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The author studies the pricing of information with private value (e.g., management consulting, legal advice, medical diagnosis). Anecdotal evidence shows that in some of these markets, competing information sellers split the business to sell only first or second opinions to their customers. The author explains this pricing practice by showing that second-opinion markets are a result of temporal differentiation.

Temporal Differentiation and the Market for Second Opinions

Imagine that a patient visits a neurologist to ask for a diagnosis regarding an annoying headache. Most likely, the doctor recommends a change of lifestyle or a minor cure involving some medicine, and the patient goes home reassured. What if, however, the doctor diagnoses a major disease that requires serious surgery? In this case, the patient is likely to seek a second opinion from another specialist. Furthermore, the patient will probably look for a well-reputed expert and pay a premium for the second opinion.

This article studies similar situations, in which firms sell *private information* to consumers, which is defined as information that is valuable only (or mainly) to the client for whom it has been produced. Beyond medical diagnosis, examples include other professional consulting services, from accounting to strategic management advice. In such markets, *temporal differentiation*, in which a firm specializes in selling second opinions to clients, can often be observed. The medical profession is a familiar example. Most people will seek a second opinion if a major disease has been diagnosed by their specialist. Often, the second specialist is an expert who tends to deal with complicated cases only. Recently, most insurance companies explicitly require patients to obtain a second opinion when they have been recommended major surgery by their primary specialist.¹ An article in *BusinessWeek* (1985) shows the results of these programs for several surgical interventions (see Table

¹Several studies explicitly document the savings from these so-called mandatory second opinion programs (see, e.g., Chu, Lavoie, and McCarthy 1992; Rosenberg et al. 1991).

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Table 1
RESULTS OF MANDATORY SECOND OPINIONS

Type	Operations Proposed		Opposed by Second Doctor	
	Number		Number	Percentage
Varicose vein	6		3	50
Breast	23		9	39
Back	29		11	38
Bunion	22		8	36
Knee	58		16	28
Prostate	17		3	18
Hysterectomy	53		9	17
Gall bladder	25		3	12
Tonsils and adenoids	43		5	12
Dilation and curettage	43		3	7
Cataract	52		3	6
Hernia	39		2	5
Nose	25		1	4
Total	435		76	17

Source: Owens-Illinois Inc. Adapted from *BusinessWeek* (1985).

1). The article also documents that in response to insurers' (and patients') needs for these services, a fraction of experts—those with generally higher perceived quality—specialize in providing second opinions only.² In this way, although they serve only a small fraction of the patients, they benefit from the higher value of their advice. Indeed, the article documents that the price of a second opinion is significantly higher than the mostly standardized price of a first diagnosis.

In addition to medicine, second-opinion services can be observed in other professional consulting service areas, such as engineering, finance, marketing, and law. Binary Engineering Associates, for example, is a consulting firm that provides a special second-opinion service in various legal cases that involve mechanical engineering, fire protection

²Examples of medical associations providing second opinion services include MFHE's Second Opinion Service and Cancer Care Associates, among others.

engineering, electrocutions, and other similar problems. The Devil's Advocate is a legal fee management and litigation consulting firm that offers second opinions in litigation cases (Klausner, Miller, and Painter 1998). Although the firm is organized as a regular law firm, it does not have its own litigation practice; it only gets involved if a second opinion is needed. In marketing and media planning, there are several experts that specialize in providing second-opinion services. Documented examples include Campbell-Mithun/Chicago's second-opinion service for food service clients, as well as Trout & Ries and Fusion Group Two, both of which are marketing consulting firms that provide second opinions on communication programs.³ Second-opinion services are also abundant among portfolio analysts, as is documented in an article in *Medical Economics* (1994). The article points out that many good portfolio analysts do not actively solicit consumer business. However, in problematic situations, clients tend to find them. One of the analysts explains, "I am often asked to do analysis only, providing no services beyond rendering a second opinion" (p. 131).

