

THE COSTS OF PROVIDING ELECTRONIC JOURNAL ACCESS AND PRINTED COPIES OF JOURNALS TO UNIVERSITY USERS¹

Michael D. Cooper²

Six models are developed to analyze the cost options the University of California faces in providing access to academic journals. The driving force in this analysis is a movement by publishers to deliver the content of their journals via the Internet. The models assume electronic access will always be provided. Researchers like this capability because it provides speed and convenience, but they also recognize the importance of printed copies. The question is how the university should manage the print archive. In the cost models, a number of alternatives are presented. These include the status quo, where libraries continue to receive, process, bind, and store journals on their shelves, and variations such as storing material at library storage facilities, forgoing binding completely, storing journals in pamphlet boxes, keeping materials on display shelves for a limited time and then discarding them, and sending materials directly from the publisher to a library storage facility.

Introduction

A number of factors are forcing academic libraries to reconsider how they deliver the content of research publications to their users. The first is the ubiquitous nature of Internet access in the work and home environments of users. The second is a significant growth in the availability of electronic

1. This research was supported by a grant from the Mellon Foundation on December 21, 2000, to the University of California Office of the President (UCOP) to support a study of alternative methods of managing library collections composed of both print and digital materials. The author wishes to thank Laura Fosbender and Claire LeDonne, of the staff of the Collection Management Initiative, for their help in supplying data and is especially grateful for the assistance of Joanne Miller, of the UCOP, Office of Library Planning and Policy Development, in filtering and analyzing a myriad of pieces of information that contributed substantially to this report. Gary Lawrence, director of Library Planning and Policy Development at UCOP, is responsible for the author's involvement in this project. He has done a great job of providing clear objectives and lucid explanations and of steering the author away from bad mistakes.
2. School of Information, University of California, Berkeley. E-mail cooper@berkeley.edu.

[*Library Quarterly*, vol. 76, no. 3, pp. 323–351]

© 2006 by The University of Chicago. All rights reserved.

0024-2519/2006/7603-0007\$10.00

versions of journal articles. Publishers are making the content of their journals available to users over the Internet with the aid of Web-browser software. The third is increases in the prices that publishers are charging libraries for print subscriptions to their journals. For the largest academic libraries in the United States, the expenditure on serials over the last fourteen years has increased an average of 8 percent per year. The fourth is the current economic climate. Libraries are facing significant shortfalls just to maintain their current collection of materials, in addition to meeting capital outlays, staffing needs, and maintenance requirements.

Given these forces, libraries are looking for alternative, cost-effective ways to deliver information. One major alternative is to give users access to the electronic version of a journal instead of the printed version. This article examines the hypothesis that there are economies to be gained by providing electronic access to journals. At the same time, it examines the cost of maintaining printed copies of journals and providing access to them for scholars. The hypothesis is examined in terms of a series of cost models that show the expenditure incurred by the University of California for a variety of methods of access and storage of academic journals.

Journal Access and Storage Cost Models

Six cost models are explored in this article. The first is a model that could be termed an "electronic library." In the electronic library model, the library negotiates contracts with journal publishers to allow its users to have electronic access to journals. It catalogs the electronic resource, sets up a communications infrastructure to support access to the resource, and allows users access to the journals. No printed copies of journals are acquired, checked in, displayed, cataloged, bound, circulated, or stored.

The other models are variations on the electronic library concept. They all provide electronic access to journals, but, in addition, paper copies of journals are kept to meet the long-term needs of scholars. These paper copies are checked in, displayed, circulated, and bound. After binding, they are kept on local library shelves. In one variation of these models, the bound copies are not shelved in the local library but in a regional or campus storage facility.³ In another variation, the printed copies are kept for awhile to facilitate browsing, then discarded.

All of these models require that certain costs be determined. Once the costs are known, they can be combined to form a picture of the overall cost structure of each alternative. The cost elements fall into several major

3. In a library storage facility, materials may be stored by size so as to optimize the number of volumes that can fit in a given area.

categories. One is the construction cost to build and to outfit a physical facility. A second is acquisition cost. Library materials such as books, journals, and electronic journal subscriptions must be purchased, and this cost is a significant component of the models. A third is a processing cost. In addition to the cost of the raw materials of books and journals, libraries expend considerable labor in the process of purchasing the materials, receiving them once purchased, checking in each serial issue, cataloging journal (or serial) titles and books, and moving the materials to the library shelves. Finally, the library makes the materials available to the user by circulating them. There are significant library labor costs in this operation.

Expenditure Trends and Journal Pricing Issues in Academic Libraries

Academic libraries are currently facing severely reduced budgets, increased journal subscription costs, increased electronic journal access fees, and a change in the balance between the amount paid for printed versus electronic journals. An Association for Research Libraries (ARL) [1] report gives an indication of trends in expenditures for large academic libraries over the period 1986–2000. While the U.S. Consumer Price Index (CPI) grew 57 percent over the period, librarian salaries were up 92 percent, library material expenditures were up 149 percent, and serial (academic journal) expenditures were up 192 percent. The CPI's annual rate of change was 3.3 percent, while serials' expenditures increased 8 percent per year, more than two times faster than the CPI.

Apart from these price increases, the actual cost of an average journal subscription is high. Lee van Orsdel and Kathleen Born [2] report that print subscription prices per year for scientific journals varied from a low of \$553 in business and economics to a high of \$2,229 in physics. The prices in nonscience areas are often less expensive. While the scientific disciplines have very high journal prices, some other areas, such as language and literature (\$111) and art and architecture (\$114), are more modest. The percent increases (or decrease in only one case) for the titles confirm the ARL statistics cited above—the changes average about 8.35 percent for this group. When the number of titles in their list is weighted by the subscription price per title and the sum of the weighted values are divided by the number of subscriptions, the average annual subscription price for this group is \$745.

Although these numbers could provide some basis for planning serials' budgets, there are difficulties. The problem comes from the growth in the number of electronic journals and the pricing of these journals. The ARL [1] reported that the total expenditure by ARL members for electronic resources in 1994–95 was about \$11.8 million. By 2000–2001, this number

had risen to \$117.4 million. Further, the disparity in the average annual expenditure increases for electronic resources versus nonelectronic library materials is extreme. For example, in 1999–2000, expenditures on print materials increased 3.4 percent, while those for electronic materials increased 27 percent. In 2000–2001, the same figures were 9.1 percent and 32.7 percent, respectively.

One of the outcomes of this situation is that, in the cost models that follow, a number of assumptions will be made about the prices of electronic and print subscriptions paid by the university. Because the situation is so difficult to predict, the analysis in this article will rely on simulation techniques to try to compensate for the major fluctuations expected in average serial prices.

Previous Research on Cost Models

The goal of this analysis is to examine the costs of providing users with access to both electronic and printed copies of journals. This goal is consistent with the objective of a major university library system, namely, to provide continuous access to both current and past issues of journals in the collection.

A number of models have been used to characterize one or both parts of this scenario. In a series of articles, Carol H. Montgomery [3], Montgomery and Donald W. King [4], and Montgomery and JoAnne Sparks [5] have proposed a methodology for comparing the cost to a library of maintaining electronic and print subscriptions to journals.⁴ In their context, maintaining a storehouse of past printed publications is not necessary: “Drexel’s approach to back files of print journals will seem cavalier, if not totally irresponsible, to those concerned with the archival role of libraries. Our position is that archival storage in most subject areas is not part of the mission of the Drexel Library” [5, p. 5]. Montgomery and King [4] report that the total cost per use for all types of electronic journals is \$2.00, while the cost per use for print journals is \$17.50. Obviously, there are numerous qualifications to the methodology and to the data that must be made, but this is still a significant difference. Providing electronic rather than print copies of journal articles can result in considerable cost savings for libraries.

