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ECONOMIC MODELS TO EVALUATE SDI PRICING PERFORMANCE

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ECONOMIC MODELS TO EVALUATE SDI PRICING PERFORMANCE*

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SUMMARY

My recent research has been an attempt to explore pricing of computer-assisted selective dissemination of information (SDI) through the application of models from the field of economics.[15] I suggest that an economic consideration of features of SDI service operation will provide information of value to SDI system planners. The particular model discussed here is a modified descriptive model from the field of industrial organization. Although a total of nine structural elements were examined in my research, I present in this paper two major elements for their impact on SDI center activity: price elasticity of demand and costs (including marginal costs and economic scale).

1. Selective Dissemination of Information: Definitions

Selective dissemination of information can be described as a service which provides each of its subscribers with a periodic, tailored listing of new documents that have been entered into the system's file. Each subscriber receives a different set of references, depending upon his or her particular interest, as defined in the subscriber's "interest profile". The profile is a logically-associated group of terms representing a user's topic of interest. It is made up of names of colleagues pursuing related research, significant words and thesaurus terms, classification numbers and codes, names of organizations noted for their research activity in the topic being searched, etc.; the actual composition of the profile is a function of the data base it is being searched against. To create an SDI notification, the profile is screened against the most recently received up-date of the data base. The citations that match the requirements of the interest profile are printed out by the computer (usually taking the form of a paper printout or card output) and are mailed to the subscriber. This is done automatically at regular intervals. (Fig. 1).

SDI service is designed to keep the subscriber (or "user") regularly informed of new documents published in the subscriber's area(s) of interest in order that he or she can keep abreast of the latest developments. A "user" in this study is an individual who is the recipient of current awareness notifications. In the survey done for this study, approximately 40,500 users were served by 18 agencies (or "centers"). These users were located in a variety of organizational settings: 43% of the users were identified as being in private industry; 49% in academic institutions; 7% in government agencies; and 1% in nonprofit organizations or professional societies.

Centers that offer current awareness services from machine-readable data bases exist as part of other organizations. They are affiliated most often with libraries and information service groups (over half the centers in the sample). Other centers are affiliated with computer service facilities located within parent organizations. (Fig. 2) SDI centers outside of this environment, formed to offer SDI on a purely commercial basis without a supporting parent organization, have not succeeded thus far.

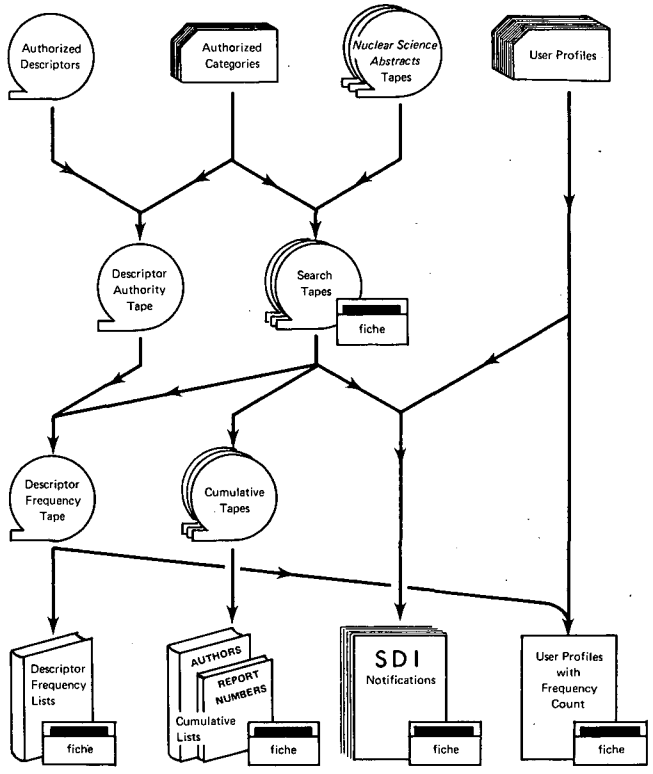

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Fig. 1 Schematic of SDI Service Offered by the Lawrence Berkeley Laboratory from Nuclear Science Abstracts Data Base.

