The Economics of Information
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# THE ECONOMICS OF INFORMATION[1]

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One should hardly have to tell academicians that information is a valuable resource: knowledge *is* power. And yet it occupies a slum dwelling in the town of economics. Mostly it is ignored: the best technology is assumed to be known; the relationship of commodities to consumer preferences is a datum. And one of the information-producing industries, advertising, is treated with a hostility that economists normally reserve for tariffs or monopolists.

There are a great many problems in economics for which this neglect of ignorance is no doubt permissible or even desirable. But there are some for which this is not true, and I hope to show that some important aspects of economic organization take on a new meaning when they are considered from the viewpoint of the search for information. In the present paper I shall attempt to analyze systematically one important problem of information—the ascertainment of market price.

[1] I have benefited from comments of Gary Becker, Milton Friedman, Zvi Griliches, Harry Johnson, Robert Solow, and Lester Telser.

## I. THE NATURE OF SEARCH

Prices change with varying frequency in all markets, and, unless a market is completely centralized, no one will know all the prices which various sellers (or buyers) quote at any given time. A buyer (or seller) who wishes to ascertain the most favorable price must canvass various sellers (or buyers)—a phenomenon I shall term "search."

The amount of dispersion of asking prices of sellers is a problem to be discussed later, but it is important to emphasize immediately the fact that dispersion is ubiquitous even for homogeneous goods. Two examples of asking prices, of consumer and producer goods respectively, are displayed in Table 1. The automobile prices (for an identical model) were those quoted with an average amount of "higgling": their average was \$2,436, their range from \$2,350 to \$2,515, and their standard deviation \$42. The prices for anthracite coal were bids for federal government purchases and had a mean of \$16.90 per ton, a range from \$15.46 to \$18.92, and a standard deviation of \$1.15. In both cases the range of prices was significant on almost any criterion.

Price dispersion is a manifestation—and, indeed, it is the measure—of ignorance in the market. Dispersion is a biased measure of ignorance because there is never absolute homogeneity in the commodity if we include the terms of sale within the concept of the commodity. Thus, some automobile dealers might perform more service, or carry a larger range of varieties in stock, and a portion of the observed dispersion is presumably attributable to such differences. But it would be metaphysical, and fruitless, to assert that all dispersion is due to heterogeneity.

TABLE 1

ASKING PRICES FOR TWO COMMODITIES

A. CHEVROLETS, CHICAGO, FEBRUARY, 1959*

| Price (Dollars) | No. of Dealers |
|---|---|
| 2,350–2,400 | 4 |
| 2,400–2,450 | 11 |
| 2,450–2,500 | 8 |
| 2,500–2,550 | 4 |

B. ANTHRACITE COAL, DELIVERED (WASHINGTON, D.C.), APRIL, 1953†

| Price per Ton (Dollars) | No. of Bids |
|---|---|
| 15.00–15.50 | 2 |
| 15.50–16.00 | 2 |
| 16.00–16.50 | 2 |
| 16.50–17.00 | 3 |
| 17.00–18.00 | 1 |
| 18.00–19.00 | 4 |

* Allen F. Jung, "Price Variations Among Automobile Dealers in Metropolitan Chicago," *Journal of Business*, XXXIII (January, 1960), 31–42.

† Supplied by John Flueck

At any time, then, there will be a frequency distribution of the prices quoted by sellers. Any buyer seeking the commodity would pay whatever price is asked by the seller whom he happened to canvass, if he were content to buy from the first seller. But, if the dispersion of price quotations of sellers is at all large (relative to the cost of search), it will pay, on average, to canvass several sellers. Consider the following primitive example: let sellers be equally divided between asking prices of \$2 and \$3. Then the distribution of minimum prices, as search is lengthened, is shown in Table 2. The buyer who canvasses two sellers instead of one has an expected saving of 25 cents per unit, etc.

The frequency distributions of asking (and offering) prices have not been studied sufficiently to support any hypothesis as to their nature. Asking prices are probably skewed to the right, as a rule, because the seller of reproducible goods will have some minimum but no maximum limit on the price he can accept. If the distribution of asking prices is normal, the distributions of minimum prices encountered in searches of one, two, and three sellers will be those displayed in Figure 1. If the distribution is rectangular, the corresponding distributions would be those shown in Panel B. The latter assumption does not receive strong support from the evidence, but it will be used for a time because of its algebraic simplicity.