The existence of special second-opinion services is not always a characteristic of professional consulting services. A clear example is accounting, in which firms do not specialize in providing second opinions, even though the demand for a second audit is not rare. Furthermore, there does not seem to be a difference between the prices of first or second opinions. Evidence shows that accounting firms tend to compete strongly for a contract on the initial evaluation of the client by lowering prices close to marginal costs, a strategy called "lowballing."⁴ Another example of professional consultants that do not seem to specialize in providing first or second opinions is the large information technology (IT) analyst firms, such as Gartner Group, Forrester Research, Meta Group, Yankee Group, and others. Often, these firms help clients choose between emerging technologies and applications through customized consulting services or company-specific reports on competitive and market trends. Although it is not rare for clients to hire multiple analysts (Forrester, for example, claims that 90% of its clients are also Gartner clients), these consulting firms do not specialize in providing first or second opinions. Also, their prices, though perceived to be high by clients, tend to be in the same range.⁵

In view of this anecdotal evidence, the goal of this article is to study competing firms' pricing strategies in private information markets. In particular, under what conditions will (and can) firms specialize in selling second opinions to their clients? Private information markets are typically characterized by a consultative sales process. As a result of this process, clients typically commission information from one firm at a time, and firms are usually familiar with the client's decision problem. In other words, firms can assess the value of information they provide and thus can price the information accordingly. This is important because the value of additional information changes over time as a function of

the content of the information that was previously sold to the client. How should information sellers price their products in such competitive situations? Should they target all consumers in their initial search for information, or should they cater only to a subset of consumers with a high valuation for a second opinion? In particular, how will this decision depend on the competing experts' product characteristics and costs? My goal is to provide meaningful insights to answer these questions.

The next section briefly summarizes the relevant literature, and then I present a model of private information markets. I solve this model and relate the findings to the examples presented previously. The article ends with a discussion of the results and conclusions. For improved readability, all derivations and extensions are given in an Appendix, which is available on request.

RELATED LITERATURE

Among recent articles in information marketing, the most similar to the present study is Sarvary and Parker's (1997), which focuses on competition among information sellers.⁶ The fundamental difference is that though their article pertains to static competition in public information markets, the present article studies dynamic competition in private information markets. In private information markets, firms sell information that is valuable only (or mainly) to the customer for whom the information has been specifically produced. As mentioned previously, in this setting, prices are determined through a consultative sales process.⁷ As a result, the firm is familiar with the client's decision problem and has the opportunity to price discriminate. Thus, unlike in previous research, one important characteristic of this setting is that there is no consumer heterogeneity.

Familiarity with the client's decision problem also means that the nature of competition is fundamentally different from that studied in previous research. Here, firms may know in which phase of the information acquisition process the client is. As a result, they can estimate the clients' willingness to pay for an opinion in every stage of the client's decision process. Because the value of a second opinion is contingent on the content of the information purchased before, information sellers face an inherently dynamic pricing problem. In particular, when setting prices, they need to consider whether they will sell a first or a second opinion.

A key new finding in this setup is that under some conditions, competing information sellers price in such a way that they sell information to the same clients in different phases of the clients' information search processes. The lower quality firm sells a first opinion to all clients, some of which will also buy a second opinion from the higher quality firm for a higher price. This outcome is referred to as temporal differ-

³See *Marketing & Media Decisions* (1985), *Business Marketing* (1987), and *Marketing News* (1981).

⁴For a recent theoretical article showing that lowballing can occur even without positive transaction costs for switching auditors, see Schatzberg (1994).

⁵See *Information Week's* (Violino and Levin 1997) recent survey of 300 information systems executives on IT analysts' services.

⁶For models with a monopolistic information seller, see, for example, Iyer and Soberman (2000), Pasa and Shugan (1996), Chu and Messinger (1997), and Raju and Roy (2000). Here, the situation in which the information seller is involved in fixing the diagnosed problem is not modeled. Wolinsky (1993) and Emons (1997) show that the relevant question in this case is the moral hazard of the expert in overstating the customer's problem. The present article does not deal with moral hazard issues.

⁷Because the information produced is customer specific, the client's decision context is generally explained to the expert. Also, the client will not (cannot) hire several experts simultaneously. For example, companies do not hire several consultants simultaneously for the same project, even though they shop around for consultants.

entiation, because it leads to a softening of competition between firms.

It is important to distinguish temporal differentiation from two related concepts: (1) vertical differentiation and (2) temporal discrimination. In vertical differentiation (see, e.g., Moorthy 1988), the outcome is similar in some respects, namely, that there is a positive correlation between firms' qualities and equilibrium prices. However, there are important differences. First, under vertical differentiation, no consumer buys both products. Second, whereas in vertical differentiation consumer heterogeneity is clear from the beginning, in this case it is generated through product consumption. In particular, in equilibrium, all consumers purchase from the lower quality firm first, and a subset of these consumers also consults the higher quality firm. Such "path-dependent" consumption is foreign to vertical differentiation. Last, in vertical differentiation, firms never benefit from competitive entry. Temporal differentiation is also different from the notion of temporal discrimination, in which a single firm chooses to price discriminate between segments of its customer base with different valuations for its product. In the context of temporal differentiation, two firms choose to sell information to the same client in different time periods, and the expected value of information depends on when the information is purchased.

