Revised

Academic Journal Pricing and Market Power: A Portfolio Approach

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Abstract

Library demand for academic journals is unique. Cost per citation is minimized across a broad field of study, subject to a budget constraint, and the result is a demand for portfolios of titles. This paper describes the demand structure and develops a two-stage model of pricing. In this model publishers may find it profitable to increase the size of their journal portfolios via mergers. Using data for some one thousand biomedical journals, I estimate several empirical models including a structural model that is able to identify the impact of past mergers. The results indicate that the demand for journals is highly inelastic, that quality- and cost-adjusted price increases have been substantial over the past decade, and that past mergers have contributed to these price increases.

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Despite their influence on the careers of economists, the production and pricing of scholarly journals have received scant attention from the profession.[1] By contrast, the issue of journal quality and scholarly research productivity have been studied in far greater detail (a search in the EconLit database using the term "journal" generates several dozen papers on this topic). Although there may be a number of reasons for this "imbalance" it is likely that the tenure process, combined with the low (if not zero) effective cost of journals on campuses have influenced our research agenda. In other words, while professors worry about their job security (publish *well*, or perish), others -- their librarians -- are charged with maintaining "free" access to all relevant journals. Of course, this pattern is observed not just in economics but across academic disciplines.

In recent years, however, easy access to journals has become threatened. Beset by persistent journal price inflation (especially in the so-called STM fields, or science, technology and medicine) and stagnant budgets, many university libraries have been forced to re-allocate dollars from monographs to journals, to postpone the purchase of new journal titles, and in some cases, to cancel titles. As a consequence, libraries now need to rely more often on inter-library loans to satisfy faculty demands. This situation and its possible causes has been studied at great length in the library science literature. With few exceptions, a consensus has evolved there which focuses on the growing importance of commercial publishers in the market for scholarly journals: *Over the past decade or more, commercial firms have aggressively raised prices at a rate disproportionate to any increase in costs or quality. This appears to be especially true for the largest commercial firms.*[2] Although the analysis underlying these conclusions is generally not of the multivariate sort, it is suggestive enough to warrant further investigation.

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[1] Two exceptions are (1) "On the Optimal Provision of Journals qua Sometimes Shared Goods," Ordover, Janusz A. and Willig, Robert D., *American Economic Review*, v68 (3), June 1978, pp. 324-38 and (2) "The Determinants of Library Subscription Prices of the Top-Ranked Economics Journals: An Econometric Analysis," Chressanthis, George A. and Chressanthis, June D., *Journal of Economic Education*, v25 (4), 1994. pp. 367-82.

[2] An alternative explanation for journal price inflation has been offered by Lieberman, Noll and Steinmuller in their 1992 working paper, "The Sources of Scientific Journal Price Increase," Center for Economic Policy Research, Stanford University. They argue that entry by new titles over time has lowered circulation for existing journals, forcing the latter to raise prices to cover fixed costs. They estimate a supply and demand system for a set of journals and find that supply is downward sloping, consistent with this notion that individual titles exhibit scale economies. However, after controlling for this and other factors there remains a significant inflation residual that is unexplained by the model.

This paper summarizes the preliminary results of an ongoing effort to determine whether increased market power might have contributed to this price inflation. My interest in this subject began in late 1997 while I was still employed by the U.S. Justice Department's Antitrust Division. At that time, the Division began a series of reviews of proposed mergers between commercial publishers of science, technology, and medicine (STM) journals, including (1) Reed-Elsevier, Wolters-Kluwer and Thomson; (2) Wolters-Kluwer and Waverly; and (3) Harcourt and Mosby.

In a merger investigation the analytical challenge begins with market definition, followed by an assessment of potential competitive harm. However, as I discovered, this exercise is not routine in the case of academic journals. Customer demand and the definition of markets that result are unique for antitrust purposes. Although most STM journals are highly differentiated even within sub-disciplines, cost per journal citation is minimized across a broad field of study, subject to a budget constraint, and the result is a demand for *portfolios* of titles. In other words, unlike most markets involving differentiated products, it is not appropriate to model demand as a discrete choice process. Rather, the typical library attempts to provide access to as many STM journals as possible through a combination of subscriptions and inter-library exchanges.

The paper describes the demand structure and develops a model of pricing in this environment. One of the preliminary findings is that publishers may find it profitable to increase the size of their journal portfolios via mergers. A second objective of the paper is to examine whether past STM publishing mergers increased the merged firms' market power, resulting in higher prices. Using data for some one thousand biomedical journals, I estimate several empirical models including a structural model that is able to identify the impact of past mergers. The results indicate that the demand for journals is highly inelastic, that quality- and cost-adjusted price increases have been substantial over the past decade, and that past mergers have contributed to these price increases. I conclude with a discussion of future directions for this research and its relevance to antitrust policy in the US and abroad.

Antitrust Analysis and Journal Demand

The first step in antitrust analysis is defining the market in order to determine whether a monopolist could in fact wield power in this market. In scholarly publishing, experience as a user suggests that each *unique* journal title constitutes a distinct market for the purposes of antitrust analysis. For example, no one would argue that articles in *Brain Research* could be easily substituted for ones in the *New England Journal of Medicine*, much less those in the *American Economic Review*. If each title corresponds to an antitrust market, then owners of individual titles already have the capacity to achieve monopoly returns; a corollary is that mergers don't matter. Furthermore, even if markets are defined somewhat more broadly, say, to include titles whose content overlaps, the likelihood that two publishers (among dozens) would together control sufficient content (in a market with thousands of titles) to warrant antitrust scrutiny seems small.

These priors about market definition imply that demands for individual titles are unrelated. However, this intuition proved to be incorrect, at least for the major purchasers of STM journals, the libraries. Discussions with dozens of librarians revealed the following: purchase of academic journals by libraries is generally based on two factors — annual subscription price and expected usage. To assemble and maintain their collections, most libraries appear to construct a cost per use ratio for each title.[3] Given a budget for a relevant academic field, e.g., medicine, they then proceed to rank journals from lowest to highest in that field according to this ratio, and identify a cutoff above which titles need to be canceled; conversely, if their holdings in the relevant field do not exhaust the budget, additional titles can be purchased until the budget constraint is met. From year to year, as budgets and titles' usage change, collections are adjusted accordingly.[4] Over the past decade or so the general trend is for increases in library budgets to lag journal price inflation; a consequence is that many libraries have been forced to re-allocate dollars from monographs to journals, to postpone the purchase of new journal titles, and in some cases, to cancel titles.

The most interesting aspect of library journal acquisition, of course, is that individual titles within a given field are considered simultaneously. So, for example, medical libraries group titles from various sub-fields, e.g. neurology, biochemistry, clinical medicine, etc., into a single "portfolio" and broadly apply the

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[3] This claim is literally true for medical libraries; though other types of academic libraries may not be as precise in their processes, they appear to behave in similar fashion. In any case, this is an empirical question that can be tested using holdings data.