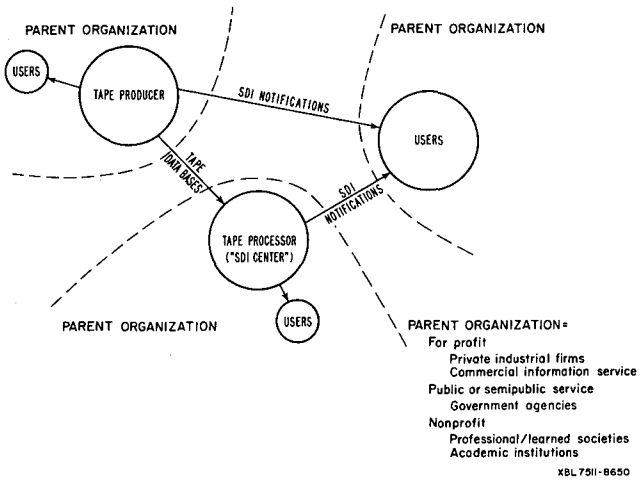

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Fig. 2 Components of Selective Dissemination of Information Market.

2. SDI Centers: A Time of Reappraisal

The 19 centers that participated in the survey offer service from 32 different publicly-available machine-readable data bases and are found in a variety of organizational settings: government (21% of the centers), industry (26%), academic (32%), and nonprofit organization or professional society (10%). A fifth category was created (commercial) for those centers that are part of businesses that sell information products for a profit (10% of the centers).

These centers, while involved in technological change, are also in the midst of reappraisal because

of increasing pressure to operate in a cost effective manner.[3,6] System performance is increasingly being evaluated in terms of how cost recovery the service is--or needs to become.

The growth in the number of centers being established has tapered off and the 1970's are marked by retrenchment for many centers. University-based SDI centers had been supplying subsidized or free services to an impressive number of local users and for-fee services to a much smaller number of nonaffiliated users, but with the ending of muc' of the government subsidy, many centers are in a period of financial reassessment. Financial constraints have led to increased interest in the establishment of regional and national search service centers. No longer is it envisioned that each major university and government installation will acquire the bibliographic data bases and process them itself.[6,9] Competition has also entered the picture in the form of the appearance and rapid growth of retrospective search service offered online--an attractive, albeit perhaps more expensive, alternative to the batch search mode of the SDI centers.

SDI is an expensive service to provide[9] and, increasingly, centers must face the issue of charging users to recover costs or of finding institutional or other funding to support their continued existence. Mauerhoff has summed up the future of search centers succinctly: "... the American search centers have had their critics, and it appears that their success and survival in the seventies will be determined by the influence of their services on the user, their promotional efforts, and price structures."[9]

3. The Model: SDI as an Industry

Industrial organization, a branch of applied economics, has an approach that might prove useful to center management. The basic model grew out of work at Harvard in the 1930's and, using it, SDI centers are considered as constituting firms in an industry. Market structural elements are explored for their role in center conduct.

The remainder of the paper presents two major structural elements: price elasticity of demand and costs such as marginal costs. The elements will be defined first, then identified for SDI service using data from the literature and recent surveys, and finally discussed for their impact on operations.

4. Price Elasticity of Demand for SDI Service

Price elasticity of demand is a sensitivity to price change. It is defined to be the percent change in quantity purchased resulting from a 1 percent change in price. Although this measure exists, elasticities are used more often as broad descriptions ("highly elastic," "low elasticity," etc.) than as exact numbers, even when these may have been estimated. Demand highly sensitive to price changes is described as being "elastic"; demand not highly sensitive to changes in price is "inelastic".

An examination of survey data and literature suggests that there are a group of characteristics of SDI users that affect their demands for current awareness service, and consequently, their willingness to pay for such service. These include the research interest(s) of the user, the information gathering behavior of the user, his/her organizational affiliation, the time span of research interests, the availability of funds, and finally the motivation--and, some even say, the innovative propensity--of the user.