The notions of path-dependent consumption and contingent consumer valuations are related to models presented by Wernerfelt (1996) and Zettelmeyer (1999). These articles examine a situation in which the buyers' willingness to pay for a good depends on how much the buyers know about their valuation for the good. Thus, by first providing consumers with information, a firm may subsequently be able to sell its product profitably at a higher price (if only to a subset of consumers). The present study is somewhat different, because here, information is the core product (i.e., not decoupled from a physical good). Because giving information to consumers means selling the core product, firms have no incentive to "teach" consumers unless the firms can profitably sell several information products to the same consumer, a case that is briefly discussed subsequently.

THE MODEL

In what follows, I first build a model that describes the clients' underlying decision problem. Then, I characterize the information sellers and the product space, under the assumption that information characteristics (in particular, quality) are exogenous. An extension shows that depending on the cost of providing quality, the results do not change even if firms endogenously choose their quality levels.

Throughout the article, a specific example is used to illustrate the model: that of a monopolistic firm that seeks the help of consultants to determine the demand for its product. The client is a monopolist that is the only potential user of the information (as discussed previously, in private information markets consumer heterogeneity is absent). It is important to mention that this context is analytically identical to other contexts in which client-specific information is produced and sold by competing firms.

Client

Consider a monopolist (the client) with the following simple decision problem. The monopolist produces a durable product at constant unit cost c . It faces a rectangular

demand curve: Its customers' willingness to pay for one unit of the product is $r > c$. The monopolist does not know the size of the demand; it only knows that there are two states of the world (denoted L and H) with equal prior probabilities. Without loss of generality, it is assumed that in state L the demand is 0, in state H the demand is 1, and $r = 1$ (i.e., $0 < c < 1$). The monopolist is risk neutral and seeks to determine the quantity, Q , to produce. Without further information, its expected profit is $E\pi = [\Pr(D = H) - c]Q$, which is maximized by choosing Q^* , where

$$Q^* = \begin{cases} 0 & \text{if } \Pr(D = H) \leq c \\ 1 & \text{if } \Pr(D = H) > c. \end{cases}$$

With a uniform prior, the monopolist chooses to produce one unit if and only if $c < 1/2$.⁸ However, the monopolist could purchase information from a consultant to refine its view of the world and improve its production decision.

Consultants

There are two consultants that may produce and sell information to the client about the state of the world. Consultant i 's product is a prediction about the demand, denoted s_i ($i = 1, 2$), and is assumed to be produced at marginal cost k_i , which is related to the level of effort needed to produce the information. If the consultant believes that the demand is 0, then $s_i = 0$; otherwise, $s_i = 1$.

The model assumes that each consultant offers only one information product (i.e., firms cannot engage in discrimination). When is this assumption likely to hold? In many information markets, product quality (e.g., the reliability of a forecast, the validity of a recommendation) is not directly observable at the time of purchase. Most of these situations involve human judgment based on expertise or experience (e.g., a doctor's diagnosis, strategic management advice). In such cases, it is difficult to implement discrimination, that is, to provide different levels of quality for judgment. Furthermore, in such markets, perceptions of quality develop over time through repeated confrontation of the seller's information with reality. This imperfect process implies that sellers need to deliver consistent quality over time to build reputation. In such a case, a high quality firm may be reluctant to offer a low quality product in light of its long-term objective to maintain its reputation. If ex post it is hard to remind potential customers that the lower quality product was based on a less thorough analysis (and offered at a lower price), it may be risky to engage in a discrimination strategy. In other cases, observing and therefore communicating the quality of information may not be difficult. These situations often involve information that is generated with a specific piece of equipment or research technology whose diagnostic characteristics are well understood (e.g., a computerized tomography scanner, a standard marketing survey). Then, an information seller holding several such technologies (e.g., a medical lab, a market research firm) could easily price discriminate on the basis of these technologies' well-known reliabilities. In summary, this assumption is likely to hold in situations in which information is based on human judgment and experience, the quality of information is hard to com-

⁸The assumption of a uniform prior is not restrictive, because higher/lower c essentially results in the same range of decision weights as the ones produced by different priors.

municate, perceptions of quality take time to develop, and firms worry about their reputations.