[4] This type of constrained optimization problem is commonly referred to in the operations research literature as a "knapsack" problem. Note that in practice a library's budget constraint may be "soft"; it may be expanded slightly to accommodate the marginal journal that doesn't quite "fit" the budget. For an introduction to this issue in the OR literature see "Introduction to Operations Research Techniques" by H. Daellenbach and J. George, Allyn and Bacon (1978).

cost per use criterion. Thus, titles compete with each other for budget dollars across an entire field, rather than across a narrow sub-field, as intuition might otherwise suggest (an intuition based on the perspective of the typical user of journal materials). Furthermore, since journal content is highly differentiated even within sub-fields, libraries try to provide access to as many STM journals as possible through a combination of subscriptions and inter-library exchanges.

Publishers' Pricing Strategies

Given this demand structure, how do publishing firms price their journals? First, there exist at least two types of journal companies— commercial and non-profit— and these have different strategies. In general, the latter are mostly intent on disseminating knowledge, whereas the former are primarily interested in profits. Here I assume that the non-profit firms set prices to cover costs (and are thus ignored in the analysis that follows).

A Model of Journal Pricing

Commercial journal publishers, like firms in any industry, will take into account the structure of demand and the likely strategies of competitors when setting prices. As described earlier, libraries – which constitute the bulk of demand for STM journals – attempt to purchase the most "usage" given their budgets for serials.[5] In practice this amounts to ranking journals on a cost/use basis and identifying a threshold cost/use value above which titles are no longer added (the budget is exhausted);

More formally, suppose there exists T titles of varying usage or quality, u_t.[6] Then given the price for each title, p_t, libraries can rank their journals on a cost/use

[5] To simplify the analysis, the possibility of inter-library exchanges is ruled out. This assumption implies that, on a cost/use basis, the cost of inter-library loans exceeds the costs of all subscriptions. In the next version of the paper I will explicitly address the possibility of an "outside good." Also, the model assumes that libraries make no duplicate purchases, an assumption that is generally correct except for the highest-use journals.

[6] To allow for the fact that journal usage will differ from library to library I permit the u_t to vary across institutions. However, I assume that the ratio u_t / u_s is constant in all libraries for any pair of titles, t and s. This assumption guarantees that cost/use rankings are identical across libraries.

basis,

$$p_{T-n}/u_{T-n} < p_{T-m}/u_{T-m} < .... \quad \text{where } 0 < m,n < T$$

And given some budget B, a library can choose titles for its collection according to this ranking until B is fully allocated. The cost/use ratio for the last title added, p^*/u^* can be used to determine subsequent additions and cancellations of titles.

How are prices set in this demand environment? I consider two cases: one in which the number of libraries exceeds the number of possible budget levels, and a second case where each library budget is unique.

Case 1: Budget Classes

To simplify the analysis suppose there are two types of library budgets, B_S and B_L, respectively, and $B_S < B_L$ (the results can be easily generalized to include additional budget classes). The corresponding population of each type is N_S and N_L (where $N_S + N_L > 2$). I assume that each of the T titles are sold by a separate publisher. No price discrimination is allowed, i.e. annual subscriptions are sold for a unique price. Common journal production costs consist of a fixed component, F > 0, and a marginal cost, c = 0.

We consider a two-stage game.[7] In the first period, each of the T firms consider whether to target (through advertising, etc.) all libraries or just those with large budgets. Once these sunk investments have been made, each firm takes into account the pricing strategies of firms that have made a similar marketing choice. To better understand this dynamic game, consider first the end-period pricing strategies.

Suppose z (T - z >0) firms have chosen to target all libraries. For sales to be made to the entire set of buyers by each of these firms it must be true that

$$p_1 + p_2 + p_3 + ... + p_z \leq B_S \qquad (1)$$

Given this budget constraint, how do each of the z firms set its price? Given

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[7] Although equilibria exist in a one-stage version of this game, the set of parameters for which they exist is smaller. In any case, the two stage version is more realistic.

libraries' cost/use selection criterion, a "high" price raises a firm's profits so long as it's associated cost/use ratio lies below the threshold of each library. Consider the case where firms have set prices so that their cost/use ratios are all equal, that is,

$$\frac{p_1}{u_1} = \frac{p_2}{u_2} = \ldots = \frac{p_z}{u_z} \qquad (2)$$

If (1) is also satisfied (with equality), then an increase in price by one firm results in the loss of its sales to at least the small budget libraries. A drop in price, on the other hand, has no effect on the firm's demand but lowers profits. Thus, when both (1) and (2) are satisfied a Nash equilibrium exists. The result for the T - z firms that target the large budget libraries is the same (note though, that in (1), B_S is replaced by $B_L - B_S$).[8]

Are each of these budget-class equilibria unique? Suppose (1) holds but not (2), i.e. at least two different cost/use ratios are observed. Then the lower ratio firms can increase profits with certainty by raising their prices a small amount. Libraries will respond by not purchasing from (some of) the higher ratio firms. Thus, in the second stage of the game, once firms have chosen a budget class, prices that satisfy (1) and (2) constitute a unique equilibrium. Using these two relationships, prices for firms targeting all libraries, and those targeting just large libraries, can be expressed, respectively, as

$$P_i = \frac{B_S * u_i}{\sum_{i=1}^{z} u_i} \quad , \quad P_j = \frac{(B_L - B_S) * u_j}{\sum_{j=z+1}^{T} u_j}$$

The corresponding (gross) profits are

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[8] Although cost/use ratios are identical for firms targeting the same budget class, this is unlikely *across* budget classes. In fact, such an occurrence is most improbable. Presumably, as budget classes are added to the model, the number of unique cost/use ratios increases as well. This result would correspond to the empirical fact that cost/use ratios vary greatly.

$$\Pi_i = \frac{(N_S + N_L) * B_S * u_i}{\sum_{i=1}^{z} u_i}$$

and

$$\Pi_j = \frac{N_L * (B_L - B_S) * u_j}{\sum_{j=z+1}^{T} u_j}$$

As intuition might suggest, in a given budget class, price and profits are increasing in a journal's quality. On the other hand, the price and profitability of a journal is decreasing in aggregate class quality.

Given this end-period result, how do firms select their target budget class? Since higher quality firms enjoy relatively more market power, one might expect these firms to target the most lucrative budget class. This in turn will be determined by the relative magnitudes of $(N_S+N_L)B_S$ and $N_L(B_L-B_S)$. For the remainder of this section of the paper, I assume that the former is larger. This assumption corresponds to the observation that in most journal markets the number of "small" libraries far exceeds the population of "large" ones, and that B_L-B_S is not "too" large.