Using a different methodological approach, Michael D. Cooper [6, 7] has examined a related problem—determining the most economic ap-

4. There appears to be some inconsistency in the numbers and costs reported in these three articles. It will be assumed that the Montgomery and King [4] article contains the best information.

proach to storing library materials in a large university system, specifically, the University of California's San Diego (UCSD) campus. Cooper examined the costs of storing materials in on-campus library facilities versus regional library facilities. The methodology used in that study has relevance here: the unit costs of the tasks involved in selecting, acquiring, processing, circulating, and storing library materials were computed by measuring the time required to perform the tasks and then using average salary costs to compute the unit costs of the tasks. The alternatives examined in that study are also relevant here because the proposed solutions to the current problem involve different locations for storing materials.

It was found that construction cost per volume for a new open-stack library facility was about \$26.00, while the same cost for a regional library facility was \$4.55. To circulate an item from a local open-stack library costs \$0.87; from a regional storage facility, the cost is \$15.32.⁵ At the time of this study, about half the cost of circulating an item from a regional facility was attributable to the cost of moving the item from the regional facility to the local library. Since then, as we shall see, this cost has been reduced substantially. Nevertheless, circulating an item from a regional facility incurs additional costs because the facility is designed to store items in the most compact manner, not to provide access to them in the most efficient way.

In another study, Cooper [8] analyzed six options available to the U.S. National Library of Medicine (NLM) for additional storage space to meet the growth in their collection, which he compared with the costs of operating the existing library facility. Construction costs to store a volume have a low of \$1.48 for aboveground storage adjacent to the library, where construction costs are minimal. When the library moves a storage facility off the National Institutes of Health campus, the construction cost rises to \$2.86, and when an underground storage facility is built adjacent to the existing NLM building, the cost rises to \$3.63. The cost of processing materials to be moved to a new facility and moving the materials to the new facility are constant across alternatives (\$2.23 per volume), except when the facility is off campus (\$2.96 per volume).⁶

Because of differences in retrieval times, differences in the type of shelving used, and differences in distances traveled to retrieve the item, circulation costs vary according to the type of facility constructed. In the existing library, the circulation cost is \$3.26 per volume. For the on-campus alternatives, the costs range from \$3.65 to \$4.24 per volume. When a vol-

5. These values have been adjusted for inflation to the year 2001, using the inflation index in app. A.

6. These values also have been adjusted for inflation.

ume is retrieved from an off-campus site, the cost is \$10.54–\$10.68 per volume.

In some cases, a viable alternative to physical delivery of the material is to scan an article and deliver the scanned item rather than a bound volume. This has the advantage of reducing wear on the physical volume and expediting the request. The scanned item can be transmitted electronically to the requesting library or the requestor if desired. The scanning cost per article was estimated at \$3.10 when done within an NLM facility and \$5.00 at a contractor site.

Construction Costs

The analysis that will be presented later in this article relies on many individual costs for its conclusions. The major categories of costs that will be examined include construction costs for new library facilities, costs for journal subscriptions, costs for processing materials at a local library, costs for processing materials at storage facilities, and the costs of circulating materials from local and storage facilities.

Libraries have two major alternatives for storing materials: in a library on the university campus or in a storage facility off campus. There are variations on these alternatives, for example, by the type of shelving that is used: regular shelving that holds about 12.5 bound volumes of material per assignable square foot (ASF) of space and compact shelving that holds about 38.6 volumes per ASF.⁷

Cooper's [6] construction cost figures (adjusted for inflation) show that the cost per volume for the construction of a new open-stack facility is \$25.93 and of a new regional storage facility is \$4.55. Four construction cost alternatives examined by Cooper [8] for the U.S. NLM are relevant here. Construction of a new underground storage facility with high-density shelving was calculated at \$3.63 per volume. Construction of an above-ground storage facility on campus, with high-density shelving, was \$1.48, and construction of an off-site storage facility with high-density shelving was \$2.86.

As of the middle of 2002, the University of California had eight library construction projects on multiple campuses in various stages of development. Some projects had just begun, and some were far enough along to have firm construction costs established. For the on-campus library projects, the average project cost per ASF was \$447.00 for a complete library

7. These values are standards that are used by the University of California in its library planning activities.

facility, or \$35.76 per volume. For the one regional storage facility under construction, the cost was \$318.00 per ASF, or \$8.24 per volume.⁸ Unlike previous regional storage facilities in which there was one concrete floor upon which were built a series of stack levels, this facility consists of a series of concrete floors that will house shelving. This difference in construction form could account for the difference in construction costs between this figure and the other estimates. Although the construction costs for the library facilities given in Cooper [6, 8] are relevant to this analysis, the current construction costs from the University of California will be used for future calculations. There has been a rapid escalation in construction costs in the last few years, and it may not be accurate simply to extrapolate costs using inflation adjustment or construction price adjustments from values in previous years or from other locations.

The costs of \$35.76 per volume for on-campus library construction and \$8.24 for regional library construction must be adjusted to arrive at a cost per volume per year for storage. Generally accepted accounting principles recommend that the life of a building be in the range of twenty-five to thirty years. For these calculations, the buildings will be assumed to have a useful life of twenty-five years. Thus, the cost of storing a volume in a library facility per year is $\$35.76/25$, or \$1.43, while the cost of storing a volume in a storage facility is $\$8.24/25$, or \$0.33 per year.

Journal Prices

One of the most difficult aspects of this analysis is to determine the subscription costs that the university will pay for printed copies of journals and computer access to the electronic form of academic journals. Libraries now pay for printed copies of the journals and for the rights of their users to have access to the electronic form of the journal through the Internet.

This situation is significant because it has a major influence on the present cost analysis. One factor in modeling the trade-off between the uses of electronic journals versus printed copies of journals, and the subsequent storing of printed copies, is the cost to the university for electronic access or the print subscription itself. There was no stability in electronic

8. The costs per ASF in this paragraph were supplied by the UCOP, Office of Facilities Planning, and Office of the Director of Design and Construction Services. These costs do not include the cost of land on which to build the facility, the costs to utility companies to make their utilities available at the site (if necessary), or equipment costs. They do include shelving costs. Although some of the costs used in these calculations are taken from planning cost documents, final construction costs for these projects are generally very close to the planned costs.

access fees or subscription changes at the time this article was written. Without price stability, it is difficult to arrive at a trade-off analysis that will have any lasting applicability.

As of mid-2002, the University of California's campuses paid an average of about \$952 for a subscription to one printed journal title per year and an average of \$530 for electronic access to one journal title per year. Roughly 64 percent of the total expenditure was for printed copies of journals, and 36 percent was for electronic access to those same journals.⁹ The average subscription price computed from Van Orsdel and Born [2] was \$745. Given the university's strong research emphasis, it is not surprising to find its average above that of Van Orsdel and Born. The University purchases almost all of the most specialized journals that are published, and these publications are priced accordingly.

Processing Costs

Most of the models in this cost analysis assume that library journals will be received at the local library and then shipped and stored at a regional or campus storage facility. The major tasks performed by the local library include selecting material that will be transferred to the storage facility, processing materials at a local library facility before they are transferred to storage, and transporting them to the storage facility. Once materials reach the storage facility, additional processing takes place—for example, receiving the materials from the local library, updating bibliographic information, and shelving the items in compact storage at the facility.