TABLE 2

DISTRIBUTION OF HYPOTHETICAL MINIMUM PRICES BY NUMBERS OF BIDS CANVASSED

| No. of Prices Canvassed | Probability of Minimum Price of \$2.00 | Probability of Minimum Price of \$3.00 | Expected Minimum Price |
|---|---|---|---|
| 1 | .5 | .5 | \$2.50 |
| 2 | .75 | .25 | 2.25 |
| 3 | .875 | .125 | 2.125 |
| 4 | .9375 | .0625 | 2.0625 |
| ∞ | 1.0 | 0 | 2.00 |

In fact, if sellers' asking prices ($p$) are uniformly distributed between zero and one, it can be shown that:[2] (1) The dis-

[2] If $F(p)$ is the cumulative-frequency function of $p$, the probability that the minimum of $n$ observations will be greater than $p$ is

$$[1 - F(p)]^n = \left[\int^1 dx\right]^n .$$

tribution of minimum prices with $n$ searches is

$$n(1-p)^{n-1}, \qquad (1)$$

(2) the average minimum price is

$$\frac{1}{n+1},$$

and (3) the variance of the average minimum price is

$$\frac{n}{(n+1)^2(n+2)}.$$

Whatever the precise distribution of prices, it is certain that increased search will yield diminishing returns as measured by the expected reduction in the minimum asking price. This is obviously true of the rectangular distribution, with an expected minimum price of $1/(n+1)$ with $n$ searches, and also of the normal distributions.[3] In fact, if a distribution of asking prices did not display this property, it would be an unstable distribution for reasons that will soon be apparent.[4]

For any buyer the expected savings from an additional unit of search will be approximately the quantity ($q$) he wishes to purchase times the expected reduction in price as a result of the search,[5] or

$$q\left|\frac{\partial P_{\min}}{\partial_n}\right|. \qquad (2)$$

The expected saving from given search will be greater, the greater the dispersion of prices. The saving will also obviously be greater, the greater the expenditure on the commodity. Let us defer for a time the problem of the time period to which the expenditure refers, and hence the amount of expenditure, by considering the purchase of an indivisible, infrequently purchased good—say, a used automobile.

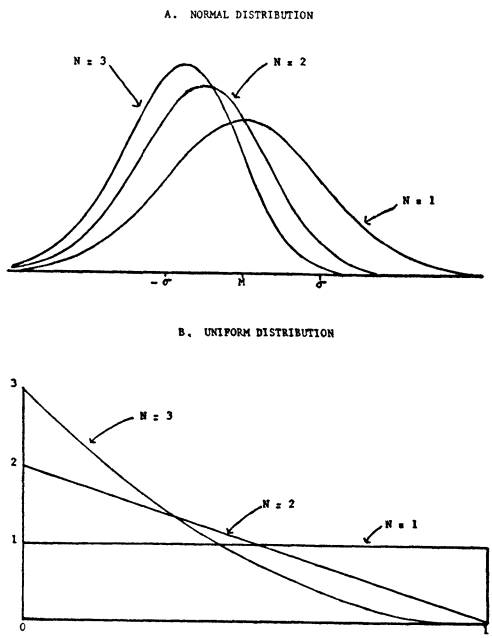


FIG. 1.—Distribution of minimum prices with varying amounts of search.

[3] The expected minimum prices with a normal distribution of mean $M$ and standard deviation $\sigma$ are

| Search | Expected Minimum Price |
|---|---|
| 1 | $M$ |
| 2 | $M - .564\sigma$ |
| 3 | $M - .846\sigma$ |
| 4 | $M - 1.029\sigma$ |
| 5 | $M - 1.163\sigma$ |
| 6 | $M - 1.267\sigma$ |
| 7 | $M - 1.352\sigma$ |
| 8 | $M - 1.423\sigma$ |
| 9 | $M - 1.485\sigma$ |
| 10 | $M - 1.539\sigma$ |

[4] Robert Solow has pointed out that the expected value of the minimum of a random sample of $n$ observations,

$$E(n) = n\int_0^\infty p(1-F)^{n-1}F'dp,$$

is a decreasing function of $n$, and

$$[E(n+2) - E(n+1)] - [E(n+1) - E(n)]$$

is positive so the minimum decreases at a decreasing rate. The proofs involve the fact that the density function for the $r$th observation from the maximum in a sample of $n$ is

$$n\binom{n-1}{r-1}F^{n-r}(1-F)^{r-1}F'dp.$$

[5] The precise savings will be ($a$) the reduction in price times the quantity which would be purchased at the higher price—the expression in the text—*plus* ($b$) the average saving on the additional purchases induced by the lower price. I neglect this quantity, which will generally be of a smaller order of magnitude.

The cost of search, for a consumer, may be taken as approximately proportional to the number of (identified) sellers approached, for the chief cost is time. This cost need not be equal for all consumers, of course: aside from differences in tastes, time will be more valuable to a person with a larger income. If the cost of search is equated to its expected marginal return, the optimum amount of search will be found.[6]

Of course, the sellers can also engage in search and, in the case of unique items, will occasionally do so in the literal fashion that buyers do. In this—empirically unimportant—case, the optimum amount of search will be such that the marginal cost of search equals the expected increase in receipts, strictly parallel to the analysis for buyers.