Another question is, What is the implication of relaxing the assumption that firms offer only one information product? Solving a general model in which each consultant has different and multiple quality levels proved intractable. It is likely, however, that the key differentiation result does not hold in this case. As expected, in a model in which both consultants have the same low and high quality products, there is perfect competition between firms, and equilibrium prices drop to marginal costs. This suggests that in a competitive setting, discrimination may not be an optimal strategy for private information sellers, even when it is easy to implement. However, the present model falls short of providing a thorough verification of this conjecture.

Without loss of generality, suppose that Consultant 1 is "better" than Consultant 2. This asymmetry may represent a difference in reputation or levels of experience for producing information, and for the moment, it is assumed to be exogenous. In the case of doctors, for example, Consultant 1 may work at a more prestigious institution or have better credentials. In the case of consultants, a firm may be perceived as better because it has more contacts or experience. To capture this asymmetry, the products are assumed to be characterized by their accuracy, q_i (thus, $q_1 \geq q_2$), and their correlatedness (dependence), ρ . Firm i 's accuracy is simply defined as $q_i = \Pr(s_i = 1|D = 1) = \Pr(s_i = 0|D = 0)$. It is assumed that $q_i > 1/2 \forall i$; that is, the consultants' predictions are informative. It is also assumed that a better information product needs more effort to produce; that is, $k_1 \geq k_2$. The measure of product dependence is $\rho = \Pr(s_i = x|s_j = x) \forall i \neq j, x = 0, 1$. Notice that ρ is a probability, not a real correlation, though it captures the same concept. Furthermore, ρ is not independent from the q_i 's, and in the Appendix, it is shown that $1 - 2\delta \geq \rho \geq 1 + 2q_1q_2 - (q_1 + q_2)$, where $\delta = (q_1 - q_2)/2$. When $\rho = 1 - 2\delta$, the consultants' information sources are perfectly correlated, and when $\rho = 1 + 2q_1q_2 - (q_1 + q_2)$, they are "independent."⁹ In summary, the (q_1, q_2, ρ) parameter space can be thought of as the product attribute space, which is assumed to be common knowledge.

Monopoly

First, the model for a monopolist is solved. The monopolist can sell only a single product to the client. It will simply price the product at the value of information. It is easy to show that if $1/2 < q < \max(c, 1 - c)$, then the expected value of acquiring information from a single firm, denoted U , is 0. The reason is that, in this case, whatever the newly acquired information is, the decision based on the prior will not be changed.¹⁰ Thus, from now on, assume that $q_1 \geq q_2 > \max(c, 1 - c)$. Then the monopolist charges the value of information, denoted U :

Lemma 1: Assume that $q > \max(c, 1 - c)$ and $2k < \min(c - 1 + q, q - c)$. Then, the monopolist charges $p^M = U$, where

$$U = \begin{cases} [c - (1 - q)]/2 & \text{if } q > 1 - c > c \\ (q - c)/2 & \text{if } q > c > 1 - c. \end{cases}$$

Competition

Second, consider the case in which the client can acquire information sequentially from firms. In each time period, the client buys the information product, which maximizes its net surplus, which is the value of information minus its price. Thus, the client keeps buying information as long as it finds information products with positive surplus. When the client stops buying information, the game is over, because it is assumed that the client makes a decision on production quantity. This search process is consistent with traditional search models in economics (see, e.g., Weitzman 1979).¹¹ In Period 1, the client can buy information from one of the firms or nothing. If the client buys nothing, then it makes the decision on the basis of its prior, the game is over, and firms are left with zero profits. If the client buys information in Period 1, it looks at the information and, in Period 2, has the option to buy the information product of the second firm.

As mentioned previously, firms are familiar with the client's decision problem. In particular, there are two distinct periods, because firms know whether the client buys information for the first or second time. Furthermore, it is assumed that if the client buys information for the second time, the firms also know the content of the first information product. This assumption can be relaxed and the results do not change. As is shown subsequently, the reason is that given the prices, the mere fact of purchasing information from a second firm reveals the content of the information delivered by the first firm. This is because the value of information is contingent on the content of the first diagnosis.¹² Another problem with this assumption is that the second firm may use the first one's study. This is true in practice. An expert will rely on the results of the examinations of previous experts, for example. This idea, however, is captured by the measure of correlatedness, ρ .

