
5 Consumer search and pricing

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Abstract

In most cases, consumers must search for information about prices and product attributes, and find it too costly to become perfectly informed. The consequent departure from perfect information affects the pricing behavior of sellers in a variety of ways. The purpose of this chapter is to review the literature on consumer search, and on the consequences of consumer search behavior for the behavior of markets. The review first focuses on summarizing theoretical models optimal search, and on how costly search may affect the behavior of markets. Two of the key results in this literature are that price dispersion should exist in equilibrium, and that differences in search costs provide a motive for price discrimination. After summarizing the theoretical models, the review presents empirical results on consumer search, and on pricing by sellers given differences in consumer search costs. Specific results for different information sources, including word of mouth, advertising, retailing and the Internet are discussed.

Introduction

In his seminal paper Stigler (1961) pointed out that there appears to be substantial and persistent price dispersion in markets for commodities such as coal. This is a direct contradiction of the standard model of perfect competition, in which the law of one price should prevail. Setting out to explain this anomaly, Stigler pointed out that the standard assumption that consumers are informed about all alternatives should be violated if search is costly. Since it only pays to search up to the point where the marginal benefits of search equal its marginal costs, a rational consumer will accept a price above the minimum when the expected gain from searching further is less than the cost. Therefore rational consumers can pay a price higher than the minimum, and price dispersion can result.

Thus began the study of the relationship between consumer search and market prices, which has burgeoned into a large and diverse literature over the past 40+ years. The objective of this review is to summarize this literature. Since the initial literature, including Stigler's article, was focused on the consumer side of the market, I shall consider models of optimal consumer search first. Then I shall discuss equilibrium models of search and price dispersion, and the empirical literatures on pricing and search that are related to these models. Finally I shall consider research that explores the relationship between search, pricing and different institutions that provide information and facilitate sales. My intent is to provide a broad overview of these very diverse areas that shows how they fit together rather than to provide a detailed review of each that cites all of the available references.

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Models of consumer search

Stigler (1961) considered a decision rule in which the searcher sets the number of items to be searched as the number at which the expected gains from an additional search are equal to the expected cost of that search. In this model all alternatives are assumed to be equally promising *a priori*, and search for an item is assumed to yield a complete understanding of that item. While this is sufficient to prove the point that expected-utility-maximizing consumers with positive search costs should not be fully informed, Stigler’s formulation is a very simplified model of search that does not capture the more general case in which priors on alternatives may be different, and search may be sequential. Nevertheless Stigler’s model may be a reasonable approximation to search in some situations; for example when soliciting bids for repair work when the bidder has time to prepare a proposal, and the purchase is not made until proposals are received. In this case, if one knew the variance of payoffs prior to searching, and the costs of soliciting and evaluating each contractor’s proposal, tables in Stigler’s article or in David (1970) and Ratchford (1980) could be used to determine the number of contractors to solicit bids from.

While still restrictive in many respects, the model of Weitzman (1979) considers the more general case in which the consumer may have different priors across alternatives, and in which the consumer can search sequentially. Weitzman assumes expected utility maximization, that search for an item uncovers all information about it, that there is recall, that there is no parallel search, and that there are no joint costs of search in which several alternatives can be inspected for the price of one. Given these assumptions, Weitzman proves the optimality of a stopping rule in which alternatives are searched in order of their reservation utility, and the consumer stops searching if the payoff exceeds the reservation utility of the next best alternative. Otherwise the consumer searches the alternative that is next in the ranking, and repeats the process until an alternative that meets the stopping criterion is found.

The reservation utility for alternative i , V_i^R , is the payoff value at which the consumer would be indifferent between searching the item at a cost of C_i or accepting the payoff V_i^R . The value of V_i^R is the one that equates the cost of searching i with the expected gain from looking for a payoff that exceeds V_i^R :

$$C_i = \int_{V_i^R}^{\infty} (V_i - V_i^R)f(V_i)dV_i$$

If the consumer already has an item with a payoff greater than V_i^R , he/she should stop since the expected gain from search is less than the cost. If the consumer does not have a payoff as high as V_i^R , he/she should continue to search because the expected gain will exceed the expected cost.

As an example, consider the case where V_i is normally distributed, with a mean \bar{V}_i , standard deviation σ_{V_i} . Then the integral on the right becomes σ_{V_i} times the value of the unit loss integral L_i^R that equates the right side with C_i :

$$C_i = \int_{V_i^R}^{\infty} (V_i - V_i^R)f(V_i)dV_i = \sigma_{V_i}L_i^R$$

The reservation value of i can then be calculated as

$$V_i^R = \bar{V}_i + \sigma_{V_i}z_i^R$$

Table 5.1 Example of application of the Weitzman model

Rank	c	σ_{v_i}	$L^R = c/\sigma_{v_i}$	z^R	\bar{V}_i	$V_i^R = \bar{V}_i + \sigma_{v_i}z_i^R$	$\Pr(V_i > V_{i+1}^R)$
1	3	15	0.20	0.49	50	57.35	0.3156
2	3	10	0.30	0.22	55	57.20	0.6179
3	6	20	0.30	0.22	50	52.02	

