Referral Infomediaries

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An interesting phenomenon has been the emergence of "infomediaries" in the form of Internet referral services in many markets. These services offer consumers the opportunity to get price quotes from enrolled brick-and-mortar retailers and direct consumer traffic to particular retailers who join them. This paper analyzes the effect of referral infomediaries on retail markets and examines the contractual arrangements that they should use in selling their services. We identify the conditions necessary for the infomediary to exist and explain how they would evolve with the growth of the Internet. The role of an infomediary as a price discrimination mechanism leads to lower online prices. Perhaps the most interesting result is that the referral infomediary can unravel (i.e., no retailer can get any net profit gain from joining) when its reach becomes too large. The analysis also shows why referral infomediaries would prefer to offer geographical exclusivity to joining retailers.
(Referral Services; Infomediaries; Intermediaries; Internet; Price Discrimination; Retail Competition; Exclusive Contracts)

1. Introduction

The exponential growth of the Internet is an important business development of the last decade. The growth of e-commerce has been accompanied by changes to the traditional ways of doing business in everal industries. The emergence and growth of the so-called "infomediaries" such as ⟨autobytel.com⟩ and ⟨carpoint.com⟩ in the automobile industry, ⟨avviva.com⟩ in real estate, ⟨austinlrs.com⟩ in legal services, and ⟨healthcareadvocates.com⟩ in medicine evidence the impact of these institutions on the functioning of conventional markets.

The performance of these infomediaries and their impact on the traditional retail marketplace have been closely watched in the automobile industry. These infomediaries (or Internet referral services), such as Autobytel, Autovantage, and Carpoint provide consumers with information on invoice prices, specifications, reviews, and the opportunity to get a price quote from a local retailer who is enrolled with the service. Third-party referral infomediaries are affecting the way consumers shop and buy their cars. A J. D. Powers study in July 1999 reported that retailers collected an average of 37 leads a month from Internet referral infomediaries and closed an average of 15%. Forrester Research reports that more than two million households used these Internet companies to research car purchases and estimates that 50% of new car buyers will research purchases online in the next five years. A Consumer Reports survey (*Wall Street Journal*, March 17, 2000) also indi-

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cates that consumer experience with these infomediaries has been positive and that 60% of those who used this service to generate a price quote will go back to them in the future. In fact, the National Automobile Dealers Association (NADA), after fighting with these independent Internet services for several years, has finally decided to launch its own car-shopping website (*Wall Street Journal*, March 16, 2000).

The conventional wisdom on these Internet referral infomediaries is that they are valuable to consumers because consumers can now use these services to research car prices and get binding price quotes from retailers. Less clear is the role of these intermediaries for the retailer and for retail competition. Consider the reactions of retailers to the emergence of referral infomediaries. Reactions cited in a *Wall Street Journal* article indicate dealer concerns over intense price competition "...*the beginning of a never ending nightmare*" (*Wall Street Journal*, July 12, 1999). A survey by J.D. Power also found that 48% of the retailers surveyed perceived Internet referral services to be a threat to the existing system. At the very least, these reports indicate that referral infomediaries are likely to have economic impact on retail markets. The analysis presented in this paper is aimed at contributing to an understanding of this phenomenon and its effect on retail markets.

1.1. Infomediaries: Key Research Issues

In established markets (such as the one for automobiles), referral infomediaries primarily reallocate existing customers between retailers in a geographical market. Consumers are not likely to purchase more cars just because of the emergence of a referral service. This reallocation of customers obviously affects retail competition and therefore retailer profits. This raises a series of research questions. How will these intermediaries change the functioning of the retail market and the nature of retail competition? What type of contractual arrangements should these intermediaries use in selling their services to retailers? Under what market conditions will a referral infomediary be viable? What are the implications of the growing reach of the Internet for these institutions?

The model that we develop to study these issues captures two economic characteristics that define a referral infomediary. On the consumer side, an infomediary performs the function of price discovery. A consumer who uses the service can costlessly get an additional retail price quote before purchase. On the firm side, a referral infomediary endows enrolled retailers with a price discrimination mechanism. A retailer that joins a referral infomediary has the ability to price discriminate between consumers who come through the service and those who come directly to the retail store.

We examine how the infomediary affects the market competition between retailers. We also investigate the optimal contractual policy that a referral infomediary should use to sell its service. *Conceptually, this is the problem of how a seller should contract for the sale of a price discrimination mechanism.* The literature on price discrimination has dealt with how firms can price discriminate between different groups of consumers and on the efficiency of different types of discrimination mechanisms. We go beyond the question of "how" a firm can price discriminate to investigate the manner in which a vendor can sell the ability to price discriminate in a competitive market. We investigate whether the referral infomediary should grant market exclusivity to a retailer, as opposed to adopting a nonexclusive policy. This question is relevant because there is significant variation in the policies adopted by different automobile referral services. Autobytel, the largest and perhaps the most successful Internet referral infomediary, offers geographical exclusivity to its retailers. In contrast, firms such as AutoWeb and AutoVantage used a nonexclusive policy in most areas.

1.2. Brief Overview of Model, Intuition, and Results

Our model consists of a referral infomediary and a market with two downstream retailers who compete in price. In the absence of the infomediary the market is comprised of three segments: a segment loyal to each retailer and a comparison shopping segment that shops on the basis of the lowest price. The segment of loyal consumers for a retailer can be thought of as having negligible transaction costs of considering that retailer but having prohibitively high costs at the competing retailer. Therefore, in the absence of the infomediary these consumers only consider their favorite retailer. The comparison shopping segment has negligible transaction costs of considering both retailers before purchase. The referral infomediary is modeled as an independent firm that reaches some proportion of the total consumer population (a function of the reach of the Internet in this market), and it performs the following functions: (a) It allows consumers to costlessly get a price quote from the enrolled retailer and (b) it allows an enrolled retailer the ability to price discriminate between consumers who come via the referral infomediary and consumers who come directly to the retail store.

The impact of the infomediary on market competition is best illustrated by the case in which only one retailer is enrolled in the institution. The enrolled retailer has the ability to offer a referral price as well as a retail price to consumers who come directly to the store. In contrast, the other retailer can only offer a store price. This changes the behavior of consumers who use the institution. Consumers who would have shopped at the enrolled retailer in the absence of the infomediary can now choose from the lower of the referral and store price at that retailer. Consumers who would have shopped at the nonenrolled retailer in the absence of the infomediary will now be able to choose from the lower of that retailer's store price and the referral price. The comparison shoppers who originally searched both the stores will now be able to choose from the lowest of the two store prices plus the referral price. The behavior of consumers who do not use the infomediary remains unchanged.

Our analysis provides several useful implications:

• *Retail Prices*: The referral price (i.e., price quote to the consumer who approaches retailer via Internet) will be lower than the retail store price offered by the enrolled retailer. The incentives of the retailer while setting the online referral price is driven not only by the comparison shoppers who search at both stores, but also by the consumers who would have searched only at the competing store. Thus the use of the referral service as a competitive price discrimination mechanism leads to lower online prices.

• *Retailer Profit*: The profits of the enrolled retailer are in the form of an inverted U w.r.t. to the reach of the referral infomediary: i.e., profits first increase and then decrease with the reach of the infomediary. The intuition is as follows. The enrolled retailer's profit is governed by three effects. The retailer enjoys the benefit of a *demand effect* because it gets the opportunity to quote a price to all the online consumers, some of whom were previously inaccessible to the retailer. The benefit from this demand effect increases with the reach of the institution. However, the referral infomediary also creates a *competitive effect* because it enables the enrolled retailer to poach on the competitor's customers. The strategic response of the competing retailer is to price aggressively in order to protect its customer base. This increases the intensity of price competition and has negative impact on retailer profit. Finally, there is a *price discrimination effect*. The enrolled retailer can price discriminate the users and nonusers of the infomediary by offering different referral and store prices, enabling better surplus extraction from the market. This effect has a positive impact on the profit of the enrolled retailer. The benefit derived from price discrimination reaches its maximum when the sizes of the infomediary user and nonuser segments are relatively close. Thus the benefit of the price discrimination effect for the enrolled retailer increases and then decreases as the reach of the infomediary increases. Consequently, when the reach of the referral infomediary is small enough, the benefit from the increased demand and price discrimination ability for the enrolled retailer dominates the cost of the increased competition created by the infomediary. This results in the retailer's profit increasing with the reach. However, as the reach of the infomediary further increases the price discrimination benefit diminishes and retail competition becomes so intense that profit of the enrolled retailer declines with increasing reach.

• Infomediary Contracting Strategy: We find that the referral infomediary will prefer an exclusive strategy of allowing only one of the retailers to enroll. A nonexclusive strategy implies that consumers who use the Web will get referral prices from both retailer. This creates a Bertrand-type competition for these consumers. Consequently, once either one of the retailers enrolls, the other retailer will make greater profits staying out even if the institution owner allows access for free. This result is supported by the available anecdotal evidence. Autobytel has consistently offered geographical exclusivity to its member retailers and industry experts have pointed to this as being one of the reasons why Autobytel has emerged as the largest and most profitable referral infomediary. Firms such as AutoVantage and Auto-Web, which used the nonexclusive approach, have been less successful.

• The Impact of the Increasing Reach of the Internet: The analysis also provides insight into how the referral infomediary might evolve in the future. We find that the infomediary can unravel (in the sense that no retailers can gain any net profit from joining) when its reach becomes very high. In this case, any retailer that joins the infomediary will be able to poach on a large proportion of the competitor's customers. The resulting price competition is so intense that the joining firm will make no net profit than if it had not joined. Consequently, a retailer will not join even if the referral infomediary allows access for free and the institution unravels as a result. It is perhaps this issue that is at the heart of the current attempts by referral services such as Autobytel to diversify into additional service areas such as financing and after-market services.

We also extend the model to the case where the referral infomediary can identify consumers of different segments and find that with customer identification the infomediary can exist for all values of reach. This implies that referral services can make complementary investments in consumer identification as the reach of the infomediary increases. Finally, we extend the basic model to accommodate asymmetry in retailer loyalty and also examine the case where the reach of the Internet varies across the comparison shopping and the retailer loyal segments.

The rest of the paper is organized as follows. Section 2 reviews the related research and §3 presents the basic model. Section 4 examines the effect of the infomediary on retail competition while §5 examines the infomediary's optimal contracting policies. In §6, we develop extensions to the basic model. Section 7 concludes with a brief summary and directions for future research.

2. Related Research

Our analysis of the referral infomediary as a price discrimination in a competitive market shows that Internet referral prices can be lower than the prices offered to consumers who do not use these services. Recently Scott Morton et al. (2001) used transaction data obtained from Autobytel to compare online prices to retailer showroom prices and found that on average customers with an Autobytel referral paid 2% less for their cars. They attribute this result to Autobytel selecting low-cost retailers, to the bargaining power of the referral service, and to the lower costs of serving an online customer. Other papers have also empirically investigated the impact of the Internet on prices and on market behavior (Brown and Goolsbee 2000, Brynjolfsson and Smith 1999) and have shown that while the Internet does lead to lower average online prices, it does not lead to marginal cost pricing implying zero economic profits for firms. A paper by Lal and Sarvary (1999) also makes similar arguments for nonsearch goods. This paper shows another important context for this view: that of an Internet institution acting to provide a price discrimination and demand reallocation mechanism. While the referral infomediary might imply lower Internet prices, it does not mean zero profits for the competing retailers.

The paper also adds to the emerging research on Internet institutions. For example, Iyer and Pazgal (2002) analyze the impact of Internet comparison shopping agents on retail competition and show why some online retailers might join a shopping agent despite the fact that this institution allows costless search among all member retailers. While the infomediary also helps consumers to reduce search costs, the feature of the infomediary that is focused on in this paper is the ability of the infomediary to distinguish between online and offline consumers and to allow a retailer to price discriminate between these two groups.

3. The Model

We first discuss the specifics of the market in a world without Internet referral infomediaries.

