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Do University Site Licenses for Academic Journals Benefit the Scientific Community?

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When academic journals were distributed only as paper editions, the obvious way for scholars to share a journal was to use the copy found on the shelves of their own university library. With the arrival of electronic access, the logistics of journal-sharing has changed radically. Physical proximity, which once made libraries the natural venue for shared access, is no longer important. Despite this change, university libraries have continued to act as publishers' revenue collectors and gatekeepers, by purchasing *site licenses* that entitle their faculty and students to access journals electronically.[1] Since there is no compelling *logistic* reason for university libraries to do so, we ask whether university-wide site licenses perform a *fiscal* function that benefits the academic community. We find a surprising answer. If a journal is priced to maximize the publisher's profits, scholars on average are likely to be worse off when universities purchase site licenses than they would be if access were by individual subscriptions only. But site-licenses are not *always* disadvantageous. Journals published by professional societies and university presses are often priced as if their objective is to achieve the largest possible circulation consistent with recovery of their costs. When such journals are sustained by institutional site licenses, the net benefits to the scientific community are larger than if these journals are sold only by individual subscriptions.

A Numerical Example

A simple example illustrates the basic reason for these findings. A scientific journal is of interest to four types of scientists, A, B, C, and D. There are 100 scientists of each type and the buyer values[2] of the four types for this journal are respectively, \$300, \$200, \$100, and \$50. The cost of editing the journal and putting it online is \$24,000. Once the journal is produced, there is no additional cost to adding another subscriber.

[1] Commercial publishers typically include electronic site licenses with print for a surcharge of 10-25% and offer electronic subscriptions without print for about the same price as print alone. It is common for commercial journal publishers to charge per-page prices that are 5 or 6 times the prices charged for similar journals by university presses and professional societies. See T. Bergstrom [3], P. Carey [4], R. Kirby [5].

[2] An individual's *buyer value* for an item is the largest amount of money that she would be willing to pay to have it rather than not have it. This is sometimes called the *reservation price* or *willingness-to-pay.*

A profit-maximizing publisher

Suppose that the journal's publisher is a profit-maximizer who must charge the same price to all buyers. At price \$300, only type A's buy the journal and 100 subscriptions are sold. At price \$200, the A's and B's buy, and 200 subscriptions are sold. At \$100, the publisher sells 300 subscriptions, and \$50 it sells 400. Profit is maximized by selling 200 subscriptions at \$200 each. Revenue is then \$40,000; since production costs are \$24,000, profit is \$16,000. A buyer's *consumer's surplus* is defined as the difference between her buyer value and the price that she actually pays. At a price of \$200, type A scientists each get a consumer's surplus of \$100, while type B's get zero consumer's surplus. Types C and D also get zero consumer's surplus since they pay nothing and get nothing. Scientists therefore receive a total consumers' surplus of $\$100 \times 100 = \$10,000$.

Now imagine that the scientists are employed at 100 universities, each of which employs one scientist of each type. The publisher chooses not to sell individual subscriptions but sells site licenses to university libraries; a site license provides free access to all scientists at a subscribing university. Acting in the best interests of its scientists, a university will buy a site license so long as the site license price does not exceed the sum of its resident scientists' buyer values.[3] Since each university has one scientist of each type, the sum of buyer values at each university is \$650. The publisher can set a price of \$650 and sell one site licence to each university. The 100 sales yield a revenue of \$65,000 and a profit of \$65,000-\$24,000=\$41,000.

With university site licenses, all four types of scientists get access to the journal while with individual subscriptions, only types A and B have access. Since there is no real cost to extending access to everyone, site licenses offer superior efficency. But paradoxically, with site licenses, the consumer surplus for the scientific community *decreases*. The site license price of \$650 is equal to the sum of all scientists' buyer values at each university. Thus, with site licenses, profit-maximizing publishers absorb *all* of the social gains yielded by the journal, leaving the scientific community no better off than if the journal did not exist.

[3] In practice, university librarians have only crude information about scientists' buyer values, based on requests and complaints. Thus a library's willingness to pay for a journal may deviate in either direction from the sum of faculty buyer values.

A non-profit publisher

What happens if this journal is produced by a professional society that seeks the largest possible circulation consistent with recovering its total costs from subscription revenue? The society could exactly recover its total costs by setting a price of \$80 and selling 300 subscriptions (to types A, B, and C). There is no price at which the society could recover its costs *and* sell to all 400 scientists, since the type D's will buy only if the price is \$50 or less. At a price of \$80, scientists of types A, B, and C have consumer's surpluses of \$220, \$120, and \$20 respectively. The scientists' total consumers' surplus is \$36,000.