With this assumption, a potential equilibrium candidate for the first stage game involves the z highest quality firms targeting all libraries, and the remaining T - z firms focusing on the large budget customers (an "ordered" equilibrium). For this to constitute a Nash equilibrium, no individual firm can wish to defect from its budget class. In the case of one of the z high quality firms this implies,

$$\Pi_i > \frac{N_L * (B_L - B_S) * u_i}{[\sum_{j=k+1}^{T} u_j] + u_i} \qquad (3)$$

For the lower quality firms, the corresponding inequality is

$$\Pi_j > \frac{(N_S + N_L) * B_S * u_j}{[\sum_{i=1}^{z} u_i] + u_j} \qquad (4)$$

Combining (3) and (4) yields the following equilibrium condition,

$$\frac{[\sum_{j=z+1}^{T} u_j] + u_i}{\sum_{i=1}^{z} u_i} > A > \frac{\sum_{j=z+1}^{T} u_j}{[\sum_{i=1}^{z} u_i] + u_j} \qquad (5)$$

where

$$A = \frac{N_L (B_L - B_S)}{(N_S + N_L) B_S} < 1$$

The LHS inequality in (5) is simply a re-arranged form of (3); the RHS inequality is based on (4). For a Nash equilibrium to exist in this stage, (5) must hold for all firms. Furthermore, if (5) holds for the *zth* and *Tth* journals, it is easy to demonstrate that (5) is satisfied for all firms. To see this, note that for the zth journal the LHS is at its *minimum* value ($u_z < u_i$ for all i < z); for the Tth journal, the RHS ratio is at its *maximum* value ($u_T < u_j$ for all j < T). If (5) holds for these two firms, then it is satisfied in all instances.[9] Thus, searching for an "ordered" equilibrium involves first checking that the RHS inequality holds for the Tth journal and then identifying the marginal high quality journal for which the LHS inequality

[9] To rule out other possible equilibria, it is necessary to check whether (5) would hold if one or more of the high quality firms exchanged places with lower quality firms, i.e. they switched budget classes. In the example discussed below, (5) is not satisfied under these alternative scenarios and thus the equilibrium described is unique.

is satisfied.

How do mergers affect outcomes in this simple model? There are a number of potential scenarios: mergers within budget classes, those across budget classes, and some combination of these first two cases. Consider the case of a within-class merger involving two high-quality firms. What pricing strategy does the merged firm adopt? As we noted earlier, a journal's profitability is decreasing in aggregate class quality. This suggests that the merged firm might benefit from raising the price of one of its titles enough to cause the small budget libraries to drop it and replace it with a lower quality title. This would lower the aggregate quality of firms targeting all libraries, and thus enhance the profitability of the merged firm's remaining general circulation title. The profitability of the "dropped" title may go up or down (if the pre-merger equilibrium was unique, then profits decline), depending on the model's parameters. The sum of these two components will determine the post-merger pricing strategy. If the net effect is positive, then the merger is harmful: the average quality of library collections decreases.

This result can be easily expressed using the above notation. Refer to the two high quality titles controlled by the merged firm as journals "1" and "2." Suppose the title now targeted at large budget libraries (the "dropped" title) is journal 2. Its profits are then

$$\Pi_2^{post-merger} = \frac{N_L * (B_L - B_S) * u_2}{[\sum_{j=z+1}^{T} u_j] - u^* + u_2} < \Pi_2^{pre-merger}$$

where u^* is the quality of the journal that now replaces journal 2 in small budget collections. I assume that the pre-merger equilibrium was unique. This implies that 2's post-merger profits decline.

Journal 1's profits are

$$\Pi_1^{post-merger} = \frac{(N_S + N_L) * B_S * u_1}{[\sum_{i=1}^{T} u_i] + u^* - u_2} > \Pi_1^{pre-merger}$$

Journal 1's profits increase since aggregate quality in its budget class declines.

This strategy will be adopted if

$$\Delta\Pi_1 + \Delta\Pi_2 > 0$$

A Numerical Example:

- Five Publishers, each sell one title.
- The five journals vary in use or quality, u, with values of 12, 10, 8, 6, and 4.
- Two types of library budgets, small and large, with values of 10 and 20, respectively.
- 125 libraries have small budgets, 75 have large budgets.

Given these parameters one can demonstrate that a unique "ordered" Nash equilibrium exists with the following characteristics

- The three highest use titles are sold to all libraries; the two lowest use titles are sold to just the large-budget libraries.
- Prices, cost/use and profits are as follows:

Use Value	Price	Cost/Use	Profits
12	4	0.33	800
10	3.33	0.33	667
8	2.67	0.33	533
6	6	1	450
4	4	1	300

Suppose a merger occurs between firms owning titles with use value 12 and 8. What are the features of the post-merger equilibrium?

- ❑ It is profitable for the merged firm to raise the price of the “8" journal significantly, resulting in a re-targeting of its customer base, namely the large budget customers; the owner of the “6" journal finds it profitable to reduce its price and sell to all libraries.

- ❑ The quality of small-budget libraries declines by 7%.

- ❑ Post-merger prices, cost/use and profits are as follows:

Use Value	Price, (Δ)	Cost/Use, (Δ)	Profits, (Δ)
12	4.29 (+0.29)	0.36 (+0.03)	857 (+57)
10	3.57 (+0.24)	0.36 (+0.03)	714 (+47)
8	6.67 (+4)	0.83 (+0.5)	500 (-33)
6	2.14 (-3.86)	0.36 (-0.64)	429 (-21)
4	3.33 (-0.67)	0.83 (-0.17)	250 (-50)

Case 2: Unique Budgets

Allowing for unique library budgets changes the analysis in subtle but important ways. Suppose N unique budgets, B_i, are distributed according to some continuous density function, $f(B_i)$, with support (B_L, B_H) and cdf, $F(B_i)$, where $F(B_L)=0$ and $F(B_H)=1$. Assuming the same two-stage game as before, analysis of the second stage in the game is simplified since each of the T firms target a different set of libraries in the first period.

Suppose this is true, then in the second period firms choose prices consistent with their first period choices. For example, consider an ordered equilibrium in which during the first period the highest quality firm, Z_1, targets the largest population of libraries, with support (B_1, B_H) where $B_1 \geq B_L$; the next highest quality firm, Z_2, targets a subset of this population with support (B_2, B_H) where $B_2 > B_1$, and so on. Then, in the second period, Z_1 sets a price, P_1, equal to B_1, Z_2 sets a price, P_2, equal to $B_2 - B_1$, etc. Because of their first period choices, firms have no incentive to undercut (in a cost/use sense) other firms selling to larger library populations since undercutting has no impact on quantity sold. Similarly, given that their first period choices are optimal, no firm has an incentive to raise prices and sell to a smaller population.

So how do the T firms choose their target population in the first period? Consider an ordered equilibrium where T=2. Given the distribution of N budgets, Z_1 needs to target a population set so that Z_2 has no incentive to "undercut" and target a larger set. In terms of second period prices,

$$P_2 \, N \, (1 - F(P_1 + P_2)) \geq (u_2/u_1) \, P_1 \, N \, (1 - F((u_2/u_1)P_1)) \qquad (1)$$

where u_1 and u_2 correspond to the quality of Z_1 and Z_2, respectively, and $u_1 > u_2$. Similarly, given Z_2 's targeted population, Z_1 can't find it profitable to target a smaller, higher budget population:

$$P_1 \, N \, (1 - F(P_1)) \geq (u_1/u_2) \, P_2 \, N \, (1 - F(P_2 + (u_1/u_2)P_2)) \qquad (2)$$

For T=3, the number of relevant constraints increases to 6 (3 x 2); for T=4 the number is 12 (4 x 3), etc. Depending on journal quality, the distribution of budgets, etc., some of these constraints may be redundant.