As part of the current study, an extensive investigation took place to accurately assess local library processing costs and other costs. Data were collected from nine University of California campus libraries and two storage facilities, the Northern Regional Library Facility (NRLF), located in Richmond, California, and the Southern Regional Library Facility (SRLF), located in Los Angeles. Library and storage-facility staffs were supplied with a list of tasks for which the time spent and the number of units processed was recorded. These tasks included both library and storage-facility processing and bibliographic control activities. Average salary costs by job title were used to compute total costs and then unit costs. The costs from the nine campuses were summarized, as were the costs from the two storage facilities.

The unit costs that were derived from the study were expressed in two

9. These numbers should be considered very rough approximations of publisher prices that were in flux at the time of the study—for publishers in the Collection Management Initiative (CMI) study—and were arrived at by considerable subjective judgment.

TABLE 1
COST TO SELECT AND PROCESS MATERIALS FOR SHIPMENT TO A STORAGE FACILITY (\$)

Cost Category	Cost per Title	Cost per Volume
Select materials for transfer to a storage facility	8.89	2.26
Process materials:		
Staff preparation of titles	.52	.13
Pull volumes and affix labeling		.21
Size volumes		.02
Prepare for record updates; print records	.18	.05
Revise pulled material; place searches and holds		.16
Pack and secure trucks		.02
Refile forms or documentation	.05	.01
Update records	.43	.11
Total processing		.71
Transportation		.60
Total selection, processing, and transportation		3.57

SOURCE.—University of California Office of the President, Office of Library Planning and Policy Development, Collection Management Initiative cost study, 2001–2.

NOTE.—Some values were originally computed in terms of cost per title and some in cost per volume. Where there is a parallel entry in a row with two figures, the original value was computed as a cost per title and was converted using the values in app. B to give the cost per volume. Where there are no entries in the “Cost per Title” column, the value was originally computed as a cost per volume.

different units: number of volumes of books or periodicals processed and number of titles processed. For this study, and for related research into library stack space use, it was necessary to have a common set of units. A study was undertaken to measure the amount of shelf space used by a random sample of periodical titles. This study found that the average number of bound volumes in a serial title run for all the serial titles sampled on the University of California campuses was 32.4. This number is relatively high because of the extensive research holdings that the university maintains. Appendix B gives some of the major measures that were derived from the study.

Table 1 summarizes the processing costs incurred by local libraries in preparing material to be sent to a storage facility. These costs were determined by the CMI study that surveyed only printed journals for which an electronic version of the journal was available. This is not a random sample but one that focuses on a specific category of materials. The table shows that the cost to select material to be transferred to a storage facility is \$8.89 per title, or \$2.26 per volume.¹⁰ Processing costs include preparing titles for transfer, removing volumes from the shelves in anticipation of their movement to the facility and labeling them, modifying the bibliographic records that represent the physical item, and packing the material for shipment to the facility. These costs total \$0.71 per volume. The university

10. The conversion from titles to volumes uses the data in app. B.

TABLE 2
SUMMARY OF PROCESSING COSTS FOR MOVING MATERIALS TO A STORAGE FACILITY (\$)

Cost Category	CMI Cost Study	Cooper UCSD Study [6]	Cooper NLM Study [8]
Select materials for transfer to a storage facility	2.26	.93	.59
Process materials for transfer to a storage facility	.71	2.14	1.37
Transport materials to the storage facility	.60	.31	.56
Subtotal	3.57	3.38	2.52
Process materials at the storage facility	2.88	1.64	.83
Total	6.45	5.02	3.35

NOTE.—The values from 1989 and 2000 have been adjusted for inflation.

currently contracts with a vendor to move materials from local libraries to storage facilities at a fixed cost of \$0.60 per volume, irrespective of the originating or receiving library. The total selection, processing, and transportation cost is \$3.57 per volume.

The costs per volume for selection, local processing, and transportation from Cooper's [6] UCSD study are \$0.93, \$2.14, and \$0.31, respectively.¹¹ This totals \$3.38, which is quite similar to the \$3.57 derived in the current CMI study. In Cooper's study for the NLM [8], he found selection costs of \$0.59, processing costs of \$1.37, and transportation costs of \$0.56; this gave a total cost of \$2.52.¹²

A second category of costs occurs the first time material is sent to a storage facility. Based on a cost analysis prepared in 1991, and adjusted for inflation using the index in appendix A, it is estimated that the cost of receiving and processing a volume for storage in a University of California storage-facility collection is \$2.45 [9]. The labor cost for shelving a volume at the same facility is estimated at \$0.43. Cooper [6] estimated the processing and shelving cost at \$1.64. Cooper's NLM study [8] found regional library processing costs to be \$0.56 (2001 dollars) when NLM ran the facility and \$1.11 when a contractor ran the facility.¹³ A comparison of these processing costs is given in table 2.

Journal issues that are held at a local library or sent to a library facility may be left as individual items or may instead be bound. Two types of binding are possible: full buckram binding of the issues, estimated to cost

11. These numbers have been adjusted for inflation.

12. See table 4 [8, p. 15]. The original 1999 figures were \$0.53, \$1.13, and \$0.50, respectively. The numbers in the text have been adjusted to 2001 values.

13. The original values before adjusting for inflation were \$0.50 and \$1.00, respectively.

TABLE 3
TWO ESTIMATES OF THE COST OF CIRCULATING MATERIALS FROM A UNIVERSITY OF
CALIFORNIA REGIONAL STORAGE FACILITY (\$)

Cost Category	Cost per Volume
CMI cost study cost estimates:	
Process user request for materials stored at regional library facility	1.28
Receive item from regional library facility and circulate item to user	1.75
Receive item from user and return item to regional library facility	.47
Total	3.50
Cooper [6] cost estimates:	
Verify that item is in regional storage and place request for it	1.97
Retrieve item from hold shelf and charge item out to user	.98
Clear item from circulation file at library and return it to regional storage facility	.98
Total	3.93

NOTE.—The estimates in the lower panel have been adjusted for inflation to the year 2001 using the index in app. A. Although the categories in the two panels are slightly different, each panel fully encompasses the circulation activity.

\$12.87 per volume, or placing the items in pamphlet file boxes (at a cost of \$3.20 per volume).¹⁴

Storage-Facility Circulation Costs

The final category of costs encompasses those related to supplying materials to the user from a storage facility—circulation costs. There are two methods of delivery. The first is delivery of the physical material, usually a bound volume. The bound volume is usually delivered by transporting it to the library closest to the requestor and having the user come to the library to pick it up.¹⁵ The second is delivery of a reproduction of the requested material, such as a photocopy. The reproduction can be delivered in the same manner as the bound volume, by shipping it to the closest library. It can also be faxed to the user or transmitted via e-mail.

The CMI cost study analyzed the costs of providing a physical volume from a storage facility to a user at a requesting library. Table 3 summarizes the results of the analysis. The cost per volume to process a user's request

14. The University of California Bindery in Richmond, California, supplied the costs of binding. Pamphlet files are purchased in bulk in various sizes. The cost of pamphlet binding is the average of the cost of the two most used file sizes.