With unique goods the efficiency of personal search for either buyers or sellers is extremely low, because the identity of potential sellers is not known—the cost of search must be divided by the fraction of potential buyers (or sellers) in the population which is being searched. If I plan to sell a used car and engage in personal search, less than one family in a random selection of one hundred families is a potential buyer of even a popular model within the next month. As a result, the cost of search is increased more than one hundredfold per price quotation.

The costs of search are so great under these conditions that there is powerful inducement to localize transactions as a device for identifying potential buyers and sellers. The medieval markets commonly increased their efficiency in this respect by prohibiting the purchase or sale of the designated commodities within a given radius of the market or on non-market days. The market tolls that were frequently levied on sellers (even in the absence of effective restrictions on non-market transactions) were clear evidence of the value of access to the localized markets.

Advertising is, of course, the obvious modern method of identifying buyers and sellers: the *classified* advertisements in particular form a meeting place for potential buyers and sellers. The identification of buyers and sellers reduces drastically the cost of search. But advertising has its own limitations: advertising itself is an expense, and one essentially independent of the value of the item advertised. The advertising of goods which have few potential buyers relative to the circulation of the advertising medium is especially expensive. We shall temporarily put advertising aside and consider an alternative.

The alternative solution is the development of specialized traders whose chief service, indeed, is implicitly to provide a meeting place for potential buyers and sellers. A used-car dealer, turning over a thousand cars a year, and presumably encountering three or five thousand each of buying and selling bids, provides a substantial centralization of trading activity. Let us consider these dealer markets, which we shall assume to be competitive in the sense of there being many independent dealers.

Each dealer faces a distribution of (for example) buyers' bids and can vary his selling prices with a corresponding effect upon purchases. Even in the markets for divisible (and hence non-unique) goods there will be some scope for higgling (discrimination) in each individual transaction: the buyer has a maximum price given by the lowest price he encounters among the dealers he has searched (or

[6] Buyers often pool their knowledge and thus reduce the effective cost of search; a few remarks are made on this method below.

plans to search), but no minimum price. But let us put this range of indeterminacy aside, perhaps by assuming that the dealer finds discrimination too expensive,[7] and inquire how the demand curve facing a dealer is determined.

Each dealer sets a selling price, $p$, and makes sales to all buyers for whom this is the minimum price. With a uniform distribution of asking prices by dealers, the number of buyers of a total of $N_b$ possible buyers who will purchase from him is

$$N_i = K N_b n (1-p)^{n-1}, \qquad (3)$$

where $K$ is a constant.[8] The number of buyers from a dealer increases as his price is reduced, and at an increasing rate.[9] Moreover, with the uniform distribution of asking prices, the number of buyers increases with increased search if the price is below the reciprocal of the amount of search.[10] We should generally expect the high-price sellers to be small-volume sellers.

The stability of any distribution of asking prices of dealers will depend upon the costs of dealers. If there are constant returns to scale, the condition of equal rates of return dictates that the difference between a dealer's buying and selling prices be a constant. This condition cannot in general be met: any dealer can buy low, and sell high, provided he is content with a small volume of transactions, and he will then be earning more than costs (including a competitive rate of return). No other dealer can eliminate this non-competitive rate of profit, although by making the same price bids he can share the volume of business, or by asking lower prices he can increase the rewards to search and hence increase the amount of search.

With economies of scale, the competition of dealers will eliminate the profitability of quoting very high selling and very low buying prices and will render impossible some of the extreme price bids. On this score, the greater the decrease in average cost with volume, the smaller will be the dispersion of prices.[11] Many distributions of prices will be inconsistent with any possible cost conditions of dealers,[12] and it is not evident that strict equalities of rates of return for dealers are generally possible.

If economies of scale in dealing lead to

[7] This is the typical state of affairs in retailing xcept for consumer durable goods.

[8] Since $n(1-p)^{n-1}$ is a density function, we must multiply it by a $dp$ which represents the range of prices between adjacent price quotations. In addition, if two or more sellers quote an identical price, they will share the sales, so $K = dp/r$, where $r$ is the number of firms quoting price $p$.

[9] For

$$\frac{\partial N_i}{\partial p} = -\frac{(n-1)N_i}{(1-p)} < 0,$$

and

$$\frac{\partial^2 N_i}{\partial p^2} = \frac{(n-1)(n-2)N_i}{(1-p)^2} > 0$$

if $n > 2$.

[10] Let

$$\log N_i = \log K + \log N_b + \log n + (n-1)\log(1-p).$$

Then

$$\frac{1}{N_i}\frac{\partial N_i}{\partial n} = \frac{1}{n} + \log(1-p) = \frac{1}{n} - p,$$

approximately.

[11] This argument assumes that dealers will discover unusually profitable bids, given the buyers' search, which is, of course, only partly true: there is also a problem of dealers' search with respect to prices.