In a number of simulations, ordered equilibria were observed that resemble the actual data, e.g. high quality journals exhibit high prices and low cost/use ratios while low quality journals have low prices and high cost/use ratios.[10] Furthermore, mergers between various firms in these simulations were often profitable. Typically multi-journal firms raised the price of their lower quality, higher cost/use journals substantially while slightly lowering the price of their highest quality, lower cost/use journals; other firms' prices adjusted in similar fashion. An explanation is that by lowering the price of high quality journals "more" demand remains for the low quality journals, allowing the latter to raise prices disproportionately.

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[10] In the simulation ten firms, each owning a single journal, compete for sales to libraries. The journals vary in quality by a factor of 70, and library demand for journals is a linear function of budget size, $Q(B) = A - dB$ where A and d are positive constants.

Testing the Portfolio Theory

The Institute for Scientific Information (ISI) tracks citations for over 8,000 STM journals in various fields. Some guesses place the world population of academic journals close to 30,000. Not surprisingly, the number of publishers, both commercial and non-profit, is large as well. With respect to biomedical journals, ISI tracks titles published by at least 70 companies. Over the past decade a flurry of merger activity has been observed in the STM publishing market, particularly in the past two years. Since the latter half of 1997 alone, at least six major commercial publishers have been purchased by competitors. In addition, numerous small-scale transactions involving one or two journal titles occur every year.

Although these recent natural experiments will provide a rich empirical opportunity in the near future (once several years of post-merger prices are generated), two mergers that occurred earlier in the 1990s should shed some light on the likely impact of this ongoing merger wave. In 1991, Reed-Elsevier purchased Pergamon and its large portfolio of STM titles, including some 57 ISI-ranked biomedical journals. At the time, Elsevier's biomedical portfolio numbered 190 titles. During the same period, Wolters-Kluwer added Lippincott's 15 ISI-ranked biomedical titles to its collection of 75 biomed journals. Since that time both companies's portfolios have grown further. In 1998, according to ISI data, Elsevier's portfolio stood at 262 titles; Kluwer controlled 112 journals.

A. Empirical Models

Previous empirical studies of journal pricing have not attempted to assess the extent of market power in the academic publishing market. Cressanthis and Cressanthis (1994) specified a reduced form hedonic model to study the determinants of economic journal pricing. Their results suggest that prices are related to journal characteristics (e.g., prices are increasing in journal quality and size). Lieberman, et. al. (1992) estimated a supply and demand system using data for 225 ISI-ranked science journals. They find that supply is downward sloping, consistent with the notion that publishing is characterized by scale economies at the individual title level. Based on this evidence they argue (indirectly) that entry by new titles has lowered circulation for existing journals, forcing the latter to raise prices to cover fixed costs. Furthermore, they identify a significant inflation residual that is unexplained by the model.

Three empirical models are estimated here. First, to test whether libraries' acquisition strategies reflect a ranking of journals according to cost/use values, we estimate an exponential cumulative distribution function. We test whether cost/use values and journal demand are inversely related. Second, we estimate a structural two-equation model that explicitly accounts for the possibility of increased market power due to mergers. Third, we estimate a reduced form Bertrand reaction function that is a function of firm portfolio size.

1. Exponential CDF

An examination of the Medical Library Association's membership list reveals that most member libraries maintain small to medium collections, reflecting their modest budgets. Major research collections constitute a relatively small fraction of this population. Thus, it is anticipated that demand for low cost/use journals should greatly exceed demand for high cost/use titles. The exponential density function and its corresponding cdf is appropriate in this context for testing whether higher cost/use values (observed in larger budget collections) and journal demand are inversely related.

After ranking journals according to their cost/use values, library budgets can be constructed from the observed price data. In other words, if library *i* in the sample subscribes to *m* titles from a population of *n* titles (*n* > *m*), these journals should be the *m* lowest cost/use journals, with a budget equal to

$$B_{im} = \sum_{1}^{m} p_i \quad .$$

The expected value for journal m's demand can then be expressed as a product of the observed library population, N, and the cumulative probability of library budgets larger than or equal to B_{im}:

$$N \int_{B_m}^{\infty} \frac{e^{-B/a}}{a} dB = N\, e^{-B_m/a}$$

Taking logs, the estimating demand equation is

$$\log(q_m) = \log(N) + (1/\alpha) \bullet B_m + \epsilon$$

where ϵ is an iid disturbance term. To facilitate comparison across different years in the sample, e.g. 1991 and 1995, journals that had missing observations in either year were omitted. Furthermore, since demand for the relatively small number of general subject journals is distinct from the majority of more specialized titles, the former are excluded as well (see below for an explanation on how these general titles can be identified).

2. Structural Market Power Model.

The model of journal pricing presented earlier implies that publishers' prices are likely to exceed marginal costs. The extent of this market power is influenced by journal quality, library budgets, as well as the number and quality of competitive titles. Furthermore, under certain conditions it is profitable for a firm to raise its prices after an increase in portfolio size resulting from a merger. The challenge in establishing the empirical importance of this latter possibility lies in isolating the influence of portfolio size on prices. Cost increases, quality improvements, changes in demand elasticity, etc. are all potential confounding factors. I specify a model below that is designed to identify the effects of mergers during the sample period. The empirical model borrows from the existing literature, especially Baker and Bresnahan (1988), Baker (1989), and Rubinovitz (1993) (1989).[11] None of these papers, however, consider the impact of mergers on pricing.

Consider the following inverse demand function:

$$P_i = f(Q_i, \mathbf{Q}, \mathbf{Y_i}) + \epsilon \qquad (1)$$

where P_i is the price of journal *i*, Q_i is the number of annual subscriptions to journal i, **Q** is the vector of subscriptions to other journals, $\mathbf{Y_i}$ is a vector of exogenous factors that can shift demand, and ϵ represents random fluctuations in demand. Because of the large number of journals in the sample, it is necessary to reduce the dimensionality of (1). Furthermore, the main source of this problem, the vector **Q**, is endogenous. To address both of these econometric issues, a

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[11] Jonathan Baker and Timothy Bresnahan, "Estimating the Demand Curve Facing A Single Firm," *International Journal of Industrial Organization*, Vol. 6 (1988), pp. 283-300. Jonathan Baker, "Identifying Cartel Policies Under Uncertainty: The U.S. Steel Industry, 1933-1939," *Journal of Law and Economics*, Vol. 32 (1989), pp S47 - S76. Robert Rubinovitz, "Market Power and Price Increases for Basic Cable Service Since Deregulation," *Rand Journal of Economics*, Vol. 24 (1993), pp. 1-18.

single-dimensional, exogenous variable, Δu_i, is substituted. This variable is defined as (u_i - u^*) where u^* is the mean value of journal quality in the sample. Δu_i, is assumed to be exogenous, and acts as an instrument for **Q** since sales of other journals are a function of their (relative) quality. After this substitution, the inverse demand can be written as