15. There is a small amount of use of a regional library facility collection by users who come to the facility itself. There is not enough appreciable difference in cost of this activity versus the normal delivery service to warrant segregating its costs from the others.

for material stored at a storage facility was \$1.28, while the cost to receive the item shipped from the storage facility to the local library was \$1.75. Once the user was finished with the item and returned it to the local library, the cost to receive it and return it to the storage facility was \$0.47. Those costs total \$3.50. Two trips of \$0.60 per volume add \$1.20 in transportation costs, making the total cost of circulating the volume from the storage facility \$4.70 per volume. Table 3 also summarizes the results from Cooper [6]. Although the cost categories are different, the process being described is the same. The total from this study came to \$3.93.

In Cooper's NLM study [8], he found a circulation cost of \$10.54 from an off-campus storage facility.¹⁶ This cost included the cost of selecting the item from the shelves of the facility, transporting it to the library, circulating it to the user, discharging it from the user, transporting it back to the storage facility, and reshelving it at the facility. Transportation costs are a large proportion of the total (\$7.23 in 2001 dollars). If this is subtracted from the total, then circulation costs are \$3.31—not dissimilar from the other amounts in table 3.

The costs of the second form of circulation, delivering a reproduction of the item to the user from the storage facility, were computed using the Uniform Fee Schedule estimates prepared by the UCOP, Office of Library Affairs [9]. These estimates were adjusted for inflation to the year 2001. A cost of \$3.94 for each reproduction circulated to a user was established. In Cooper [8], the cost of this type of circulation at the NLM was found to be \$3.10 (adjusted to 2001), while a contractor was willing to offer the service at \$5.00 per request.¹⁷

Summary of the Cost Models and Unit Costs

The previous sections have summarized the literature and the cost data available for analysis. This section restates the cost models and synthesizes the cost data. The following section will present a comparative analysis of the costs of each approach.

Six different cost models for the provision of journal content to users are analyzed. The first is to provide users with electronic access to journals but not to subscribe to printed copies of those journals. The second through sixth models all assume that the library will subscribe to the printed version of the journal. The costs presented in the first model will always be incurred. That is, the library will provide electronic access to

16. See table 8 [8, p. 22]. The total cost in 1999 was \$9.48.

17. *Ibid.*

journals. The library needs to choose which of the second through sixth models are appropriate. To obtain the total cost of providing electronic and printed access to a collection of journals, one adds the cost from model 1 to one of the costs from models 2–6.

Model Summary

Model 1.—Users have access to the electronic copies of journals through their browser software and the Internet. When printed copies are needed, they can be obtained from the local library or from the storage facility. The cost of acquiring, processing, or storing the printed copy of the journal is not included in this model. The only cost included in this model is the electronic access fee for the journal.

Model 2.—The local library continues to maintain its subscription to the printed copy of the journal and displays the current issues on its shelves for browsing. But after a normal period of time, the library removes the individual issues from the browse shelves, binds them in buckram for storage, and sends them to its stacks.

Model 3.—The third model is a variation on model 2 in which, instead of the local library sending the buckram-bound volume to its stacks, it sends the volume to a storage facility.

Model 4.—The local library keeps the printed copy of the journal available for browsing for a certain amount of time and then discards it. This is done on the theory that the value of the printed copies is for browsing and, once a sufficient amount of time has elapsed, the electronic form can substitute for a print copy from a storage facility. In this model, there are no construction costs for either a local library or a storage facility. There are costs to the library for updating its records when it discards the materials.

Model 5.—The fifth model assumes that the local library will make current copies of the journals available for some period of time, and then they will send unbound issues to the storage facility where the issues will be stored in pamphlet boxes.

Model 6.—If it is assumed that most user requirements for current journal articles can be met by electronic access, printed copies of the journals can be sent directly from the publisher to the storage facility, bypassing the local library. Model 6 presents that scenario. In the model, there are construction costs for a storage facility, and there are processing costs incurred when the storage facility receives the materials. But there are no costs to local libraries for handling the materials.

In models 2–5, one factor is constant. No construction costs are included

for the library space occupied by journals when they are displayed for browsing. If printed copies of journals are removed, the space they currently occupy will be filled with other journals.

These models are summarized in table 4. The first four rows of the table describe the characteristics of each model. Thus, in the column labeled "Model 1," the method of access to the journal content is only electronic. In model 2, the printed copies are retained at the local library initially and remain there. Finally, the issues are bound in buckram. In model 4, the library retains printed copies of the journals for awhile and then discards them.

Following the description of each model in table 4 are a series of rows with the unit costs associated with that model. For example, for model 1, the only cost element is the access fee the library pays to the publisher so that its users may view the content of the journals with their browser software. In model 5, the library must house bound copies of the journals in a storage facility at a rate of \$0.33 per volume per year. It must pay subscription costs of \$952.00 per title per year, it must select material to be sent from the local library to the storage facility at a rate of \$2.26 per volume, it must process the materials at the storage facility at a rate of \$0.71 per volume, and it must transport the material from the local library to the storage facility at a rate of \$0.60 per volume. At the storage facility, each volume must be processed at a cost of \$2.88 per volume. When a user at the local library requests a volume or an issue from the storage facility, the cost to the library is \$4.70; if a reproduction is supplied, the cost is \$3.94 per article. In model 6, material is shipped directly from the publisher to the storage facility, so there are only construction costs for the storage facility (\$0.33 per volume) and processing costs at that facility (\$2.88).

The costs in table 4 are a synthesis of the data presented earlier in this article. They are derived from estimates taken from the CMI study with two exceptions. Construction costs come from the UCOP's unit responsible for construction activities, and the circulation costs from a local library come from Cooper [8]. The table shows the significant cost savings that can be achieved by storing a single volume at a storage facility—\$0.33 versus \$1.43 per volume per year. It also shows the cost savings of storing materials in pamphlet boxes rather than bound volumes. The difference here is \$9.67 per volume. Depending on the way the materials are handled, local library or storage-facility processing costs are incurred or avoided. The full cost of moving materials from a local library to a storage facility is \$3.57 per volume, while the cost of processing material at a storage facility is \$2.88 per volume.

When all these factors are cumulated, the variation in the fixed costs gives one good measure to evaluate the alternatives. When electronic resources are used, there are no fixed costs for the university. Aside from that, the

TABLE 4
SUMMARY OF UNIT COSTS FOR ELECTRONIC ACCESS AND PRINT ACCESS TO JOURNAL ARTICLES (\$)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Method of access to journal content	Electronic access only	Print access only	Print access only	Print access only	Print access only	Print access only
Initial status of printed copies of journals	NA	Retain at local library	Retain at local library	Retain at local library	Retain at local library	(See cell below)
Final status of printed copies of journals	NA	Retain at local library	Move to storage facility	Discard after defined period	Move to storage facility	Sent directly from publisher to storage facility
Binding status of printed copies of journals	NA	Bind issues in buckram	Bind issues in buckram	NA	Store issues in pamphlet boxes	Store issues in pamphlet boxes
Construction cost per volume per year:						
On-campus library facility with regular shelving		1.43				
Storage facility with compact shelving			.33		.33	.33
Cost of selecting materials for acquisition	NC	NC	NC	NC	NC	NC
Journal subscription costs per title per year:						
Electronic access fee	530					
Printed copy of journal		952	952	952	952	952
Processing costs to move a volume to a storage facility or to discard it:						
Select material to be sent to storage			2.26	2.26	2.26	
Process materials for transfer to storage			.71	.71	.71	
Transport materials to storage			.60		.60	
Binding costs per volume		12.87	12.87		3.20	3.20
Processing costs per volume at the storage facility			2.88		2.88	2.88
Total fixed costs (excluding electronic access fee/journal subscription cost)	.00	56.20	58.33	2.97	20.32	16.75
Circulation costs per issue or volume:						
Circulation from a local library		3.26	3.26	3.26	3.26	
Circulation from a storage facility			4.70		4.70	4.70
Supply a reproduction of the journal article to the user from a storage facility			3.94		3.94	3.94