Price elasticity measurements for the SDI industry as a whole are not available, but some observations are possible. One Charging Center Survey center representative felt that demand for SDI in general was inelastic since, if prices are lowered for SDI, there would be no great increase in the demand for SDI. [Charging Center Survey interview, ASIDIC Fall 1974 Meeting, September 26-27, 1974]. Perhaps this is because, analogous to medical service, either a need for the service exists or it does not. Lowering the price does not necessarily create a need for the service; someone will not have his tonsils out just because the price of the operation has been lowered. Those SDI users already being served will not buy more--but, of course, new users may be attracted to the service and current users may be more willing to renew at a lower price.

The variety of user characteristics identified in the survey data suggests that price elasticity of demand differs among the different segments of the SDI market. King, writing about information services in general[7], expects the institutional market to have a relatively inelastic demand curve (demand not highly sensitive to changes in price) while on the other hand he expects the market consisting of individual users probably to have an elastic (highly sensitive to price changes) demand curve.

An additional indication of the elasticity of demand for SDI service can be obtained by examining some of its determinants:

First, the price elasticity of demand for a commodity depends on the number and closeness of the substitutes that are available. If a commodity has many close substitutes, its demand is likely to be price elastic, i.e., if increases occur in the price of a product, its buyers will turn to the close substitutes that are available. It would seem that different classes of SDI users have different elasticities of demand for current awareness service. For example, certain classes of users have close substitutes available to them (e.g., academic users can do the searching themselves) and thus their demand for SDI service would be price elastic. If prices of SDI increased, this class's use would decrease. In other cases, demand would be more inelastic for those users who could not get the information any other way. Other close substitutes, in addition to doing the search manually, include online searching and doing without the service. Recent literature[4,6] talks of SDI and retrospective searching in batch or online mode interchangeably. Of course, doing without the service entirely is a substitute.

Secondly, elasticity of demand is likely to depend on the importance of the commodity in consumers' budgets. Industrial users' demand for SDI might be more inelastic than other users because expenditures for SDI profiles constitute only a small portion of the typical research unit's budget.

Third, price elasticity of demand for a commodity depends on the range of uses for it. If a commodity has a wide range of uses, it is felt that its demand will be more elastic than if it can be used in only one area. SDI demand would be rather inelastic in this case; although the SDI center may offer a variety of information services from machine-readable data bases, an SDI notification itself does not have an apparent range of uses.

If price elasticity of demand is indeed inelastic for some segment(s) of the market for SDI service, this suggests that efforts to increase the demand for SDI

services should not be solely related to modifying the prices but should be supplemented with non-price competition (e.g., advertising, product design) to raise the total demand for the product.

5. SDI Cost Characteristics

There are various ways of expressing the cost of a specified event or output program. An economist's definition of the cost of an event is the highest-valued opportunity necessarily forsaken.[1] For example, the cost of providing SDI service is the value of the most valuable goods and services that could be obtained from the manpower, equipment, and materials used currently in mechanized current awareness service production.

A variety of costs are included when determining the cost of a product or service. The majority of the data to which I had access was explicit private cost data; in general, cost data on SDI center operations are difficult to obtain. SDI centers are so frequently embedded within other organizations that the center's own costs are difficult to isolate. The Charging Center Survey done for this study was able to gather little cost data; consequently, the analysis drew upon findings of SDI center cost surveys undertaken by May[12] and Vickers[11,14] for the Organization for Economic Cooperation and Development (OECD). Fixed costs, variable costs, and marginal costs in the short run were explored for SDI centers.

Despite the difficulty in obtaining usable cost data, several observations are possible: 1. Costs of SDI center operations were distributed in approximately the same ratio among centers reported in the literature and for the majority of centers surveyed for computer processing, personnel, and data base acquisition: 30% for computer processing, 60% for personnel, and 10% for data base acquisition. 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.

2. Despite the similar distribution of operating costs, there is wide variation in actual expenditures to operate an SDI center, even among centers offering service from the same data base. May found variations of from $40 to $220 in computer processing costs for three centers which process the same data base. The variability can be attributed to such factors as organizational management, methods of costing, and salary variations in addition to technical factors such as the computer processing equipment used. Perhaps the variability is attributable to the quality of the service being offered (one of the centers in the above example uses 10 to 12 terms for its retrieval, whereas another in that trio uses 50 to 60 terms).