Consider the example in Table 5.1. The reservation utilities V_i^R are seen to depend on the costs of search, standard deviation of utilities and expected utility. Although the second alternative has the highest expected utility, the first has a larger standard deviation, which leads it to have the highest reservation utility. Basically the first alternative offers a better chance of 'striking it rich'. The third alternative gets set back in the order of reservation utilities because it has a high search cost (6). Weitzman's rule dictates that consumers should search the ranked first alternative first, with a probability of being able to stop after one search of 0.3156. If the payoff from the first search is less than 57.2, the reservation utility of the second alternative, the consumer should continue searching. Similarly, if the payoffs from both the first and second searches are less than 52.02 the consumer should go on to the third alternative. At this point the consumer should choose the best of the three items. The expected number of searches = $1*(0.3156) + 2*(1 - 0.3156)*(0.6179) + 3*(1 - 0.3156)*(1 - 0.6179) = 1.95$

Moorthy et al. (1997) applied the Weitzman model to develop an explanation of the relationship between prior brand perceptions and search. In their model, prior brand perceptions govern search, and these are expected to vary with experience. In particular, they show that prior brand perceptions can create the U-shaped relationship between knowledge and search that is often uncovered in laboratory experiments (Johnson and Russo, 1984). They tested their hypotheses on a panel of automobile shoppers in which data were obtained as the search progressed. They found that priors and search effort, and brands and attributes searched, vary with experience as hypothesized.

Around the time of Weitzman's article, labor economists began using hazard models to model search for a job and the duration of unemployment; good examples of these models are Lancaster (1985), Wolpin (1987), Jones (1988) and Eckstein and Wolpin (1990, 1995). Since there is a direct analogy between searching for the highest wage for a job and for the lowest price for a product, and since the structure of the search problem is similar in both cases, these job search models can also be applied to consumer price search with only minor modifications.

An application drawn from the labor economics literature to modeling the duration of search for automobiles was presented by Ratchford and Srinivasan (1993). In their model, price offers arrive at a constant rate, with the distribution of price offers following a Pareto distribution. The hazard of terminating the search and buying a car is then the product of the arrival rate of offers and the probability that an offer exceeds the reservation price. The observed outcomes of prices paid and time devoted to search result from two equations: an equation that determines the level and rate of arrival of offers, which depends on seller characteristics and the consumer's efficiency at search; and an equation that determines the reservation price, which depends on the same factors plus the cost of

search per unit of time. Ratchford and Srinivasan (1993) employ these equations in estimating the determinants of observed prices and search time, and in calculating monetary returns to additional search time.

The job search models of Wolpin (1987) and Eckstein and Wolpin (1990) are early examples of dynamic structural models. Their structural modeling approach has carried over into the literature on packaged goods choice in the form of models that postulate Bayesian learning of brand attributes through consumption (Erdem and Keane, 1996; Erdem et al., 2003; Mehta et al., 2003).

This structural approach has recently been applied to consumer search prior to purchase by Erdem et al. (2005). Using a very rich panel dataset that tracks a sample of potential computer buyers from early in their search to purchase, the authors simultaneously model gathering information from retailers, and the final choice of a computer. The panel has six waves in which respondents report the sources that they consulted, their quality perceptions of the competing brands, their price expectations, and, if applicable, their choice. Respondents are assumed to follow a Bayesian updating process for incorporating quality information from five information sources. Specifically, if L_{ikt} is a dummy variable indicating whether consumer i visits information source k at time t , if x_{ijkt} is a similarly defined noisy but unbiased signal from a given source, z_{ijt} is consumer i 's quality perception error at t , and σ_{ijt}^2 is the variance of perceptions at time t , the Bayesian updating formula for quality perceptions is given by (Erdem et al., 2005, p. 219):

$$\sigma_{ijt}^2 = \left[\frac{1}{\sigma_{j0}^2} + \sum_{s=1}^t \sum_{k=1}^5 \frac{L_{iks}}{\sigma_k^2} \right]^{-1}$$

$$z_{ijt} = z_{ijt-1} + \sum_{k=1}^5 L_{iks} \frac{\sigma_{ijt-1}^2}{\sigma_{ijt-1}^2 + \sigma_k^2} (x_{ijkt} - z_{ijt-1})$$

where σ_{j0}^2 is the variance of prior information, σ_k^2 is a measure of the reliability of source k , and information signals are assumed to be independent across sources. Smaller values of σ_k^2 lead to smaller σ_{ijt}^2 and more complete updating.