[12] With the rectangular distribution of asking prices, if each buyer purchases the same number of units, the elasticity of demand falls continuously with price, so that, if average cost equaled price at every rate of sales (with one seller at each price), marginal costs would have to be negative at large outputs. But, of course, the number of sellers can be less at lower prices.

a smaller dispersion of asking prices than do constant costs of dealing, similarly greater amounts of search will lead to a smaller dispersion of observed selling prices by reducing the number of purchasers who will pay high prices. Let us consider more closely the determinants of search.

### DETERMINANTS OF SEARCH

The equation defining optimum search is unambiguous only if a unique purchase is being made—a house, a particular used book, etc. If purchases are repetitive, the volume of purchases based upon the search must be considered.

If the correlation of asking prices of dealers in successive time periods is perfect (and positive!), the initial search is the only one that need be undertaken. In this case the expected savings of search will be the present value of the discounted savings on all future purchases, the future savings extending over the life of the buyer or seller (whichever is shorter).[13] On the other hand, if asking prices are uncorrelated in successive time periods, the savings from search will pertain only to that period,[14] and search in each period is independent of previous experience. If the correlation of successive prices is positive, customer search will be larger in the initial period than in subsequent periods.[15]

The correlation of successive asking prices of sellers is usually positive in the handful of cases I have examined. The rank correlation of anthracite price bids (Table 1) in 1953 with those in 1954 was .68 for eight bidders; that for Chevrolet dealers in Chicago February and August of 1959 was .33 for twenty-nine dealers—but, on the other hand, it was zero for Ford dealers for the same dates. Most observed correlations will, of course, be positive because of stable differences in the products or services, but our analysis is restricted to conditions of homogeneity.

As a rule, positive correlations should exist with homogeneous products. The amount of search will vary among individuals because of differences in their expenditures on a commodity or differences in cost of search. A seller who wishes to obtain the continued patronage of those buyers who value the gains of search more highly or have lower costs of search must see to it that he is quoting relatively low prices. In fact, goodwill may be defined as continued patronage by customers without continued search (that is, no more than occasional verification).

A positive correlation of successive asking prices justifies the widely held view that inexperienced buyers (tourists)

[13] Let the expected minimum price be $p_1 = f(n)_1$ in period 1 (with $f' < 0$) and let the expected minimum price in period 2, with $r$ a measure of the correlation between sellers' successive prices, be

$$p_2 = \left(\frac{p_1}{f(n_2)}\right)^r f(n_2)\ .$$

If the cost of search is $\lambda$ per unit, total expenditures for a fixed quantity of purchases ($Q$) per unit of time are, neglecting interest,

$$E = Q(p_1 + p_2) + \lambda(n_1 + n_2)\ .$$

Expenditures are a minimum when

$$\frac{\partial E}{\partial n_1} = Qf'(n_1) + Qr[f(n_1)]^{r-1} \times [f(n_2)]^{1-r} f'(n_1) + \lambda = 0$$

and

$$\frac{\partial E}{\partial n_2} = (1-r)Q[f(n_1)]^r \times [f(n_2)]^{-r} f'(n_2) + \lambda = 0\ .$$

If $r = 1$, $n_2 = 0$, and $n_1$ is determined by $Qf'(n_1) = -\lambda/2$, the cost of search is effectively halved.

[14] See n. 13; if $r = 0$, $n_1 = n_2$.

[15] Let $f(n) = e^{-n}$. Then, in the notation of our previous footnotes,

$$n_1 - n_2 = \frac{2r}{1-r}\ ,$$

approximately.

pay higher prices in a market than do experienced buyers.[16] The former have no accumulated knowledge of asking prices, and even with an optimum amount of search they will pay higher prices on average. Since the variance of the expected minimum price decreases with additional search, the prices paid by inexperienced buyers will also have a larger variance.

If a buyer enters a wholly new market, he will have no idea of the dispersion of prices and hence no idea of the rational amount of search he should make. In such cases the dispersion will presumably be estimated by some sort of sequential process, and this approach would open up a set of problems I must leave for others to explore. But, in general, one approaches a market with some general knowledge of the amount of dispersion, for dispersion itself is a function of the average amount of search, and this in turn is a function of the nature of the commodity:

1. The larger the fraction of the buyer's expenditures on the commodity, the greater the savings from search and hence the greater the amount of search.
2. The larger the fraction of repetitive (experienced) buyers in the market, the greater the effective amount of search (with positive correlation of successive prices).
3. The larger the fraction of repetitive sellers, the higher the correlation between successive prices, and hence, by condition (2), the larger the amount of accumulated search.[17]
4. The cost of search will be larger, the larger the geographical size of the market.