6. SDI Marginal Costs

Marginal cost is defined as the addition to total cost resulting from the addition of the last unit of 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 of "Q + 1" profiles.

In Fig. 3 the marginal cost function is graphed with the average cost functions for SDI service from one data base as calculated for one sample center. Anal-

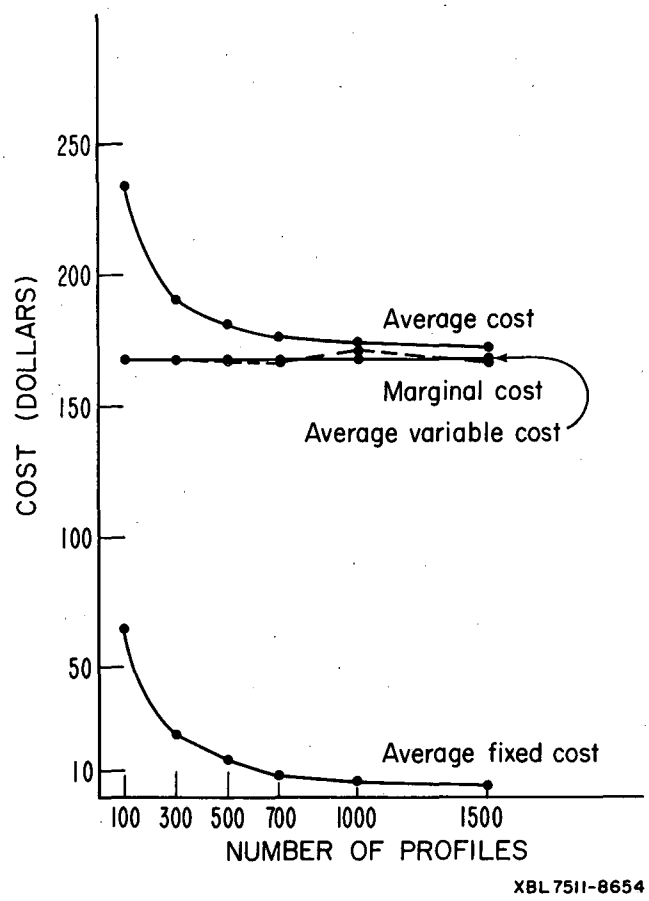

Fig. 3 Average and Marginal Cost Curves for a Sample SDI Center.

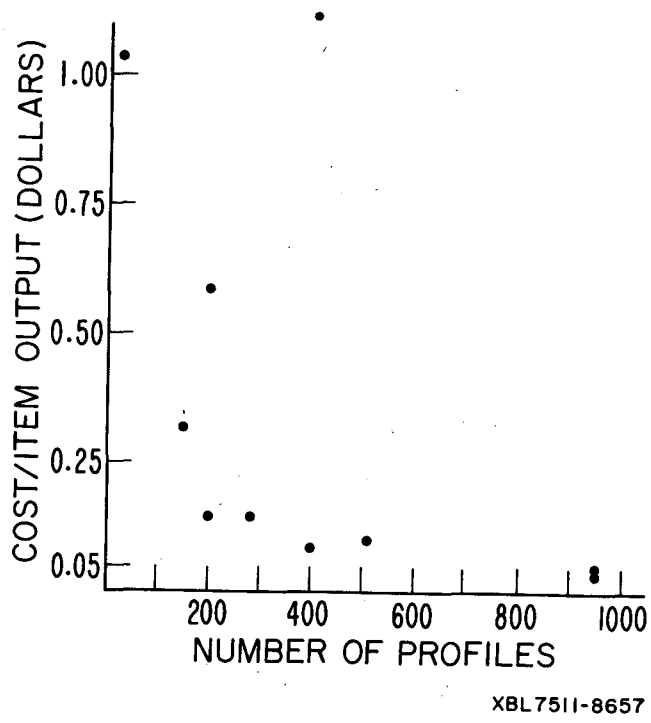

Fig. 4 Scatter Diagram of SDI Average Costs from Ten Centers.

ysis of more data is required but it is suggested that marginal cost (MC) appears to be constant and that the marginal cost curve is everywhere below the average cost (AC) curve. This relationship between average cost and marginal cost plays a role in pricing when the technique of marginal cost pricing is used. This will be discussed in greater detail later in the paper.