Given the above Bayesian updating mechanism for information sources, and an adaptive model of price expectations, Erdem et al. estimate a structural model in which each consumer optimizes the choice of the five information sources over the six periods of the panel, optimizes the timing of the choice given price expectations, and optimizes the make and quality level of computer chosen. While this model assumes that consumers can make very complex calculations, it also represents a direct empirical application of an optimizing model of search. Since this paper represents the state of the art in combining theoretical and empirical analysis of consumer search, it deserves careful study.

Models of search and pricing

If many consumers do not search much, there is a potential opportunity to exploit their ignorance by charging higher prices, so that price levels should be inversely related to search. Conversely, while some consumers may not search, those who can afford to search extensively will attempt to locate lower prices. This leads to the possibility that price dispersion, which is commonly observed in actual markets, will exist in equilibrium.

For our purposes, price dispersion may be defined as offering physically identical items for sale at different prices. Price dispersion may be either spatial (across sellers at one

point in time), or temporal (prices vary within a seller over time). There are at least four explanations for equilibrium price dispersion in the literature:

- Price dispersion due to differences in search costs and seller costs (Carlson and McAfee, 1983).
- Periodic sales due to adoption of mixed strategies by competing sellers to capture sales from high and low search cost segments (Varian, 1980).
- Markdowns due to demand uncertainty (Lazear, 1986; Pashigian, 1988; Smith and Achabal, 1998).
- Differences in services provided by sellers (Ehrlich and Fisher, 1982; Ratchford and Stoops, 1988, 1992).

Each of these explanations is discussed below.

While earlier equilibrium models of price dispersion had been developed (e.g. Salop and Stiglitz, 1977), Carlson and McAfee (1983) presented a model that was amenable to empirical testing, and was later tested by Dahlby and West (1986). The model of Carlson and McAfee addresses a homogeneous commodity sold by different sellers. Each buyer in the market will buy one unit. *A priori*, consumers know the distribution of prices, but not the specific price of any item. They search sequentially for the lowest price using a stopping rule in which search is terminated when the expected gain from additional search is less than the constant cost of the additional search. This cost per item searched is assumed to vary across consumers with a uniform distribution bounded at 0 on the low end. In this framework, a consumer with the highest search cost still has a $1/n$ (n = number of items) chance of getting any price, including the lowest one. A consumer with a search cost low enough to justify searching further if the highest price is encountered has a $1/(n - 1)$ chance of getting any of the other prices, and so on. Given the uniform distribution of search costs, Carlson and McAfee derive a demand function of the following form:

$$(q_j/\bar{q}) = 1 - (1/T)(p_j - \bar{p})$$

where j refers to firm, 'bar' denotes mean, q is quantity, p is price, and T is the upper bound of the uniform distribution of search costs. Increases in T (upward shifts in the distribution of search costs) make demand less sensitive to price changes.

On the supply side, Carlson and McAfee assume that unit costs differ across firms by a parameter α_j . Given the demand curve outlined above, their assumed cost function, and n competing sellers, they derive Nash equilibrium prices for each seller. Given that firms earn nonnegative profits, they show that the variance of prices in this model is proportional to the variance in the unit cost parameters α_j . If this variance is 0 and all firms have the same cost function, there will be no price dispersion: price dispersion is driven entirely by differences in unit costs in this model. However, if costs are the same for all firms, each firm will charge an equilibrium markup that is proportional to T , the highest search cost. Thus search costs affect price levels, and the variation in costs drives price dispersion.

While the Carlson and McAfee model leads to demand and cost functions that can be estimated empirically, it does not readily extend to differentiated products. Given the potential for empirical application, efforts to make this model applicable to products with different attributes may be worthwhile.

Salop and Stiglitz (1977) considered a monopolistically competitive market in which there were two segments of consumers – completely informed and completely uninformed, and showed that two prices could emerge in the market even though the competing sellers have identical U-shaped cost curves. As noted by Varian (1980), this a model of spatial competition.

A weakness of this model is that consumers never learn about the existence of the lower prices. To address this problem, Varian (1980) formulated a model of temporal price discrimination in the face of segments of informed and uninformed consumers, and a market with identical firm cost functions and free entry. Since firms are torn between the desire to extract surplus from the uninformed consumers and the desire to capture all of the business of the informed consumers by charging the lowest price, there is no pure strategy equilibrium in this model. The Nash equilibrium solution that maximizes expected profit for each firm is to select prices at random from an equilibrium distribution function. This allows each firm to capture a surplus from the uninformed consumers, while occasionally having the lowest price and therefore getting the business of the informed consumers. One way to interpret the practice of randomly offering relatively low prices in an effort to capture the informed consumers is that these low offers represent sales or promotions. Thus Varian's analysis provides a rationale for sales and promotions as the outcome of mixed strategies in a competitive market when there are differences in the degree to which consumers are informed. In the Varian model, price dispersion exists over time even though firms have identical costs. A testable outcome of the model is that the rank order of prices charged by firms in a market should fluctuate randomly over time.

