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**ECONOMIC MODELING: AN AID TO THE PRICING OF
INFORMATION SERVICES**

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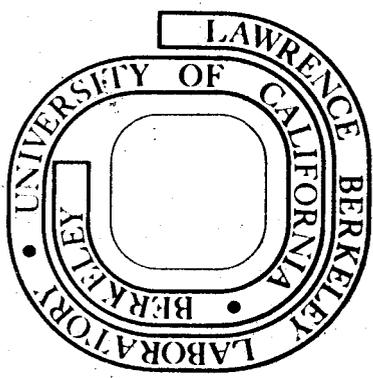
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ECONOMIC MODELING: AN AID TO THE PRICING
OF INFORMATION SERVICES

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Introduction. Faced with the pressures of limited budgets and of increased competition for the use of funds, information centers and libraries are initiating user fees. There have been, however, few precedents or guidelines to which information administrators might turn for assistance in formulating their pricing policies.

This paper treats pricing as a problem in decision making and explores several approaches to pricing that are common in the business literature for their applicability to the pricing of information products and services: average cost pricing, price discrimination, and marginal cost pricing. Components of the pricing decision are identified and cost-based pricing is emphasized. The information service used as an example in the paper is computer-assisted selective dissemination of information (SDI) with data drawn from OECD-sponsored SDI cost surveys (1,2,3) and from my recent study of SDI pricing activity (4).

Pricing is only one element in the total management picture, with pricing decisions closely intertwined with overall managerial objectives and strategies. Prices are not usually set according to the dictates of theory; pricing is an art and pricing decisions reflect a blend of intuition, past experience, and sophisticated analysis. However, there is a body of pricing theory which may provide a point of reference for information service administrators. This paper is an overview only--intended to encourage a curiosity about the potential of pricing models.

Components of the Pricing Decision. Pricing is a dynamic, multi-stage process in which, theoretically, the pricing objective (determined by management with the organization's overall goals in mind) produces pricing policy which, in turn, is translated into pricing practices.

In traditional literature, management's overall pricing objectives are assumed to be profit maximization,

and this is the objective used in microeconomic theory's classic model. Actually, businesses pursue goals which are partly non-monetary such as achieving or maintaining a certain share of the market or attaining a particular level of sales or service. Cotton (5) points out that the desire to fully utilize existing resources is a particularly strong pricing objective for in-house computer centers.

Traditional library and information service goals have been to minimize costs, to limit losses to a budgeted amount, and to maintain standards of service. However, with the growing opinion that information services should pay for themselves, pricing objectives that include recovery of operating costs or total costs are appearing. Thirteen of the 15 SDI centers responding to this portion of my survey gave cost recovery as their primary objective in charging. These centers had varying degrees of self sufficiency as their goal, ranging from recovering only a portion of operating costs to becoming financially self-sustaining and even net revenue producing.

There is rarely only one pricing objective--multiple and often conflicting goals are pursued. One example that may be encountered in information services would be to have goals of charging the socially optimal price while achieving total cost recovery. A balancing and blending of objectives is required.

Related to the aims or objectives of the pricing decision are the methods employed in calculating what price to charge. A variety of pricing methods can be used to meet a given pricing objective. These pricing practices do not necessarily have to be cost-oriented, i.e., the price of a product does not have to be the production cost of the product at that moment. Prices can also be based on the demand for a product or on the activities of competitors. For example, there are several pricing methods that could be used to meet the objective of total cost recovery: average-cost pricing, cost-plus pricing, imitative pricing, value-of-service pricing, price discrimination, target rate of return pricing, etc.

PRICING PRACTICES

For purposes of discussion, pricing practices are commonly grouped by which one of the market structure elements is most emphasized in the technique: cost, demand, or competition.

Cost-Based Pricing. In a cost-based pricing approach, organizations set their prices largely or even entirely on the basis of their costs. Typically, in cost-based pricing, all costs are included, usually with a somewhat arbitrary allocation of overhead made on the basis of expected operating levels. Common cost-oriented pricing practices include those familiar to us from the retail trades: markup, cost-plus, and target rate of return pricing. In both cost-plus and markup pricing the price is determined by adding some fixed percentage to the unit cost of production. These popular methods have their disadvantages: [1] Demand for the product is not sufficiently taken into account. [2] Cost-based methods place a great deal of faith in the precision of cost information which may be unfounded, especially when general overheads are allocated on an arbitrary basis.

