et al*. (2011).

Our two most expensive journals, *Experimental Brain Research* and *Angewandte International,* are commercially published, but our next most costly journals are published by the Institute of Physics, the American Institute of Physics and the Royal Society of Chemistry. All three are listed as not-for-profit organizations. The IOP and RSC websites http://publishing.iop.org/ and http://www.rsc.org/publishing/aboutrscpublishing.asp respectively state that "any surplus from IOP Publishing goes to support science through the activities of the Institute" and "any surplus is reinvested in supporting the global scientific community. The American Institute of Physics publisher site states: "we are a highly business-driven, entrepreneurial organization with a responsibility to generate a profit for the many publishers with whom we partner" http://partners.aip.org/. Counting our three AIP journals as "commercial" rather than "society" resulted in our commercially published journals appearing 50% more expensive than non-profit titles (average $2,747 versus $1,830). This did not change the finding that commercially published journals are not significantly more expensive than society-published journals ($t = 1.329$, $p = 0.192$), but it does suggest a lack of clear distinction between non-profit or not-for-profit societies and their publishing activities. The American Chemical Society has drawn similar criticism for its corporate structure and strong opposition to open-access publishing (Drake, 2005; Gawrylewski, 2007). This is not to argue that commercial publishers are blameless in terms of inflating journal prices, but rather that some 'nonprofit' publishers are not immune to the same practice.

Another aspect of high science journal prices is simple demand: researchers in the sciences predominantly publish and cite journal articles, while those in the social sciences and humanities are equally or more likely to publish in and cite books (Huang & Chang, 2008). The libraries of STM companies and large research institutions are typically much better funded than those of smaller colleges, especially those without a heavy science concentration. These prestigious research institutions attract prolific researchers, grant writers and publishers who need (and have the power to insist on) immediate and current access to the best publications in their fields. Having libraries that offer these resources in turn feeds the institution's prestige. Unfortunately the fact that these libraries are willing and able to pay high prices helps to keep the price high.

A more complex spin on a similar theme is Bergstrom's (2001) "coordination game" explanation of the academic journal publishing monopoly. Bergstrom likens the high price of particular journals to the high price of particular hotels that are traditionally used for important meetings in "The Parable of Anarchists' Annual Meeting" (p. 190-191.) In this scenario "a journal has prestige simply because in the past it has served as a meeting place where able scholars have coordinated their efforts and libraries their purchases." (Bergstrom, 2001; p. 191). Once particular journals are established as prestigious, leading and aspiring scholars alike will be wish to publish and cite articles from them, editors and reviewers will contribute their labor in return for prestige, and libraries will wish to subscribe to them (see Edlin & Rubinfeld [2004] for a similar model of "coordinated equilibrium"). Publishers of the prestigious journals can set prices far above average and achieve what is virtually a monopoly, especially given the substantial barriers to establishing new, potentially journals (Edlin & Rubinfeld, 2004). Copyright law sustains their market power because competing publishers cannot reproduce the same articles (Bergstrom & Bergstrom, 2004). Under most commercial copyright agreements authors sacrifice or retain only limited rights to reproduce or distribute their own work, and libraries can only fill a limited in the number of interlibrary loan requests. Meantime, the increasingly expensive journals either become out of reach for smaller and poorly funded libraries, or they drain the library's acquisition budget and preclude the purchase of other important resources. The situation is exacerbated when libraries become virtually locked into Big Deal packages, the price of which are typically based on the cost of pre-existing subscriptions which were purchased in better economic times. As Edlin & Rubinfeld (2004) observe, "large publishers have accumulated substantial power over price, and they have exercised it" (p. 142).

Another consequence of the "coordination game" is that access to scholarly work is restricted to those who can afford to pay for it. It is this aspect of high science journal prices that prompted the introduction of the Federal Research Public Access Act of 2006 (Cornyn & Lieberman, 2006) and, after much resistance from the commercial publishing community, the National Institute of Health Public Access Policy, which became permanent in 2009. It is the restriction on access to scholarly work rather than the cost to academic libraries that has largely fueled the open access (OA) movement. Libraries clearly benefit from the increasing availability and popularity of open access journals, especially if there is an associated reduction in the price of and/or demand for commercially published journals. However, it is important to keep in mind that open access does not mean 'free' (Suber, 2010). The costs may be substantially less than those charged by commercial publishers, largely because corporate profit and marketing assume lower or no importance, but the remaining costs are simply shifted from the purchaser to the producer. Some open-access publishers charge publication or 'author' fees, although these may be reduced or waived in cases of economic hardship. Publication charges for *Public Library of Science* (PLoS) journals range from $1,250 to $2,900 per article, and *BioMed Central* journals have an 'article processing charge' of $1,680. Publication fees for commercially published journals that offer open access options are similar – Elsevier charges up to $2,000 per article. Some individuals and small institutions find that publication fees limit their ability to support open access publishing just as much or more than the high cost of science journals, especially when the latter are specifically borne by the library. For example, Beaudouin-Lafon (2010) estimates that author fees for his computer science laboratory would be over $250,000 a year -- more than four times its current serials budget.