(1') $$P_i = f(Q_i, \Delta u_i , \mathbf{Y_i}) + \epsilon$$

Using (1') a marginal revenue curve can be derived by differentiating revenue with respect to Q_i:

(2) $$MR_i = P_i + Q_i f_Q + \epsilon$$

where f_Q (<0) is the partial derivative of the demand function with respect to Q_i. By equating (2) with the short run marginal cost of producing journal i, the following "quasi-supply" relationship can be defined:

(3) $$P_i = -Q_i f_Q + c(\mathbf{Z}_{i,} \mathbf{W}_i) + \mu$$

where $\mathbf{Z_i}$ and $\mathbf{W_i}$ represent vectors of endogenous and exogenous factors, respectively, that may shift costs, and μ is a random cost shock. Typically, to allow for the possibility that market power is not fully exercised an additional parameter, θ, is introduced, so that (3) can be rewritten as:

(4) $$P_i = -\theta_i Q_i f_Q + c(\mathbf{Z}_{i,} \mathbf{W}_i) + \mu$$

The monopoly outcome holds when $\theta_i = 1$; $\theta_i = 0$ corresponds to perfect competition.

Note that the marginal cost function is independent of Q_i, an assumption that is generally accepted as true in journal publishing. This condition allows us to empirically identify an increase in market power due to mergers among publishers. When marginal costs are independent of Q_i (and efforts are made to account for other factors that may shift costs), there remain two other possible explanations for an observed increase in journal prices following a merger. One possibility is that the absolute value of journal *i's* demand elasticity has declined, holding market power, or θ_i, constant. An alternative explanation is that θ_i has increased.

To simplify the estimation, the demand function for journal *i* is assumed to take the following form

$$P_i = e^{a\,0} e^{a\,1\Delta u_i} Q_i^{a\,2} Y_i^{a\,3} \cdots Y_i^{a\,N} e^{e} \qquad (5)$$

Given this functional form, the derivative of demand with respect to Q_i equals

$$f_{Q_i} = a_1 P_i / Q_i \qquad (6)$$

Substituting equation (6) into (4), equation (4) can be written as

$$P_i = -\theta_i\, \alpha_1\, P_i + c(\boldsymbol{Z_i}, \boldsymbol{W_i}) + \mu \qquad (7)$$

or

$$P_i = (c\,(\boldsymbol{Z_i}, \boldsymbol{W_i}) + \mu) / (1 + \theta_i\, \alpha_1\,). \qquad (8)$$

If $c(\boldsymbol{Z_i}, \boldsymbol{W_i}) = e^{\beta 0} Z_i^{\beta 1} W_i^{\beta 2} e^{\mu}$ (where the Z_i and W_i are taken to be scalars), then after taking the natural log of both sides of (8) this equation becomes,

$$\ln P_i = \beta_0 - \ln(1 + \theta_i\, \alpha_1) + \beta_1 \ln Z_i + \beta_2 \ln W_i + \mu \qquad (9)$$

Since $\theta_i\, \alpha_1$ is likely to be relatively small for our application, $\ln(1 + \theta_i\, \alpha_1) \approx \theta_i\, \alpha_1$, and so (9) can be simplified to

$$\ln P_i = \beta_0 - \theta\alpha_1 + \beta_1 \ln Z_i + \beta_2 \ln W_i + \mu \qquad (10)$$

This general form of the quasi-supply function is estimated below. However, θ_i, the primary parameter of interest cannot be identified. To overcome this difficulty, consider the following strategy. If $(\theta_i\, \alpha_1)$ changes after a merger, and (10) can be estimated using data from before and after a merger, then it is possible to identify the *change* in this product by estimating

$$\ln P_i = \beta_0 - \theta_i\, \alpha_1 - (\theta_i\, \alpha_1)^{*} \bullet \text{Merger dummy} + \beta_1 \ln Z_i + \beta_2 \ln W_i + \mu \qquad (10a)$$

where *Merger dummy* is a dummy variable that takes on a value of one for post-merger observations associated with journal *i* and zero otherwise; $(\theta_i \alpha_1)^*$ is the post-merger change in this product. Therefore, estimating (10a) provides an estimate of price changes due to a merger, after controlling for changes in journal costs and quality. To determine whether the change in this product is due to a change in θ_i and/or α_1 it is necessary to estimate a modified version of (5) that provides values for α_1 and the change in this parameter, α_1^*.

The two equations to be estimated, the quasi-supply function and the demand function, have the following form:

(10a') $\ln Price_{ijt} = \beta_{ij} - (\theta_j \alpha_{1j})^* \bullet Merger\ dummy_{jt} + \beta_1 \ln Papers_{ijt} + \beta_2\ Time\ trend_t + \mu_{it}$

(5') $\ln Subscriptions_{ijt} = A + \delta_1 \bullet \Delta u_{it} + \delta_{1j} \ln Price_{ijt} + \delta_{2j}^* \ln Price_{ijt} \bullet Merger\ dummy_{jt} + \delta_3 \bullet \ln Citations_{it} + \delta_4 \bullet BH\ dummy_i + \epsilon_{it}$

The three subscripts, *i, j,* and *t*, refer to journal *i*, publisher *j,* and year *t.* Note that $\delta_{1j} = 1/\alpha_{1j}$.

β_{ij}: firm ***j***'s fixed effect, common to all journals *i* owned by ***j***.

Subscriptions$_{it}$: the number of medical libraries that purchased annual subscriptions to journal *i* in year *t*.

Price$_{ijt}$: the institutional annual subscription price for journal *i* in year *t*.

Citations$_{ijt}$: the number of citations received by articles published in journal *i* in years *t-4* through *t* in year *t.*

BH dummy: a dummy variable that equals one if the journal is listed in the Brandon-Hill journal list, and zero otherwise.[12] This variable indicates whether a journal is a general (=1) or specialized title (=0), and is thus an exogenous measure of circulation "potential."

Papers$_{it}$: measured by the number of papers published by journal *i* in year *t*.

Time trend : a continuous variable that equals one if an observation is associated

[12] Brandon, Alfred N., and Dorothy R. Hill, "Selected List of Books and Journals for the Small Medical Library," *Bulletin of the Medical Library Association* 85.2 (Apr. 1997): 111-35.

with 1988, 2 if the associated year is 1989, etc.

Δu_{it}: ($Citations_{it}$ - $MCITES_t$) where the latter term in the parentheses is the mean value of citations in year t.

Demand for a journal is expected to be decreasing in price, increasing in citations and Δu, and increasing when journals are classified as a BH title. A publishers' journal price is expected to be decreasing in the subscription count, increasing in the number of papers published, and increasing over time.

Three variables in the model are treated as endogenous - *Price*, *Subscriptions*, and *Papers*. Publishers may change a journal's paper count for any number of reasons – increasing (or decreasing) interest in a subject, as part of a strategy to enhance quality, etc. – and can do so in a timeframe of a year or less. Therefore, it is reasonable to treat *Papers* as an endogenous factor. To improve the precision of the 2SLS estimates, two excluded exogenous variables are used as instruments: log *Age* and $(\log Age)^2$, where *Age* = [Year of observation - journal i's year of first publication], e.g. [1995 - 1945]. A journal's age is a good instrument for *Papers* in particular because older journals tend to publish more articles.