Demand-Based Pricing. Demand-oriented pricing looks at the intensity of demand for a product or service. It is pricing based on what the traffic will bear or on what the perceived value of the product or service is. Lower prices are charged when or where demand is weak and higher prices are charged when or where demand is intense, even though unit costs may be the same in both cases. One of the common forms of demand-based pricing is price discrimination whereby a particular product is sold at more than one price.

Demand-based pricing has been a difficult approach for information services to implement, both because of a lack of data as to demand for information services when fees are involved and also because of an ignorance in the market as to the value of information. While consumers are accustomed to paying for legal and medical information, until recently there has been no precedent for paying directly for what is considered "library"-type information, traditionally provided without a direct charge to the user. Unlike prices for some products such as soft drinks, chewing gum, and pay telephone calls, there has been no "known price" in the market place for bibliographic information of the kind dispensed by library and information centers.

In their setting of prices, centers in the SDI survey did not attempt to take into account the value of the information they disseminated. Most center representatives, while recognizing the validity of such an approach, stated that pricing on the basis of the value of the information was not feasible.

Competition-Based Pricing. Using competition-oriented pricing, a firm does not base its price on its own costs nor on the demand for the product, but, instead, it bases its price on what other producers of the same product or service are charging. The firm does not necessarily charge the same as its competitors but will change prices depending on competitors' activities, even if its own costs or demand have not changed. "Going rate" or "imitative" pricing is a popular technique that is competition oriented. With going-rate pricing, sellers in an industry may arrive at prices either by imitating the prices of competitors or else by trying to keep their prices at the average level charged by the industry. It is popular because, where costs are difficult to measure, it is felt that the going-rate price represents the collective wisdom of the industry concerning a price that would yield a fair return. Conforming is also felt to be least disruptive of industry harmony.

Among the SDI centers surveyed, the early stages of pricing were marked by use of imitative pricing. A variety of reasons for using this approach were given by survey respondents: [1] Few centers had sufficient cost data to use as a basis for pricing decisions. [2] Little was known about the nature of the demand for SDI services in a fee situation; centers could not base their prices on their own demand estimations. [3] The earliest established, most active centers were themselves concerned with pricing at an early date and were seen as representative of the wisdom of the industry. [4] Among centers that were competitive, it was natural to take into consideration the prices being charged by other centers offering the same data bases or competing to serve the same user groups.

COST DEFINITIONS

Costs represent a starting point for developing pricing structures. Before examining specific pricing strategies for information services, let us define several key cost concepts: fixed costs, variable costs, average costs, and marginal costs.

Fixed costs refer to outlays which remain constant or unchanged regardless of the firm's quantity of output. For example, for SDI services, these fixed costs include the expenses incurred in acquiring the data bases (either by creating them or by purchasing them from data base suppliers), in converting the data bases to a format searchable by the system, and in maintaining the data

bases. These fixed operating costs do not vary with the number of profiles output by the center.

There are certain fixed costs which are incurred in the overall center operation (as compared with the fixed costs listed above which are directly related to the provision of service from specific data bases), such as the costs of computer rental, space rental, insurance, and management salaries. These are referred to as fixed overhead costs and cannot be specifically attributed to any one particular SDI profile produced by the center.