Firms price their products for both time periods. Again, this feature is related to the special character of private information markets, namely, that (1) firms are consulted sequentially and (2) prices are not posted but rather are set through a consultation process. As is shown subsequently, the substantive results do not change if firms are restricted to choose a single, posted price for both periods. In what follows, subscripts are used to identify firms, and superscripts are used to identify time periods. For example, p_i^t denotes the price of firm i ($i = 1, 2$) in period t ($t = 1, 2$). For marginal costs, it is assumed that $k_1 \geq k_2$ (i.e., the better quality firm has higher marginal cost) and $c - 1 + q_i > 2k_i$, $i = 1, 2$.

⁹The two information sources are never completely independent, because they are linked by the underlying "truth" (the true value of D). Independence in this context means that it is only the underlying truth that links them. Here, only positive correlation between the samples is allowed, because this is the practically relevant case.

¹⁰For example, assume that $c < 1/2$ and $q < 1 - c$. Then, a priori, the client chooses $Q^* = 1$. However, even after $s = 0$ is observed, the posterior probability of the event $D = H$ is $1 - q$. Staying with the original action (Q^*), expected profits are $\pi = (1 - q) - c$. Because $q < 1 - c$, this profit is larger than 0 (the profit under $Q = 0$).

¹¹Notice that the demand side of the model is not new. What is original about the model is that the cost of acquiring information (i.e., the price of information) is endogenous, because the suppliers of information are also maximizing agents.

¹²For example, in the second period, a second opinion is only valuable, say, if the first diagnosis gives $D = L$. Then the firm can price according to the value of information contingent on $s^1 = L$, because when $s^1 = L$, the value of information is 0 anyway.

(i.e., costs are lower than the value of information from any single seller). To help interpret some of the results, two additional quantities are introduced:

Definition: Let $\delta = (q_1 - q_2)/2$ and

$$\mu = \begin{cases} (1-p)(1-2c)/2 & \text{if } q > 1-c > c \\ (1-p)(2c-1)/2 & \text{if } q > c > 1-c. \end{cases}$$

The difference between the firms' qualities is essentially represented by δ ; μ is harder to interpret. The Appendix shows that μ basically measures the added value of an additional information product compared with a single one.

Next, it is necessary to assess the value of the client acquiring an additional information product after it has acquired one already. This value will depend on which product was bought first by the client. The following two lemmas summarize this analysis for both of these cases when $c < 1/2$. For $c \geq 1/2$, the results are conceptually identical.

Lemma 2: Assume that $c < 1/2$ and the client has already acquired information from Firm 1. When this information predicts that the demand is high ($s_1^1 = 1$), the value of Firm 2's information product is $V_2^2 = 0$. When the information acquired in the first period predicts that the demand is low ($s_1^1 = 0$), $V_2^2 = \max(0, \mu - \delta)$.

Lemma 3: Assume that $c < 1/2$ and the client has already acquired information from Firm 2. When this information predicts that the demand is high ($s_2^1 = 1$), the value of Firm 1's information product is $V_1^2 = \max(0, \delta - \mu)$. When the information acquired in the first period predicts that the demand is low ($s_2^1 = 0$), $V_1^2 = \delta + \mu$.

Corollary 1: If firm i sold its information product in the first period, then the price of information in the second period is $p_j^2 = \max(k_j, V_j^2)$ $j \neq i$.

Corollary 2: The client's reservation price for buying information in the first period is equal to the value of a single information product.

The first corollary is straightforward: Any firm selling in the second period will price the information at its value. This value, however, may be less than the cost of producing the information, in which case there is no second-period market. The second corollary states that the client anticipates that in the second period, all the consumer surplus will be extracted by the information seller (Corollary 1); therefore, the value of buying information from a particular firm in the first period does not contain any option value (i.e., expected surplus) of buying additional information from another firm later.¹³

Now the equilibrium prices can be calculated. Given the dynamic game, subgame perfect equilibria in pure strategies are sought. The proposed equilibria provide a complete characterization of the game in the sense that the conditions for the existence of the proposed outcomes cover all param-

Figure 1
SUMMARY OF OUTCOMES

Average Quality: $(q_1 + q_2)/2$			
Low	Medium	High	
Mixed Strategy Equilibrium Both firms compete for second period business; $p^C > p^M$.	Temporal Differentiation High quality firm sells in second period with probability $1/2$; $p^C > p^M$. Low quality firm sells in first period; $p^C = p^M$.	Pure Strategy Equilibrium Low quality firm has no business; $p^C < p^M$.	Large Marginal cost difference, $k_1 - k_2$
	Pure Strategy Equilibrium Low quality firm sells in first period; $p^C < p^M$. High quality firm sells in second period with probability $1/2$; $p^C < p^M$.		Small

eter regions of the game. In other words, under each condition, there is a unique, subgame perfect equilibrium in pure strategies. Furthermore, the conditions together exhaust all feasible parameter combinations.