3.1. Retailers and the Consumer Market

We consider two retailers ($i = 1, 2$) who compete in prices in the end-consumer market. Retailers are assumed to be identical in terms of selling costs, and these costs are set to zero without loss of generality. This assumption enables us to develop the demand-side implications of the Internet institution on market competition, which is the primary focus of this paper.

The market consists of a unit mass of consumers. Consumers buy at most one unit of the product and have identical reservation prices that can be normalized to 1 without any loss of generality. However, consumers are heterogeneous in terms of their transaction costs of considering a retailer. These costs include the cost of price discovery as well as any shopping costs that are incurred for considering and buying the product at a retailer. A proportion a of consumers have zero transaction cost of considering both retailers before making the buying decision. These consumers are akin to the informed consumers or switchers in the standard models of sales such as in Varian (1980) and Narasimhan (1988). We will call these consumers "comparison shoppers" in the paper.

Of the remaining $1 - a$ consumers, a segment of them with a size of b_1 incur zero transaction cost of considering retailer-1 (R1) but a prohibitively high cost of considering retailer-2 (R2). Consequently, they only shop at R1 in the absence of an Internet referral infomediary. In the rest of the paper we will label this segment of consumers as R1-shoppers. The remaining segment of size b_2 are R2-shoppers. They have zero cost of considering R2 but have a prohibitively high cost for R1. These consumers only shop at R2 in the world without the referral infomediaries. In the basic model we assume that $b_1 = b_2 = b = \frac{1}{2}(1 - a)$. Later we allow b_1 to be different from b_2 in § 6.

3.2. The Impact of a Referral Infomediary

Suppose that a referral infomediary now emerges. A recent study (J. D. Powers and Associates 2000) reveals that nearly 5% of all new car buyers now use an online referral infomediary. Clearly, this number will change over time as the reach and familiarity of the infomediary evolves. To model this we assume that a fraction, k (where $0 < k < 1$), of all consumers use the referral infomediary; k is the reach of the referral infomediary. We assume for now that this reach is identical across all consumer segments but will relax this assumption in §6.

The infomediary can enroll either one retailer or both. Apart from offering a price to consumers who directly visit the store, an enrolled retailer has the ability to offer the k online consumers a referral price. The impact of the infomediary on consumer behavior is captured as follows: Consumers who use the referral infomediary will get an additional price quote from an enrolled retailer at zero cost (consumers can get two price quotes if both retailers are enrolled).[1] In other words, the referral infomediary eliminates the cost associated with price discovery (and thereby reduces the transaction cost of considering a retailer). A consumer with price information obtained through both the referral infomediary and

[1]One might argue that retailers can set up websites that also offer price quotes. However, a retailer website cannot substitute for independent third-party intermediation. There are a number of aspects of the purchasing process that cannot be credibly verified and agreed upon on the quote via a retailer website. A retailer can offer a low price quote, but such a quote might not be completely enforceable. For example, there might be problems of non-availability of the exact make/model that the customer needs or ambiguity about financing incentives. The retailer might opportunistically use these aspects once the consumer comes to the showroom. The existence of an independent third-party infomediary mitigates these problems and allows the offer of credible online prices to consumers. We thank the Area Editor for helpful comments on this issue.

store visit(s) will choose the lowest price and purchase at the retailer who offers that price (either through the online infomediary or at the store). An enrolled retailer can potentially offer different prices to consumers who visit the store directly or inquire prices online. In this manner the infomediary allows a member retailer to price discriminate among its customers.[2]

3.3. The Game

The objective is to study how retail competition will respond to the emergence of a referral infomediary and also to analyze how the infomediary should organize its contractual relationship with retailers. We therefore analyze a two-stage game. In the first stage the referral infomediary chooses a contract that has two dimensions. The first is a decision on whether to sell the service exclusively to only one retailer in a market (denoted by the subscript x) or nonexclusively to both retailers (denoted by the subscript n). Contingent on this, the referral infomediary also has to choose the payment contract, which we denote as C_{iz} (where i denotes the retailer and $z = x, n$).

First, consider the exclusive contract under which the referral infomediary makes an exclusive offer to one of the two retailers. Figure 1 indicates the timing of the contracting game. If the first retailer rejects the offer the infomediary has the option of offering the service to the second retailer. Thus under the strategy of enrolling only one retailer, say retailer 1, the referral infomediary's contracting strategy consists of an offer of C_{1x} to retailer 1 and an offer C_{2x} to the other retailer, retailer 2, in the event that retailer 1 rejects the infomediary's offer. Given this game structure, the infomediary's problem is to choose C_{1x} and C_{2x} to maximize its profit. Analytically there is no difference between whether the referral infomediary sets both C_{1x} and C_{2x} prior to the first retailer's decision or sets C_{1x} first but sets C_{2x} only if the first retailer rejects the offer.[3] Note also that in our model, the exclusive contract will be self-enforcing in equilibrium: Once a retailer accepts the infomediary's offer, the competing retailer will have no incentive to enroll even if the infomediary offers access for free. If a nonexclusive contract is used, the infomediary simultaneously makes offers to both retailers and the retailers simultaneously decide whether or not to accept the contract. A retailer will join the infomediary only if its net gain from joining is positive. In cases where a retailer is indifferent between enrolling the referral service and staying out, we assume that it will choose not to enroll.

Contingent on the contract, the game involves price competition between retailers in which both retailers simultaneously choose prices. If a retailer is enrolled in the referral infomediary it can choose an online referral as well as a store price. A retailer that is not enrolled chooses only a store price. We will analyze the basic model in the next section to examine the effect of the referral infomediary on retail competition.

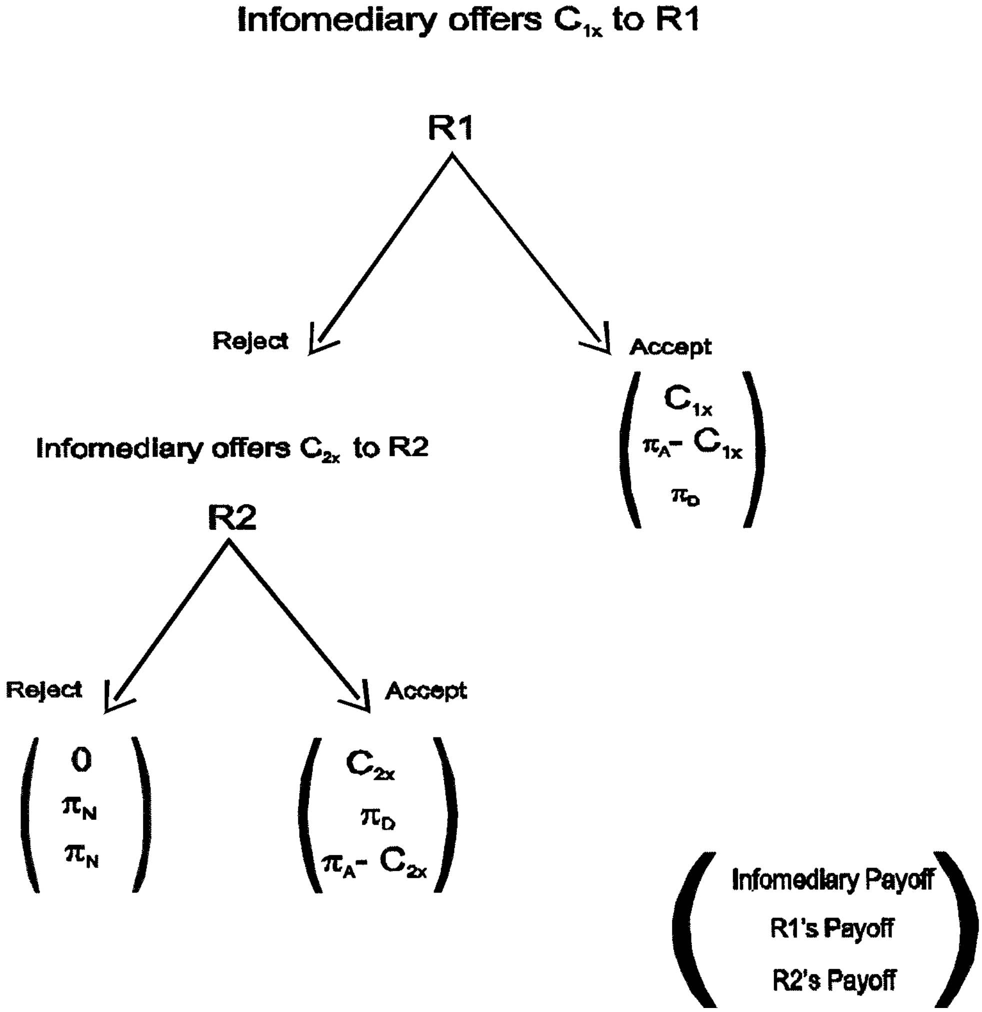
4. Referral Infomediary and Retail Competition

In this section, we analyze the price competition between retailers and the effect of the Internet referral infomediary on this competition. To begin with we briefly state the results pertaining to the case of retail competition in a market without the referral infomediary. This will provide the baseline against which the impact of the institution can be compared. Without the referral infomediary the model collapses to a standard model of price competition as in Varian (1980) or Narasimhan (1988) with a segment of

[2]Note that on-floor negotiations can also help a retailer to discriminate between consumers. However, such discrimination is only relevant for consumers who enter the store. In contrast, the infomediary can enable the enrolled retailer to reach a segment that it could not otherwise access: i.e., it can allow the retailer to offer a price quote to consumers who would otherwise have shopped only at the competing retailer. Thus, while choosing the online price, the enrolled retailer also has the incentive to "poach" on the other retailer's loyal consumers. Furthermore, it should be noted that the main results of this paper will hold even if there already exists price discrimination (in the shop floor) prior to emergence of the infomediary.

[3]The part of the game tree that follows the action by R1 to reject C_{1x} is off the equilibrium path, and C_{2x} represents the off-equilibrium threat, which supports C_{1x}.

Figure 1 Contracting Game (If R1 Is the Enrolled Retailer in Equilibrium)



a consumers who consider both retailers and buy at the lower price and two segments of b consumers that consider only one retailer. In equilibrium both retailers adopt mixed-strategy pricing. Let $H_1(p) = \Pr(p_1 \geq p)$ and $H_2(p) = \Pr(p_2 \geq p)$, where p_1 and p_2 are the prices offered by R1 and R2 respectively. The equilibrium price distributions are $H_i(p) = b/a(1/p - 1)$, where $[b/(b + a) < p < 1]$. Firms' equilibrium profits are $\pi_i = b$ and firms' average equilibrium prices are $E(p_i) = b/a \ln[(b + a)/b]$.

Depending upon the first-stage contract, there are two possibilities: one in which only one retailer joins the infomediary and the other in which both retailers join. We begin our analysis with the case where only one retailer is enrolled.

4.1. Only One Retailer Is Enrolled

Suppose that R1 is the enrolled retailer. R1 can therefore set two prices—a store price p_1 for the consumers who come directly to the store and a price, p_{1e}, for the consumers who come through the referral infomediary. In this manner, the referral infomediary allows R1 to price discriminate between the consumers who use the referral infomediary and those who do not use it. However, the other retailer, R2, who is not enrolled in the infomediary can set only one price, p_2, for consumers who come to its store.[4]

Let us now examine how the referral infomediary changes consumer behavior. Among the group of k consumers who are reached by the infomediary, we have a segment of ak comparison shoppers who will consider both retailers and will also get an online referral price. This segment will make its choice based upon the lowest price of p_1, p_2, and p_{1e}. A segment of kb R1-shoppers make purchase decisions based upon the prices p_1 and p_{1e}. There is also another segment of kb consumers who were R2-shoppers in the world without the infomediary and did not consider R1's store. In the presence of the infomediary, these consumers can now receive R1's referral price and make a purchase decision based upon the prices p_2 and p_{1e}. Finally, the behavior of the group of $(1 - k)$ consumers who do not use the referral infomediary will obviously not change from what we specified in § 3.1. In other words, the group of $(1 - k)a$ comparison shoppers will still consider both of the retailers and buy at the lower price of the two prices p_1 and p_2, while the group of $(1 - k)b$ R1-shoppers (R2-shoppers) will visit R1 (R2) and buy at $p_1(p_2)$.