The effects of two mergers are evaluated. The firms involved were Reed/Elsevier and Pergamon, and Wolters/Kluwer and Lippincott. Both combinations occurred during 1990-91.[13] For these 4 publishers, $Merger\ dummy_{jt}$ =1 for the period 1992-98. Furthermore, in (10a'), separate intercepts are estimated for each publisher; for each firm involved in a merger a separate $Merger\ dummy_{jt}$ coefficient is estimated. Similarly, in (5'), separate $Price_{ijt}$ coefficients (corresponding to the demand elasticities) are estimated for each publisher; and again, for each firm involved in a merger a separate value for α_{1j}^* is estimated.

3. Reduced Form Bertrand Reaction Function

The models of journal pricing discussed earlier suggest that larger firms may find it profitable to set higher prices, all else equal. One method for testing this hypothesis is to specify a reduced form Bertrand reaction function that includes a measure of firm size, namely the number of journals in a firm's sample portfolio. Two econometric concerns must be addressed when using this approach. First, is firm size exogenous? Second, are there other factors besides firm size that

[13] To best evaluate the impact of these mergers, only journals that existed *prior* to 1989 are included in the estimation. This is the vast majority of observations in the sample.

may permit a firm to set higher prices? With respect to the first issue, the use of panel data and the ability to specify firm-specific fixed effects eliminates most of the interpretive problems normally associated with this variable.[14] If firm size is merely a proxy for some other X-factor (say, lower costs, or skill at introducing new journals), then specifying fixed effects allow us to measure the impact of changes in portfolio size over time holding firm attributes constant. Regarding the second issue, changes in a product's residual demand, a shift in firm conduct, etc., will influence equilibrium prices and may be correlated with firm size. Hence, the results from this reduced form approach should be evaluated in the context of those obtained elsewhere in the paper.

The reduced form model specification is

$$\ln \text{Price}_{ijt} = \beta_j - \beta_1 \text{ PortSize}_{ijt} + \beta_2 \text{ Time trend}_t + \beta_3 \bullet \Delta u_{it} + \beta_4 \bullet \ln \text{Citations}_{it} + \beta_5 \bullet \text{BH dummy}_i + \beta_5 \ln \text{Age}_{it} + \beta_5 (\ln \text{Age}_{it})^2 + \mu_{it}$$

where

PortSize$_{ijt}$: the number of journals in the sample owned by firm ***j*** in year ***t***, common to all journals ***i*** owned by ***j***.

The remaining variables are defined as before in section 2.

B. Data

For the period 1988-98, the DOJ collected publisher and price data for some 3000 journals, and holdings information from various libraries. This data has been supplemented with additional information extracted from the Institute for Scientific Information's (ISI) Journal Performance Indicators database (JPIOD). This database allows us to calculate annual citation rates for individual journals[15]; JPIOD also includes the number of papers published annually by each journal during the sample period.

This paper's empirical discussion is focused on a subset of these several

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[14] See Richard Schmalensee's chapter in the Handbook of Industrial Organization, Handbooks in Economics 10, Amsterdam; New York: North Holland, 1989.

[15] Journal citations are used as a proxy for actual usage in libraries.

thousand journals, namely, biomedical titles. The reasons for this choice are several. First, based on our discussions with various librarians, biomedical libraries are most likely to evaluate their purchases using the portfolio approach described earlier; furthermore, these libraries typically make no distinctions among various biomedical disciplines, permitting us to consider all biomedical titles as part of a single, large portfolio. Finally, practical considerations, including the fact that biomedical holdings data is reported in a relatively standard fashion, encouraged our initial focus on this subset of titles.[16]

During the sample period, almost two thousand ISI-ranked biomedical journals were published; price data were available for about 1800 of these titles (complete time series were available for most but not all journals). Of this latter group, almost 1400 were published by organizations with at least three ISI-ranked titles. For the analysis presented here, only journals sold by commercial firms with portfolios consisting of ten or more titles were considered (thus excluding journals distributed by small private publishers as well as the non-profits). Complete holdings data for 194 U.S. medical libraries were collected, representing in aggregate some 60,000 subscriptions to ISI-ranked journals; the libraries were randomly selected from among Medical Library Association members (the MLA's membership numbers approximately 1500). Libraries of all sizes are represented in the sample, some holding less than ten subscriptions, while others report collections exceeding 1,300 titles.

The sample period, 1988-1998, is useful in at least two respects. First, it is sufficiently long to assess whether inflation continues to plague the journal market (and dovetails nicely with Lieberman, et. al.'s (1992) sample, which includes data from 1978-88). Second, as described above, the period contains a number of natural experiments, i.e., publishing mergers, that enables us to identify the impact of mergers on pricing. Growth via merger should be distinguished from organic internal growth arising from the introduction of new titles. The latter may produce benefits (such as coverage of emerging fields of study) that helps to offset any intentional competitive harm; harm associated with acquisitions, on the other hand, is less likely to be balanced by substantial benefits – journals are

[16] Unlike most fields, biomedical scholars enjoy the use of the National Library of Medicine's central database that contains information on several thousand medical collections. Although this data source offered substantial benefits with respect to the initial phase of data collection, the data was not ideally organized for analysis purposes. One of the major difficulties was that much of the data - some 25% -- was too idiosyncratic for data processing; as a consequence several hundred additional hours of manual effort were required to transform the data into usable form.

simply reshuffled, and any fixed cost savings seem to be small.[17]

Descriptive Statistics

Using the ISI-defined biomedical portfolio and the corresponding library holdings we can calculate the actual size of various commercial publishers' journal portfolios as well as the observed sample portfolios. Table 1 reports this information using both sources. It is clear from this table that significant variation in portfolio size exists in the industry. Note that, based on the ISI numbers, the proposed 1998 merger between Reed/Elsevier, Wolters/Kluwer and Thomson would have affected about 42% of the biomedical titles owned by large commercial publishers.

Table 2 presents information on average price, citations, cost/use (price/citation), and number of papers published for each publisher in the years 1988 and 1998. Though prices, citations and paper counts generally increased during the period, the rate of change for prices was far more striking, resulting in higher cost/use numbers by the end of the period. For example, Elsevier's average journal price more than tripled during the period, while the corresponding citation and paper counts increased less than 25%.

Table 3 provides average circulation rates for titles by publisher in 1988 and 1998.[18] Given that nominal prices for increased dramatically over the sample period, the apparent inelasticity of demand indicated by these numbers is remarkable. It suggests that library serials budgets increased sufficiently during the period to absorb most of the price increases. At the same time, these numbers provide indirect support for the model of journal pricing presented earlier in the paper: all else equal, if library budgets increase, firms have an incentive to proportionally raise prices.

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[17] Furthermore, if publishing mergers do result in cost savings, economic theory implies that post-merger prices should *decline*, everything else equal.