Suppose that the society offers a site license to each of the 100 universities at a price of \$240. The sum of buyer values at each university exceeds \$240, and so all 100 libraries will subscribe. The total revenue of \$24,000 exactly repays the society's costs. Scientists at each university get a consumers' surplus of \$650−\$240 = \$410 and the sum of consumers' surpluses is \$41,000. Thus when the publisher prices at average cost, the provision of university-specific site licenses *increases* consumer's surplus.

Stochastic models

Our numerical example assumes that all universities employ the four types of scientists in the same proportions and hence all have the same willingness to pay for a site license. Thus a publisher can expropriate *all* of the benefits that arise from the existence of a journal by charging a single price equal to the sum of buyer values at each university.

To explore the outcome when universities are less uniformly constituted, we study models in which there are several universities and each university has n scientists[4] whose buyer values are drawn from a specified distribution function F. If journal access is sold by individual subscriptions at price p, then only those scientists with buyer values of at least p will subscribe and the seller's revenue will be proportional to $p\,(1 - F(p))$. If access is sold by university site licenses at a price np, then assuming that libraries purchase a journal when the sum of buyer values exceeds the price, a university will

[4] In the real world, variation in the size of universities produces variation in willingness to pay. If the prices of site licenses do not depend on university size, the largest universities retain some consumers' surplus, while very small univerisities will not subscribe. In principle, publishers could improve their profits by price discriminating by university size. Publishers have typically not done so when selling print editions, but recently several major publishers have begun to do so for electronic site licenses.

purchase the journal only if the *mean buyer value* of its faculty exceeds the *per capita* price p of a site license. In this case, the seller's revenue will be proportional to $p\,(1 - F_n(p))$ where F_n is the distribution of the sample mean for a group of size n. A profit-maximizing publisher will choose a per capita price p that maximizes its total revenue. For a specified distribution and any given size of university groups, we can calculate the profit-maximizing price, the publishers' expected profits, the scientists' expected per capita consumers' surplus, and expected deadweight loss.[5]

Thus we can explore the effect of group size on profits, consumers' surplus and deadweight loss. As group size increases, the variance of mean buyer values across groups decreases. For sufficiently large groups of equal size, this variance becomes arbitrarily small and a profit-maximizing seller can sell site licenses to almost all groups at a per capita price that is arbitrarily close to the population mean buyer value. Therefore for large group size, a profit-maximizing publisher captures almost the entire value of net benefits and the academic community is left with almost no consumers' surplus.[6]

The results for small groups are less straightforward. We have studied three distributions for which the distribution of sample means for small samples is managable: the normal distribution, the uniform distribution, and the exponential distribution. We discuss the case of the exponential distribution below. Results for the normal and uniform distribution are qualitatively similar, with a few interesting differences that space prevents us from discussing here.[7]

Exponentially distributed buyer values

Suppose that buyer values are distributed according to the exponential distribution function,[8] $F(x) = 1 - e^{-x}$. With this distribution, the mean buyer

[5]Deadweight loss is a measure of the inefficiency caused by excluding some scientists from access to the journal and is equal to the expected total of buyer values of those scientists willing to pay less than p for a subscription.

[6]Economists (Adams and Yellen [1], Schmalensee [6]) introduced a similar idea to explain the profitability to a monopolist of marketing a bundle of several products rather than selling them individually. Bakos *et al* [2] note that because group formation reduces variance of demand, sharing of software or video casettes among acquaintances may increase rather than decrease the seller's profits.

[7]Our code is available at `http://XXXXXXXXXX`, along with a similar analysis for the normal and uniform distributions. Calculations were performed numerically using *Mathematica*. David Park provided additional routines used in producing the graphs.

[8]We leave the choice of currency units unspecified. The reader may want to think of x as measured in hundreds of dollars. The exponential distribution is convenient because sample means of independent draws from this distribution have gamma distributions.