NOTE.—The numbers are derived from many sources and are described in the text. The fixed-cost total is not simply a sum of the fixed costs since certain conversion factors apply. NC = not collected; NA = not applicable.

least fixed costs are incurred in model 4 (\$2.97) because the material is discarded after some period of time and there are neither construction nor binding costs. The third least expensive fixed-cost option is model 6 (\$16.75). Here, materials are kept in the storage facility but are shipped directly from the publisher to the facility, thus bypassing some processing and transportation costs. In this model, the materials are stored in pamphlet boxes, thereby reducing costs substantially. Model 4 has the lowest fixed cost, but there is no copy of record maintained. If the university wishes to maintain a copy of record, the lowest fixed-cost alternative comes in model 6.

Model 5 has a fixed cost of \$20.32. The fixed-cost difference comes from the fact that the material spends some time in a local library before being sent to the storage facility. The \$3.57 difference is processing costs. Model 2 has a fixed cost of \$56.20, and Model 3 has a fixed cost of \$58.33. In each of these cases, it is either the binding costs or the processing costs, or both, that make the models especially expensive compared to the alternatives.

Simulation Analysis

In this cost analysis of alternative delivery approaches for journal content, there are two important variables about which values are difficult to state with any certainty: (1) the electronic access fee and subscription cost to a journal and (2) the number of times an electronic or print copy of a journal will be used in a year. In order to complete the comparative analysis of the alternatives described in table 4, a simulation approach was taken. In this approach, the electronic access fee and subscription cost were systematically varied, as was the number of uses per year, to see the effect on the average cost per circulation of an item.

The overall strategy in the analysis is to compute an average cost per circulation or average cost per electronic access. The first step is to compute the total cost for each circulation; this is the fixed costs plus the variable costs. The variable costs change as the number of times the item is circulated changes. Variable costs are unit costs, so, for each unit of circulation, the variable costs are multiplied by the number of times the item is circulated. The average cost is the total cost divided by the number of units of circulation. In computing the average cost, the number of units of circulation enters the equation twice, once as a multiplier of the variable costs and once as a divisor for the total cost.

The fixed costs do not vary as the number of uses of a volume changes. An example of a fixed cost is construction cost in which, for a given year, it costs a fixed amount of money to provide space to store the volume, irrespective of the number of times it is used. Another fixed cost that occurs in some models is the cost of selecting materials to be sent to a storage

facility. This cost occurs once when the item is sent for the first time and does not recur. Still another fixed cost is the cost of binding the material.

The second category of costs is variable. They vary depending on the number of times the volume is circulated or the number of electronic accesses that are made to the database.¹⁸ For printed volumes, the variable costs are simply the unit costs of circulating the item. For electronic journals, there are no variable costs because the cost of providing electronic access (the communications infrastructure) is not considered in this analysis.¹⁹ This infrastructure is so multipurpose that it would be nearly impossible to distinguish its use for one activity versus another.

For the simulation analysis, it was assumed that both the electronic access fees and print subscription fees vary. For the electronic access fee, values of \$500, \$600, and \$700 per year were chosen for analysis. For print subscription fees, values of from \$900 to \$1,000 per year were selected. These values correspond to the average fee (\$530) and subscription costs (\$952) in the CMI sample. In addition, it was assumed that the number of electronic accesses varies from twenty to seventy-five per year and that the number of circulations of the printed copies varies from one to twenty per year. The reason for the disparity in the assumptions about usage is that it is much more likely that the electronic version will receive high usage because of the manner of its availability. Materials that are selected and sent to a storage facility are low-use items.

Figure 1 shows how the average cost of electronic access varies for three different access fees of \$500, \$600, and \$700 per year. When there are twenty accesses, the average cost of an access is \$25, \$30, and \$35, respectively. Since there are no other fixed or variable costs accounted for in the model, aside from the access fee, these figures are derived by dividing the number of accesses by the yearly fee. As the number of uses per year drops into the range of fifty to seventy-five, the average cost per use begins to flatten. For a \$500 fee, it ranges from \$7 to \$9 per use. For a \$700 fee, the range is \$9–\$13. It seems highly likely that the number of electronic accesses to a journal title will greatly exceed twenty per year, given the size of the university community composed of more than 100,000 students, staff, and faculty. If this is the case, the cost per use will be even lower.

All the proposed solutions that the University of California is considering for providing access to scholarly journals include ensuring electronic avail-

18. The determination of what constitutes a single use of a vendor's electronic database is subject to contractual negotiations. For simplicity, it is assumed, in this article, that it is a single use of a single journal article.

19. Under some circumstances, the fees charged by vendors for electronic access can vary. The library can contract for X simultaneous uses at Y dollars and then pay an additional amount if the number of uses exceeds X. This situation was not considered in the analysis.

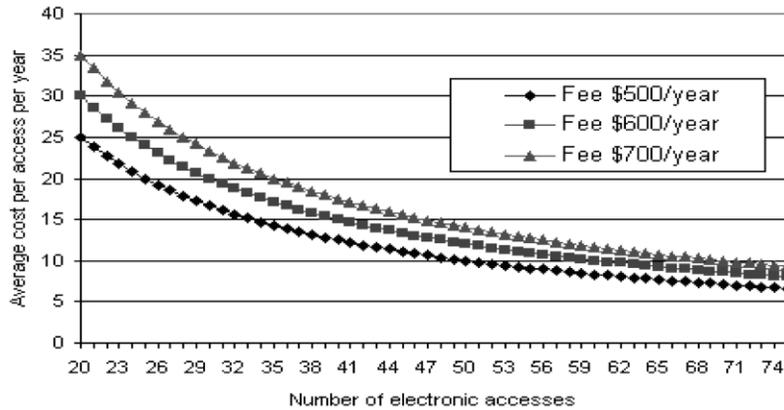


FIG. 1.—Average cost per access to the electronic format of an academic journal

ability as well as some form of access to the printed version of the material. Thus, the costs in model 1—the model that provides electronic access alone—will always be incurred. The costs of any one of the other five options will be additional.

Table 5 shows the average cost per use for two alternative subscription costs for each of models 2–6. The subscription fees modeled are \$900 and \$1,000 per journal per year. The calculations of average cost per circulation are given for one to twenty uses.

The simulation results do not show a significant difference in the cost of storing materials among any of models 2–6. For example, at ten uses per volume and a \$900 subscription fee, the average cost ranges from \$94 to \$101. At \$1,000, the average cost ranges from \$104 to \$111. Thus, whether the material is kept in the local library, shipped to a storage facility, bound in buckram, or stored in pamphlet boxes causes an average cost difference of about \$7 per circulation. However, there is a significant difference in the final outcome. For model 4, the printed copy is available for browsing and then discarded. Even though model 4 is the least expensive, there is no printed copy remaining. With model 5, costing a few dollars more at the ten-uses level, one obtains a copy of record. And, if one considers model 6, which preserves a copy of record and sends it directly to the storage facility, one saves about a dollar over model 5 at the ten-uses level.