To proceed with the analysis, note that there exists no pure strategy equilibrium in this game. The reasoning for this is as follows: (a) Suppose that one retailer, say R2, chooses a price p_2 that is not too low and Then R1 would like to just undercut p_2 in order to attract the comparison shoppers. (b) Otherwise, R1 will set prices equal to the reservation price in order to maximize the profit from its customers who do not comparison shop. A similar reasoning applies to R2's reactions to R1's choices of p_1 and p_{1e}.

[4]Lal and Villas-Boas (1996) examine a situation where one firm competes by choosing two prices against another firm choosing single price in a mixed-strategy equilibrium. They examine price promotions in a channel with exclusive dealing by one of the manufacturers. In their paper the nonexclusive retailer offers two prices for two manufacturer brands, and these prices are relevant only for customers who shop at that retailer. In our analysis the two prices charged by R1 are for the same product but for different groups of customers (i.e, online and offline consumers). Therefore, the two prices allow R1 to price discriminate and also to reach some of R2's loyal (online) shoppers who were previously inaccessible to R1.

Denote $H_{11}(p) = \Pr(p_1 \geqslant p)$, $H_{1e}(p) = \Pr(p_{1e} \geqslant p)$, and $H_2(p) = \Pr(p_2 \geqslant p)$. The profit function of R1 when it charges p_1 and p_{1e} can be written as

$$\pi_1 = (1-k)bp_1 + (1-k)aH_2(p_1)p_1 + kb\min(p_1, p_{1e}) + kbH_2(p_{1e})p_{1e} + kaH_2(\min(p_1, p_{1e}))\min(p_1, p_{1e}). \quad (1)$$

The first term in the right-hand side of (1) is R1's profit from the R1-shoppers without an online referral. The second term is R1's profit from the comparison shoppers who do not use the referral infomediary. The third term is R1's profit from the R1-shoppers who also use the referral infomediary. The fourth term is R1's profit from the R2-shoppers who now also use the referral infomediary. The final term is R1's profit from the comparison shoppers who use the referral infomediary and search at both R1 and R2's stores as well.

In Appendix A we provide the full analysis of the mixed-strategy equilibrium. The solution methodology for this game is nontrivial because of the fact that one of the firms is price discriminating and because of the effect that the infomediary has on consumer behavior. The equilibrium price support is described in the following proposition. Proofs of all the propositions are in Appendix A.

PROPOSITION 1. *In equilibrium, the support for the prices charged by R1 is continuous with $p_1 \in (p_m, 1)$ and $p_{1e} \in (p_b, p_m)$, where*

$$p_m = \frac{b(1-b)}{(1-b)^2 - (1-2b)k} \quad \textit{and}$$
$$p_b = p_m(1-k) \quad \textit{if } k < (1-b)$$

and

$$p_m = 1 \quad \textit{and} \quad p_b = b \text{ otherwise.}$$

The price support for R2 is also continuous with $p_2 \in (p_b, 1)$.

This proposition establishes the first result of the paper, namely, the relationship between the online referral price and the store price offered by the retailer enrolled in the infomediary. This issue has both theoretical and institutional relevance. It is related to the manner in which a firm should use a price discrimination mechanism in the face of competition. As shown in Proposition 1, the referral price offered by the retailer will be lower than the store price. Therefore, the emergence of the infomediary, as well as its role as a mechanism that offers consumers an additional price quote, leads to unambiguously lower online referral prices.

To understand why the online market is more price elastic for R1, consider the relative proportion of R1-shoppers to the comparison shoppers that R1 faces among the referral service users as opposed to nonusers. A lower value of this relative proportion implies higher price elasticity in the segment. Denoting the relative proportions as γ_I and γ_s for the infomediary user and nonuser segments that R1 faces respectively, we have that

$$\gamma_I = \frac{kb}{ka + kb} < \gamma_s = \frac{(1-k)b}{(1-k)a}. \tag{2}$$

The above inequality obtains because R1 has the incentive to use the referral price to also compete for the kb R2-shoppers who were previously inaccessible (in addition to competing for the comparison shoppers). Therefore, R1 offers a lower online price than store price. Thus, the price discrimination mechanism enabled by the infomediary and the incentive of R1 to compete for the consumers who were otherwise captive to R2 leads to lower online prices than its store prices.

This result helps to clarify the available empirical evidence regarding the impact of referral infomediaries on retail price competition. In a study using transaction data from Autobytel, Scott Morton et al. (2001) compare online transaction prices to regular showroom prices. The authors find evidence that consumers who came to Autobytel retailers with an online referral paid on average 2% less than those who go directly to the retailer without a referral. Conditional on the retailer and the Car chosen, consumers with a referral paid on average $379 less than an offline consumer. The data that we acquired from a Carpoint-affiliated Volkswagen retailer in St. Louis, MO also shows that the online referral prices offered are lower than the retailer showroom prices.[5] Proposition 1 provides a basis for why referral infomediaries have been perceived as beneficial for consumers and for the growth in their usage.

Given the relationship between p_1 and p_{1e} shown in Proposition 1, we can now rewrite the profit function in (1) as $\pi_1 + \pi_{11} + \pi_{1e}$, where,

$$\pi_{11} = (1-k)bp_1 + (1-k)aH_2(p_1)p_1, \tag{3}$$

and

$$\pi_{1e} = kbp_{1e} + (kb + ka)H_2(p_{1e})p_{1e}. \tag{4}$$

The first component π_{11} is R1's expected profit from the segment of consumers who do not get a referral price and who therefore buy at the store price p_1. The second component π_{1e} is R1's profit from the segment of consumers who use the infomediary and get a referral price quote p_{1e} from R1.

The relationship between p_1 and p_{1e} established in Proposition 1 also allows us to specify R2's profit as follows:

$$\begin{aligned}\pi_2 = {} & (1-k)bp_2 + (1-k)aH_{11}(p_2)p_2 \\ & + kbH_{1e}(p_2)p_2 + kaH_{1e}(p_2)p_2.\end{aligned} \tag{5}$$

The first term in the right-hand side of (5) is R2's profit from the consumers who do not use the referral infomediary and who are R2-shoppers. The second term in R2's profit from the comparison shoppers who do not use the referral infomediary. The third term is R2's profit from its own shoppers who now use the referral infomediary. The final term is R2's profit from the comparison shoppers who also use the referral infomediary.

Recall that this analysis pertains to the subgame where only one retailer is enrolled by the infomedi-

[5]We have 18 months of data from a Volkswagen retailer in St. Louis. The data comprises the transaction prices and gross profits on every car sold by the retailer for a contiguous period of 18 months in 1999–2000. It also includes the information on whether or not each consumer came to the retailer with a referral. Across all models of Volkswagen cars we found that the average price offered to consumers with referrals was lower by $570.

ary. The consequence of this exclusivity is that R1 can poach R2's consumers via a suitable choice of p_{1e} while simultaneously limiting its subsidy to shoppers at its store by choosing an appropriate store price p_1 (which, as shown in Proposition 1, is always greater than p_{1e}). In contrast, R2 has to rely on a single price p_2. The equilibrium results are summarized in Proposition 2.

PROPOSITION 2. In the case where retailer 1 enrolls in the referral infomediary but retailer 2 does not, both retailers adopt mixed strategies in equilibrium. In equilibrium, we have that

(1) If $k < 1 - b$, then

$$\pi_1 = \pi_{11} + \pi_{1e} = b(1-k)\frac{(1-b)^2 + bk}{(1-b)^2 - (1-2b)k},$$

where

$$\pi_{11} = b(1-k), \quad \pi_{1e} = b\left[\frac{(1-b)k(1-k)}{(1-b)^2 - (1-2b)k}\right];$$

$$\pi_2 = b\left[\frac{(1-b)^2(1-k)}{(1-b)^2 - (1-2b)k}\right];$$

$$H_{11}(p) = \frac{\pi_2}{(1-k)(1-2b)p} - \frac{b}{(1-2b)};$$

$$H_{1e}(p) = \frac{\pi_2}{k(1-b)p} - \frac{1-k}{k}; \quad H_2(p) = \frac{b}{a}\left(\frac{1}{p} - 1\right)$$

for

$$(p_m < p < 1), H_2(p) = \frac{\pi_{1e}}{(1-b)kp} - \frac{b}{1-b} \quad \text{for } (p_b < p < p_m);$$

$$E(p_1) = \frac{\pi_2}{(1-k)(1-2b)}\ln\left(\frac{1}{p_m}\right) + b\left[\frac{k}{(1-b)^2 - (1-2b)k}\right];$$

$$E(p_{1e}) = \frac{\pi_2}{k(1-b)}\ln\left(\frac{1}{1-k}\right); \quad \text{and}$$

$$E(p_2) = \frac{b}{a}\ln\left(\frac{1}{p_m}\right) + \frac{\pi_{1e}}{k(1-b)}\ln\left(\frac{1}{1-k}\right).$$

(2) If $k \geqslant 1 - b$, then $\pi_{11} = (1-k)b$, $\pi_{1e} = kb$, $\pi_1 = \pi_{11} + \pi_{1e} = b$; and $\pi_2 = b(1-b)$.[6]

[6]Since this scenario is not relevant for the equilibrium of the whole game (as we will show later), we just provide the equilibrium profits here in order to save space.

Proposition 2 indicates that the impact of the infomediary on retail competition depends upon its reach. We begin the discussion with the case when the reach is small.

4.1.1. Reach of the Infomediary Is Small ($k < 1 - b$). The first point to note is that the profit of the enrolled retailer first increases and then decreases with the reach of the infomediary. Increasing reach has three effects that govern R1's profit. First, an increase in the reach of the infomediary creates a positive demand effect for R1: Among the consumers who use the referral infomediary, R1 can now potentially get additional demand from the segment of consumers who would have previously shopped only at R2. Furthermore, the infomediary allows R1 to offer an additional lower price to attract the comparison shoppers online. However, an increase in k also creates a competitive effect. Because R1 can now use a low referral price p_{1e} to poach on the previously guaranteed consumers of R2, the strategic response of R2 is to price aggressively and charge a lower p_2 in equilibrium to protect its customer base (i.e., R2-shoppers).[7] This leads to more intense price competition imposing a negative effect on both retailers' equilibrium profits. Finally, there is a price discrimination effect. The enrolled retailer can price discriminate the users and nonusers of the referral infomediary by offering an online referral price different from its store price. This price discrimination ability has a positive effect on the profit of the enrolled retailer. The magnitude of this effect reaches its maximum when the sizes of the infomediary user and nonuser segments are relatively close and declines thereafter with further increases in the reach.[8] As a result, when the reach is small enough, the benefit from the increased demand and the price discrimination effect for the enrolled retailer

[7]In fact, it can be easily checked from Proposition 2 that the average price charged by R2 decreases with k.

[8]When $k \to 0$ or $k \to 1$, R1 will only face one segment (i.e., nobody uses the referral infomediary or everybody uses it). Therefore, there will be no price discrimination effect if $k \to 0$ or $k \to 1$. This means that the benefit of the price discrimination effect is maximum at an intermediate value of k.

dominates the cost of the increased competition created by the referral infomediary. This results in the enrolled retailer's profit increasing with the reach of the institution. However, as the reach further increases the benefit from the price discrimination effect diminishes and retail competition becomes so intense that the profit of the enrolled retailer declines with increasing reach. An alternate way to understand this result is to notice that R1's profit from consumers who do not use the infomediary, π_{11} (i.e., the profit associated with the store price p_1), decreases with the reach of the infomediary, whereas the profit from consumers who use the infomediary, π_{1e} (which is associated with the referral price p_{1e}), increases with the reach. Consequently, R1's total equilibrium profit has an inverse U relationship with k.

Note also that the profit of the enrolled retailer, R1, is always greater than the profit of its competitor. The fact that R1 has exclusive access to consumers using the referral infomediary ensures that it always has higher or equal profit than in a world without the infomediary. In contrast, R2 will be hurt by the referral infomediary and its profit will be strictly lower than in a world without the infomediary. Not only does R2 get lower demand, but it is also forced to charge a lower price on average to prevent its consumers who get a referral price from being poached. As we will demonstrate in §5, this reallocation of profits between the retailers is a determinant of the profit that the infomediary can make.