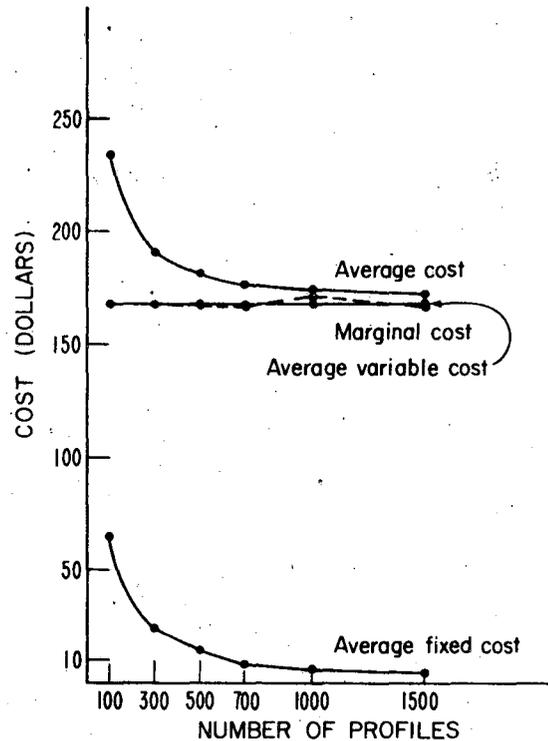
In his survey, May (3) found that SDI centers operating at levels of fewer than 300 profiles had fixed costs as high as 50 percent of total costs (fixed plus variable costs). If the center had more than 300 users, the fixed costs accounted for about 20 percent of total costs.

Outlays that are proportional to, or vary with, the amount of business done or the volume of goods produced are called variable costs: costs associated directly with the level of activity under discussion. For SDI services these include the cost of staff to formulate the profiles, the cost of computer processing, output printing and reproduction, mailing and distribution, royalties, and the portion of overhead that is related to the staff (social security, vacation, sick leave, etc.). Each of these expenditures increases with the larger number of users in the system, but the rate of increase can vary. The sum of variable and fixed cost is the total cost.

Overhead costs are included under variable costs because they usually are calculated as a percentage of staff costs, which, with the exception of supervisory staff and management, are usually assumed to be variable. It is difficult to separate the true overheads of the itself from the overheads of the institution of which the center is a part. In May's survey overhead costs vary from 15 percent to 100 percent of staff costs.

Cost functions used in average cost pricing include average fixed cost, average variable cost, and average (total) cost (corresponding to the three total cost functions). As an example, average cost functions have been graphed in Figure 1, using data from an SDI center in May's survey. Average cost (AC) declines over the range of output, reflecting the allocation of the fixed costs to larger quantities of output.

Marginal cost (MC) is defined as the addition to total cost resulting from the addition of the last unit of output. It is the ratio of the increase in cost to the increase in output for a small increment in output. Marginal cost, as applied to SDI service, could be defined as the additional cost incurred by a center when it adds one more profile to run on a particular data base. Marginal cost is calculated by subtracting the total cost of "Q" profiles from the aggregate cost of "Q + 1" profiles.



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Fig. 1. Average and Marginal Cost Curves for a Sample SDI Center.

The marginal cost for SDI service as calculated from the sample center is graphed with the average cost functions in Figure 1. Analysis of more data is required, but it can be seen that marginal cost appears to be constant and that the marginal cost curve is everywhere below the average cost curve. This relationship between average cost and marginal cost plays a role in pricing when the technique of marginal cost pricing is used.

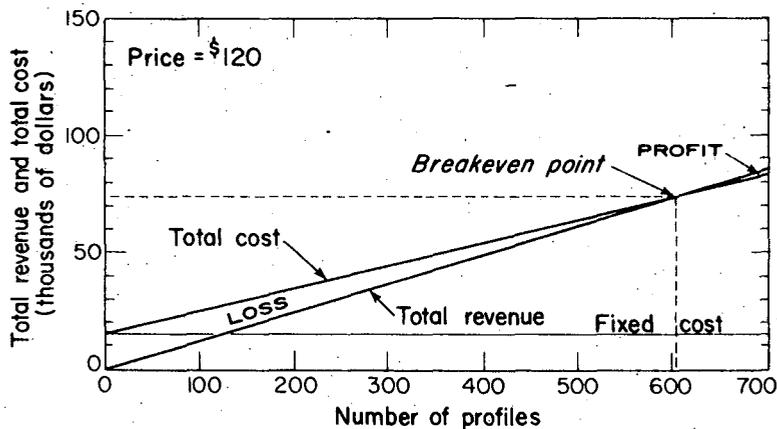
THREE PRICING TECHNIQUES

Now let us look at three basic pricing strategies which may prove appropriate to information service and product pricing: average cost pricing, price discrimination, and marginal cost pricing.