Alternatives to publication fees include institutional support or memberships, voluntary donations, government or research grant funding, or following the "green" open access route of self-archiving material in institutional repositories (SPARC 2009; Suber, 2010). However, these alternatives also involve some level of cost and/or time commitment. For example, even if an institutional repository is developed in-house and thus has no apparent cost, it requires considerable personnel time and expertise to develop and maintain. The double bottom line is that OA still requires library or institutional funds in some form, as well as a commitment from librarians, faculty and high-level administrators that is lacking in most US institutions, although further advanced in Europe (Ayris, 2011). Many libraries, including our own, are not only reluctant to make bold changes but also fail to act cooperatively. In terms of cooperating over open access and possible vetoes on over-priced subscriptions, libraries face what Frazier (2001) identifies as a version of the classic Prisoner's Dilemma (Axelrod & Hamilton, 1981) and Bergstrom & Bergstrom (2004) term a collective action problem. It is unclear how much of our failure to act cooperatively for the common good reflects the inherently conservative yet competitive nature of today's academic institutions versus preoccupation with each individual library best serving its constituents during times of financial crisis.

It is not only a conservative academic culture that helps maintain high journal prices. Another factor is program accreditation requirements for institutional subscriptions to specific journals, especially long-established, high impact, and expensive titles from 'reputable' publishers (the guidelines for chemistry accreditation are largely provided by the American Chemical Society.) Impact factors, the most widely-used measure of a journal's prestige, are based on the number of times the average article in a journal was cited in other articles each year. Traditional impact factors have a number of weaknesses, including the susceptibility of scores to a few highly-cited articles and authors (Meho, 2007) and the generally low impact factors of specialized journals compared with inter-disciplinary journals (Milman, 2006). Beaudouin-Lafon (2010) suggests that impact factors can be and often are manipulated by commercial publishers asking editors to "encourage authors of accepted papers to include references to their journals" (p.32). Meho (2007) also points out that citations and impact factors do not capture how often an article or journal is read or used but not cited. Unfortunately, institutions and granting agencies seem slow to accept "download counts" as a valid measure of research impact.

There are numerous explanations for the high cost of science journals, including high production costs, publisher profits and near-monopolies supported by copyright law; simple supply and demand, the "coordination game', barriers to new journals, promotion and tenure practices, impact factors, resistance to open access publishing, and lack of coordinated library action. Whatever the reasons, for smaller academic libraries like ours, ever-increasing journal prices exacerbate the chronic problem of reconciling a steadily increasing demand for information resources with ever-decreasing funds.

Closing argument and the value of academic libraries.

Seton Hall is not a large research institution; we are a medium sized university offering a wide diversity of majors. Some publishers and database vendors base their rates on full time enrolment (FTE), which is of some help with pricing. However, in regards to science subscriptions, basing prices on our entire student body neglects the fact that the sciences make up only a small part of our curriculum. Only 16 of over 80 majors are in the sciences, and almost a third of these are offered in conjunction with other departments or institutions. Only 3 of our 67 Masters programs are in the sciences, and only 2 of our 16 doctoral programs are in the sciences (we offer a PhD in chemistry & biochemistry and a PhD in molecular biology). In other words, only about 15% of our programs are in the sciences, but we pay the same price for many journals as institutions with a much larger science and research component.

It would seem that the relatively small size of our science programs supports cutting back science acquisitions and joining the ranks of small, non-research institutions which do not need – or simply cannot afford – good science resources. But there are compelling counter-arguments. First, our science departments are small but highly productive. The department of chemistry & biochemistry and the department of biological sciences, which respectively house our two doctoral programs in the sciences, lead all other areas of the university in terms of publication and research grants. These two departments produced over 25% of the SHU publications listed in Scopus for the past five years, and each bought in over $5 million in grant money during the same period. Twenty five authors are among the top 40 SHU authors listed in the Scopus database. Four of the top ten authors are current faculty members and one is an emeritus chemistry professor. All five are actively publishing and writing successful research grants.

Although the library receives no portion of these grants or indirect costs, library resources are an essential component of successful grant applications. These grants help fund not only research and equipment; they help fund graduate students and staff for the departments concerned, and add to the prestige of a university (Weiner, 2009). In addition, many of the journals and databases that the library provides are required for program accreditation, especially for the doctoral programs. These programs provide valuable revenue and prestige for our university, and failing to meet accreditation standards would be a significant loss – especially if it became known that the failure was primarily due to lack of library resources. Finally library resources provide a good return on investment (ROI), especially in the sciences and medical sciences.