[18] These numbers exclude titles that commenced publication after 1988. Including these newer titles would tend to lower the reported 1988 figures relative to the later 1998 numbers.

Estimation Results
The estimation results for the exponential cdf, structural market power, and reduced form Bertrand reaction function models are reported in Tables 4, 5, and 6, respectively. In Table 4, the results for the exponential cdf model are consistent with expectations. The *budget9X* parameters are negative and significant in both 1991 and 1995. The results suggest that higher cost/use journals are purchased by few libraries. For example, in 1991, the marginal journal for a $100,000 budget library has a cost/use value equal to about 0.22 and, using the parameter estimates, is held by about 30 of the 194 libraries in the sample. The marginal journal for a $200,000 budget library has a cost/use value equal to about 0.59, and is held by some 17 libraries. The smaller parameter value in 1995 reflects the combined effect of low demand elasticity and substantial price inflation over the 4 year period. A library that purchased the complete set of titles in both years experienced about a 70% increase in outlays, from approximately $292K to $498K.[19]

Turning to the structural model results, Table 5 reports only the parameters of interest, e.g. the various firm-specific intercept terms in the quasi-supply function are omitted. Note also that in the demand equation, the price coefficients for Pergamon and Lippincott are estimated relative to the corresponding estimates for their merger partners.

Parameters for the *Time Trend, ln Papers, Brandon Hill,* Δu, and *ln Citations* variables are all precisely estimated and have the expected signs. The Time Trend estimate implies that, after controlling for changes in quality and costs, publishers increased annual journal prices some 140% over the 1988-98 period. Demand for titles included in the Brandon-Hill list is on average 90% larger than demand for more specialized journals. The Δu parameter suggests that as a journal's quality improves relative to the average value in the sample, demand increases. All else equal, higher values for *ln Papers* and *ln Citations* increases equilibrium prices and shifts demand outward, respectively.

Demand is apparently very inelastic. The reported parameters indicate that the merging firms' demand elasticities were all greater than -0.36 (none of the estimated elasticities were less than -0.50). These results suggest that publishers have an incentive to completely exhaust library serial budgets. Of course, the results for the *Time Trend* parameter suggest that this did occur.

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[19] Remember that this "complete set of titles" is a subset of the sample analyzed in the other 2 models

This observation is consistent with numerous librarians' experiences and with what some publishers have admitted in our conversations.[20] Given this combination of inelastic demand and price inflation, any increases in library budgets are likely to just cover the cost of existing subscriptions at the expense of new collection development.

Did the two publishing mergers earlier in the decade enhance the participating firms' market power? With respect to the Elsevier-Pergamon transaction the answer is quite clear. Since the *Price•Merger dummy* parameters in the demand equation for these two firms are equal to zero, we can interpret the corresponding *Merger dummy* coefficients in the quasi-supply equation as pure, merger-induced market power effects. Post-merger, Elsevier journal prices increased about 5.2% and the former Pergamon titles experienced a 27% increase. Note that this asymmetry corresponds to the two firms' pre-merger differences in portfolio sizes (begging the question of whether a theoretical counterpart exists.). This "asymmetry correspondence" is observed in the Kluwer-Lippincott merger as well. Post-merger, the former Lippincott titles, experienced a 30% price increase while the Kluwer prices remained basically unchanged. However, in this case the Lippincott price increase is not solely a consequence of enhanced market power. The Lippincott *Price•Merger dummy* estimate implies that demand for Lippincott titles became slightly more inelastic in the post-merger period, contributing at least partially to the observed 30% price increase.[21]

Results for the reduced form pricing model are generally consistent with those just discussed; estimates for the various firm fixed effects are not reported in Table 6. Of particular interest is the result for the firm size parameter. For example, the Portfolio Size estimate indicates that increasing a publisher's journal portfolio by 50 results in prices about 9% higher for the "incumbent" titles. If this growth resulted from a merger with a larger firm, the acquired titles would experience a more substantial price increase. Although this result is imposed by

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[20] According to one former publishing executive, "If we didn't raise our prices each year, our competitors would grab the surplus dollars available from our customers."

[21] The relative contributions depend on the prior beliefs held regarding the pre- *or* post-merger value for θ. In the case of Lippincott, the estimated parameter values imply that if the post-merger value for θ equals 0.33 or less then the merger increased market power; if not, then post-merger a *decline* in market power is offset by an absolute decline in demand elasticity. Since it is unlikely that a merger would diminish a firm's market power, one should probably conclude that θ is below 0.33. This is also consistent with the fact that the estimated demand elasticities are below one. For some (public relations?) reason, publishers are not setting prices high enough to achieve absolute demand elasticities greater than one.

the model specification, the results from the more flexible structural model are similar.

Implications and Future Directions

When the proposed 1998 merger between Reed Elsevier and Wolters Kluwer collapsed, opposition from antitrust authorities in Europe and the U.S. was cited as a primary cause. Although no formal complaints were filed by agencies on either side of the Atlantic, regulators had sent a variety of signals indicating their serious concerns. Negotiations with the European Union had progressed the farthest and it appeared that the proposed deal would proceed only if the parties agreed to significant divestitures. It was widely reported at the time that the EU's preferred set of divestitures upset the financial logic of the merger and resulted in its demise.

What is interesting here is that the EU's main focus was *not* on academic journals, but rather legal publishing (in Europe), and that its theory of anti-competitive harm was based on traditional antitrust principles, i.e., excessive overlap in content (and therefore similar to the DOJ's approach to the Thomson/West merger). The U.S. focus, of course, was far different, in part because European legal publishing was not germane and because the model of harm relied upon was novel. Though one can only speculate on how a U.S. antitrust case might have proceeded, it is clear that the combined Reed Elsevier/Wolters Kluwer entity would have controlled large journal portfolios in a number of broad fields, including biomedicine. Assuming that these broad fields constituted antitrust markets, some of these portfolios would have crossed the U.S. Government's concentration threshold (based on the Antitrust Guidelines) with shares in excess of 30-35%. Based on the preliminary results discussed here, such a merger would have resulted in substantial price increases over time. If the U.S. had filed a complaint and had been successful with this market definition, an important *legal* precedent would have been set, one that would have made it easier to employ a portfolio theory in mergers involving combined market shares less than the threshold, e.g. the Wolters-Kluwer/Waverly merger*, and/or* a large firm buying a relatively small portfolio of journals. The recent reluctance of the Antitrust Division to oppose several mergers in the publishing industry can be at least partially attributed to "insufficient" market shares. Unfortunately, since any future deals are likely to be relatively small in scope, opposition to journal mergers will need to adopt novel approaches in the definition of both markets and concentration thresholds.[22]

This increased burden is why further refinement of the work presented here is necessary. Although antitrust policies in the U.S. and Europe have changed considerably over the past two decades in response to a better understanding of market dynamics, further reform requires the development of new and persuasive evidence that existing policies are inadequate. Refinement of this research will include theoretical and empirical components. On the theory side, the journal pricing models need to be generalized to permit larger journal populations, entry, demand heterogeneity, etc. to generate additional useful predictions (besides, "mergers can raise prices"). Empirically speaking, important future objectives include (1) using the holdings data to examine the impact of entry on prices of incumbent journals, (2) broadening the study to include the behavior of non-profit biomedical publishers, and (3) testing the robustness of this portfolio approach in other STM fields.