Average Cost Pricing. With the goal of breaking even, the price of the product should be selected to cover all the fixed and variable costs associated with the product. Thus a stated pricing objective of total cost recovery implies setting the price equal to average cost ($P = AC$).

Average cost pricing is a strategy that results in only one price or a few prices common to all users being charged. It has characterized the approach of many public agencies to establishing tolls or user charges for highways, airports, bridges, and similar facilities. The costs included in the pricing are those of operating and amortizing a facility and are familiar accounting data which are more readily available to management than other types of costs. It is a relatively simple pricing scheme to administer.

A cost-based pricing decision is often analyzed by using a breakeven chart. Figure 2 shows a simple breakeven chart created for one of the sample centers in my SDI survey, using its current SDI profile price. The breakeven point, at which total revenue equals total cost, shows the decision maker how much of the product must be sold at a proposed price in order to cover costs and then to start making a profit. If capacity of the system is exceeded before a breakeven point is reached, then cost recovery is not possible given existing capacity constraints. This model makes several assumptions: it generally assumes a linear total cost function, it assumes that all costs can be represented as either fixed or variable, and that all units are sold at the same price.



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Fig. 2. Breakeven Chart for a Sample SDI Center.

Average cost pricing has several disadvantages. First, it may result in a price that is high from a public

welfare point of view. As many of the costs of running a computer-based information service are fixed, the chances are that average costs will be higher than marginal costs (as was observed in the surveyed SDI center figures), thus producing a higher price that may deter consumers from using the service.

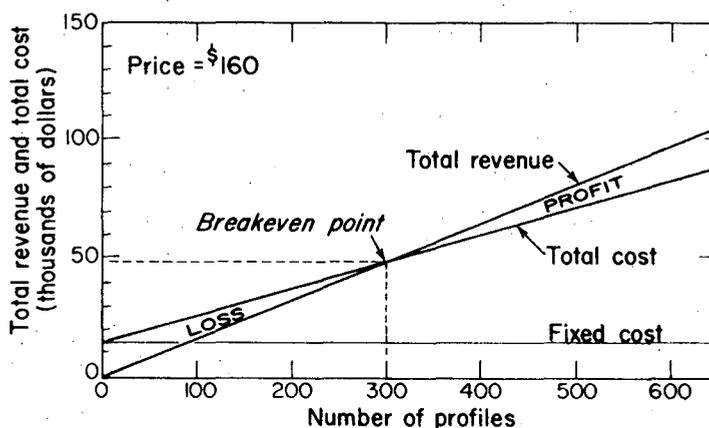
Next, average cost pricing uses accounting data which can be misleading. Prices should recover costs expected to be incurred during the pricing period; thus costs for decision making should be prospective rather than retrospective. Accounting costs tend to be historic costs. Data regarding the probability of cost changes should be added to the analysis. Also, accounting data can be misleading because overhead cost allocations are often not treated by accountants in a way that is usable for pricing.

Third, the pricing technique may be difficult for information services to utilize because of the difficulty of obtaining cost data. Not only are information centers and libraries usually embedded within a larger organizational framework, thus making center costs difficult to isolate, but also the product ("information") is difficult to describe and measure and a large proportion of its costs are people costs. SDI surveys showed that personnel costs represent the highest percentage of operational costs for the majority of centers surveyed and for centers reported in the literature (around 60 percent). This high proportion of personnel costs suggests that SDI centers may be much like other service industries. This has implications for pricing because personnel costs are notoriously difficult to apportion among the several outputs of a firm for use in price formulation.

Finally, the most severe problem with average cost pricing is that it has no demand component, and the nature of the demand for a product or service definitely impacts on price. The breakeven chart shows what revenue will be if certain quantities are sold; it does not show what will be sold. Extensions of breakeven analysis that attempt to take into account demand and uncertainty have been suggested: [1] by adding total demand estimates expressed in terms of pessimistic, most likely, and optimistic demand figures to the analysis (6), and [2] by combining estimates of price elasticity of demand with the breakeven analysis (5). In Figure 3, the breakeven chart created for the sample center in Figure 2 now includes a demand elasticity component.