An increase in the number of buyers has an uncertain effect upon the dispersion of asking prices. The sheer increase in numbers will lead to an increase in the number of dealers and, *ceteris paribus*, to a larger range of asking prices. But, quite aside from advertising, the phenomenon of pooling information will increase. Information is pooled when two buyers compare prices: if each buyer canvasses $s$ sellers, by combining they effectively canvass $2s$ sellers, duplications aside.[18] Consumers compare prices of some commodities (for example, liquor) much more often than of others (for example, chewing gum)—in fact, pooling can be looked upon as a cheaper (and less reliable) form of search.

### SOURCES OF DISPERSION

One source of dispersion is simply the cost to dealers of ascertaining rivals' asking prices, but even if this cost were zero the dispersion of prices would not vanish. The more important limitation is provided by buyers' search, and, if the conditions and participants in the market were fixed in perpetuity, prices would immediately approach uniformity. Only those differences could persist which did not remunerate additional search. The condition for optimum search would be (with perfect correlation of successive prices):

$$q\left|\frac{\partial p}{\partial n}\right| = i \times \text{marginal cost of search},$$

where $i$ is the interest rate. If an additional search costs \$1, and the interest rate is 5 per cent, the expected reduction in price with one more search would at equilibrium be equal to $\$0.05/q$—a quantity which would often be smaller than the smallest unit of currency. But, indivisibilities aside, it would normally be

[16] For that matter, a negative correlation would have the same effects.

[17] If the number of sellers ($s$) and the asking-price distributions are the same in two periods, but $k$ are new sellers, the average period-1 buyer will have lost proportion $k/s$ of his period-1 search.

[18] Duplications will occur more often than random processes would suggest, because pooling is more likely between buyers of similar location, tastes, etc.

unprofitable for buyers or sellers to eliminate all dispersion.

The maintenance of appreciable dispersion of prices arises chiefly out of the fact that knowledge becomes obsolete. The conditions of supply and demand, and therefore the distribution of asking prices, change over time. There is no method by which buyers or sellers can ascertain the new average price in the market appropriate to the new conditions except by search. Sellers cannot maintain perfect correlation of successive prices, even if they wish to do so, because of the costs of search. Buyers accordingly cannot make the amount of investment in search that perfect correlation of prices would justify. The greater the instability of supply and/or demand conditions, therefore, the greater the dispersion of prices will be.

In addition, there is a component of ignorance due to the changing identity of buyers and sellers. There is a flow of new buyers and sellers in every market, and they are at least initially uninformed on prices and by their presence make the information of experienced buyers and sellers somewhat obsolete.

The amount of dispersion will also vary with one other characteristic which is of special interest: the size (in terms of both dollars and number of traders) of the market. As the market grows in these dimensions, there will appear a set of firms which specialize in collecting and selling information. They may take the form of trade journals or specialized brokers. Since the cost of collection of information is (approximately) independent of its use (although the cost of dissemination is not), there is a strong tendency toward monopoly in the provision of information: in general, there will be a "standard" source for trade information.

## II. ADVERTISING

Advertising is, among other things, a method of providing potential buyers with knowledge of the identity of sellers. It is clearly an immensely powerful instrument for the elimination of ignorance —comparable in force to the use of the book instead of the oral discourse to communicate knowledge. A small $5 advertisement in a metropolitan newspaper reaches (in the sense of being read) perhaps 25,000 readers, or fifty readers per penny, and, even if only a tiny fraction are potential buyers (or sellers), the economy they achieve in search, as compared with uninstructed solicitation, may be overwhelming.

Let us begin with advertisements designed only to identify sellers; the identification of buyers will not be treated explicitly, and the advertising of price will be discussed later. The identification of sellers is necessary because the identity of sellers changes over time, but much more because of the turnover of buyers. In every consumer market there will be a stream of new buyers (resulting from immigration or the attainment of financial maturity) requiring knowledge of sellers, and, in addition, it will be necessary to refresh the knowledge of infrequent buyers.

Suppose, what is no doubt too simple, that a given advertisement of size $a$ will inform $c$ per cent of the potential buyers in a given period, so $c = g(a)$.[19] This contact function will presumably show diminishing returns, at least beyond a certain size of advertisement. A certain fraction, $b$, of potential customers will be "born" (and "die") in a stable population, where "death" includes not only

[19] The effectiveness of the advertisement is also a function of the skill with which it is done and of the fraction of potential buyers who read the medium, but such elaborations are put aside.

departure from the market but forgetting the seller. The value of $b$ will obviously vary with the nature of the commodity; for example, it will be large for commodities which are seldom purchased (like a house). In a first period of advertising (at a given rate) the number of potential customers reached will be $cN$, if $N$ is the total number of potential customers. In the second period $cN(1 - b)$ of these potential customers will still be informed, $cbN$ new potential customers will be informed, and

$$c[(1-b)n - cN(1-b)]$$

old potential customers will be reached for the first time, or a total of

$$cN[1 + (1-b)(1-c)] .$$

This generalizes, for $k$ periods, to

$$cN[1 + (1-b)(1-c) + \ldots + (1-b)^{k-1}(1-c)^{k-1}] ,$$

and, if $k$ is large, this approaches

$$\frac{cN}{1-(1-c)(1-b)} = \lambda N . \quad (4)$$

The proportion ($\lambda$) of potential buyers informed of the advertiser's identity thus depends upon $c$ and $b$.