TABLE 5
SUMMARY OF SELECTED JOURNAL COST SIMULATION RESULTS (\$)

No. of Uses	Subscription Cost/Year = \$900					Subscription Cost/Year = \$1,000				
	Model 2	Model 3	Model 4	Model 5	Model 6	Model 2	Model 3	Model 4	Model 5	Model 6
1	959	963	906	925	921	1,059	1,063	1,006	1,025	1,021
2	481	484	455	465	463	531	534	505	515	513
3	322	324	304	311	310	355	357	338	345	344
4	242	244	229	235	234	267	269	254	260	259
5	194	196	184	189	188	214	216	204	209	208
6	163	164	154	158	157	179	181	170	175	174
7	140	142	132	136	136	154	156	147	150	150
8	123	124	116	120	119	135	137	129	132	132
9	110	111	104	107	107	121	122	115	118	118
10	99	101	94	97	96	109	111	104	107	106
11	90	92	85	88	88	99	101	94	97	97
12	83	85	79	81	81	91	93	87	90	89
13	77	78	73	75	75	85	86	80	83	83
14	72	73	68	70	70	79	80	75	78	77
15	67	69	63	66	66	74	75	70	73	72
16	63	65	60	62	62	69	71	66	68	68
17	60	61	56	59	59	65	67	62	65	65
18	56	58	53	56	56	62	63	59	61	61
19	54	55	51	53	53	59	60	56	58	58
20	51	53	48	51	51	56	58	53	56	56

NOTE.—Values are the average cost per circulation for a given electronic access fee or journal subscription cost for a given number of circulations per year. See text for a description of each model.

A Cost-Savings Model

In previous sections of this article, the costs of providing electronic access and the costs of various strategies for storing printed copies of journals have been explored. The next issue to address is the costs or savings that could accrue to a group of libraries that provided electronic journal access for the users of that group or consortium. For example, assume that the University of California systemwide administration was to negotiate contracts with journal publishers to provide access to electronic journals for all libraries in the university system. What kind of costs or savings result from such a plan?

The model used to measure the effect of this strategy compares the cost of the current arrangement of providing printed materials with a proposed strategy in which the number of printed copies would be reduced as electronic access is provided. The cost savings are computed as the difference between the current and proposed strategies. The results presented here are for one scenario, but they can be easily extended to any number of alternatives. In that scenario, the university system has already committed itself to purchase the electronic version of the journal, and that is a sunk cost. Assume that the printed copy of the same electronic journal costs \$900 per year. Further assume that there are five libraries that currently subscribe to the printed version of the journal. Of these five libraries, one binds its copies, and after usage of the print material has declined, the bound journal is sent to a storage facility to become the copy of record (model 3). The other four libraries continue to subscribe to the journal, but when usage has declined, they discard the journal on the premise that the printed copy can be retrieved from the storage facility if needed (model 4).

The scenario under which the costs of the current alternative are defined incorporates a rather aggressive cost-savings plan. In the most conservative planning situation, each library in the consortium would maintain its own subscription to the journal and save and bind past issues. As a starting point in the present cost-savings calculations, it is assumed that the libraries are already cooperating to the extent that only one of the libraries is saving its printed version of the journals. Thus, the model of the current alternative presented here potentially understates the possible savings.

Now consider the situation in which the libraries believe that they can satisfy a considerable portion of their users' needs for the journal by providing it electronically. In this scenario, all five libraries drop their subscription to the printed form of the journal; all the while, the university systemwide administration maintains its contract for access to the electronic journal. Further, in order to provide a copy of record, the systemwide administration has printed copies of the journal delivered directly to a storage facility (model 6).

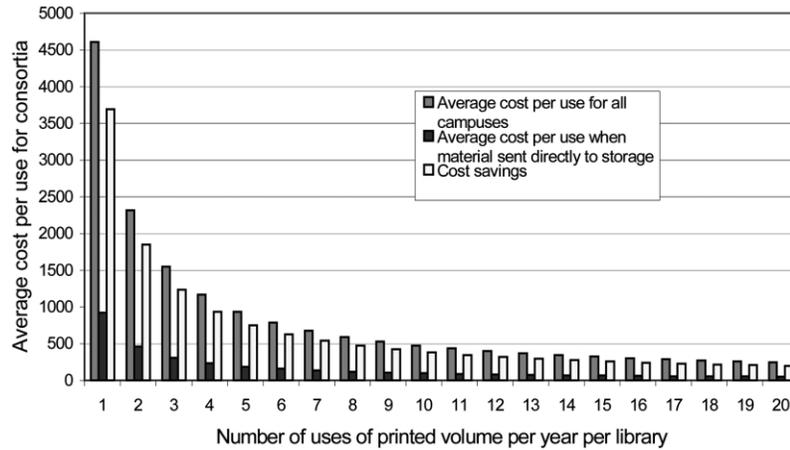


FIG. 2.—Cost savings from cancellation of individual campus print subscriptions and sending the copy of record directly from the publisher to the storage facility.

The current cost of the journal using this scenario can be computed by adding the cost of the journal under model 4 and multiplying it times the number of libraries, namely, four. To this total is added the cost of the journal under model 3 (for only one library). The cost under the proposed plan is simply the cost of the journal using model 6. And finally, the cost savings is the difference between the current cost and the cost under the proposed plan.

Figure 2 and tables 6 and 7 summarize the results from this analysis for a \$900 print subscription that is used from one to twenty times a year in each of the five libraries participating in the hypothetical consortium.²⁰ The average cost under the current plan varies from \$4,610 for one use to \$247 for twenty uses. The average cost per use for model 6 (the proposed plan) can be seen in table 5 to vary from \$921 for one use to \$51 for twenty uses. The cost savings range from \$3,689 for one use to \$196 for twenty uses. The savings are very high when the uses range from one to eleven. The change in savings diminishes beyond that point but is still quite high for every level of use. Thus, the savings of such an arrangement are significant.

20. It is important to note that the model assumes that each journal will be used from one to twenty times in each library. This means that the total uses will be from five to 100 in the simulation because there are five libraries in the consortium. The costs savings are for the consortium as a whole, not an individual library. To compute the savings value for each library, divide the average cost by the number of libraries (five).

TABLE 6
COMPUTATION OF COST SAVINGS FROM THE CANCELLATION OF INDIVIDUAL CAMPUS PRINT SUBSCRIPTIONS AND SENDING THE COPY OF RECORD
DIRECTLY FROM THE PUBLISHER TO A STORAGE FACILITY: CURRENT SCENARIO

		Current Scenario								
Uses per Library	Consortial Uses	Average Cost per Use for Library Binding and Storing Journal,		Average Cost per Use for Libraries Receiving Then Discarding Journal, Model 4		No. of Libraries Discarding Journal, Model 4	Total Cost for All Libraries That Discard the Journal		Total Cost for Libraries That Discard Plus Cost for Library That Sends Material to Storage	Average Cost per Use (Total Consortial Uses)
		Model 3 (\$)	Total Cost per Annum, Model 3 (\$)	Model 4 (\$)	Total Cost per Annum, Model 4 (\$)		(\$)	(\$)		
1	5	963	963	912	912	4	3,647	4,610	922	
2	10	484	968	458	915	4	3,660	4,628	463	
3	15	324	972	306	918	4	3,673	4,646	310	
4	20	244	977	230	922	4	3,687	4,664	233	
5	25	196	982	185	925	4	3,700	4,681	187	
6	30	164	987	155	928	4	3,713	4,699	157	
7	35	142	991	133	931	4	3,726	4,717	135	
8	40	124	996	117	935	4	3,739	4,735	118	
9	45	111	1,001	104	938	4	3,752	4,752	106	
10	50	101	1,005	94	941	4	3,765	4,770	95	
11	55	92	1,010	86	944	4	3,778	4,788	87	
12	60	85	1,015	79	948	4	3,791	4,806	80	
13	65	78	1,019	73	951	4	3,804	4,823	74	
14	70	73	1,024	68	954	4	3,817	4,841	69	
15	75	69	1,029	64	957	4	3,830	4,859	65	
16	80	65	1,034	60	961	4	3,843	4,877	61	
17	85	61	1,038	57	964	4	3,856	4,894	58	
18	90	58	1,043	54	967	4	3,869	4,912	55	
19	95	55	1,048	51	971	4	3,882	4,930	52	
20	100	53	1,052	49	974	4	3,895	4,947	49	

NOTE.—See text for a complete description of the cost-savings model and its assumptions.