4.1.2. Reach of the Infomediary Is Large ($k > 1 - b$). What happens when the reach of the referral infomediary becomes sufficiently large with $k > 1 - b$? R2 will price even more aggressively to defend its consumers. Consequently, market competition becomes so intense that there is no net profit advantage for R1 to enroll in the infomediary (note that π_1 in this case is the same as that of the case where neither retailer joins the infomediary). This leads to the interesting finding that a retailer will have no incentive to join the referral infomediary even if the infomediary allows enrollment at no cost.

It is useful to understand the feature of the infomediary captured in our model that leads to the above finding. What the referral infomediary allows is the ability for an enrolled retailer to offer a price quote even to customers who would otherwise have not shopped at their store. Specifically, a referral infomediary allows an enrolled retailer to offer a price quote to consumers who would otherwise have shopped only at the competing retailer. Thus the infomediary allows the enrolled retailer to "poach" on the other retailer's loyal consumers through the referral price. Price discrimination that involves poaching on the other retailer's loyal consumers is a key feature of the infomediary that is highlighted in this paper. It is this feature that leads to the result that increased reach of the Internet leads to the unraveling of the infomediary in the sense that a retailer will not have the incentive to join even if entry is free.

4.1.3. The Impact of the Referral Infomediary on Retail Prices. The availability of the referral infomediary also has some interesting implications for the prices offered by the competing retailers. As discussed before, the retailer enrolled in the referral infomediary offers a higher store price than its Internet referral price. Furthermore, from Proposition 2, we can also verify that the mean store price charged by R1, $E(p_1)$, is higher than R2's mean store price, $E(p_2)$. However, R1's mean Internet price, $E(p_{1e})$, is lower than $E(p_2)$. This is because the referral infomediary provides the enrolled retailer a price discrimination device, through which R1 can compete aggressively via the Internet while limiting its subsidy to its captive consumers who do not utilize the infomediary. In contrast, the nonenrolled retailer has to use a single store price to compete with both the store price and the Internet referral price from its rival. Thus, the average price charged by R2 lies in between R1's average Internet referral price and average store price.

Next, consider the impact of k on prices. We find that the difference between the average store price and the average Internet price of the enrolled retailer, $E(p_1) - E(p_{1e})$, increases with k. This clearly highlights the price discrimination function of the referral infomediary. Note that $E(p_1)$ increases with k, because p_1 is used by the retailer to exploit the R1-shoppers who are not using the referral infomediary. As the reach increases, the retailer will increasingly focus on those consumers with increased store prices. As expected, $E(p_1)$ also increases with b, the size of R1's captive consumers. In contrast, $E(p_2)$ decreases with k. As the reach of the infomediary increases, the nonenrolled retailer has to price more aggressively to protect its own customer base.

The relationship between the expected Internet referral price, $E(p_{1e})$, and k is also interesting. It increases with k when both k and b are sufficiently small but decreases otherwise. Recall that the nonenrolled firm, R2, competes for $(1 - k)a$ consumers with R1's store price, p_1; but it competes for $(ka + kb)$ online consumers with R1's referral price, p_{1e}. As k increases, the difference between p_1 and p_{1e} increases due to the price discrimination effect. When b and k are sufficiently small, the $(1 - k)a$ segment is large. Consequently, R2's pricing strategy will focus on attempts to undercut R1's store price, p_1, in order to win the $(1 - k)a$ consumers. This implies that the competition in the online market will be less, which leads to higher levels of p_{1e}. On the other hand, if k and/or b are large, the segment of $(1 - k)a$ consumers will be less attractive while the segment of $(ka + kb)$ consumers who use the referral infomediary becomes more important to R2. Therefore, R2 will set p_2 aggressively to compete with the online price p_{1e}. As a result, p_{1e} decreases with k when k and/or b are large.

The empirically observed prices from car retailers are usually the prices for realized transactions. The distributions of the empirically observed prices can be different from the "offered" prices of retailers that we just discussed above. For example, if a consumer in the $(1 - k)a$ segment who faced prices p_1 and p_2 but purchased from R1 because $p_1 < p_2$, then most likely in an empirical data-set only the "realized" price p_1 would be recorded but not p_2. To accommodate this fact, we derive the distributions of the realized (observed) prices from the distributions of offered prices in order to compare our results with the empirical evidence. We find that the results reported above do not change qualitatively if the offered prices are replaced by the realized prices.

Besides looking at the retailers' expected prices, we have also examined the dispersion of retailers' equilibrium prices. Some useful findings are:

- The range of p_1 decreases with k but the ranges of p_{1e} and p_2 increase with k.
- The variance of the realized (observed) price p_1 is higher than that of the realized price p_{1e} when k is small.
- When k is sufficiently small, the observed variances of both the enrolled store's prices (p_1 and p_{1e} combined) and the nonenrolled store's prices are lower than the corresponding observed price variances in a world without the infomediary.

When k increases, R1 increases p_1 in order to achieve better price discrimination. Because the upper bound of the distribution for p_1 remains the same (which is the reservation price), this implies that the range of p_1 will decrease with the reach of the infomediary. Moreover, because the size of the $ka + kb$ segment increases with the reach, the lower bound of p_{1e} and p_2 will be lower with higher k due to the increased competition for this segment of consumers.

The results above suggest that we should expect to observe lower price dispersion for Internet prices than for store prices and lower price dispersions in the market after the infomediary is introduced as long as the reach of the infomediary is small enough (note that the current reach is about 5% based on a recent J. D. Powers study in April of 2000). These implications seem to be consistent with some recent empirical findings (Scott Morton et al. 2001). The intuition behind these results is similar to that for the relationship between $E(p_{1e})$ and k. When k is small, R2 focuses on competing with p_1 for the $(1 - k)a$ segment so that its distribution will be concentrated in the range of p_1's distribution. Because the range of p_1 decreases with k, p_2 will be less dispersed as k increases in this case. This in turn leads to a decrease in R1's overall price dispersion.[9] Also, because p_2

[9]Because in equilibrium R1 responds to R2's price distribution optimally, a more concentrated distribution of R2's prices also leads to a more concentrated distribution of R1's prices.

competes more with p_1 than p_{1e} under this situation, p_{1e}'s distribution will be concentrated near its upper bound. The variance of p_{1e} is therefore lower than that of p_1 under this situation (when k is small).

4.2. Both Retailers Are Enrolled

Consider now the subgame in which both retailers are enrolled in the referral infomediary. This implies that both retailers will have the ability to offer two prices: a store price p_i and a referral price p_{ie} ($i = 1, 2$). Within the comparison shopping segment, ak consumers will use the infomediary and receive referral prices from both retailers. Their purchase decisions will be based on $\min(p_1, p_2, p_{1e}, p_{2e})$. In the remaining market, a total of $2bk$ consumers will receive referral prices, p_{1e} and p_{2e}, and also the store prices from the respective stores that they search. A set of bk consumers will choose $\min(p_1, p_{1e}, p_{2e})$, while the remaining bk of them will choose $\min(p_2, p_{1e}, p_{2e})$. Finally, the behavior of the set of $(1 - k)$ consumers who do not use the referral infomediary will remain unchanged from that specified in §3.1. We have the following proposition regarding the equilibrium in this scenario.

PROPOSITION 3. *If both retailers are enrolled in the infomediary, the equilibrium profit of each retailer is $\pi_i = (1 - k)b$. The equilibrium price strategies are $p_{ie} = 0$ and $H_i(p) = b/a[(1/p) - 1]$, where $b/(b + a) < p < 1$.*

This proposition further clarifies the manner in which the referral infomediary affects the market. Consumers who use the infomediary can get price quotes (p_{1e} and p_{2e}) from both retailers and can choose to buy at the lower of the two prices. This leads to a homogenous Bertrand price competition in the market comprising of k consumers who use the referral infomediary. Thus, the equilibrium referral prices of both retailers are zero (the marginal cost of the product), and they make zero profit from the set of k consumers. Therefore, the competition between the two retailers will be as if they perceive a smaller market comprising only $(1 - k)$ consumers who go directly to the stores. Consequently, the equilibrium profit of each retailer goes down to $b(1 - k)$, which is lower than in a world without the referral infomediary.

The characteristic of the referral infomediary captured in the model is that of a mechanism which allows consumers to be reached with an additional price quote. The referral institution in our model does not create additional demand but rather reallocates existing demand among the retailers. This seems to be an accurate way of representing the effect of the institution on retailers. In other words, we believe that consumers do not buy more cars (or increase their valuations for cars) just because Autobytel has come into existence. Rather they use services such as Autobytel and Carpoint to get price quotes in addition to search in the brick-and-mortar world. Thus an infomediary that enrolls both retailers will lead to Bertrand competition in the Internet sector and thereby reduce their profits without conferring any compensating benefit. In other words, the equilibrium profit of each retailer will be lower than that in a world without the infomediary.

5. Optimal Selling Contracts for the Referral Infomediary

We have analyzed all the possible second-stage subgames and are now in a position to go back to the first stage to examine the optimal contract and the resulting profits for the referral infomediary. In doing so, we will be able to establish the set of market conditions that supports the endogenous existence of the infomediary. The following proposition establishes the optimal contractual policy for the referral infomediary.

PROPOSITION 4. *Let the referral infomediary charge enrolled retailers a lump-sum payment. Then:*

(1) When $k < 1 - b$, the optimal contracting policy for the referral infomediary is to adopt the exclusive strategy of enrolling only one retailer. The equilibrium contracting strategy is as follows: The referral infomediary offers to charge $C_{ix} = (b^2k(1 - k))/((1 - b)^2 - (1 - 2b)k)$ to retailer i and an off-equilibrium offer $C_{jx} = b[(1 - k)(((1 - b)^2 + bk)/((1 - b)^2 - (1 - 2b)k)) - 1]$ to the

other retailer in the event that retailer i rejects C_{ix}. In equilibrium, retailer i accepts the offer and the profit of the referral infomediary is $\Pi = C_{ix} = (b^2k(1 - k))/((1 - b)^2 - (1 - 2b)k)$.

(2) When $k \geqslant 1 - b$, neither retailer will enroll for any positive payment demanded by the referral infomediary. The referral infomediary unravels and makes zero profit.

The nonexclusive strategy of enrolling both retailers can never be optimal for the referral infomediary. As discussed in the previous section, the infomediary creates Bertrand competition between the enrolled retailers for the group of k consumers who use the service if both retailers are enrolled. The reduction in retailers' profit limits the payment that the infomediary can charge. Adopting the exclusive strategy always dominates as it allows the infomediary to charge the enrolled retailer for the benefit of exclusive access. Note that the exclusive contract is self-enforcing: Once R1 accepts the infomediary's offer and enrolls, R2 will have no incentive to enroll even if the infomediary offers access for free.[10]

From Proposition 4, it is easy to verify that $\partial\Pi/\partial k > 0$ and $\partial\Pi/\partial b > 0$. The referral infomediary's profits accrue from offering access to a mechanism that provides an enrolled retailer the benefits of both demand reallocation and that of price discrimination. The demand reallocation effect increases with the reach while the price discrimination effect increases with a larger b. A higher b increases the incentive to price discriminate because it increases the difference between the price elasticities in the segments of users versus nonusers of the referral service. In other words, a higher b increases the difference between the ratios γ_s and γ_l discussed earlier. Therefore, the profits of the referral infomediary increase in both k and b.

Perhaps the more interesting point of this proposition is that it identifies the condition under which the referral infomediary can exist and make positive profits. The referral infomediary can exist as long as its reach is not too large (i.e., $k < 1 - b$). When the reach of the infomediary becomes too large, the loss of profits from the increased competition that the referral infomediary creates outweighs the benefits from the increased demand and the price discrimination ability that the enrolled retailer will have. As seen in Proposition 2, the profit of the enrolled retailer will be the same as that in a world without the infomediary. Consequently, no retailer will have an incentive to join the infomediary. Thus (and somewhat paradoxically) increasing reach can lead to an unraveling of the infomediary. Overall, the message that emerges from this analysis is that an institution that acts as a demand reallocation and a price discrimination mechanism for retailers cannot exist when its reach becomes too large.