Price Elasticity of Demand. Not a pricing technique,

price elasticity of demand is an aid in pricing because it adds the element of demand into pricing considerations. A synonym for price elasticity of demand would be "sensitivity to price change". It is defined to be the percentage change in quantity resulting from a 1 percent change in price. Although numerical estimates of elasticity can be created, elasticities are used more often as broad descriptions ("highly elastic," "low elasticity," etc.). Demand is said to be elastic for a product if a small change in price results in a proportionally larger change in amount spent by consumers on the product. The market for a product with a more inelastic demand is not so sensitive to changes in price.



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Fig. 3. Breakeven Chart Combined with price Elasticity of Demand for Sample SDI Center.

King (7) suggests that in allocating costs for information services--and consequently in setting prices--more should be allocated to the products with inelastic demand because their market will not be so sensitive to price changes.

Users have differing demands for information services, and these different segments of the users' market show differing elasticities of demand. There are many ways to categorize information users: demographically by age, sex, occupation, organizational affiliation, social class standing, etc. Among the SDI centers surveyed, users with an academic organizational affiliation were more sensitive to price changes than were users in a business environment. Seven characteristics that may be useful in identifying the user market include the research interest(s) of the user, the information gathering behavior of the user, the organizational affiliation of the user, the time span of research interests, the availability of funds, the motivation of the user (how great is his "need to know"), and the responsiveness of the user to innovation. These affect the users' demands for information service, and consequently, their willingness

to pay for such service.

Much work needs to be done on identifying and quantifying the extent and nature of the demand for information services. It is difficult to accurately assess demand for a service; however, common approaches to estimating the likely reactions of customers to a price change include direct attitude surveys, statistical analysis of the relationship between price and quantity (regression analysis, etc.), market tests, and analytic inference.

Price Discrimination. A pricing technique that utilizes differences in price elasticities of a product or service is price discrimination. It is defined as occurring when a particular commodity is sold at two or more prices with the price differentials not directly corresponding to differences in supply cost. Price discrimination may be inequitable, but it is recognized that sometimes a product or service cannot be marketed without discrimination, e.g., if cost recovery is desired (8). This may be the case for information services, and perhaps price discrimination could be used to meet administrators' cost recovery objectives.

Many publicly subsidized or publicly regulated industries currently discriminate in their pricing: transportation services (e.g., airlines' family fares), the post office, electrical utilities.

For price discrimination to be possible, certain conditions must exist: chiefly, [1] the market into which the product is to be introduced must be segmentable and the segments must show different price elasticities of demand, and [2] there should be little chance that those paying the lower price could resell the product to the segment paying the higher price (arbitrage).

Price discrimination takes various forms, depending on the basis of the discrimination: the customer, the product version, the place, or the time. Price discrimination on a customer basis seems to be applicable to information services. The following are several examples found in business practices: [1] Wealthier customers (with inelastic demand) are charged more than the less affluent. Standard examples are the pricing of legal and medical services. [2] Customers who use a service more intensively are charged more, even though the difference in cost may be negligible. [3] New customers are offered prices lower than those paid by established customers in the hope of developing loyalty. [4] Large buyers are granted price concessions exceeding the cost savings associated with volume transactions. [5] Finally, groups readily

classifiable by age, occupation, etc. that have different demand elasticities can be charged different prices.

In using price discrimination on a time basis, lower prices are charged for services that are identical except with respect to time of consumption in order to encourage fuller and more balanced utilization of capacity. Computer centers and public utilities have used this approach--varying their prices according to the day (weekend versus weekday) or time of day (charging higher rates for service at peak periods). This may be appropriate for information centers which have a volume of search requests that vary in intensity over periods of time, e.g., from season-to-season, from day-to-day, or even from hour-to-hour.