[22] To avoid future antitrust scrutiny the Elseviers of the journal publishing world are likely to grow by adding relatively small numbers of journals at frequent intervals. If pursued diligently, this stealth strategy can be just as successful as any blockbuster merger.

TABLE 1

ISI-Ranked Medical Titles from Major Commercial Publishers, 1998

	# of titles published	# of observed ISI titles	%
Blackwell	112	99	0.88
Churchill Livingston	17	12	0.71
Elsevier	262	225	0.86
Harcourt	118	109	0.92
Karger	45	39	0.87
Mosby	27	25	0.93
Plenum	22	20	0.91
Springer	99	87	0.88
Taylor	19	16	0.84
Thomson	41	36	0.88
Waverly	37	35	0.95
Wiley	78	70	0.90
Wolters-Kluwer	112	98	0.88
Totals	**989**	**871**	**0.88**

Notes:

-- observed data based on holdings for 194 medical libraries, during 1988-98 period

-- major firms are those with at least 10 ISI-ranked biomedical journals

-- underlined firms were acquired in mergers with other firms in the list during 1997-1998

TABLE 2
Selected Descriptive Stats, Avg. Values by Publisher

	1988 Price	1988 Cites	1988 Cost/Use	1988 Papers	1998 Price	1998 Cites	1998 Cost/Use	1998 Papers
Blackwell	193	1575	0.40	123	508	2652	0.55	156
Churchill Livingston	183	1726	0.26	103	721	2821	0.62	146
Elsevier	482	3477	0.36	179	1548	4222	0.78	204
Harcourt	209	3713	0.18	164	518	5294	0.34	171
Karger	321	893	0.59	86	711	935	1.01	79
Mosby	100	4071	0.07	248	241	5369	0.15	269
Plenum	233	1352	0.25	92	759	1733	1.86	121
Springer	481	2268	0.44	141	1057	2386	0.84	153
Taylor	259	759	0.48	74	658	572	1.67	55
Thomson	207	1210	0.46	92	733	2788	0.45	140
Waverly	119	3171	0.10	188	277	5770	0.16	237
Wiley	333	2205	0.38	128	1409	3338	1.10	145
Wolters-Kluwer	176	2535	0.19	154	504	3519	0.52	153
Unweighted Avgs	253	2227	0.32	136	742	3184	0.77	156

Notes:
-- numbers based on journals that commenced publication prior to 1989, and had >= 100 cites in 1988 or 1998.

TABLE 3

Avg. Circulation for ISI-Ranked Journals by Publisher

	1988 (# subscribers)	1998 (# subscribers)
Blackwell	31.72	30.16
Churchill Livingston	34.00	31.20
Elsevier	30.08	27.92
Harcourt	50.51	53.23
Karger	28.81	22.77
Mosby	94.50	96.55
Plenum	27.61	22.89
Springer	21.60	19.03
Taylor	11.67	12.08
Thomson	13.50	19.42
Waverly	61.67	63.41
Wiley	24.41	23.51
Wolters-Kluwer	41.62	42.28
Unweighted Avgs	36.28	35.73

Notes:

-- numbers based on holdings for 194 medical libraries, during 1988-98 period

-- All titles commenced publication prior to 1989

Table 4, Exponential CDF

1991 Data
Dependent Variable: Ln Subscriptions

Variable	Estimate	Error	Prob > |T|
Intercept	4.0227	0.0634	0.0001
Budget	-6.0520E-06	3.5000E-07	0.0001

# of observations: 658
Adj R-squared: 0.3095

1995 Data
Dependent Variable: Ln Subscriptions

Variable	Estimate	Error	Prob > |T|
Intercept	3.8783	0.0614	0.0001
Budget	-3.5490E-06	2.1000E-07	0.0001

# of observations: 658
Adj R-squared: 0.2922

Table 5, Structural Market Power Model

Quasi-Supply Estimation Results
Dependent Variable: Ln Price

Variable	Estimate	Error	Prob > |T|
Elsevier Merger dummy	0.0507	0.0382	0.1838
Pergamon Merger dummy	0.2384	0.0691	0.0006
Wolters Merger dummy	-0.0418	0.0573	0.4663
Lippincott Merger dummy	0.2612	0.1184	0.0274
Ln Papers	0.3686	0.0081	0.0001
Time Trend	0.0874	0.0027	0.0001

# of observations: 7588
Adj R-squared: 0.5130

Demand Estimation Results
Dependent Variable: Ln Subscriptions

Variable	Estimate	Error	Prob > |T|
Ln Price - Merger dummy, Elsevier	-0.0034	0.0079	0.6693
Ln Price - Merger dummy, Pergamon	-0.0034	0.0139	0.8066
Ln Price - Merger dummy, Wolters	-0.0268	0.0132	0.0427
Ln Price - Merger dummy, Lippincott	0.0675	0.0294	0.0219
Ln Price, Elsevier	-0.3552	0.0384	0.0001
Ln Price, Pergamon, relative to Elsevier	0.0337	0.0252	0.0497
Ln Price, Wolters	-0.3212	0.0425	0.0001
Ln Price, Lippincott, relative to Wolters	0.0495	0.0252	0.0497
Brandon Hill dummy	0.6265	0.0496	0.0001
$\Delta \hat{U}$	1.9163E-05	2.1940E-06	0.0001
Ln Citations	0.2279	0.0084	0.0001

# of observations: 7588
Adj R-squared: 0.4065

Table 6, Reduced Form Reaction Function

Portfolio Size

Dependent Variable: Ln Price

Variable	Estimate	Error	Prob > |T|
Intercept	4.5253	0.0812	0.0001
Portfolio Size	0.0016	0.0004	0.0002
ln Citations	0.1239	0.0042	0.0001
$\Delta \hat{U}$	3.5619E-05	1.3600E-06	0.0001
Time Trend	0.0795	0.0028	0.0001
Brandon Hill dummy	-0.8755	0.0272	0.0001
ln Age	0.0004	0.0332	0.9904
$(\ln Age)^2$	0.0095	0.0056	0.0923

# of observations: 8302
Adj R-squared: 0.5892

ln Portfolio Size

Dependent Variable: Ln Price

Variable	Estimate	Error	Prob > |T|
Intercept	4.3035	0.2995	0.0001
ln Portfolio Size	0.0975	0.0604	0.1066
ln Citations	0.1237	0.0042	0.0001
$\Delta \hat{U}$	3.5606E-05	1.3600E-06	0.0001
Time Trend	0.0824	0.0033	0.0001
Brandon Hill dummy	-0.8762	0.0273	0.0001
ln Age	0.0003	0.0333	0.992
$(\ln Age)^2$	0.0096	0.0057	0.0883

# of observations: 8302
Adj R-squared: 0.5887