7. Economies of Scale for SDI

Another application of cost functions is to determine whether scale economies exist for an industry and what form they take. It is not possible to draw conclusions about economies of scale for the SDI industry without further data. Sample center cost function data, with their constant marginal costs, implied constant returns to scale. Scatter diagram data shown in Fig. 4 imply at least modest scale economies.

Perhaps decreasing average costs are present at small output levels (e.g., up to 1000 profiles) with constant average costs present over the larger output range (e.g., above 1000 profiles). If this does describe the case for the SDI industry, economies of scale appear not to be substantial enough at large volume to make it worthwhile for a center to become extremely large. This would be in keeping with Dei Rossi's conclusion that for information systems with constant marginal cost, strategies which increase utilization can lead to higher net social benefit but entail producer loss.[5] Looking at OECD survey data, the optimal center size appears to be around 700 profiles. (See Fig. 5).

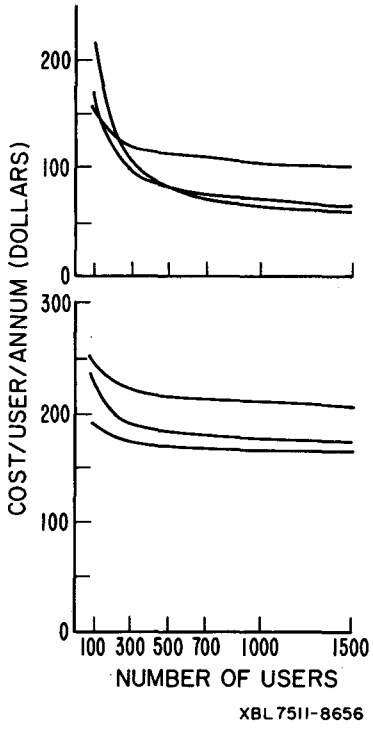

Fig. 5 SDI Service Average (Total) Cost for Two Data Bases.

8. An Application of Research Findings: Marginal Cost Pricing for SDI

This report concludes with a discussion of an approach to evaluating SDI center financing based on research findings and on the concept of marginal cost pricing.

Marginal cost pricing is considered by welfare economists to be a pricing strategy that maximizes social benefit. Using such a pricing 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). Many SDI centers, however, have total cost recovery as their stated pricing objective. This implies setting price equal to average cost (P = AC). Marginal cost is sometimes incompatible with total cost recovery, as illustrated by Dei Rossi in his excellent technical note[5]; when MC is less than AC, total cost will not be recovered.

If the cost functions defined for the sample centers are taken as typical (i.e. MC is everywhere less than AC), then SDI centers appear to fit the case where MC pricing will not result in cost recovery because the revenue yielded by MC pricing will fall short of the total costs of the firm if all the centers' users are charged P = MC.

This situation could be used as an example of the need for continued subsidy for SDI centers (assuming the value of total benefit is judged greater than the total cost of production plus the implied subsidy).[5] Specifically, Dei Rossi finds subsidization for the fixed cost component warranted in certain such situations.[5]

Where continued subsidization is not possible, however, an alternative pricing strategy could be to apply a version of marginal cost pricing that uses price elasticity of demand and which results in prices which are in proportion to marginal cost. As noted earlier, the SDI center users market can be segmented (e.g., student users versus business people), and these segments appear to have different price elasticities of demand. It may be possible to segment the users into these different markets, each having different service requirements (e.g., business users requiring confidentiality and rapid response rate) and then offer these different markets different services, charging different prices to each segment--thereby using price discrimination to recover costs. Many publicly subsidized or publicly regulated industries currently do their pricing based on elasticity of demand: transportation services (e.g. airlines' youth fare), the post office, electrical utilities. The railroads, in particular, have long practiced value-of-service price discrimination as a means of recouping overhead costs not directly traceable to carrying any particular commodity. The Interstate Commerce Commission has implicitly accepted this procedure.[10]