It might be surprising that the referral infomediary breaks down at higher values of k even though its profit (given that it is viable) actually increases with k. Understanding this helps to reveal some interesting features of the infomediary and the contract that it offers. If the infomediary is viable, its profits with the exclusive strategy are $C_{ix} = \pi_1 - \pi_2 = (\pi_1 - \pi_N) + (\pi_N - \pi_2)$, where π_N is the retailer's profit in the world without the infomediary. The first component in the expression of C_{ix}, $(\pi_1 - \pi_N)$, is the net gain in profit for the enrolled retailer compared to the situation where neither retailer joins the referral infomediary. The second component C_{ix}, $(\pi_N - \pi_2)$, is the potential loss in profit for the enrolled retailer if it rejects the contract from the infomediary but its competitor enrolls in the infomediary. In addition, the condition of $(\pi_1 - \pi_N) > 0$ must be satisfied before any retailer is willing to enroll in the referral infomediary. Because π_1 decreases with k when k is large, the referral infomediary breaks down at high reach levels even though C_{ix} is still increasing in k (because $(\pi_N - \pi_2)$ increases in k).

5.1. Variable-Fee Contracts

All the analysis up to this point was based upon a lump-sum fixed-fee contract. In this section we examine different types of variable-fee contracts that are possible.

5.1.1. Per-Referral-Based Variable Fee. Some referral services have charged retailers a per-referral-

[10]This means that the infomediary does not need a contractual guarantee to sell its service exclusively.

based-variable fee (for example, Autoweb). Suppose the referral infomediary charges a per-referral fee of v. The maximum total profit that the infomediary can get will still be the difference between the profits of the enrolled and the nonenrolled dealer. It can be shown that (for a given k) the optimal per-referral fee is $v^* = (\pi_1 - \pi_2)/k = (b^2(1 - k))/((1 - b)^2 - (1 - 2b)k)$ when $k < (1 - b)$. From this it is evident that the optimal fee is decreasing in k. In addition, the infomediary will make the same amount of profits as under the lump-sum arrangement.

5.1.2. Sales-Based Variable Fee. Next, we analyze the case where the infomediary adopts a sales-based-variable fee by charging a fee m for each unit that the enrolled retailer sells using the infomediary. As in the case of the lump-sum fee arrangement, the referral infomediary will not enroll both retailers. If both retailers are enrolled their online prices will be competed down to m. Each retailer's profit will be $\pi_i = (1 - k)b$ which is less than the guaranteed profits b that they would make if they do not enroll.

This means that the optimal strategy for the infomediary is the exclusive strategy of enrolling only one retailer. We present the full analysis of this contract in Appendix B. As in the case of the lump-sum fee, we have that, in equilibrium, the online referral price offered by the enrolled retailer will be lower than its store price. We find that for $k < (1 - b)(1 - m)$, $\pi_1 > b$ and $\pi_1 > \pi_2$ when $m \to 0$. Therefore, the infomediary is able to enroll one retailer and make positive profit. However, similar to the previous analysis with the lump-sum fee, when $k \geqslant (1 - b)(1 - m)$ the infomediary unravels in the sense that no retailer will want to enroll for any feasible value of the commission. Thus the result of this paper that the infomediary will unravel for higher values of reach continues to be valid with variable-fee contracts.

The infomediary's profit maximization problem can be written as

$$\max_m \Pi = \int_{p_b}^{p_m} \frac{m\pi_{1e}}{p_{1e} - m} \frac{-\partial H_{1e}}{\partial p_{1e}} \, dp_{1e} \qquad (6)$$

$$\text{s.t.} \quad \pi_1 > b, \quad \pi_1 > \pi_2.$$

We compared the equilibrium infomediary profits under sales-based commissions to those under the lump-sum fee. The maximum Π^* can be obtained numerically for any given k and b by grid searching for optimal m^* between (0, 1) and then be compared to the lump-sum based profits. We find that the infomediary's profit with the lump-sum fee always dominates the profit with sales-based commissions. The intuition for this result is as follows: Recall that the referral infomediary profit is comprised of two parts. The first part depends on the net gain of profit, $(\pi_1 - b)$, enjoyed by the enrolled retailer compared to the case without the infomediary. The second part is dependent on the potential loss in profit, $(b - \pi_2)$, for a retailer if it rejects the contract but its competitor enrolls in the infomediary. A sales-based commission m has both a positive and a negative effect on the profit gain $(\pi_1 - b)$. The increase in the marginal cost of the enrolled retailer by m creates double marginalization. The strategic effect of this is to soften competition for the consumers reached online and this has a positive effect on the profit gain. The commission also increases the retailer's cost of selling online through infomediary which has a negative effect on $(\pi_1 - b)$. However, the impact of m on $(b - \pi_2)$ is always negative because reduced competition for online consumers leads to less potential loss for the nonenrolled retailer. In other words, the threat which the infomediary can impose on a retailer who rejects the contract is always lower with higher commissions. In sum, the infomediary's profit with a sales-based commission contract is lower than that with a lump-sum-fee contract because the threat of not joining the infomediary is lower with the commission contract. This result sheds light on why sales-based commissions are not observed to be used by referral services in the automobile industry.[11]

[11]In addition to the incentive-based reason described above, the low incidence of variable-fee contracts is also because they may not be allowed by law in many states.

6. Extensions

6.1. The Impact of Consumer Identification

We assumed in the basic model that the referral infomediary as well as the enrolled retailer(s) cannot distinguish between the comparison shoppers, its own loyals, and the other retailer's loyal consumers. However, over time the referral infomediary would also be able to collect detailed information on consumer preferences. This should allow the infomediary and an enrolled retailer to develop the ability to identify consumer types and thereby allow the retailer to customize its price quotes accordingly. The enrolled retailer, R1, will be able to offer customized referral prices depending upon the identity of the online consumer.[12] Accordingly, let us define the referral price offered by the enrolled retailer to its own loyals (i.e., R1 shoppers) as p_{ae}, the referral price offered to R2's shoppers as p_{be}, and the referral price offered to the comparison shoppers as p_{ce}. The enrolled retailer R1's profit function is now

$$\pi_1 = (1-k)bp_1 + (1-k)aH_2(p_1)p_1 + kb\min(p_1, p_{ae}) + kbH_2(p_{be})p_{be} + kaH_2(\min(p_1, p_{ce}))\min(p_1, p_{ce}). \quad (7)$$

Using similar reasoning as in the basic model it can be shown that $p_{ae} = p_1$ and $p_1 \geqslant p_{ce}$ in equilibrium. Similarly, it can also be shown that $p_1 \geqslant p_{be}$ in equilibrium. Therefore, we have that

$$\pi_1 = (1-k)bp_1 + (1-k)aH_2(p_1)p_1 + kbp_1 + kbH_2(p_{be})p_{be} + kaH_2(p_{ce})p_{ce}. \quad (8)$$

Again, following the same logic used in deriving the equilibrium of the basic model, we can prove that the lower bound of p_1 is equal to the upper bound of both p_{be} and p_{ce} in equilibrium. From (8), we can also see that the optimization problem for R1 with respect to p_{be} and p_{ce} are the same. Thus, p_{be} and p_{ce} have the same distribution in equilibrium, i.e. $H_{be}(p) = H_{ce}(p) = H_{1e}(p)$. Therefore, R2's profit function can be written as

$$\begin{aligned}\pi_2 &= (1-k)bp_2 + (1-k)aH_{11}(p_2)p_2 + kbH_{be}(p_2)p_2 + kaH_{ce}(p_2)p_2 \\ &= (1-k)bp_2 + (1-k)aH_{11}(p_2)p_2 + (kb+ka)H_{1e}(p_2)p_2. \end{aligned} \quad (9)$$

We obtain that in the equilibrium

Proposition 5. The optimal contracting policy for the infomediary is to adopt the exclusive strategy of enrolling only one retailer. With consumer identification, the equilibrium contracting strategy is as follows: It charges $C_{ix} = b^2((1-(1-k)^2)/(b+(1-2b)(1-k)^2))$ to a retailer i and charges $C_{jx} = ((1-k)kb(1-b))/(b+(1-k)^2(1-2b))$ to the other retailer in the event that retailer i rejects the offer. The equilibrium profit of the referral infomediary is $\Pi = C_{ix} = b^2((1-(1-k)^2)/(b+(1-2b)(1-k)^2))$.

Comparing the above results with those in Proposition 4, we can see that the referral infomediary's profits are higher with consumer identification. But the more important point is that with consumer identification, the institution will not unravel as the reach increases. In fact, it is now possible for the infomediary to exist for all values of k. This provides an interesting insight into the strategies that referral infomediaries should adopt as they evolve. As the reach of the infomediary increases, it is also important for the infomediary to make complementary investments in improving customer identification. With customer identification the profits of the infomediary will always be increasing in reach regardless of the level of reach attained (i.e., $\partial\Pi/\partial k > 0$ always).

6.2. Heterogeneity in the Reach and in Retailer Loyalty

We now discuss the key implications of relaxing two assumptions in the basic model. In the basic model we assumed that retailers were symmetric in terms of the sizes of their "own" (or loyal) segments of consumers. However, in many markets retailers may differ w.r.t the size of these segments. We now relax the assumption made in the basic model and let $b_1 > b_2$ without loss of generality (i.e., let R1 be the

[12] We focus our discussion here on the case where only R1 enrolls in the referral infomediary because the infomediary uses an exclusive contract in equilibrium.

retailer with a larger size of the shoppers who only search at its store). We will label R1 as the "large" retailer and R2 as the "small" retailer. Furthermore, in the basic model we had also assumed that the reach of the infomediary, k, was the same across all the segments in the market. However, one can reasonably expect the reach of the infomediary to be relatively greater among the comparison shoppers. The available empirical evidence (see, for example, Scott Morton et al. 2001) also indicates this to be the case. Relaxing the assumption w.r.t. k, we now let k_a be the reach of the infomediary in the comparison shopping segment, and k_b be the reach among the segments of b_1 and b_2 consumers who consider only their respective retailers. We provide the analysis of this general model in Appendix B and only report the key findings here.

First, consider the effect of asymmetry in b_1 and b_2. Our analysis shows that, as long as the reach of the infomediary is symmetric across all segments, it is always optimal for the referral infomediary to exclusively enroll the large retailer in the market. In addition, the infomediary's profit increases as the retailers become more asymmetric (i.e., as b_1/b_2 increases). To understand this, note that the price discrimination ability conferred by the infomediary is more valuable for the retailer that has a larger size of loyal shoppers. In addition, enrolling the large retailer reduces the number of consumers who are likely to be poached (i.e., only b_2 consumers can be poached). This reduces the intensity of market competition and allows the infomediary to charge a higher price.

Now consider the case where there is also asymmetry on the reach dimension. We find that the infomediary's profit increases with k_a, the reach of the infomediary among the comparison shoppers. With an increase in k_a, a greater number of comparison shoppers get two prices from the enrolled retailer R1. Thus, all else being equal, the nonenrolled retailer will get less demand from the comparison shopping segment (because its store price will now have to be lower than both prices offered by R1). The strategic response of R2 will therefore be to focus more on extracting surplus from the R2-shoppers. This reduces the overall intensity of price competition between the two retailers and allows the infomediary to extract a higher profit. Next, we find that the infomediary's profit increases with k_b, the reach among the segment of consumers who do not comparison shop, if the overall reach $(k_a + k_b)$ is small; its profit decreases with k_b if the overall reach is sufficiently large. The intuition for this result is similar to that for the relationship between π_1 and k discussed in §4.1.1.

Finally, with asymmetry in reach it can be optimal for the infomediary to enroll the small but not the large retailer. It turns out that the referral infomediary will find it optimal to exclusively enroll the small retailer if: (a) the reach of the infomediary among the comparison shoppers (i.e., k_a) is sufficiently large compared to that among the loyals (k_b) and (b) b_1 is sufficiently large as compared to b_2.