TABLE 7
 COMPUTATION OF COST SAVINGS FROM THE CANCELLATION OF INDIVIDUAL CAMPUS PRINT SUBSCRIPTIONS AND SENDING
 THE COPY OF RECORD DIRECTLY FROM THE PUBLISHER TO A STORAGE FACILITY: PROPOSED SCENARIO AND SAVINGS

Uses per Library	Consortial Uses	Proposed Scenario		Cost Savings (\$)	Cost Savings per Consortial Use (\$)
		Average Cost per Consortial Use for Having Material Sent Directly from Publisher to Storage, Model 6 (\$)	Total Cost per Annum (\$)		
1	5	188	940	3,670	734
2	10	96	964	3,664	366
3	15	66	987	3,659	244
4	20	51	1,011	3,653	183
5	25	41	1,034	3,647	146
6	30	35	1,058	3,641	121
7	35	31	1,081	3,636	104
8	40	28	1,105	3,630	91
9	45	25	1,128	3,624	81
10	50	23	1,152	3,618	72
11	55	21	1,175	3,613	66
12	60	20	1,199	3,607	60
13	65	19	1,222	3,601	55
14	70	18	1,246	3,595	51
15	75	17	1,269	3,590	48
16	80	16	1,293	3,584	45
17	85	15	1,316	3,578	42
18	90	15	1,340	3,572	40
19	95	14	1,363	3,566	38
20	100	14	1,387	3,561	36

NOTE.—See text for a complete description of the cost-savings model and its assumptions.

Summary and Conclusion

This article has provided an examination of the cost factors involved in providing electronic access to journal articles and printed copies of journals to users in an academic environment. The examination began with a review of the economic trends that academic libraries are facing. While the U.S. CPI has been growing at 3.3 percent per year, expenditures on journal subscriptions have been rising at 8.0 percent per year. In addition, journal subscriptions are not inexpensive, ranging from about \$100 to over \$2,200 per title for scholarly publications. The mean subscription price found in a current survey was \$745. For the University of California, the average is about \$952. The problem is not just printed journal subscription prices but also the fees that universities pay for their users to have electronic access to journal articles through the Internet. Libraries are beginning to see a shift in the total they pay for subscriptions versus the total they pay for electronic access. Right now, the balance for the University of California is about 64 percent for printed journal subscriptions and 36 percent for electronic access fees. Publishers envision a decreased demand for printed journals and consequently are beginning to shift their pricing to raise electronic access fees. This makes it difficult to assess how a university should plan for journal expenditures, let alone decide on a strategy for managing printed journals.

A major university has an important responsibility to maintain copies of printed materials. The CMI study of more than 7,000 University of California students, faculty, and staff found that while 83 percent of the users strongly agreed, or agreed that having electronic access to journals was a good alternative to printed journals, 57 percent realized that it was very important to have printed copies of the journals available as well. From the users' standpoint, printed copies of journals are essential. Other researchers have pointed out that there are additional reasons for maintaining printed copies, including the likelihood that the longevity of a printed copy is greater than that of an electronic copy because there is no guarantee that the electronic copy will be migrated to each succeeding electronic standard as that standard emerges. Further, as journal publishers go out of business or sell their journal titles to other publishers, there is no guarantee that the publisher's electronic journals will be transferred. For these and other reasons it is essential that the University of California maintain its own copies of printed material for current and future scholars.

Six cost models were examined in this research. The first assumed that the university would provide electronic access to journals and not subscribe to printed copies of journals. No one is proposing that this model should be followed. It exists merely to serve as a building block upon which the other alternatives are based. The other models call for electronic access and for one form or another of access to printed materials. These other

models include providing electronic access and print access, binding the printed copies of the journals, storing them at the local library, and allowing users to check them out from the local library. Variations on this model include moving the bound copies to a storage facility and changing the form of binding of the journal issues to reduce cost. Another model is for the library to keep unbound issues, but when browsing has declined or a specified period has elapsed, the library would discard the journals. This model assumes that it is valuable to allow a user physical access to the journals. Finally, the printed journal issues can be sent directly from the publisher to the storage facility and stored there. In this scenario, the journal completely bypasses the local library. When the user needs the printed version, it can be requested from the storage facility.

One factor in evaluating these models is the cost of constructing a library facility to house the materials. The cost per volume per year to build a library with standard shelving is \$1.43, while the cost to construct a library storage facility in which volumes are stored in the most compact manner is only \$0.33. If materials are sent to a storage facility instead of being retained at the local library, it costs about \$3.57 per volume to process the material for shipment. When the materials are received at the storage facility and installed, there is an additional cost of \$2.88 per volume. When users request materials and check them out of a local library, the cost is about \$3.26 per volume, as opposed to \$4.70 per volume when the item is retrieved from a storage facility. The cost of circulating the volume from the storage facility is higher because volumes in the storage facility are usually stored to optimize the number of volumes on the shelves, not to facilitate the user browsing the collection. If the storage facility supplies a facsimile of the article instead of the physical volume, the cost is \$3.94 per article.

Simulation techniques were used to assess how the average cost per circulation of a volume or of an electronic access varied. The unit costs discussed above were used in each of the six cost models, and the electronic journal access fee or the journal subscription price was varied to see its effect on average cost. One other variable was also changed: the number of times the journal would be accessed or the number of times the volume would be circulated. The results of the simulation show that the average costs are not insignificant for access to printed materials but are relatively small for electronic access.

Assume the electronic access fee is \$600 per journal per year. In this case, there are no fixed costs. If there are seventy-five uses of the title per year, the cost is \$8 per use. Given the size of the user population, seventy-five uses is probably a very conservative estimate of actual use per title. If the number of uses rose to 200, the cost would be \$3 per use. This figure compares extremely favorably with the cost of any alternative in which a printed copy of the journal is either initially acquired and then discarded or kept locally

or in a remote storage facility. But a major premise of this article is that the university must maintain its own copies of printed materials. In that situation, the simulations provide the costs of the alternatives.

In model 2, in which the local library binds copies of the journals and keeps the bound volumes in its stacks, the average cost per use of a volume is \$51, assuming a subscription price of \$900 and twenty uses. In model 3, in which the library moves the bound volume to a storage facility and the subscription and usage figures remain the same as above, the cost per use is \$53. For model 5, in which the journals are stored in a facility that costs substantially less to build and are stored in pamphlet boxes, the cost per use drops to \$51. Although high, these numbers are not substantially different from one another.