If each of $r$ sellers advertises the same amount, $\lambda$ is the probability that any one seller will inform any buyer. The distribution of $N$ potential buyers by the number of contacts achieved by $r$ sellers is given by the binomial distribution:

$$N(\lambda + [1-\lambda])^r ,$$

with, for example,

$$\frac{Nr!}{m!(r-m)!} \lambda^m (1-\lambda)^{r-m}$$

buyers being informed of exactly $m$ sellers' identities. The number of sellers known to a buyer ranges from zero to $r$, with an average of $r\lambda$ sellers and a variance of $r\lambda(1 - \lambda)$.[20]

The amount of relevant information in the market, even in this simple model, is not easy to summarize in a single measure—a difficulty common to frequency distributions. If all buyers wished to search $s$ sellers, all buyers knowing less than $s$ sellers would have inadequate information, and all who knew more than $s$ sellers would have redundant information, although the redundant information would not be worthless.[21] Since the value of information is the amount by which it reduces the expected cost to the buyer of his purchases, if these expected reductions are $\Delta C_1, \Delta C_2, \ldots$, for searches of $1, 2, \ldots$, the value of the information to buyers is approximately

$$\sum_{m=1}^{r} \frac{r!}{m!(r-m)!} \lambda^m (1-\lambda)^{r-m} \Delta C_m .$$

The information possessed by buyers, however, is not simply a matter of chance; those buyers who spend more on the commodity, or who search more for a given expenditure, will also search more for advertisements. The buyers with more information will, on average, make more extensive searches, so the value of information will be greater than this last formula indicates.

We may pause to discuss the fact that advertising in, say, a newspaper is normally "paid" for by the seller. On our analysis, the advertising is valuable to the buyer, and he would be willing to pay

[20] This approach has both similarities and contrasts to that published by S. A. Ozga, "Imperfect Markets through Lack of Knowledge," *Quarterly Journal of Economics*, LXXIV (February, 1960), 29–52.

[21] The larger the number of sellers known, the larger is the range of prices among the sellers and the lower the expected minimum price after $s$ searches. But this effect will normally be small.

more for a paper with advertisements than for one without. The difficulty with having the sellers insert advertisements "free" and having the buyer pay for them directly is that it would be difficult to ration space on this basis: the seller would have an incentive to supply an amount of information (or information of a type) the buyer did not wish, and, since numerous advertisements are supplied jointly, the buyer could not register clearly his preferences regarding advertising. (Catalogues, however, are often sold to buyers.) Charging the seller for the advertisements creates an incentive for him to supply to the buyer only the information which is desired.

It is commonly complained that advertising is jointly supplied with the commodity in the sense that the buyer must pay for both even though he wishes only the latter. The alternative of selling the advertising separately from the commodity, however, would require that the advertising of various sellers (of various commodities) would be supplied jointly: the economies of disseminating information in a general-purpose periodical are so great that some form of jointness is inescapable. But the common complaint is much exaggerated: the buyer who wishes can search out the seller who advertises little (but, of course, enough to be discoverable), and the latter can sell at prices lower by the savings on advertising.

These remarks seem most appropriate to newspaper advertisements of the "classified" variety; what of the spectacular television show or the weekly comedian? We are not equipped to discuss advertising in general because the problem of quality has been (and will continue to be) evaded by the assumption of homogeneous goods. Even within our narrower framework, however, the use of entertainment to attract buyers to information is a comprehensible phenomenon. The assimilation of information is not an easy or pleasant task for most people, and they may well be willing to pay more for the information when supplied in an enjoyable form. In principle, this complementary demand for information and entertainment is exactly analogous to the complementary demand of consumers for commodities and delivery service or air-conditioned stores. One might find a paradox in the simultaneous complaints of some people that advertising is too elaborate and school *houses* too shoddy.