6.3. Incorporating Shopping Costs

In this subsection we consider an extension that generalizes the basic model by incorporating shopping costs that consumers might incur in traveling and price discovery prior to buying. Assume that all consumers have a fixed endowment of the total time available for (1) traveling to retailers and (2) price discovery, which we normalize to 1 without any loss of generality.

In a world without the infomediary there are two segments of consumers of size 1/2 each. Consumers are heterogeneous in terms of the time needed for travel and price discovery at a retailer. In the first segment (denoted as L_1), a consumer i incurs time T_{iN0} for travel and price discovery at R1 and time T_{iF0} for travel and price discovery at R2 (the subscripts N and F denote "near" and "far"). Assume that time T_{iN0} varies across the consumers in L_1, but for all consumers $T_{iN0} < T_{iF0}$ and $T_{iN0} < 1$. Therefore, consumers in this segment always search and consider R1. However, T_{iF0} varies across consumers in L_1 such that $T_{N0} + T_{F0} < 1$ for only a proportion of θ_0 consumers in this segment. Therefore, a proportion of θ_0 consumers in L_1 considers both retailers and buys from the retailer charging the lower price. The remaining $1 - \theta_0$ proportion consumers in L_1

only consider R_1.[13] Similarly, we assume that a proportion of θ_0 consumers in the second segment (L_2) considers both retailers and buys from the retailer charging the lower price and the rest $1 - \theta_0$ proportion consumers in this segment only consider R2.

Consider the impact of the infomediary and let R1 be the enrolled retailer. Consumers in L_2 who are reached by the infomediary (k proportion) will now be able to get a price quote from R1 at a negligible cost. Consequently, the time required by these L_2 consumers to consider R1 will now be T_{iF}, which is lower than T_{iF0}. This is because the referral infomediary saves the price discovery related time for L_2 consumers (and T_{iF} can therefore be thought of as the sunk cost of travel which these consumers will still have to incur). Define θ to be the proportion of these consumers in L_2 with $T_{iN0} + T_{iF} < 1$. We have $\theta > \theta_0$ because T_{iF} is less than T_{iF0}. As a result, a proportion $k(\theta - \theta_0)$ of L_2 consumers will compare R1's online price with R2's price and buy at the lower price. A proportion $k\theta_0$ of L_2 consumers will compare R1's online price and offline price with R2's price and buy at the lowest price. Similarly, L_1 consumers who are reached by the infomediary will always compare R1's online price with its offline price and buy at the lower price, and a proportion θ_0 of these L_1 consumers will compare R1's online price and offline price with R2's price and buy from the lowest price. Obviously, the behavior of the offline consumers in both segments who are not reached by the infomediary ($1 - k$ proportion) remain unchanged.

Define $b = (1 - \theta_0)/2$, $a = \theta_0$, $g = ((\theta - \theta_0)/(1 - \theta_0))k$, and $H_1(p) = \Pr(\min(p_1, p_{1e}) \geqslant p)$. The profit functions of the retailers are

$$\begin{aligned}\pi_1 &= (1-k)p_1[b + aH_2(p_1)] + kb\min(p_1, p_{1e}) \\ &\quad + gbH_2(p_{1e})p_{1e} + kaH_2(\min(p_1, p_{1e}))\min(p_1, p_{1e}) \\ \pi_2 &= (1-g)bp_2 + (1-k)aH_1(p_2)p_2 + gbH_1(p_2)p_2 \\ &\quad + kaH_1(p_2)p_2. \end{aligned} \qquad (10)$$

We can see that if $g = k$ (i.e., $\theta = 1$) retailers' profit functions are identical to that in the basic model. For $g < k$ (i.e., $\theta < 1$), similar to Proposition 1, we have that the equilibrium price support for both p_1 and p_{1e} are continuous with $p_1 \in (p_m, 1)$ and $p_{1e} \in (p_b, p_m)$. We present the solution of this model in Appendix B.

The analysis reveals that the explicit consideration of travel and price discovery costs does not affect the results of the paper. Note that as in the basic model, if both retailers enroll in the infomediary, both will charge prices at marginal cost to the $2gb + ka$ consumers who use the infomediary for comparison shopping. This means that the equilibrium profit of both retailers will be lower than their profit from not enrolling, which makes the strategy of enrolling both retailers infeasible. When only R1 enrolls, $\pi_1 > b > \pi_2$ if $(1 - k)/g > b/(1 - b)$ and $\pi_1 = b$ if $(1 - k)/g \leqslant b/(1 - b)$, where b is the profit of each retailer in the basic case without the infomediary. Thus, Retailer 1 will enroll only if $(1 - k)/g > b/(1 - b)$. Therefore, when $(1 - k)/g > b/(1 - b)$, the optimal contracting policy for the referral infomediary is to adopt the exclusive strategy of enrolling only one retailer. When $(1 - k)/g \leqslant b/(1 - b)$, which happens as $k \to 1$, neither retailer will enroll for any positive payment demanded by the referral infomediary. Thus, as in the basic model, the referral infomediary unravels and makes zero profit when its reach becomes sufficiently large.

The parameter g can be interpreted as the extent of demand reallocation created by the infomediary from R2 to R1. It is the proportion of consumers who previously considered R2 alone but who also start considering the enrolled retailer R1 because of the infomediary. The cutoff (??) beyond which the infomediary unravels decreases as g increases because of greater demand reallocation. The greater the demand reallocation, the more aggressively R2 will price in order to protect its loyal consumers,

[13]This model construction can also have the following equally valid alternative interpretation: Consumers in L_1 find it convenient to shop at R1 (for example, because they are close to the retailer's location or because they are familiar with the retailer and find price discovery easy). These consumers find R2 relatively inconvenient either because they are located far away or because R2 is unfamiliar. Only with probability $\theta_0 < 1$ a consumer in L_1 visits R2 (this can be because the consumer happened to be in the vicinity and had additional time for this retailer).

leading to more intense price competition. Consequently, the infomediary unravels for lower values of k. We also have that the infomediary's profits are increasing in g and $\partial\pi_2/\partial g < 0$ always, $\partial\pi_1/\partial g < 0$ if g and k are large, and $\partial\pi_1/\partial g > 0$ otherwise.

7. Conclusion and Future Research

Recently, we have seen the emergence of Internet intermediaries that have impacted on the strategies of firms in traditional markets in many industries. Examples include ⟨autobytel.com⟩ in the automobile market, ⟨healthcareadvocates.com⟩ in healthcare, and ⟨avviva.com⟩ in the real-estate business. The rationale for these intermediaries and their implications for competition between firms in traditional markets is the focus of this paper.

Our interest in this phenomenon is motivated by what appears to be important economic properties of these infomediaries. On the demand side, the referral infomediary helps consumers to costlessly get an additional retail price quote before purchase. On the firm side, a referral infomediary endows enrolled retailers with a price discrimination mechanism. A retailer that joins an infomediary has the ability to price discriminate between online consumers and those who come directly to the retail store. These properties raise some interesting research questions. For example, how does the infomediary affect the incentives of an individual retailer to enroll in their service? What are the implications of the infomediary for the competition between retailers in a market? What is the optimal contractual policy that a referral infomediary should use to sell its service? This last question pertains to the problem of how a seller should contract for the sale of a price discrimination mechanism.

We find that the referral price will always be lower than the retail store price offered by the enrolled retailer. This result illustrates the role of the referral infomediary as a competitive price discrimination mechanism and hence the rationale for lower online prices. More importantly, we find that the profits of the enrolled retailer are in the form of an inverted U with respect to the reach of the referral infomediary: i.e., profits first increase and then decrease with the reach of the infomediary. This result seems somewhat counterintuitive. One would expect that the ability to price discriminate and to get additional demand must result in higher profits. However, the referral infomediary also helps a retailer to poach on its competitors' customers who were previously unavailable. The strategic response by the competitor is to price aggressively in order to protect its loyal base and this intensifies price competition leading to lower equilibrium profits. This competitive effect increases with the reach of the infomediary.

Our analysis of the contracting problem of the infomediary shows that the referral infomediary prefers an exclusive strategy (of allowing only one of the retailers to enroll) to a nonexclusive strategy. A nonexclusive strategy implies that consumers who use the Web will get referral prices from both retailers. This creates Bertrand-type competition for these consumers. Consequently, both retailers make less profit than in the world without the infomediary and will stay out even if the institution owner allows access for free.

Perhaps the most interesting result is that the referral infomediary can unravel (in the sense that neither retailer can gain any net profit from joining the infomediary) when its reach becomes very high. In this case, any retailer that joins the infomediary will be able to poach on a large proportion of the competitor's customers. The resulting price competition is so intense that a retailer makes no net gain in profit from joining. It is perhaps this problem that is at the heart of the current attempts by referral services such as Autobytel to diversify into additional service areas such as financing and after-market services.

The phenomenon of infomediaries is new and this paper is an attempt at understanding the institution and its implications. There are several interesting areas for future research in this area. We do not explicitly model the role of the infomediary in allowing consumers to bargain with retailers. Consideration of this issue will help us better understand the broader economic question of how competition will be affected in markets moving from bargaining to posted prices. We study the implications of infomediaries for retailers and consumers. It would be useful to explore the implications of infomediaries for players further upstream in the channel (i.e., manufacturers). Do infomediaries represent an alternative means for manufacturer's to structure downstream behavior? Finally, it would be interesting to examine competition between infomediaries and the manner in which they would enroll retailers.

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Appendix A

PROOF OF PROPOSITION 1. We derive the mixed-strategy equilibrium for this case. Similar to the proofs of Propositions 2–5 in Narasimhan (1988), we have that in the mixed-strategy equilibrium: (1) both the joint price support of p_1 and p_{1e}, i.e., $p_1 \cup p_{1e}$, and the price support of p_2 are continuous; (2) neither firm can have a probability mass point below 1 (the reservation price) in its (joint) price support; (3) at most one firm can have probability mass at 1 in its (joint) price support; and (4) the (joint) price support is from p_b to 1 for both firms, where p_b is to be solved in equilibrium.

Denote that $H_{11}(p) = \Pr(p_1 \geqslant p)$, $H_{1e}(p) = \Pr(p_{1e} \geqslant p)$, and $H_2(p) = \Pr(p_2 \geqslant p)$. The profit function of R1 when it charges p_1 and p_{1e} can be written as

$$\begin{aligned}\pi_1 = (1-k)bp_1 + (1-k)aH_2(p_1)p_1 + kb\min(p_1, p_{1e})\\ + kbH_2(p_{1e})p_{1e} + kaH_2(\min(p_1,p_{1e}))\min(p_1,p_{1e}).\end{aligned} \tag{A1}$$

We first claim that no price pair (p_1, p_{1e}), where $p_1 < p_{1e}$, can be part of an equilibrium. The proof is as follows. Suppose a price pair (p_1, p_{1e}), where $p_1 < p_{1e}$, is in equilibrium. From (A1) we have that

$$\begin{aligned}\pi_1 = (1-k)bp_1 + (1-k)aH_2(p_1)p_1\\ + kbp_1 + kbH_2(p_{1e})p_{1e} + kaH_2(p_1)p_1.\end{aligned} \tag{A2}$$

From (A2), we can see that if $H_2(p_{1e})p_{1e} \geqslant H_2(p_1)p_1$, R1 will be better off by increasing p_1 to $p_1 = p_{1e}$. Otherwise, if $H_2(p_{1e})p_{1e} < H_2(p_1)p_1$, R1 will be better off by lowering p_{1e} to $p_{1e} = p_1$. Thus, $p_1 < p_{1e}$ can never be optimal. Therefore, we have that $p_1 \geqslant p_{1e}$ in the equilibrium. Therefore, (A1) can be reduced to

$$\begin{aligned}\pi_1 &= \pi_{11} + \pi_{1e},\\ \pi_{11} &= (1-k)bp_1 + (1-k)aH_2(p_1)p_1,\\ \pi_{1e} &= kbp_{1e} + kbH_2(p_{1e})p_{1e} + kaH_2(p_{1e})p_{1e}.\end{aligned} \tag{A3}$$

According to the property of the mixed-strategy Nash equilibrium, π_1 is invariant for all p_1 and p_{1e} on their equilibrium supports. From (A3), we can see that given the other firm's price distribution, π_{11} is not dependent on p_{1e} and π_{1e} is not dependent on p_1. Thus, π_{11} should be invariant for all p_1 on the equilibrium price support and π_{1e} should be invariant for all p_{1e} on the equilibrium price support.