Dei Rossi points out that the use of price discrimination in publicly funded systems raises many important questions of equity (e.g., with declining average cost, total cost recovery implies charging some users more than marginal cost; consequently, how should it be decided which users are the ones who will pay only marginal costs?).[5]

Baumol and Bradford may offer a theoretical solution to Dei Rossi's question and allow an optimal solution under the constraint that the enterprise recover its costs. In their article "Optimal Departures From Marginal Cost Pricing",[2] they suggest that each price be set so that the percentage deviation from marginal cost is inversely proportionate to the item's price elasticity of demand. Those items with elastic demands are priced at levels close to their marginal costs; the prices of items whose demands are inelastic diverge from their marginal costs by relatively wider margins.

As was noted earlier, observing differing elasticities of demand between the two main markets for information services and institutions as users), King[7] suggests that products for the individual market should have an elastic demand, whereas those for the institutional market should have a more or less inelastic demand. In allocating costs (and consequently prices), more should be allocated to the products with inelastic demand because their market will not be so sensitive to price changes. Or, in Baumol and Bradford's theory, the prices charged to institutions or to individual users with more inelastic demand could diverge from their marginal cost by relatively wider margins than should the prices charged to individual users or to specific classes of individual users with more elastic demand.

More research should be done to learn who purchases current awareness services and their sensitivity to price. SDI service does have both an institutional and an individual market. "Institutional" in the sense that institutions (e.g., a state college system) purchase a number of profiles for their employees and students, absorbing the cost at some level above the ultimate user so that the price of the profile is transparent to the ultimate consumer within the institution. As noted already, the individual user market is itself segmented with individual users exhibiting differing elasticities of demand (e.g., student users versus researchers). It is difficult to assess demand for a service with accuracy. There are, however, a variety of ways of estimating the likely reactions of customers to a price change. The following are several common approaches to estimating demand elasticity: direct attitude survey (e.g., Knetsch's work[8] done for pricing the recreational use of land), statistical analysis of the relationship between price and quantity (regression analysis, etc.), market tests, and analytic inference.

Perhaps a combination of the above pricing techniques could be used: institutions wishing to have SDI services for their employees and affiliates would pay a base fee--a sort of membership fee to join the SDI center--that would be proportional to the fixed cost component of the center's operation. This would be a means of recouping center overhead charges not directly traceable to any one profile or class of users. Then the individual profiles themselves would be priced at marginal cost or close to marginal cost (or to the variable cost component of the center's operation).

These alternative pricing strategies are suggested as examples of the need for accurate and complete cost data and demand information to use in making policy decisions. There are drawbacks to these pricing strategies. Primarily, these pricing procedures are not likely to be easy to administer. Markets must be identified and segmented and the price structure established and maintained. Over a period of time, demand elasticities and marginal costs change. The fewer the number of prices, the easier any rate system will be to administer or manage. 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, airways, bridges, and similar facilities. According to Meyer[10] the costs included in average cost pricing are defined as those of operating and amortizing a facility while output is some measure of the use made of that facility. It is a relatively simple pricing scheme to administer.

Schwuchow[13] recommends something similar: one fee with direct subsidies, if necessary, to certain users groups if deemed socially desirable in order to avoid bureaucratic complications and in order not to hinder the entrance of private competition into the industry.

It is suggested that exploring such policy possibilities would be a fruitful area for future research. Sources of models to be explored for their applicability to the pricing of information services such as selective dissemination of information include the pricing of semipublic goods and other analogous situations such as pricing of the recreational use of land; pricing in the transportation industries; pricing of computer time and software; pricing of goods and services offered by government bureaus; pricing in the medical profession and and other service professions; pricing in other information disseminating agencies such as cable television, radio broadcasting, other segments of the communication industry; and pricing of goods and services offered by nonprofit organizations.

Footnote and References

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