The mixed strategy model has become a staple of models that explain price dispersion, promotions, advertising and other phenomena. For example, although he uses the terminology 'loyals' and 'switchers' instead of 'uninformed' and 'informed', Narasimhan (1988) employs a mixed strategy model similar in structure to Varian's to study the frequency and depth of promotions. Another example is Iyer and Pazgal (2003), who present a mixed strategy model that explains the dispersion of posted prices at Internet shopping agents. Recently, Baye and Morgan (2004) have shown that a mixed strategy model, and dispersion of offer prices, can be generated if firms depart from maximizing behavior, even if all consumers have zero search costs.

While the mixed strategy model based on segments with different amounts of information or brand loyalty provides one explanation for the existence of periodic promotions and sales, an alternative explanation is based on seller efforts to determine what consumers will pay for an item. The basic idea is that sellers who are uncertain about demand may initially charge a high price to see if any customers will pay it. Failure to sell the item at that price conveys to the seller that the distribution of consumer willingness to pay must lie below it. It becomes optimal to reduce the price. Failure to sell at the lower price conveys information that the distribution of willingness to pay lies below the reduced price, triggering a further price cut, and so on. This approach is feasible for goods like fashion merchandise because the consumer knows that inventories of the item will not be replenished once it sells, which makes it risky to wait for prices to be reduced further. A complete model of clearance sales is provided by Lazear (1986), and empirical studies based on this model are provided in Pashigian (1988), Pashigian and Bowen (1991) and Pashigian et al. (1995). A decision support system for optimal clearance pricing was developed by Smith and Achabal (1998).

A final potential determinant of price dispersion that is unrelated to differences in physical product characteristics is differences in advertising or other services provided by sellers. The basic idea, first developed by Ehrlich and Fisher (1982), is that advertising and other services are valued by consumers because they cut down on search costs, and that consumers will therefore willingly pay a higher price for goods that are bundled with the services. If the marginal costs of providing the services are non-decreasing in both amount per customer and number of customers, optimal trade between customer i and firm j can be expressed (Ehrlich and Fisher, 1982) as

$$-dL_i/dS_j = dp_j/dS_j = dC_j/dS_j$$

This implies that the marginal reduction in search costs (L) of consumer i due to advertising or other services provided by firm j ($-dL_i/dS_j$) is equal to the marginal increase in price that firm j can command on the market resulting from a marginal increase in services (dp_j/dS_j), which in turn is equal to the marginal cost to firm j of supplying the services (dC_j/dS_j). If the above assumptions about the marginal costs of services are satisfied, and there is free entry, an equilibrium with consumers choosing service levels that satisfy the above conditions, and prices equal to average cost including the cost of providing the services ($p_j = AC_j$) will result. Thus differences in observed prices across sellers result from differences in advertising or other services provided by firms. In turn these differences result from differences in consumer demand for the services.

Thus we have four potential explanations for price dispersion in markets. Spatial price dispersion may be related to differences in search costs between buyers coupled with cost differences between sellers, and to differences in use of advertising and other services provided by sellers. Both spatial and temporal price dispersion may be related to differences in search costs and mixed strategies over time, and temporal price dispersion may be related to reducing prices over time in response to information about willingness to pay. Aside from these explanations of price dispersion, there is a consistent finding that increases in the mass of consumers with high search costs will lead to higher prices and possibly to a higher supply of services that reduce search costs.

Empirical evidence on price dispersion and search

We shall first discuss the extensive empirical literature that tests various hypotheses about price dispersion suggested by the models of price dispersion outlined in the preceding section. Since the results of these models depend on consumer behavior, we shall also examine evidence in the literature on consumer search that is related to the empirical results about price dispersion and its antecedents.

Price dispersion

The dispersion of offer prices of physically identical items in retail markets has been consistently found to be quite large, even for relatively expensive items. For example, Sorenson (2000) found an average coefficient of variation of prices of prescription drugs across retailers in a particular market to be 22 percent. Dahlby and West (1986) found a coefficient of variation of auto insurance prices across insurers in a particular market of between 7 and 18 percent. In their study of 39 products in the Boston market, Pratt et al. (1979) found coefficients of variation ranging across products from 4.38 percent to 71.35

percent, with a mean of 21.6 percent across the 29 items. In their study of prices posted at Biz Rate, Pan et al. (2002) found average coefficients of variation across eight broad categories of between 8.3 and 15.4 percent. Although these measures of dispersion do decline somewhat with price levels (Pan et al., 2006), they are still substantial for high-ticket items.

The existing evidence indicates that most of the variation in prices across retailers cannot be explained by differences in retail services, at least with existing measures of services. Pan et al. (2002) found that between 5 and 43 percent of the variation in prices of homogeneous items across the eight categories studied could be explained by differences in services across sellers, and that this percentage of explained variation was under 25 percent for seven of the eight categories. Across different products in a category, evidence in the extensive literature on price-quality relations also indicates that differences in prices across items are not closely related to differences in their quality. This literature consistently indicates that the correlation between price and overall quality is low (e.g. Tellis and Wernerfelt, 1987), or that many brands have a price that is well above a frontier that defines the minimum price for a given quality or set of attributes (Maynes, 1976; Kamakura et al., 1988).