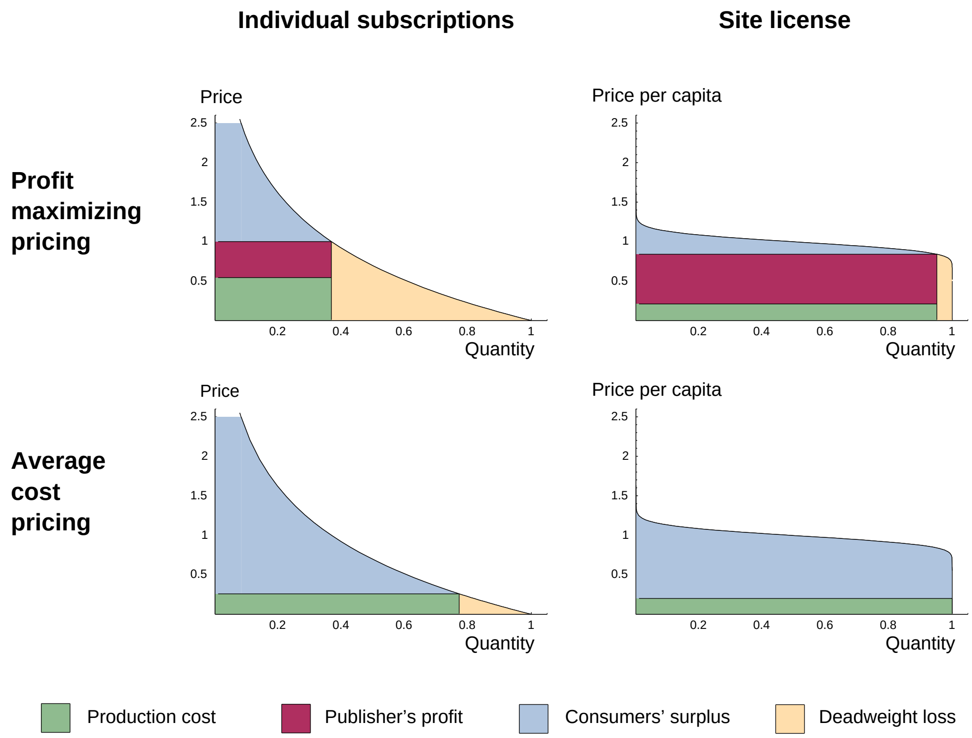

Figure 1: Demand curves, profits, costs, consumers' surplus, and deadweight loss for individual subscriptions and site-licenses.

value is 1. We assume that the total cost of producing the journal is 0.2 times the total number of scientists.

The graphs in the left column of Figure 1 show the demand curve for individual subscriptions. For each price, the corresponding quantity is the fraction of all scientists who would subscribe at this price. The graph in the upper left shows the outcome when the publisher is a profit-maximizer and that in the lower left shows the outcome when the seller prices at average cost. Simple calculus shows that a profit-maximizing seller would set the price $p = 1$ and sell subscriptions to the fraction $1/e$ of all scientists. A non-profit publisher could recover its costs by charging 0.26 per subscription and selling subscriptions to a fraction 0.77 of all scientists. The shaded areas in the graphs show total costs, profits, consumers' surplus and deadweight loss for each case.

The graphs in the right column of Figure 1 show the demand curve for

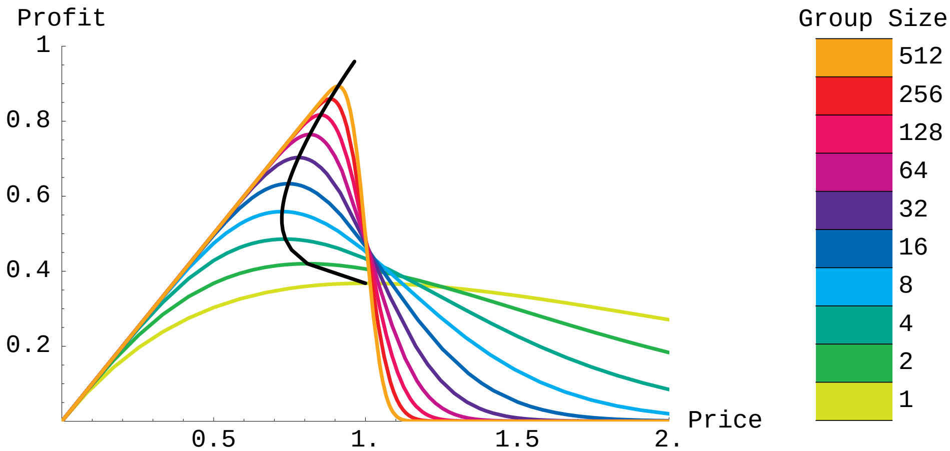

Figure 2: Per-capita profit as a function of price, for various site-license group sizes. The black arc traces the profit-maximizing price.

site licenses when scientists are randomly clustered into "universities" with 100 members. Here the demand curve gives the fraction of universities that would subscribe at each per capita price. The profit-maximizing price is 0.84 and at this price, 95% of all universities would subscribe. At a price of \$20 per capita for site licenses, virtually all universities will subscribe and thus a non-profit publisher will almost certainly recover its costs.