Using current awareness services as an example, SDI market structure seems to contain several of the conditions necessary to use this pricing technique. The market for SDI service is segmentable--SDI users can be divided into different classes based on organizational affiliation, nature of research, etc. These classes have different intensities of demand for current awareness service--institutions as consumers of information services could be expected to have more inelastic demand than individuals as consumers (7). Arbitrage is unlikely for SDI custom profiles because of the individualized nature of the product, although it may be more likely with other information products such as retrospective searches. It may be possible to segment the users into markets with different service requirements (e.g., business users requiring confidentiality and rapid response rate) and then offer the different markets different services, charging different prices to each segment, thereby using price discrimination to recover costs. The disadvantage of this or other techniques using price elasticity of demand is that it is difficult to create the elasticity measure and to identify and segment the markets. Also, the pricing schemes thus created result in multiple and often-changing prices which are difficult to administer.

Marginal Cost Pricing. The third pricing technique overviewed in this paper is marginal cost pricing, considered by welfare economists to be a pricing strategy that maximizes net social benefit. Using this technique for SDI services, the price of an SDI profile would be set so as to equal the marginal cost of that profile ($P = MC$). One of the difficulties with the technique is that data to use in calculating marginal costs are difficult to obtain and they change at different output levels.

It has been suggested that information services

should have the maximization of social benefit as their pricing objective with total cost recovery as a constraint on that objective. These goals may conflict, however. As noted earlier, the situation may exist where marginal cost appears as a constant and where the marginal cost curve is everywhere below the average cost curve for all levels of output. We have seen this in the sample SDI center data presented in Figure 1 and Dei Rossi (9) has pointed out that this situation exists for many automated information retrieval systems. In such a case, if the centers were to set their price equal to marginal cost, they would not cover their costs since total revenue ($TR = MC \times Q$) would be less than total cost ($TC = AC \times Q$).

To conclude this paper, let us see how such a situation could theoretically be resolved through use of a combination of the pricing techniques discussed in this paper.

Several pricing alternatives are possible. First, this situation could be used as an argument for continued subsidization of publicly financed information retrieval systems in those systems where there are declining average costs (assuming the value of total benefit is judged greater than the total cost of production plus the implied subsidy). In certain such situations, Dei Rossi (9) finds subsidization warranted specifically for the fixed cost component. Alternatively the information service could be priced at full cost recovery and subsidies for purchase of the service would be provided directly to the users (10).

Second, faced with the situation wherein some users will be charged more than marginal cost, the concepts of price discrimination and price elasticity of demand could be used to decide which users are the ones who will pay only marginal costs. For example, it has been noted in the SDI survey data that the SDI market can be segmented and it has been suggested that these segments have different price elasticities of demand, with institutions as users being less sensitive to price changes than individuals as users. Consequently, institutions wishing to have SDI services for their employees could pay a base "membership" fee to join the information center that would be proportional to the fixed cost component of the center's operation. The individual profiles themselves would be priced at or close to marginal cost.

A third solution may be provided by Baumol and Bradford (11) who suggest that each price be set so that the percentage deviation from marginal cost is inversely proportional to the item's price elasticity of demand. For our SDI service example, this would suggest that prices charged

to institutions as users and to users in business settings would diverge from their marginal costs by relatively wider margins than would prices charged to users who are more sensitive to price.

Summary and Conclusions. This paper has presented overviews of several approaches to pricing, defined basic cost concepts, and suggested three techniques with potential for information pricing. Data has been drawn from recent studies of computer-assisted selective dissemination of information systems.

The intent has been to suggest that flexibility be maintained when approaching the issue of pricing information services and products. There are many models of pricing behavior that can be explored for their applicability.

Finally, the paper is intended as a reminder of the need for more complete data to use in pricing decisions. To create successful pricing policies, management needs a knowledge of the organization's costs and some knowledge of the market in which the organization operates. Research is needed to learn who purchases information services and products and their sensitivity to price. More purposive cost data gathering is needed--not only efforts to improve accounting data or historic cost data but also research that takes up such issues as joint costs, avoidable costs, and correct allocation of overhead.

Price setting is an art. But if information from models can aid the decision maker in the process of price formulation then it should be explored and used.

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