A monopolist will advertise (and price the product) so as to maximize his profits,

$$\pi = Npq\lambda - \phi(N\lambda q) - ap_a,$$

where $p = f(q)$ is the demand curve of the individual buyer, $\phi(Nq\lambda)$ is production costs other than advertising, and $ap_a$ is advertising expenditures. The maximum profit conditions are

$$\frac{\partial \pi}{\partial q} = N\lambda\left(p + q\frac{\partial p}{\partial q}\right) - \phi' N\lambda = 0 \quad (5)$$

and

$$\frac{\partial \pi}{\partial a} = Npq\frac{\partial \lambda}{\partial a} - \phi' Nq\frac{\partial \lambda}{\partial a} - p_a = 0\,. \quad (6)$$

Equation (5) states the usual marginal cost–marginal revenue equality, and equation (6) states the equality of (price − marginal cost) with the marginal cost $[p_a/Nq(\partial\lambda/\partial a)]$ of advertising.[22]

[22] The marginal revenue from advertising expenditure,

$$\frac{Npq}{p_a}\frac{\partial \lambda}{\partial a},$$

equals the absolute value of the elasticity of demand by equations (5) and (6); see R. Dorfman and P. O. Steiner, "Optimal Advertising and Optimal Quality," *American Economic Review*, XLIV (1954), 826.

With the Cournot spring (where production costs $\phi = 0$) the monopolist advertises up to the point where price equals the marginal cost of informing a buyer: the monopolist will not (cannot) exploit ignorance as he exploits desire. The monopolist will advertise more, the higher the "death" rate ($b$), unless it is very high relative to the "contact" rate ($c$).[23] The monopolistic situation does not invite comparison with competition because an essential feature—the value of search in the face of price dispersion—is absent.

A highly simplified analysis of advertising by the competitive firm is presented in the Appendix. On the assumption that all firms are identical and that all buyers have identical demand curves and search equal amounts, we obtain the maximum-profit equation:

$$\text{Production cost} = p\left(1 + \frac{1}{\eta_{qp} + \eta_{Kp}}\right), \quad (7)$$

where $\eta_{qp}$ is the elasticity of a buyer's demand curve and $\eta_{K_p}$ is the elasticity of the fraction of buyers purchasing from the seller with respect to his price. The latter elasticity will be of the order of magnitude of the number of searches made by a buyer. With a uniform distribution of asking prices, increased search will lead to increased advertising by low-price sellers and reduced advertising by high-price sellers. The amount of advertising by a firm decreases as the number of firms increases.

*Price* advertising has a decisive influence on the dispersion of prices. Search now becomes extremely economical, and the question arises why, in the absence of differences in quality of products, the dispersion does not vanish. And the answer is simply that, if prices are advertised by a large portion of the sellers, the price differences diminish sharply. That they do not wholly vanish (in a given market) is due simply to the fact that no combination of advertising media reaches all potential buyers within the available time.

Assuming, as we do, that all sellers are equally convenient in location, must we say that some buyers are perverse in not reading the advertisements? Obviously not, for the cost of keeping currently informed about all articles which an individual purchases would be prohibitive. A typical household probably buys several hundred different items a month, and, if, on average, their prices change (in some outlets) only once a month, the number of advertisements (by at least several sellers) which must be read is forbiddingly large.

The seller's problem is even greater: he may sell two thousand items (a modest number for a grocery or hardware store), and to advertise each on the occasion of a price change—and frequently enough thereafter to remind buyers of his price—would be impossibly expensive. To keep the buyers in a market informed on the current prices of all items of consumption would involve perhaps a thousandfold increase of newspaper advertising.

From the manufacturer's viewpoint, uncertainty concerning his price is clearly disadvantageous. The cost of search is a cost of purchase, and consumption will therefore be smaller, the greater the dispersion of prices and the greater the optimum amount of search. This is presumably one reason (but, I conjecture, a very minor one) why uniform prices are set by

[23] Differentiating equation (6) with respect to $b$, we find that $\partial a/\partial b$ is positive or negative according as

$$b \lessgtr \frac{c}{1-c}.$$

If $c \geq \frac{1}{2}$, the derivative must be positive.

sellers of nationally advertised brands: if they have eliminated price variation, they have reduced the cost of the commodity (including search) to the buyer, even if the dealers' margins average somewhat more than they otherwise would.

The effect of advertising prices, then, is equivalent to that of the introduction of a very large amount of search by a large portion of the potential buyers. It follows from our discussion in Section I that the dispersion of asking prices will be much reduced. Since advertising of prices will be devoted to products for which the marginal value of search is high, it will tend to reduce dispersion most in commodities with large aggregate expenditures.

## III. CONCLUSIONS

The identification of sellers and the discovery of their prices are only one sample of the vast role of the search for information in economic life. Similar problems exist in the detection of profitable fields for investment and in the worker's choice of industry, location, and job. The search for knowledge on the quality of goods, which has been studiously avoided in this paper, is perhaps no more important but, certainly, analytically more difficult. Quality has not yet been successfully specified by economics, and this elusiveness extends to all problems in which it enters.

Some forms of economic organization may be explicable chiefly as devices for eliminating uncertainties in quality. The department store, as Milton Friedman has suggested to me, may be viewed as an institution which searches for the superior qualities of goods and guarantees that they are good quality. "Reputation" is a word which denotes the persistence of quality, and reputation commands a price (or exacts a penalty) because it economizes on search. When economists deplore the reliance of the consumer on reputation—although they choose the articles they read (and their colleagues) in good part on this basis—they implicitly assume that the consumer has a large laboratory, ready to deliver current information quickly and gratuitously.