Model 4 simulates the case in which the local library acquires the material, keeps it on its shelves, and then discards it after an appropriate period of time. For the same \$900 subscription that is used twenty times, the cost per use is \$48. In model 6, the material goes directly from the publisher to the storage facility. Using the same set of parameters as model 4, the cost per use is \$51. The important difference between model 4, which has the lowest cost per use, and model 6, which is slightly more expensive, is that in model 6, the university retains a copy of record of the item in a storage facility at a very minimal additional marginal cost.

Electronic journals minimize the need for physical infrastructure and provide a cost-effective, immediate means of providing access to library users. But scholars still need access to printed copies of journals, and the costs of providing this access are not insignificant. The least expensive alternative that retains printed copies of journals is for the university to have the printed copies of the journals sent directly to the storage facility. If there is a requirement that the materials be housed at a local library for some period of time before being shipped to a storage facility, the least-cost alternative is for the material to be received at the local library and then stored in pamphlet boxes at a storage facility. Storing materials in pamphlet boxes instead of binding the materials in buckram costs about four times less. Likewise, the construction costs are more than four times lower for a storage facility than an on-campus library facility.

If electronic access to journals is provided, there is a potential cost savings to the university system as a whole. To assess those savings, a cost model was constructed to compare a present acquisition policy to one in which the individual libraries relied much more on electronic access to meet user needs. The scenario modeled was one in which electronic access to journals was provided by the university systemwide administration to all members of the university community. The current policy was that each of five libraries subscribed to the printed version of a journal. One of these libraries displayed unbound copies on its shelves, bound its copies of the journal after an

appropriate period of time, and sent the bound copies to a storage facility (model 3). The other four libraries displayed the unbound copies and when usage has declined, disposed of these unbound issues (model 4).

The proposed scenario was one in which the systemwide administration continues to provide electronic access, but none of the libraries receive a printed copy of the journal. Instead, one printed copy is sent directly from the publisher to a storage facility (model 6). The cost savings from this arrangement were substantial but varied depending on the number of times the journal was requested by a user from a storage facility. If a journal with a print subscription cost of \$900 per year was used five times in each of the participating libraries in a year, the savings to the consortium would be \$748 for that one journal for one year. The savings are substantially higher for a lower number of uses, but even at twenty uses in one library per year, the savings are \$197 for the one journal.

Appendix A

Inflation Indexes

TABLE A1
UNIVERSITY OF CALIFORNIA LIBRARY INFLATION INDEX

Year	Index Value	% Change	Year	Index Value	% Change
1960-61	1.0000	8.7	1981-82	5.6626	10.8
1961-62	1.0874	3.5	1982-83	6.2724	2.2
1962-63	1.1257	6.3	1983-84	6.4112	5.2
1963-64	1.1965	5.7	1984-85	6.7476	13.1
1964-65	1.2643	6.2	1985-86	7.6334	7.6
1965-66	1.3428	7.1	1986-87	8.2140	5.8
1966-67	1.4379	6.5	1987-88	8.6912	4.5
1967-68	1.5318	7.5	1988-89	9.0862	3.2
1968-69	1.6469	7.5	1989-90	9.3811	4.8
1969-70	1.7708	7.6	1990-91	9.8289	4.7
1970-71	1.9060	4.7	1991-92	10.2881	1.2
1971-72	1.9949	2.6	1992-93	10.4164	2.9
1972-73	2.0471	10.3	1993-94	10.7184	1.5
1973-74	2.2569	11.7	1994-95	10.8770	3.4
1974-75	2.5213	11.6	1995-96	11.2482	2.8
1975-76	2.8133	10.4	1996-97	11.5653	2.2
1976-77	3.1070	9.2	1997-98	11.8209	2.3
1977-78	3.3935	9.1	1998-99	12.0982	2.4
1978-79	3.7019	5.3	1999-2000	12.3834	3.9
1979-80	3.8971	21.3	2000-2001	12.8716	4.5
1980-81	4.7285	19.8	2001-2	13.4483	5.1

SOURCE.—University of California Office of the President, Director of Library Planning and Policy Development.

Many of the costs and prices used in this analysis were compiled in different years. In a number of cases the values have been inflation adjusted for comparison purposes. The adjustments were made using an inflation index designed specifically for use by the University of California Office of the President in Oakland, California, and compiled and maintained by the director of Library Planning and Policy Development. The values of that index are reproduced in table A1.

Appendix B

Collection-Management Initiative Shelf-Management Statistical Results

Table B1 summarizes a few of the more important ratios that were derived from the CMI conducted by the UCOP during 2002. It also presents two other constants that are used in the cost-model calculations.

TABLE B1
COLLECTION-MANAGEMENT INITIATIVE SHELF-MEASUREMENT STUDY BASE VALUES

Description	Value
Average number of feet of shelf space used for a single journal title	3.124
Average number of feet of shelf space used for a single volume of a journal	.132
Average number of volumes per title	32.40
Average number of volumes per title per year	3.93
Average number of volumes per title per year, assuming final year is unbound	4.23
Number of serial titles stored in a library in display format in one ASF of shelving per year	1.00
Number of serial titles stored in a library in a pamphlet box in one ASF of shelving per year	3.45

NOTE.—ASF = assignable square foot.

REFERENCES

1. Young, Mark; Kyrillidou, Martha; and Blixrud, Julia. *ARL Supplementary Statistics, 2000–2001*. Washington, DC: Association of Research Libraries, 2003. <http://www.arl.org/stats/sup/index.html>.
2. Van Orsdel, Lee, and Born, Kathleen. "Periodicals Price Survey, 2002: Doing the Digital Flip." *Library Journal* 127, no. 7 (April 15, 2002): 51–56. <http://www.libraryjournal.com/article/CA206383.html>.
3. Montgomery, Carol H. "Measuring the Impact of an Electronic Journal Collection on Library Costs." *D-Lib Magazine* 6, no. 10 (October 2000). <http://www.dlib.org/dlib/october00/montgomery/10montgomery.html>.

4. Montgomery, Carol H., and King, Donald W. "Comparing Library and User Related Costs of Print and Electronic Journal Collections." *D-Lib Magazine* 8, no. 10 (October 2002). <http://www.dlib.org/dlib/october02/montgomery/10montgomery.html>.
5. Montgomery, Carol H., and Sparks, JoAnne. "Framework for Assessing the Impact of an Electronic Journal Collection on Library Costs and Staffing Patterns." Paper presented at the Economics and Usage of Digital Library Collections Conference, Ann Arbor, MI, March 24, 2000. <http://www.si.umich.edu/PEAK-2000/montgomery.pdf>.
6. Cooper, Michael D. "A Cost Comparison of Alternative Book Storage Strategies." *Library Quarterly* 59, no. 3 (July 1989): 239-60.
7. Cooper, Michael D. "The Sensitivity of Book Storage Strategy Decisions to Alternative Cost Assumptions." *Library Quarterly* 61, no. 4 (October 1991): 414-28.
8. Cooper, Michael D. "A Cost Analysis of Book Storage Options at the National Library of Medicine." Technical report, School of Information Management and Systems, University of California, Berkeley, May 1999. <http://beachmat.berkeley.edu/~mike/TechReports/NLMStorageCosts1999.pdf>.
9. University of California Office of the President. "Uniform Fee Schedule and Model for UC Regional Library Facilities." Schedule prepared by the Office of Library Affairs, University of California, Berkeley, January 10, 1991.