Although uncontrolled differences in service or product attributes may be part of the explanation for observed price dispersion and low price-quality correlations, the existing evidence seems more consistent with costly search. For example, Sorenson (2000) found that prices for repeatedly purchased prescription drugs had lower margins and less dispersion than less frequently purchased ones. Because the annual expenditure is higher, incentives to search for drugs are greater, and Sorenson's evidence is therefore consistent with consumer incentives to search for lower prices. Sorenson also concluded that at most one-third of the observed price dispersion can be attributed to pharmacy fixed effects, which may be due to some combination of cost and service level differences across pharmacies.

Dahlby and West (1986) employed the model of Carlson and McAfee (1983) in their study of price dispersion in an automobile insurance market, and concluded that price dispersion in this market can be explained by costly consumer search. Employing a unique dataset on market shares and prices, Dahlby and West (1986) estimated distributions of search costs for buyers of auto insurance that explained the observed variation in prices and market shares.

However, data on sales and market shares of items are generally difficult to obtain for specific sellers. To remedy this problem, Hong and Shum (2006) showed that, if one assumes optimal search by consumers and pricing according to an optimal mixed strategy by each seller, the distribution of search costs can be recovered from the observed distribution of prices. The basic idea is that a given distribution of search costs implies a particular frequency distribution of prices that arise from the optimal mixed strategies. If the observed frequency distribution corresponds to the optimal one, the distribution of search costs can be recovered. Using this approach, the authors developed a non-parametric estimator of the distribution of search costs for a fixed sample size model of search, and a maximum likelihood estimator for a sequential search model, under the maintained assumption that the distribution of search costs follows a gamma distribution. The authors presented some limited empirical evidence on search costs derived from observed price distributions of four books.

Search

Articles that are representative of the literature that examines the overall extent of pre-purchase search for consumer durables are: Punj and Staelin (1983); Wilkie and Dickson (1985); Beatty and Smith (1987); Srinivasan and Ratchford (1991); Ratchford and Srinivasan (1993); Moorthy et al. (1997); Lapersonne et al. (1995). A consistent finding of this literature is that the overall extent of search is limited for many buyers, and that the number of alternatives seriously considered for purchase is typically a small fraction of the number available. Despite the limited search, Ratchford and Srinivasan (1993) estimated that consumers tend to search until they are reasonably close to the point where the marginal saving in price equals the marginal costs of search. The U-shaped relationship between knowledge and search (Moorthy et al., 1997) discussed earlier suggests that price dispersion may result partly from price discrimination against consumers with low knowledge.

A number of studies have addressed price search by grocery shoppers. Carlson and Gieseke (1983) found that the percentage saved increases with stores shopped. Urbany et al. (1996), and Putrevu and Ratchford (1997), studied the relation between self-reported grocery search activities and attitudinal and demographic variables. They found that perceived price dispersion, knowledge of prices, ability to search and access to price information are positively related to search, while measures of time costs are negatively related. Fox and Hoch (2005) studied the impact of shopping more than one store on the same day, which they defined as cherry picking, and found that the savings resulting from the additional trip averaged \$14.66, which is high enough to justify the extra trip for the average consumer (the trip is justified as long as its opportunity cost is less than \$14.66).

While other authors employed either panel data on actual prices, or survey data, Gauri et al. (2007) collected both types of data. They studied both spatial (more than one store in a time period) and temporal (stocking up at one store when promotions are offered) dimensions of search and found that each search strategy can generate about the same level of savings, while a combination of the two strategies can generate the highest savings. They also found that patterns of search were largely driven by consumer geographical locations relative to stores.

There is a more micro body of research that infers how consumers search for repeatedly purchased items that are sold in a supermarket. As with consumer durables, survey research indicates that consumers do not search extensively for specific grocery items. For example, Dickson and Sawyer (1990) found that only about 60 percent of consumers checked the price of the item they bought before purchase, and that less than 25 percent checked the price of any competing brand. A majority of consumers could not accurately recall prices that they paid.

Consistent with these findings, models of costly and incomplete search have been estimated on scanner panel data. Murthi and Srinivasan (1999) built a model in which consumers evaluate alternatives only part of the time, and show that this provides better predictive performance than models that do not incorporate this partial evaluation behavior. Bayesian learning models were employed by Erdem and Keane (1996), Erdem et al. (2003), and Horsky et al. (2006) to represent the evolution of consumer preferences as they gain more experience with different brands. Mehta et al. (2003) combined the extensive body of literature on consideration sets (see the references in their paper),

Bayesian updating of quality and price perceptions, and a search model that balances benefits and costs of search, to determine which brands are considered on a particular occasion.