Next, we claim that there is no more than one common point on the equilibrium supports of p_1 and p_{1e}. The proof is as follows. Suppose there exist two points representing prices p_a and p_b, which are common to the supports of p_1 and p_{1e}. From (A3) and the invariance property in a mixed-strategy equilibrium of π_{11} and π_{1e} as defined above, we have that

$$\begin{aligned}&\pi_{11}(p_a) = \pi_{11}(p_b)\\ &\quad\Rightarrow (1-k)bp_a + (1-k)aH_2(p_a)p_a\\ &\quad= (1-k)bp_b + (1-k)aH_2(p_b)p_b\\ &\quad\Rightarrow \frac{p_bH_2(p_b) - p_aH_2(p_a)}{p_a - p_b} = \frac{b}{a},\end{aligned} \tag{A4}$$

and

$$\begin{aligned}&\pi_{1e}(p_a) = \pi_{1e}(p_b)\\ &\quad\Rightarrow kbp_a + kbH_2(p_a)p_a + kaH_2(p_a)p_a\\ &\quad= kbp_b + kbH_2(p_b)p_b + kaH_2(p_b)p_b\\ &\quad\Rightarrow \frac{p_bH_2(p_b) - p_aH_2(p_a)}{p_a - p_b} = \frac{b}{a+b}.\end{aligned} \tag{A5}$$

Comparing (A4) with (A5), we have that $b/a = b/(a+b) \Rightarrow b = 0$, which contradicts $b > 0$. Hence, the claim holds.

From the above, we have that in the equilibrium: (1) the joint price support of p_1 and p_{1e} is continuous; (2) $p_1 \geqslant p_{1e}$; and (3) there is no more than one common point in the joint price support of p_1 and p_{1e}. Therefore, there exists a p_m so that p_1 is distributed from p_m to 1 and p_{1e} is distributed from p_b to p_m. We have also shown before that the price support is from p_b to 1 for p_2. This completes the proof of Proposition 1. The exact expressions for p_m and p_b are reported in the proposition and are derived as shown in the proof of Proposition 2. □

PROOF OF PROPOSITION 2. From Proposition 1, we have that for R1

$$\begin{aligned}\pi_1 &= \pi_{11} + \pi_{1e},\\ \pi_{11} &= (1-k)bp_1 + (1-k)aH_2(p_1)p_1 \qquad (p_m \leqslant p_1 \leqslant 1),\\ \pi_{1e} &= kbp_{1e} + kbH_2(p_{1e})p_{1e} + kaH_2(p_{1e})p_{1e} \qquad (p_b \leqslant p_{1e} < p_m).\end{aligned} \tag{A6}$$

Consider R2's profit, π_2. We have that

$$\begin{aligned}\pi_2 = (1-k)bp_2 + (1-k)aH_{11}(p_2)p_2\\ + kbH_{1e}(p_2)p_2 + kaH_{1e}(p_2)p_2.\end{aligned} \tag{A7}$$

From the three invariance conditions that must be satisfied in a mixed-strategy equilibrium, we have that

$$\frac{d\pi_{11}}{dp_1} = 0, \qquad \frac{d\pi_{1e}}{dp_{1e}} = 0, \qquad \frac{d\pi_2}{dp_2} = 0. \tag{A8}$$

Denote $H_{11}(1) = q_1$, $H_2(1) = q_2$, and $H_{1e}(p_m) = q_{1e}$. From the proof of Proposition 1, we have that

$$\begin{array}{lll} H_{1e}(p_b) = 1, & H_{11}(p_m) = 1, & H_2(p_b) = 1, \\ q_{1e} = 0, & q_1 q_2 = 0 & (\text{if } p_m < 1), \\ H_{1e}(p_b) = 1, & H_{11}(p_m) = 1, & H_2(p_b) = 1, \\ q_1 = 1, & q_2 = 0, & q_{1e} \geqslant 0 \quad (\text{otherwise}). \end{array} \tag{A9}$$

The equations in (A8) define a set of ordinary differential equations (ODE) with the boundary conditions provided in (A9). This system of ODEs can be solved using the standard techniques for solving ODEs (see e.g., Rainville and Bediant 1974), which gives the equilibrium price distribution functions $H_1(p)$, $H_{1e}(p)$, and $H_2(p)$. Then the equilibrium solutions for π_1, π_{11}, π_{1e}, π_2, q_1, q_{1e}, q_2, $E(p_1)$, $E(p_{1e})$, and $E(p_2)$ can be obtained from (A6), (A7), (A9) and their definitions. The results along with the solutions for p_b and p_m are reported in Propositions 1 and 2 in this paper. The cut-off condition $k < 1 - b$ corresponds to the condition for $q_1 < 1$ (i.e., $p_m < 1$). □

PROOF OF PROPOSITION 3. In this subgame, firms are in Bertrand competition for the $ka + 2kb$ consumers who use the infomediary. Therefore, $p_{1e} = 0$. For the remaining market, a size of $(1 - k)b$ consumers each will buy from R1 (R2) and pay $p_1(p_2)$; a size of $(1 - k)a$ of consumers will buy from the dealer with lower store price. Thus, the competition in this case between the two firms using p_1 and p_2 is as if there was no infomediary but with the market size scaled down by $1 - k$. Therefore, $\pi_i = (1 - k)b$ and $H_i(??)(p) = b/a(1/p - 1)$ in the equilibrium. □

PROOF OF PROPOSITION 4. As discussed in paper, if neither dealer enrolls, $\pi_N = b$. Consider the case in which one retailer (say R1) enrolls in the infomediary. Denote the equilibrium profit of the enrolled retailer as π_A and the profit of the nonenrolled retailer as π_D. Finally, denote the equilibrium profits of the retailers when both are enrolled as π_B. We have from Proposition 2, if only one dealer enrolls (say R1),

$$\pi_A = b(1-k)\frac{(1-b)^2 + bk}{(1-b)^2 - (1-2b)k} \quad \text{and}$$

$$\pi_D = b\left[\frac{(1-b)^2(1-k)}{(1-b)^2 - (1-2b)k}\right]$$

if $k < 1 - b$; or $\pi_A = b$ and $\pi_D = b(1 - b)$ if $k \geqslant 1 - b$. From Proposition 3, if both dealers enroll, we have that $\pi_B = b(1 - k)$.

Consider the contract in which the infomediary offers C_{1x} to R1, and makes the (off-equilibrium) threat to offer C_{2x} to R2 in the event R1 rejects C_{1x}. Referring to Figure 1, R1 will accept C_{1x} if $\pi_A - C_{1x} \geqslant \pi_D$, if it is the case that rejection of C_{1x} by R1 results in R2 accepting C_{2x}. Note that (in the event of rejection of C_{1x} by R1) R2 will accept C_{2x} if $\pi_A - C_{2x} \geqslant \pi_N$. Thus the optimal contract involves the infomediary charging R1 $C_{1x} = \pi_A - \pi_D$ and threatening to sell to R2 (in the event of rejection by R1) at a price of $C_{2x} = \pi_A - \pi_N$. However, this threat is only credible if $C_{2x} > 0$, which is true when $k < (1 - b)$.[14] Therefore, for $k < (1 - b)$, we have that the optimal

$$C_{1x} = \frac{b^2k(1-k)}{(1-b)^2 - (1-2b)k} \qquad \text{and}$$

$$C_{2x} = b\left[(1-k)\frac{(1-b)^2 + bk}{(1-b)^2 - (1-2b)k} - 1\right].$$

Furthermore, in this range note that $\pi_B < \pi_D$, which means that the exclusive contract offer is self-enforcing (i.e., if R1 accepts the offer, then R2 is better off not accepting).

Consider the case when $k \geqslant (1 - b)$, $\pi_A = b$, $\pi_D = b(1 - b)$, $\pi_N = b$, and $\pi_B = b(1 - k)$. To solve for the contracting equilibrium of this case, consider the event that R1 has rejected some C_{1x} offered by the infomediary. Because $\pi_A = \pi_N$, R2 will not enroll in the infomediary for any $C_{2x} > 0$. Thus if R1 rejects any C_{1x} it can guarantee itself a profit of π_N. Because $\pi_A = b$ there is no $C_{1x} > 0$ that will be accepted by R1. □

PROOF OF PROPOSITION 5. Note that exactly as in the basic model it is not optimal for the infomediary to enroll both retailers. For the case of one retailer being enrolled, given the profit functions in (A8) and (A9) in this paper, the equilibrium solutions can then be derived using the same method of proof as in Propositions 1 and 2 of the basic model. We obtain that in equilibrium the profit of the enrolled retailer R1 is

$$\pi_{1e} = b + \frac{(1-k)kb(1-b)}{b + (1-k)^2(1-2b)},$$

where

$$\pi_{11} = b, \ \pi_{1e} = \frac{(1-k)kb(1-b)}{b + (1-k)^2(1-2b)};$$

$$\pi_2 = \frac{(1-k)b(1-b)}{b + (1-k)^2(1-2b)}; \quad p_m = \frac{b}{b + (1-k)^2 a};$$

$$p_b = \frac{(1-k)b}{b + (1-k)^2 a};$$

[14] Note that we assume that the vendor is able to make take-it-or-leave-it offers and therefore the off-equilibrium contract is $C_{2x} = \pi_A - \pi_N$. We can think of any other negotiating configuration. All that is necessary for a credible off-equilibrium threat is that there be gains to trade between the vendor and R2 which is true for this case.

$$H_{11}(p) = \frac{\pi_2}{(1-k)(1-2b)p} - \frac{b}{(1-2b)};$$
$$H_{1e}(p) = \frac{\pi_2}{k(1-b)p} - \frac{(1-k)b}{k(1-b)};$$
$$H_2(p) = \frac{b}{(1-k)a}\left(\frac{1}{p}-1\right) \quad \text{for } (p_{1m} < p < 1),$$
$$H_2(p) = \frac{\pi_{1e}}{(1-b)kp} \quad \text{for } (p_b < p < p_m);$$
$$q_1 = \frac{b - b(1-k)^2}{b + (1-2b)(1-k)^2}; \qquad q_2 = 0;$$
$$E(p_1) = \frac{\pi_2}{(1-k)(1-2b)} \ln\left(\frac{1}{p_m}\right) + q_1;$$
$$E(p_{1e}) = \frac{\pi_2}{k(1-b)} \ln\left(\frac{1}{(1-k)}\right); \quad \text{and}$$
$$E(p_2) = \frac{b}{a}\ln\left(\frac{1}{p_m}\right) + \frac{\pi_{1e}}{k(1-b)}\ln\left(\frac{1}{1-k}\right).$$

The equilibrium profits for each firm when neither firm enrolls and both firms enroll in the infomediary are the same as those in the basic model. Applying the same method of proof and notations as that for Proposition 4, we have that the infomediary will use an exclusive contract by offering to charge R1 $\pi_A - \pi_D = b^2[1 - (1-k)^2/b + (1-2b)(1-k)^2]$ with a threat to charge $\pi_A - \pi_N = (1-k)kb(1-b)/b + (1-k)^2(1-2b)$ to R2 if R1 rejects the offer. It can be verified that this threat is credible. □

Appendix B

Sales-Based Variable-Fee Contract

Consider the case where the infomediary adopts a sales-based variable-fee contract by charging a fee m for each sale to consumers who use the infomediary. As in the basic model, the referral infomediary will not enroll both retailers because then both retailers will charge their online prices at m and each will obtain profit $\pi_i = (1-k)b < b = \pi_N$ in equilibrium.