Ignorance is like subzero weather: by a sufficient expenditure its effects upon people can be kept within tolerable or even comfortable bounds, but it would be wholly uneconomic entirely to eliminate all its effects. And, just as an analysis of man's shelter and apparel would be somewhat incomplete if cold weather is ignored, so also our understanding of economic life will be incomplete if we do not systematically take account of the cold winds of ignorance.

## APPENDIX

Under competition, the amount of advertising by any one seller ($i$) can be determined as follows. Each buyer will engage in an amount $s$ of search, which is determined by the factors discussed above (Sec. 1). He will on average know

$$(r-1)\lambda+\lambda_i$$

sellers, where $\lambda_i$ is defined by equation (4) for seller $i$. Hence,

$$\frac{\lambda_i}{(r-1)\lambda+\lambda_i}$$

per cent of buyers who know seller $i$ will canvass him on one search, and

$$\left(1-\frac{\lambda_i}{(r-1)\lambda+\lambda_i}\right)^s$$

per cent of the buyers who know $i$ will not canvass him in $s$ searches,

$$s \leq (r-1)\lambda+\lambda_i\,.$$

Therefore, of the buyers who know $i$, the proportion who will canvass him at least once is[24]

$$1-\left(1-\frac{\lambda_i}{(r-1)\lambda+\lambda_i}\right)^s.$$

If we approximate

$$\frac{\lambda_i}{(r-1)\lambda+\lambda_i}$$

by

$$\frac{\lambda_i}{r\lambda}$$

and take only the first two terms of the binomial expansion, this becomes

$$\frac{s\lambda_i}{r\lambda}.$$

The receipts of any seller then become the product of (1) The number of buyers canvassing him,

$$\frac{s\lambda_i}{r\lambda}\lambda_i N = T_i,$$

(2) the fraction $K$ of those canvassing him who buy from him, where $K$ depends upon his relative price (and the amount of search and the number of rivals), and (3) sales to each customer, $pq$. If $\phi(T_i Kq)$ is production costs and $ap_a$ advertising costs, profits are

$$\pi = T_i K p q - \phi(T_i K q) - a p_a.$$

The conditions for maximum profits are

$$\frac{\partial\pi}{\partial p} = T_i\left(K\frac{\partial pq}{\partial p} + pq\frac{\partial K}{\partial p}\right) - T_i\phi'\left(K\frac{\partial q}{\partial p} + q\frac{\partial K}{\partial p}\right) = 0 \qquad (8)$$

and

$$\frac{\partial\pi}{\partial a} = Kpq\frac{\partial T_i}{\partial a} - \phi' Kq\frac{\partial T_i}{\partial a} - p_a = 0. \qquad (9)$$

The former equation can be rewritten in elasticities as

$$\phi' = p\left(1+\frac{1}{\eta_{qp}+\eta_{Kp}}\right) \qquad (8a)$$

Price exceeds marginal cost, not simply by $(-p/\eta_{qp})$ as with monopoly, but by the smaller amount

$$\frac{-p}{\eta_{qp}+\eta_{Kp}},$$

where $\eta_{Kp}$ will generally be of the order of magnitude of the number of searches made by a buyer.[25] Equation (2) states the equality of the marginal revenue of advertising with its marginal cost. By differentiating equation (2) with respect to $s$ and taking $\phi'$ as constant, it can be shown that increased search by buyers will lead to increased advertising by low-price sellers and reduced advertising by high-price sellers (with a uniform distribution of prices).[26]

By the same method it may be shown that the amount of advertising by the firm will decrease as the number of rivals increases.[27] The aggregate amount of advertising by the industry may either increase or decrease with an increase in the number of firms, $s$, depending on the relationship between $\lambda$ and $a$.

[24] The formula errs slightly in allowing the multiple canvass of one seller by a buyer.

[25] In the case of the uniform distribution, $\eta_{Kp}$ is

$$\frac{-(s-1)p}{1-p}.$$

[26] The derivative $\partial a/\partial s$ has the sign of $(1+\eta_{Ks})$, and this elasticity equals

$$1+s\log[1-p]$$

with a uniform distribution of prices.

[27] By differentiation of equation (2) with respect to $r$ one gets

$$r\frac{\partial a}{\partial r}\left\{\lambda_i\frac{\partial^2\lambda_i}{\partial a^2}+\left(\frac{\partial\lambda_i}{\partial a}\right)^2\right\} = \lambda_i\frac{\partial\lambda_i}{\partial a}\left(1-\frac{r}{K}\frac{\partial K}{\partial r}\right).$$

The term in brackets on the left side is negative by the stability condition; the right side is positive.