Summary of empirical results

The extensive theoretical literature on how consumers should search indicates that they should terminate their search at the point where the expected gain from additional search is less than the expected cost. If this search is costly, consumers should not gather complete information on all alternatives, and if it is costly enough, they should not search at all. Differences in gains and costs of search across consumers should determine differences in the amount of search that they undertake.

While individual consumers may not behave optimally according to a normative decision rule, the empirical literature on search generally indicates that differences in search across consumers are consistent with the predictions of the normative models. In both durables and grocery markets, it appears that consumers who perceive more gains from search actually do search more, and that more search is associated with savings. In durables markets, there is a group of consumers, generally knowledgeable and experienced, who do not search extensively. Nevertheless, while this limited search appears to be partly due to prior information that makes further search unnecessary, and may also be due to high search costs, one wonders if there is more to the story.

Search, sources of information and pricing

While the market models of search and pricing outlined above usually abstract from specific sources of information, it is clear that consumers use a variety of sources in the course of their search. Following Klein and Ford (2003), these information sources can be broadly classified as personal (word-of-mouth, talking to salesperson, inspection at the retail outlet), and impersonal (advertising, *Consumer Reports*). They can be further classified as seller-sponsored attempts to influence sales (advertising, salesperson), and neutral or objective (friend/relative, *Consumer Reports*). Finally, the impersonal sources can be classified by medium (Internet, print). Because they involve considerations related to search and pricing that have not yet been incorporated into this review, we shall concentrate our discussion on word-of-mouth, advertising, retail and the Internet.

Word of mouth

There has been extensive study of word of mouth as a source of information in automobile purchases, with the results generally indicating that heavy users of this source tend to be young, female, inexperienced at buying cars, and low in confidence about their ability to judge them (Furse et al., 1984; Ratchford et al., 2007). They are likely to employ a purchase pal who is viewed as having more knowledge of car buying in their search (Furse et al., 1984).

The latter indicates an important consideration in studying word of mouth as an information source: someone must supply the information. This role of information supplier often appears to be filled by persons described as market mavens (Feick and Price, 1987). Market mavens are individuals who tend to collect a broad array of marketplace information with the intent of sharing it with others (Urbany et al., 1996). They appear to collect more information about food, drug, and other items sold at grocery stores (Feick

and Price, 1987; Urbany et al., 1996). The implication is that market mavens, who appear to enjoy gathering and sharing marketplace information, may play a significant role in enhancing the efficiency of consumer markets.

Advertising

Since the advertiser is normally engaging in this activity in order to make money, and consumers are likely to be aware of this, the possibility that advertising may be a signal rather than a direct source of information needs to be discussed. The possible role of advertising in cutting down on search costs has been discussed above. But there are cases in which the veracity of advertising cannot be verified through pre-purchase search (Nelson, 1974). There have been many attempts to develop formal arguments about the role of advertising and price as signals of quality in cases where consumers do not find it cost-effective to learn about quality prior to purchase (this work is reviewed by Kirmani and Rao, 2000). One of the major arguments in this literature is that advertising serves as a performance bond to motivate the firm to maintain its quality: firms advertise up front to convince consumers that they will maintain their quality; in return they get a price premium that is forfeited if their quality deteriorates. Since the firm cannot earn an adequate return on the advertising investment if it allows quality to decline, the advertising signal is credible (Klein and Leffler, 1981; Shapiro, 1983). While the rationale for the result is different from the case of informative advertising, the outcome is similar: in Ehrlich and Fisher (1982) consumers pay a higher price to avoid search costs; in signaling models they pay a higher price to get insurance of high quality.

In contrast to the signaling models discussed above, which have the most direct application to manufactured goods, Bagwell and Ramey (1994) modeled the use of advertising as a signal in retail markets. Their clear prediction is that advertising will be associated with lower prices and better buys. In their model, investments in selling technology lower costs, expansion of product line increases sales from any given set of customers, and marginal selling costs are constant or declining. All of these factors are complementary and allow the larger retailer to offer lower prices. Consumers who are aware of the heaviest advertiser employ advertising as a signal to patronize that retailer. They are rewarded with the lowest prices, while that retailer achieves the best information technology, broadest product line and lowest marginal costs. Other research related to search in retail markets is discussed in the next section.

Retailing

Since retailers not only function as an information source, but also set or negotiate prices, provide locational convenience, assemble assortments, hold inventory and finalize transactions (Betancourt, 2004), their role in the search process is unique. All of these activities have an impact on the full price of the product (price plus search and transaction costs). In general, since information, convenience, assortments, inventories and other services reduce search costs, retailers who provide them can cover their cost through higher prices. We shall review a number of studies that have addressed these tradeoffs between services that reduce search costs and price.