If only one retailer enrolls, we first prove that there is no more than one common point on the equilibrium supports of p_1 and p_{1e}. Suppose not, and there exist two prices, p_a and p_b with $p_b > p_a$ on the supports of both p_1 and p_{1e}. From the invariance property of profits in a mixed-strategy equilibrium, we have

$$\pi_{1e}(p_{1e} = p_a, p_1 = p_a) = \pi_{1e}(p_{1e} = p_b, p_1 = p_a) \Rightarrow$$
$$kbH_2(p_a)(p_a - m) = kbH_2(p_b)(p_b - m)$$

and

$$\pi_{1e}(p_{1e} = p_a, p_1 = p_b) = \pi_{1e}(p_{1e} = p_b, p_1 = p_b)$$
$$\Rightarrow k(p_a - m)[b + (b+a)H_2(p_a)] = k(p_b - m)[b + (b+a)H_2(p_b)]$$
$$\Rightarrow (p_b - m)H_2(p_b) - (p_a - m)H_2(p_a)/p_a - p_b = b/(a+b).$$

Obviously, the above two equations cannot hold simultaneously. Thus, either the support of p_1 is always higher than the support of p_{1e} or the support of p_1 is always lower than the support of p_{1e}.

If the support of p_1 is always lower than the support of p_{1e}, we have

$$\pi_{1e} = kbH_2(p_{1e})(p_{1e} - m) \quad (p_m \leqslant p_{1e} \leqslant 1),$$
$$\pi_{11} = bp_1 + aH_2(p_1)p_1 \quad (p_b \leqslant p_1 \leqslant p_m),$$
$$\pi_2 = (1-k)bp_2 + aH_{11}(p_2)p_2 + kbH_{1e}(p_2)p_2.$$

Solving the above equations leads to $\pi_{11} = b$, $p_m = 1$, and $\pi_{1e} = 0$ for any positive m. Since the condition for a retailer i to enroll in the referral infomediary is $\pi_2 > b$, neither retailer enrolls.

If the support of p_1 is always higher than the support of p_{1e}, we have that

$$\pi_{11} = (1-k)p_1[b + aH_2(p_1)] \qquad (p_m \leqslant p_1 \leqslant 1),$$
$$\pi_{1e} = k(p_{1e} - m)[b + (b+a)H_2(p_{1e})] \qquad (p_b \leqslant p_{1e} \leqslant p_m),$$
$$\pi_2 = (1-k)[b + aH_{11}(p_2)]p_2 + k(b+a)H_{1e}(p_2)p_2.$$

Let

$$h = 1 - \frac{m(1-b)^2 - (1-b)b}{2(1-b)ma} + \frac{\sqrt{[m(1-b)^2 - (1-b)b]^2 + 4bma(1-b)k}}{2(1-b)ma}.$$

Solving the above equations leads to equilibrium results as follows: (1) if $k < (1-b)(1-m)$, then $\pi_{11} = (1-k)b$, $\pi_{1e} = k[b + (a+b)h](p_m - m)$, $\pi_2 = (1-k)(1-b)b/(b+ah)$, $p_m = b/(b+ah)$; (2) if $k \geqslant (1-b)(1-m)$, then $\pi_{11} = (1-k)b$, $\pi_{1e} = kb(1-m)$, $\pi_2 = (1-b)[b(1-m)+m]$, $p_m = 1$. Moreover, $p_b = \pi_{1e}/k + m$, $H_{11}(p) = \pi_2/(p(1-k)a) - b/a$, $H_{1e}(p) = \pi_2/(p(ka+kb)) - (1-k)/k$, $H_2(p) = \pi_{11}/(p(1-k)a) - b/a$ for $p \in (p_m, 1]$, and $H_2(p) = \pi_{1e}/((p-m)k(a+b)) - b/(a+b)$ for $p \in (p_b, p_m)$.

Since $\pi_1 \leqslant b$ for $k \geqslant (1-b)(1-m)$, neither retailer enrolls under this situation. For $k < (1-b)(1-m)$, we have that $\pi_1 > b$ and $\pi_1 > \pi_2$ when $m \to 0$. Therefore, the infomediary is able to enroll the retailer and still make positive profit in this case. Therefore, this case provides the equilibrium of the whole game if the infomediary is viable. Notice that $k < (1-b)(1-m)$ cannot hold for any positive m if $k \geqslant (1-b)$. Thus, the condition for the infomediary to be viable is $k < (1-b)$, which is the same as the condition in the case where the lump-sum-fee contract is used.

The infomediary's profit maximization problem in this case is

$$\max_m \Pi = \int_{p_b}^{p_m} m\pi_{1e}/p_{1e} - m - \partial H_{1e}/\partial p_{1e}$$
$$dp_{1e} = \pi_{1e}\pi_2/k(a+b)[1/m \ln(p_m - m)p_b/(p_b - m)p_m + (1/p_m - 1/p_b)]$$
$$\text{s.t.} \quad \pi_1 > b \quad \text{and} \quad \pi_1 > \pi_2.$$

The maximum Π^* can be obtained numerically for any given k and b by grid searching for optimal m^* between (0, 1).

Heterogeneity in Reach and in Retailer Loyalty

The case where neither dealer enrolls is similar to the case in Narasimhan (1988) where firms have asymmetric loyalty. We have that $\pi_1 = b_1$ and $\pi_2 = ((b_2 + a)b_1)/(b_1 + a)$ if $b_1 > b_2$; or $\pi_2 = b_2$ and $\pi_1 = ((b_1 + a)b_2)/(b_2 + a)$ otherwise.

Consider the case where only one dealer enrolls. Following an analysis similar to that for Proposition 1, we can show that the nature of equilibrium price support is similar. Therefore, the profit function for R1 is

$$\begin{aligned}
&\pi_1 = \pi_{11} + \pi_{1e}, \quad \text{where} \\
&\pi_{11} = (1-k_b)bp_1 + (1-k_a)aH_2(p_1)p_1 \qquad (p_m \leqslant p_1 \leqslant 1), \qquad \text{(A10)} \\
&\pi_{1e} = k_b b p_{1e} + k_b b H_2(p_{1e})p_{1e} + k_a a H_2(p_{1e})p_{1e} \quad (p_b \leqslant p_{1e} \leqslant p_m),
\end{aligned}$$

and the profit function for R2 is

$$\begin{aligned}
\pi_2 = {} & (1-k_b)bp_2 + (1-k_a)aH_{11}(p_2)p_2 \\
& + k_b b H_{1e}(p_2)p_2 + k_a a H_{1e}(p_2)p_2. \qquad \text{(A11)}
\end{aligned}$$

Solving the set of differential equations similar to the one that we did for Proposition 2 but with the profit functions given above, we obtain the following equilibrium results: Define

$$H_{2m} = \frac{\frac{(1-k_b)b_2 + (1-k_a)a}{(b_2+a)}(k_b b_1 + k_b b_2 + k_a a) - k_b b_1}{(k_b b_2 + k_a a)}.$$

If $H_{2m} \geqslant 0$ and $(((1 - k_b)(b_1 - b_2H_{2m}))/[(1 - k_b)b_1 + (1 - k_a)aH_{2m}]) \geqslant 0$, then $\pi_{11} = (1 - k_b)b_1$, $\pi_{1e} = [k_bb_1 + (k_bb_2 + k_aa)H_{2m}]p_m$, $\pi_2 = (b_2 + a)p_b$, and $p_m = \pi_{11}/[(1 - k_b)b_1 + (1 - k_a)aH_{2m}]$, $p_b = \pi_{12}/(k_bb_1 + k_bb_2 + k_aa)$.

If $H_{2m} > 0$ and $(((1 - k_b)(b_1 - b_2H_{2m}))/[(1 - k_b)b_1 + (1 - k_a)aH_{2m}]) < 0$, then $\pi_{11} = [(1 - k_b)b_1 + (1 - k_a)aH_{2m}]p_m$, $\pi_{1e} = (k_bb_1 + k_bb_2 + k_aa)p_b$, $\pi_2 = (1 - k_b)b_2$, $p_m = \pi_2/[(1 - k_b)b_2 + (1 - k_a)a]$, $p_b = \pi_2/(b_2 + a)$.

If $H_{2m} < 0$, then $\pi_{11} = (1 - k_b)b_1$, $\pi_{1e} = k_bb_1$, $\pi_2 = (b_2 + a)\, p_b$, $p_m = 1$, and $p_b = k_bb_1/(k_bb_1 + k_bb_2 + k_aa)$.

Also, we have that $H_{11}(p) = \pi_2/((1 - k_a)ap) - ((1 - k_b)b_2)/((1 - k_a)a)$, $(1 > p > p_m)$; $H_{12}(p) = \pi_2/((k_bb_2 + k_aa)p) - ((1 - k_b)b_2 + (1 - k_a)a/(k_bb_2 + k_aa))$, $(p_m > p > p_b)$; $H_2(p) = \pi_{11}/((1 - k_a)ap) - ((1 - k_b)b_1)/((1 - k_a)a)$, $(1 > p > p_m)$; and $H_2(p) = \pi_{12}/((k_bb_2 + k_aa)p) - k_bb_1/(k_bb_2 + k_aa)$, $(p_m > p > p_b)$.

For the case where both dealers enroll in the infomediary, firms are in Bertrand competition for the $k_aa + 2k_bb$ consumers who use the infomediary. Therefore, $p_{ie} = 0$. For the remaining market, the competition is similar to the case in Narasimhan (1988) where R1 has $(1 - k_b)b_1$ loyal consumers, R2 has $(1 - k_b)b_2$ loyal consumers, and there are $(1 - k_a)a$ switchers. Therefore, $\pi_i = (1 - k_b)b_i$ and $\pi_j = [(1 - k_b)b_j + (1 - k_a)a](1 - k_b)b_i/(1 - k_b)b_i + (1 - k_a)a$ if $b_i \geqslant b_j$.

Following the same logic as discussed in the proof of Proposition 4, we still have that the infomediary uses an exclusive contract in equilibrium.

Incorporating Shopping Costs

Consider the case where only one firm is enrolled in the infomediary. For $g < k$ (i.e., $\theta < 1$), following a similar method as in the proof of Proposition 1, we can show that the nature of the equilibrium price support is similar to that in the basic model. Therefore, the profit functions of the two firms shown in (10) in the paper become

$$\begin{aligned}
&\pi_{11} = (1-k)[b + aH_2(p_1)]p_1 \qquad (p_m \leqslant p_1 \leqslant 1), \\
&\pi_{1e} = [kb + (gb + ka)H_2(p_{1e})]p_{1e} \qquad (p_b \leqslant p_{1e} \leqslant p_m), \\
&\pi_2 = (1-g)bp_2 + (1-k)aH_{11}(p_2)p_2 + (gb + ka)H_{1e}(p_2)p_2.
\end{aligned}$$

Let $h = ((1 - k)(b + a) - gb)/(b + a)$. Solving the above equations leads to equilibrium results as follows: (1) if $(1 - k)/g > b/(1 - b)$, then $\pi_{11} = (1 - k)b$, $\pi_{1e} = kb + gb^2h/(b + ah)$, $\pi_2 = [(1 - g)b + (1 - k)a]\, (b/(b + ah))$, $p_m = b/(b + ah)$; (2) if $(1 - k)/g \leqslant b/(1 - b)$, then $\pi_{11} = (1 - k)b$, $\pi_{1e} = kb$, $\pi_2 = (kb(b + a))/(kb + ka + gb)$, $p_m = 1$. Moreover, $p_b = \pi_{1e}/(kb + ka + gb)$, $H_{11}(p) = \pi_2/(p(1 - k)a) - ((1 - g)b)/((1 - k)a)$, $H_{1e}(p) = \pi_2/(p(ka + gb)) - ((1 - g)b + (1 - k)a)/(ka + gb)$, $H_2(p) = \pi_{11}/(p(1 - k)a) - b/a$ for $p \in [p_m, 1]$, and $H_2(p) = \pi_{1e}/(p(ka + gb)) - kb/(ka + gb)$ for $p \in (p_b, p_m)$.

Given the above equilibrium, enrolling both retailers is not optimal for the infomediary. Also, in the exclusive contract $\Pi = C_{ix} = \pi_2 - \pi_1$ and $C_{jx} = \pi_1 - b$ still hold.

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