The game has three qualitatively different outcomes, which are summarized in Figure 1. The outcome in which firms temporally differentiate their products is considered. This constitutes the central result of the article. Next, two outcomes are described in which there is no temporal differentiation but rather firms compete for selling information in the same, either the first or the second, time periods. For expositional purposes, only the case in which $c < 1/2$ is considered. The case in which $c > 1/2$ leads to identical results.

The Case of Temporal Differentiation

Proposition 1. Assume that $q_1 \geq q_2 > 1 - c > c$ and $c - 1 + q_1 > 2k_1 \forall i$. If

(Condition 1) $1 - c + k_2 + \mu < (q_1 + q_2)/2 < 1 - c + k_1 + \mu$,

then Firm 2 sells information in the first period and Firm 1 sells information in the second period with probability $1/2$. The equilibrium prices are $p_1^1 \geq (\mu + \delta + k_1)/2$, $p_2^1 = (c - 1 + q_2)/2$, and $p_1^2 = \delta + \mu$. In this equilibrium, Firm 2's profit is equal to its monopoly profit, whereas Firm 1's profit is higher than its monopoly profit.

This equilibrium corresponds exactly to the idea of temporal differentiation and is generally consistent with the real-life outcomes in which firms explicitly market their products as first and second opinions, respectively. The firm with less reliable information is consulted first in equilibrium, and the higher quality firm is only consulted contingent on the first firm's forecast (on average, with probability $1/2$). More important, there is a systematic difference between the prices of first and second opinion services, the price of a second opinion being significantly higher (even higher than the monopoly price of the high quality firm). When is this outcome likely to happen? Condition 1 provides an answer. First, according to Condition 1, the average quality of information must be between some boundaries

¹³This result makes use of the assumption that the firm that sells in the second period knows the content of its competitor's product. Without this assumption, however, the substantive results do not change. Then, the second-period seller must decide which first-period outcome (forecast) to take into account for pricing its information product. The client can anticipate this problem and can calculate the expected surplus (if any) it can get in the second period. Then, the client's reservation price in the first period is the value of information plus this expected value.

that are largely defined by the difference between the firms' marginal costs. In particular, under Condition 1, the two firms must have sufficiently different costs and/or qualities. The more similar firms' costs are, the smaller is the parameter region defined by the condition; that is, the less likely it is that Condition 1 is fulfilled. With symmetric firms (i.e., identical costs), this equilibrium can never exist. Similarly, if marginal costs are negligible for producing information, this equilibrium can never occur. This feature is markedly different from the results of previous research on public information markets, in which the same product is sold to many consumers. In those studies, marginal costs do not play a role in market outcomes.

Another important feature of this equilibrium is that neither of the firms is hurt by competition.¹⁴ The higher quality firm benefits from the existence of the lower quality firm, because its expected profit is higher than monopoly profits would be. The intuition behind this outcome is intriguing. The information of the lower quality firm is unreliable. If it reinforces the decision based on the prior and c alone, however, then the client is confident enough to make the decision without further information. However, when it contradicts the prior decision, the client is more "confused" than before; that is, the value of a precise piece of information becomes even higher than before. In essence, the lower quality firm screens the market for the higher quality firm. In equilibrium, the higher quality firm sells information in the second period only half of the time but is still better off than if it were a monopolist.

Outcomes with No Temporal Differentiation

In this section, dynamic equilibria, in which firms do not (cannot) differentiate their services temporally, are considered. First, a set of outcomes in which both firms compete for the first-period business is analyzed.

Proposition 2. Assume that $q_1 \geq q_2 > 1 - c > c$ and $c - 1 + q_i > 2k_i \forall i$. If

$$(\text{Condition 2}) \quad 1 - c + k_1 + \mu \leq (q_1 + q_2)/2,$$

then both firms have an incentive to capture first-period business and their (expected) competitive profits are lower than monopoly profits. There are three possible outcomes:

1. If $k_1 \geq \mu + \delta$ and $\delta < k_1 - k_2$, then Firm 2 gets first-period business and the equilibrium prices are $p_1^1 = k_1$ and $p_2^1 = k_1 - \delta$. Furthermore, there is no business for Firm 1 in the second period.
2. If $k_1 \geq \mu + \delta$ and $\delta \geq k_1 - k_2$ or if $k_1 < \mu + \delta$ and $\delta - \mu \geq k_1 - 2k_2$, then Firm 1 gets first-period business and the equilibrium prices are $p_1^1 = \delta + k_2$ and $p_2^1 = k_2$. There is no business for Firm 2 in the second period.
3. If $k_1 < \mu + \delta$ and $\delta - \mu < k_1 - 2k_2$, then Firm 2 gets first-period business and equilibrium prices are $p_1^1 = (\delta + \mu + k_1)/2$ and $p_2^1 = (\mu - \delta + k_1)/2$. There is business for Firm 1 with probability $1/2$ in the second period, and the second-period price for information is $p_1^2 = \delta + \mu$.