A study conducted at the University of Illinois at Urbana-Champaign determined a return of $4.38 in grant income to the university for every dollar invested in the library in 2006 (Luther, 2008; Kaufman, 2008). A subsequent study of nine universities showed variation in ROI based on grant money, ranging from 64 cents per dollar invested to $15 per dollar invested (Tenopir *et al*., 2010). ROI for library investment in electronic resources was higher, ranging from $6.40 to $155 per dollar invested in the library. Increases in the library budget were positively correlated with increased grant funding over a ten year period. Both studies emphasize that the reported returns were based solely on the library's contribution to research grant income, and did not include the value of library resources in other areas such as teaching, learning outcomes, and student retention. One study concludes that "Institutional leaders rely on the library to help recruit, evaluate, and retain productive faculty, undergraduate, and postgraduate students, and to bolster their institutions' international reputations" (Tenopir *et al*., 2010, p. 23). Several other studies demonstrate return on investment in terms of student retention (Mezick, 2007; Emmons & Wilkinson, 2011) and the reputation of the university (Weiner, 2009). Weiner also notes that the quality of the library and its resources influences faculty decisions in regard to accepting position or remaining at institutions. Plutchak (2011) described how faculty felt the loss of reputation as well as loss of access to articles after deep budget cuts to the University of Alabama at Birmingham Lister

Hill Library caused cancellation of many resources, including *ScienceDirect*. Some of the more disturbing responses that lack of resources caused inability to train the next generation of researchers, and that “what I study is determined by the resources I have access to”.

In closing, I would argue that libraries must vigorously engage two related issues. One is the ever-increasing cost of science journals. This will require cooperation among libraries as well as between libraries, publishers and vendors in terms of negotiating sustainable prices and/or affordable open access options. The second issue is inadequate library budgets. Stakeholders and administrators need to be educated in terms of the real and rising costs of information resources (many seem to equate “online” with “free”) and see library resources not as an expense, but as a critical investment in the future.

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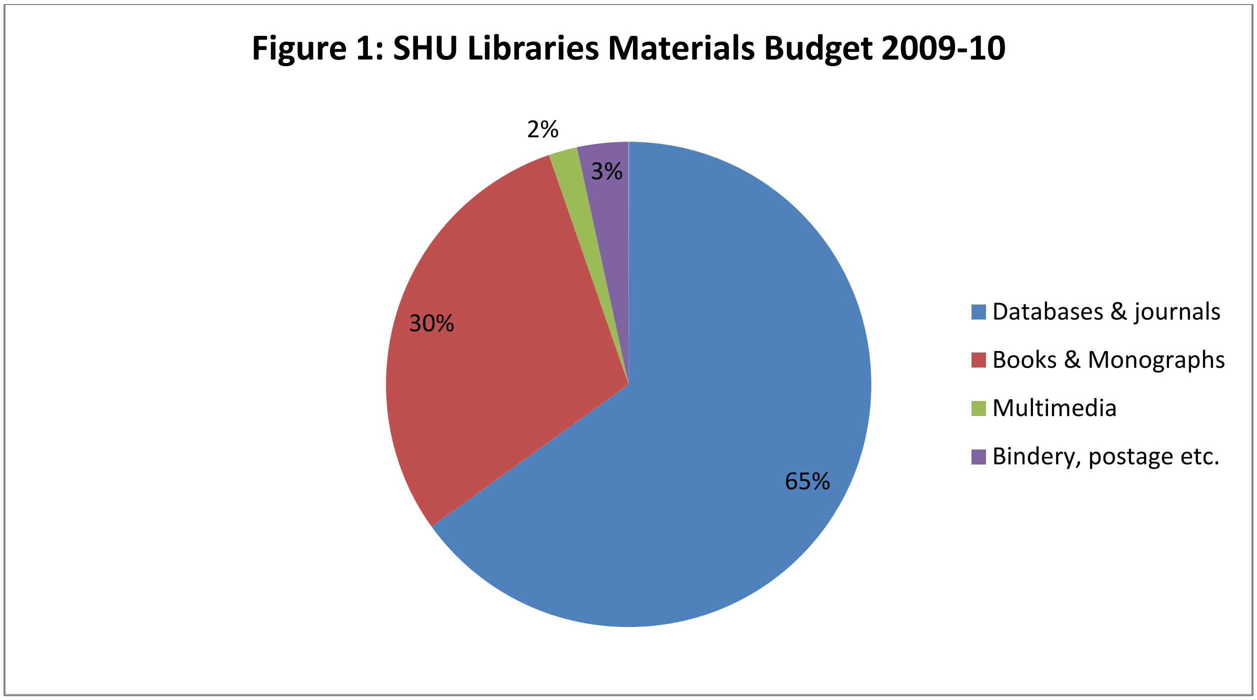
Figure 1: SHU Libraries Materials Budget 2009-10
2%
3%
30%
65%
Databases & journals
Books & Monographs
Multimedia
Bindery, postage etc.