Messinger and Narasimhan (1997) studied the impact of large assortments that create economies of one-stop shopping. In their model, which is similar in structure to the model of Ehrlich and Fisher (1982) discussed above, the equilibrium assortment of a

supermarket is the assortment that equates the marginal saving in consumer shopping costs with the marginal cost to the store of providing a larger assortment. The cost saving to consumers comes from spreading a fixed travel cost over a higher number of items bought. The authors estimate that consumers trade a 1–2 percent increase in store margin for a 3–4 percent decrease in shopping costs that results from the large supermarket assortments.

The desire of buyers to shop in one location to minimize search costs often leads retailers of a given type to locate proximate to one another even though this creates more competition between them. For example, automobile retailers often cluster together, and major specialty stores for clothing and sporting goods tend to locate in the same mall. This clustering benefits buyers by lowering the cost of shopping for multiple items, or the cost of comparison shopping. In the latter case, it also makes the clustered retailers more competitive, which they endure because the clustered site is attractive to consumers (Wernerfelt, 1994b). A study by Arentze et al. (2005) provides a framework for the estimation of these retail agglomeration effects, and a case analysis that indicates that the effects on demand are substantial.

Once a potential buyer incurs the cost of a trip to a retailer, the retailer gains a measure of monopoly power over the buyer: if the buyer does not purchase, the cost of going to the next store must be incurred. Knowing this, the buyer will be more likely to patronize the retailer if the retailer can commit to not exploiting the buyer's sunk costs of traveling to the retailer. Wernerfelt (1994b) explains that such a commitment can be achieved by the co-location described above (the cost of going to the next seller becomes low), and also by price advertising that provides a legal commitment to provide the advertised price. Conversely, Wernerfelt (1994b) shows that retailers can employ negotiated prices to soften price competition. Manufacturers can also soften price competition between retailers by making the models available at competing retailers slightly different, thereby making it difficult for consumers to make price comparisons (Bergen et al., 1996).

One case in which the buyer's sunk travel costs may be exploited is when a stock-out is encountered. In this case, because the cost of the extra trip may not be worth it, the consumer may still buy other items from the retailer and may substitute for the item that is subject to the stock-out (see Anupindi et al., 1998 for a method for estimating substitution effects when stock-outs occur). Hess and Gerstner (1987) show that retailers may be able to induce an extra trip by using a rain check policy when there is a stock-out.

Since retail salespeople appear to be a key source of consumer information for appliances and durables (Wilkie and Dickson, 1985), it is important to examine the circumstances under which salespeople will be used as an information source. Wernerfelt (1994a) presents a model in which salespeople will be the preferred source of information for complex products in which a dialog between salesperson and consumer is needed to establish a match, and in which the salesperson is motivated to give honest answers by the prospect of repeat business.

Search and the Internet

Since the advent of the Internet provided an altogether new information source and form of retailing that quickly received widespread use by buyers and sellers, it is not surprising that this medium has been the subject of a great deal of theoretical and empirical research. The early expectation was that the Internet would reduce search costs and lead

to something approaching Bertrand competition. For example, Bakos (1997) predicted that the Internet would increase the participation of consumers in markets, and create improved matches between buyers and sellers. However, it did not take long for more sober views to emerge. The paper by Lal and Sarvary (1999) provides one important exception to the belief that the Internet will always increase competition. The authors show that, by making it easy to order over the Internet, the cost of acquiring a brand that has been bought in the past relative to an unknown brand that requires inspection before purchase is altered. One can acquire the known brand over the Internet at a low cost but must incur the cost of traveling to a retailer to get the needed information about the unknown brand. This gives the seller of the known brand a cost advantage that he/she can exploit in setting prices. Thus the Internet can promote brand loyalty and lessen competition.

Internet shopping agents (ISAs) that present comparative price data for competing sellers have become a common feature of Internet commerce. Despite the fact that users of an ISA should have no trouble determining which seller charges the lowest price, a large number of studies have shown that prices listed on ISAs typically exhibit a large degree of dispersion, similar in magnitude to 'brick and mortar' retail prices (see the review in Pan et al., 2006). Baye and Morgan (2001) and Iyer and Pazgal (2003) have explained this apparent anomaly as the adoption of mixed strategies. Firms want to trade off between extracting surplus from non-searching (loyal) customers and obtaining the business of those who consult the ISA. Similar to Varian (1980), this leads sellers who belong to the ISA to choose mixed strategies, which leads to the observed dispersion in posted prices. Because the chance of having the lowest price declines as the number of sellers increases, Iyer and Pazgal (2003) show that, as long as the reach of the ISA does not increase substantially with the number of members, ISA members will give more weight to loyal customers and charge higher prices as the number of members of the ISA increases. Since the chance of getting the business of ISA shoppers declines as the number of sellers increases, at some point it will be more profitable to cater exclusively to the non-ISA customers. Thus not all sellers will join an ISA. For the three categories they studied (books, music CDs and movie videos), Iyer and Pazgal (2003) did find evidence of variation in the identity of the seller offering the minimum price that is consistent with mixed strategies, and a tendency of prices to increase with the number of sellers.