¹⁴Although our model does not explicitly consider the possibility of one specialist recommending another, this result is consistent with the general observation in the medical profession that specialists are comfortable referring their clients to their colleagues. Also, the higher profits enjoyed by Firm 1 could be kicked back to Firm 2 for referrals. These referrals could subsidize Firm 2 and further increase the profits of Firm 1.

The message of Proposition 2 is quite simple. Both firms are trying to capture first-period business (most of the time, there is no second-period business at all), and the firms' production costs decide which is in a better position to do so. When the difference between the firms' qualities, δ , is large compared with their cost difference, the better quality firm wins the price game and drives its competitor out of the market. In the opposite case, it is the lower quality firm that wins. In the latter scenario, the better quality firm may have a "backup" in the sense that there may still be some business remaining in the second period. The interesting question to ask is, Why do firms try to capture first-period business? Condition 2 provides an answer. It indicates that the products have high quality and/or they are correlated. In other words, the value of another piece of information (μ) is small. That is why both firms try to be the first to sell their products. This results in harsh price competition between information sellers, and competition definitely hurts a monopolistic seller (profits are lower than monopoly profits for both firms). This equilibrium is consistent with the observed competition among accounting firms, in particular, with the strategy called "lowballing," in which firms tend to price their services close to marginal cost.

The last equilibrium of the game is when both firms prefer to sell information in the second period. An interesting feature of this equilibrium is that, in this case, firms still must consider the first-period business; otherwise, there is no market at all (i.e., somebody must be the first to sell information). As a result, in this case, only a mixed-strategy equilibrium exists.

Proposition 3. Assume that $q_1 \geq q_2 > 1 - c > c$ and $c - 1 + q_i > 2k_i \forall i$. If

$$(\text{Condition 3}) \quad 1 - c + k_2 + \mu \geq (q_1 + q_2)/2,$$

then both firms are trying to sell information in the second period. There is a mixed-strategy equilibrium in which prices in the second period are $p_1^2 = \delta + \mu$ and $p_2^2 = \mu - \delta$. In the first period, firms choose their monopoly prices, $(c - 1 + q_i)/2$, with probability ψ_i , and a higher price with probability $1 - \psi_i$, where

$$\psi_i = \frac{2(c - 1 + q_j) - 4k_j}{c - 1 + q_j - 3k_j + p_j^2}, \quad i \neq j.$$

Expected competitive profits of both firms are higher than monopoly profits.

Here, in contrast to the outcome described in Proposition 2, both firms try to sell information in the second period. Even though the actual outcome might be the sequential consultation of two firms, the order in which firms will be consulted is random. In this sense, there is no temporal differentiation between the firms. Furthermore, under some conditions—namely, when in the first period both firms price above monopoly prices—the client does not buy information at all. In this case, the client makes a decision on production quantity without consulting any of the firms. In terms of prices, although in any individual outcome the price of a second opinion is higher, the average price firms charge is high (higher than the monopoly price), but it is not significantly different for the two firms. When would such an outcome happen? Condition 3 provides an answer: when information products are unreliable and their correlation is

low—that is, when the value of an additional piece of information (μ) is large.

According to Condition 3, such equilibria are likely to happen in private information markets with high uncertainty. Competition among the big IT analyst firms, which provide firm-specific advice in the volatile high-tech sector, is an example. Indeed, in addition to multiple consultations and generally high prices, *Information Week's* (Violino and Levin 1997) recent survey of 300 information systems executives reveals that the general consensus among users is that IT analysts' services are of low quality. Analysts are criticized by the majority of executives for providing generally unreliable information. Similar trends (multiple consultations and high prices) are reported for the top four IT analysts in another survey by *Computer World* (1997).