Figure 2: Expenditure on individual journals by subject area (based on 2010 Ebsco renewal invoice prices).

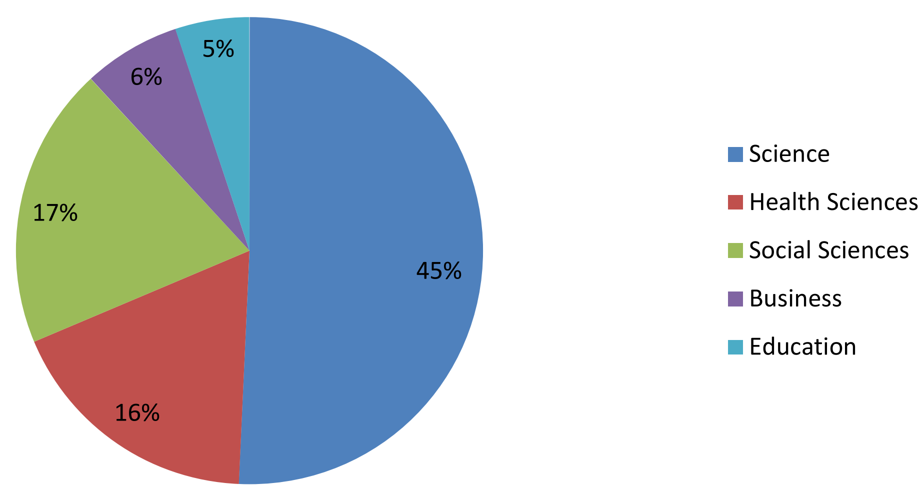

Table 1: Average Annual Subscription Prices for Periodicals in the US, 2009-11

	2009	**2010**	**2011**	**% increase 2009 to 2011**
Average Price per title	$961	$992	$1,051	9.4%
Arts & Humanities	$143	$160	$172	20.3%
Social Sciences	$507	$532	$572	12.9%
Sciences	$1,476	$1,539	$1,636	10.8%
Chemistry	$3,690	$3,792	$4,044	9.6%
Physics	$3,252	$3,368	$3,499	7.6%
Biology	$1,980	$2,035	$2,167	9.4%
Engineering	$2,047	$1,925	$2,035	-0.6%
Astronomy	$1,781	$1,921	$2,008	12.7%
Geology	$1,632	$1,607	$1,791	9.7%
Botany	$1,581	$1,695	$1,731	9.5%
Zoology	$1,510	$1,532	$1,647	9.1%
Math & Computer Science	$1,472	$1,541	$1,593	8.2%
Food Science	$1,390	$1,530	$1,564	12.5%
Health Sciences	$1,401	$1,398	$1,470	4.9%
Technology	$1,950	$1,237	$1,374	-29.5%
General Science	$1,174	$1,287	$1,333	13.5%
Geography	$1,145	$1,094	$1,155	0.9%
Agriculture	$1,089	$1,110	$1,103	1.3%

Source for 2009: Library Journal Periodical Price Survey 2009 (van Orsdel & Born, 2009)
Source for 2010: Library Journal Periodical Price Survey 2010 (Henderson & Bosch, 2010)
Source for 2011: Library Journal Periodical Price Survey 2011 (Bosch et al., 2011)

Data for 2009 and 2010 based on “print title prices that can be ordered through a vendor”; data for 2011 include only online and print and online prices.

Table 2: SHU Libraries 2010 Annual subscription costs for journals by subject area

Subject Area	No. of Journals	Min	Max	Average	SE
Science	53	$175	$11,324	$2,212	326.62
Medicine, health, nursing	59	$42	$4,125	$699	81.76
Social Sciences	79	$59	$2,601	$633	63.55
Business	30	$103	$2,065	$516	73.96
Education	29	$83	$1,621	$408	62.00
Humanities	79	$25	$2,418	$356	44.69

* Based on Ebsco 2010 renewal invoice, individually priced items. Packages & standing orders not included.
Science journals are more expensive than non-science journals ($2,212 versus $529, $t = 5.130$, $p < 0.001$)
Science journals are more expensive than health & nursing journals ($2,206 vs. $699; $t = 4.493$, $p < 0.001$)

Table 3: SHU Libraries 2010 annual subscription costs for journals by publisher type

	Journals	Minimum	Maximum	Average	Standard error
Commercial publishers (n = 10)	20	$175	$11,324	$2,550	657.59
Nonprofit publishers (n = 22)	32	$212	$9,402	$2,039	354.79

Commercially published journals are not significantly more expensive than journals from Nonprofit publishers, ($t = 0.683$, $p = 0.500$, 2-tailed test).