The single-peaked curves in Figure 2 show the relationship between the per-capita price and the publisher's per-capita profit when buyer values are exponentially distributed. Different colors correspond to different group sizes. For each group size, the profit-maximizing price is the value at which the price–profit curve peaks. The black curve connects the locus of these profit-maximal price–profit combinations. Moving along the black curve from the peak of the yellow curve (individual sales) to the orange curve (groups of 512), the profits of the seller rise monotonically, while the per-capita price decreases with group size for group sizes up to 7 and increases with group size beyond that.

Figure 3 shows that for a profit-maximizing seller, every increase in group size leads to an increase in seller's profits, a decrease in consumers' surplus[9],

[9]Consumers' surplus decreases even as per capita price decreases because the gain in surplus from reduced prices is offset by the chance that individuals with high buyer values will belong to groups with low average buyer values and thus be excluded from access.

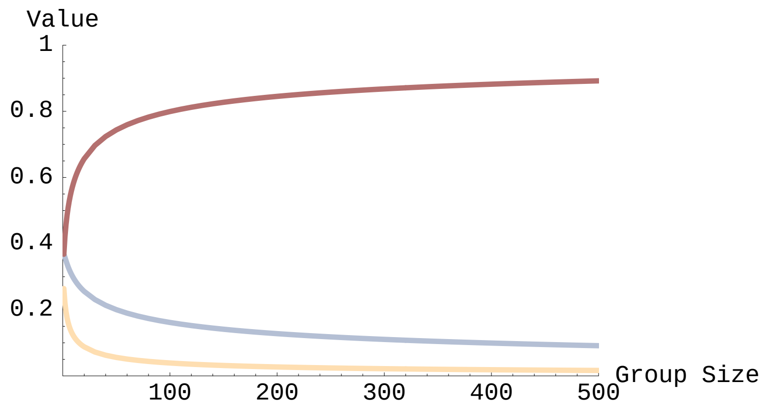

Figure 3: Per capita profit, consumer surplus and deadweight loss as a function of site-license group size, with a profit-maximizing publisher and exponentially distributed buyer values.

and a decrease in deadweight loss. Although the sale of site licenses to larger groups increases efficiency, in the sense of increasing the sum of profits and consumers' surplus, the gains in efficiency are more than absorbed by the sellers, so that the scientists are actually worse off as group size increases.

Discussion

Our models suggest that universities, acting collectively, would benefit by purchasing site licenses from journals that set their prices close to average cost and by refusing to purchase site licenses at prices significantly above average cost. Publishers pursuing maximum profits would be faced with the alternative of supplying site licenses at prices close to average cost or of selling individual subscriptions only. Either of these outcomes would leave the academic community with greater net benefits than a policy of purchasing journal site licenses whenever the sum of the buyer values of library users exceeds the price.

From the perspective of a single university, the solution to this dilemma is not so simple. Our examples assume that profit-maximizing publishers would set individual subscription prices to maximize individual subscription revenue. This would be a reasonable assumption if libraries collectively refused to buy site licenses at high prices. If libraries decide independently whether to buy site licenses, publishers have an incentive to set high prices for individual subscriptions, so as not to spoil the market for site licenses. Given high prices for individual subscriptions, it is likely that individual libraries act in their patrons' best interest when they purchase some site licenses priced far above average cost.

For non-profit journals, individual and collective incentives operate in the same direction. The scientific community benefits and individual universities benefit if libraries purchase site licenses and make access freely available to their faculty and students. Our analysis suggests that the scientific community would benefit if overpriced journals were displaced by journals that set prices close to their average costs. This makes a case for non-profit professional societies and university presses to expand their existing journals and to start new electronic journals. Individual scholars could advance this process by refusing to do unpaid referee work for overpriced journals and by favoring reasonably priced journals with their submissions.

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