DISCUSSION AND CONCLUSIONS

The previous sections present a model to explore pricing behavior in markets of private information, in which firms produce and sell information that is of value mainly to a specific client. Outcomes are identified by which firms differentiate their products temporally; that is, they price in such a way that clients consult them systematically in the same phase of their learning process. In this way, the findings provide a rationale for the existence of special second-opinion services and distinguish the conditions under which such practices are likely to be observed. The outcome of temporal differentiation is consistent with the anecdotal evidence on price and quality levels as well as the pattern of multiple consultations in markets for second opinions. Beyond explaining a new phenomenon, the findings provide additional normative insights compared with previous research. In particular, they draw attention to the way appropriate pricing can lead to a reduction in competition through differentiation. They also point to conditions under which such a strategy can be implemented. In this respect, the role of marginal costs for producing private information is in sharp contrast with the findings of previous research that is based on static models.

The model includes several assumptions, which need to be discussed. It was assumed that each firm knows the content of the information that was previously sold to the client. As shown previously, this assumption is not restrictive, and relaxing it does not change the results. The reason is that the client's intention to buy an additional piece of information reveals the content of the previous information product. A related restriction is that there are only two states of the world (H and L). With a continuum of states, the client's intention to buy would not completely reveal the content of the first-period information. Still, it would help the firm selling in the second period learn about the content in a Bayesian fashion and use this information for pricing in the second period. In such a model, firms selling in the second period would not be able to extract the total surplus from consumers.

Another assumption in the model is that firms choose prices in both periods. As is shown, this assumption may be related to prices being set through a consultative sales process—that is, firms are familiar with the client's decision. Then, from a technical point of view, a price charged in the first period is not credible in the second period, because the client's willingness to pay for information is known to have changed. However, institutional constraints

and the information sellers' lack of sophistication may prevent the updating of prices. One of the interesting features of the model is that the substantive findings do not change if firms are restricted to set a single price for both periods.¹⁵ The reason is that the "action" takes place in the first period. When it is decided which firm sells in the first period, that firm will not compete for second-period business.

Finally, the model considers a duopoly. What would happen if multiple independent competitors sell information? It is unlikely that temporal differentiation would occur with more than a few sellers (firms are never observed offering "third opinions," for example). The reason is that the value of an additional piece of information decreases rapidly with the number of information sources. The model is relevant only if competition is restricted to a few firms or when firms have significant market power. Similarly, firms were restricted to sell only one information product. As discussed previously, the selling of multiple information products (high and low quality) may lead to increased price competition, which suggests that in a competitive setting, discrimination is not an optimal strategy for information sellers.

The concept of temporal differentiation may be relevant in consumption contexts other than information. A basic driver behind the results is that consumption of the two information products is sequential and path dependent. The consumption of one product influences the willingness to pay for a competing product. This aspect of the problem may be found in other consumption contexts, an example being the situation in which consumers adopt a product category gradually, and through the process, they learn about their own preferences. For example, a consumer might decide to try tennis and buys a cheap tennis racket to determine if he or she enjoys the game. Upon finding the experience positive, the consumer might invest in a higher quality racket. Notice that in this case, the low quality product is essentially an information product, because a significant portion of its value comes from finding out more about tennis. Although this problem is similar to this context (as well as the one explored by Wernerfelt [1996] and Zettelmeyer [1999]), care should be taken when the results are generalized. Other product contexts are generally dominated by additional issues, the most important among these being consumer heterogeneity. In contrast, in private information markets, the path-dependent nature of consumption is the central issue for pricing.

There are opportunities for both theoretical and empirical research in the area of information marketing. A direction for theoretical research is to endogenize information product quality by relating it to the discrepancy between its content and the truth in a dynamic setting, thereby providing an endogenous account for sellers' reputations. Empirical research in the area of information marketing lags behind

¹⁵With a single, posted price set by each firm, the equilibrium prices corresponding to temporal differentiation (Proposition 1) are $p_1 = \delta + \mu$ and $p_2 = (c - 1 + q_2)/2$. In Proposition 3, under posted prices, firms randomize between their previous second-period monopoly price and their first-period monopoly price. In both cases, consumer behavior remains exactly the same. The only difference under posted prices is that in Proposition 2, there would be mixed strategy equilibria: Firms have an incentive to cut price to win the first-period price war, but after a certain point they are willing to obtain the second-period business instead; this gives the competing firm the incentive to raise price and so forth. Still, the substantive result of harsh price competition remains valid.

theoretical developments, at least on the supply side. Recent studies, including this article, propose several hypotheses about competitive patterns but can only show anecdotal evidence to support the theories. Empirical research based on systematically collected industry data would be valuable for the field.

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