Aside from the evidence of considerable dispersion of posted prices among Internet retailers, there is a body of evidence that indicates that the Internet does lead to lower prices and more efficient search on the part of consumers. For example, for data collected from early 1998 through early 1999, Brynjolfsson and Smith (2000) found that online book and CD prices were 9–16 percent below the offline prices of the same items. Garbarino (2006) shows that the lower online book and CD prices have persisted though 2006, although the gap has narrowed in recent years. Additional evidence that the Internet leads to lower prices is provided by Brown and Goolsbee (2002) and Zettelmeyer et al. (2006). Using micro-level data on transaction prices for term insurance that allows estimation of relationships between prices paid and differences in Internet use, Brown and Goolsbee (2002) determined that the Internet lowered term insurance prices by 8–15 percent from 1995 to 1997. Using a matched set of data on transaction prices and survey data on search behavior, Zettelmeyer et al. (2006) estimated that access to price data and referrals through the Internet leads to a decline

in transaction prices of about 1.5 percent, and that the benefits of the Internet accrue mainly to those who dislike bargaining.

As pointed out by Bakos (1997), the Internet need not lower prices if it makes it easier to locate sellers that provide a better match to consumer preferences. The better match can allow the seller to command a higher price. Lynch and Ariely (2000) found evidence of this in their experimental study of wine purchasing. More accessible quality information did lead to decreased price sensitivity in their experiments.

In addition to influencing prices, the Internet can affect other aspects of search. In particular, it may affect the total amount of effort that consumers put into their search in either direction: by allowing consumers to search more efficiently, the Internet should lead to a reduction in the effort required to obtain a given amount of information; however, the increased efficiency may make it cost-effective to attempt to locate more information than would otherwise be the case. Evidence from data on search for automobiles before and after the Internet appeared suggests that the latter effect predominates and that the Internet tends to lead to increased total search (Ratchford et al., 2003; Ratchford et al., 2007).

In addition to affecting the total amount of search, the Internet should also alter the allocation of effort between sources. Evidence for automobile search in Ratchford et al., (2003) and Ratchford et al. (2007) indicates that the Internet has had a major impact on time spent with the dealer, considerably reducing this time, and specifically reducing time spent in negotiating price with the dealer. This is consistent with the finding cited above that the Internet leads to lower prices for automobiles. Consumers do appear to come to the dealer with price information obtained from the Internet, making the price negotiation more efficient in terms of time spent, while at the same time neutralizing the salesperson's advantage in negotiating price. This should ultimately have an impact on margins that can be obtained by dealers, and on the number and skill of salespeople that they retain.

Conclusions and future research

Forty-plus years after his original article, Stigler's basic insight that search is costly, and that this will create price dispersion, still holds. Since the dispersion of offer prices for physically identical items is a pervasive phenomenon, even in cases where prices are easy to compare, models that fail to account for this may be assuming away something important and should be treated with caution.

The existing evidence about consumer search for both durables and groceries indicates that buyers stop well short of obtaining complete information, and in many cases obtain almost no new information. However, given that search is costly, it is not clear that consumers systematically search less than some normative model might tell them to. In fact, evidence presented in Ratchford and Srinivasan (1993), Fox and Hoch (2005) and Gauri et al. (2007) indicates that marginal gains to search are not far out of line with marginal costs. Moreover, empirical studies of search behavior generally indicate that search varies across consumers in ways that are consistent with fundamental search models.

One reason why it is hard to determine whether consumers search too little or too much compared to a normative model is that costs of search are difficult to measure. Time costs appear to differ considerably from wage rates, and shopping time may be a consumption good in itself (Marmorstein et al., 1992). Moreover, while there are obvious constraints

on consumers' ability to process information, this information-processing capacity generally is not incorporated into estimates of search costs. Learning more about the nature and magnitude of search costs would seem to be a potentially fruitful area for further research.

Existing models indicate that average and minimum prices, and price dispersion, increase with the variation in search costs across consumers (an assumption that the lowest search cost is 0 – some consumers are fully informed – is generally required to solve for equilibrium). Price dispersion may arise from heterogeneity of consumer search costs, accompanied either with cost differences among sellers or mixed strategies aimed at targeting consumers with different levels of search costs. It may also arise from heterogeneity in demand for services that reduce search costs, with consumers that demand more services paying higher prices. Finally, temporal price dispersion may arise from seller efforts to learn the maximum price at which an item will sell.

While the mixed strategy explanation for price dispersion is commonly used, and there is some evidence that the identity of the minimum-priced seller does fluctuate through time, one must worry about the realism of this explanation. It seems questionable that sellers really do randomize their prices through time, although possibly this is a good approximation. Development of a model of pricing and price dispersion that is more closely related to actual seller behavior, and that incorporates services provided by the seller that may reduce search costs, would seem a good area for further research. Possibly, extension of the model of Carlson and McAfee (1983) to the case where sellers are differentiated on the services they offer would be a good way to proceed.

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