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## Strategic Benefits of Referral Services

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# Strategic Benefits of Referral Services

## **Abstract**

Internet referral services, hosted either by independent third-party infomediaries or by manufacturers serve as "lead-generators" in electronic marketplaces, directing consumer traffic to particular retailers. The conventional wisdom on Internet referral services is that they are valuable to consumers because they can be used to compare prices and get binding price quotes from retailers. Less clear is the role of such referral services for the manufacturers and the retailers. In addition, a manufacturer's entry into the online referral business has implications for pricing, allocation of channel profits and retail competition.

In a model of price dispersion, we investigate the competitive implications of these institutions on retailer prices and their impact on channel structures and distribution of profits. Models that analyze firm conduct in distribution channels (Jeuland and Shugan, 1983; Moorthy, 1987) typically do not consider third-party infomediaries. In a paper closely related to ours, Chen, Iyer and Padmanabhan (2002) examine how an infomediary affects the market competition between retailers. However they do not consider the impact of an upstream manufacturer's referral services on the behavior of downstream players.

We consider a model with a distribution channel consisting of a manufacturer, an infomediary, and two retailers. We focus, in particular, on the response of the manufacturer to the presence of an infomediary. Consumers are heterogenous both in their valuations and in search behavior, so that price dispersion exists in equilibrium. Price dispersion has been extensively studied, both theoretically (Varian, 1980, and Narasimhan, 1988, for example) and empirically. Brynjolfsson and Smith (2000) and Clemons, Hann and Hitt (2002) find that price dispersion continues to exist on the Internet.

In our model, the online sales environment results in lower customer acquisition costs. However, it also offers retailers less information about a consumer's willingness to pay. In the offline channel, consumers physically walk into stores, and retailers are able to determine willingness to pay, via a costly negotiation process. This enables them to discriminate offline between high and low valuation consumers. Online, they lose this ability to discriminate.

In an industry such as the auto industry, purchases are infrequent, with significant time gaps. In such a setting, it is reasonable to think of consumer preferences changing from one purchase to the next, and hence of a lack of availability of information online. If purchases were more frequent (e.g., books or CDs), one can think of more information being available online rather than offline, providing an even stronger reason to divert traffic online. The impact of online consumer information on retailer pricing strategies has been studied by Ghose, et al (2002) and Aron, Sunderarajan and Vishwanathan (2001), among others.

We find that, first, the establishment of manufacturer referral services leads to an increase in channel profits and a reallocation of some of the increased surplus, through the franchise fee, to the manufacturer. The impetus to increased profits comes from both retailers' ability to price discriminate between informed and uninformed consumers, and by the lowering of acquisition costs due to diversion of traffic from the offline to the online channel. Thus the strategic decision by the manufacturer to adopt an online referral service affects both channel profits achievable and the allocation of profits among channel members.

Second, a higher offline customer acquisition cost (incurred by retailers) is beneficial to the infomediary, but detrimental for the manufacturer. Conversely, increasing heterogeneity in consumer valuations hurts the infomediary, but benefits the manufacturer. Higher profits for the non-enrolled translate into higher franchise

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fees for the manufacturer, while the smaller difference in profits between retailers results in lower referral fees for the infomediary.

Third, online prices are lower than offline prices for the retailer enrolled with the infomediary. The referral service is essentially used as a price discrimination mechanism, to distinguish between uninformed and informed consumers. We also show that in equilibrium, with or without the introduction of the manufacturer referral service, the retailer associated with the infomediary, has higher expected sales and gross profits. Further, the sales of each retailer remain the same even after the introduction of the manufacturer referral service.

Fourth, some of the online cost savings are transferred to the consumer, leading to an overall increase in consumer welfare. This happens both through heightened price competition and an increase in the segment of consumers which observe the largest set of prices.

Finally, our model provides some insights into the closing efficiency of such referral services. Since a referral request is not a costless process, a significant parameter which all players need to keep in mind is the average closing ratio of this mechanism. Our results are in accordance with empirical evidence. We also discuss some possible extensions to our model and how they would not change the qualitative nature of our main results.

This paper, therefore, offers a different viewpoint on how manufacturers can increase profits by diverting traffic into online channels. In the auto industry, manufacturers cannot directly sell to consumers. However, they can extract higher profits from the channel by increasing their franchise fee. This provides them with an incentive to reduce the acquisition costs in the channel. The tradeoff is that, since consumer purchases in this industry are infrequent, little information about consumers is available online. Offline, a retailer is able to infer a consumer's willingness to pay. We show that, for a wide range of parameters, the cost savings dominate any losses due to absence of online information. Further, in the presence of competition from a third party infomediary, a manufacturer can use a referral website as a device to regain some control over the channel.

**Keywords**

Manufacturer Referral Services, Price Dispersion, Acquisition Costs, Franchise Fees, Infomediary

# 1 Introduction

Consumers' affinity for neutral information has led to the emergence of a large number of independent sources on the Internet that offer high-quality information about firms' products, their availability and prices, at no cost to consumers. These infomediaries offer consumers the opportunity to get price quotes from enrolled brick-and-mortar retailers as well as invoice prices, reviews and specifications. While a referral service does not, in fact, "sell" any product, it does shift much of the consumer search process from the physical platform of the traditional retailer to the virtual world of the Web. Importantly, Internet referral services serve as "lead-generators" in electronic marketplaces directing consumer traffic to particular retailers. This shift in buying behavior from a conventional to an electronic marketplace is an outcome of big strides undertaken in E-Commerce technology and is significant in its implications for consumers, manufacturers and retailers.

Consider the auto industry in the U.S., in which manufacturers are prohibited by law from selling directly to consumers. Both infomediaries and manufacturers now offer web-based referral services, which are growing in popularity. Industry-wide, 6% of all new vehicles in 2001 were sold through an online buying service, up from 4.7% in 2000.<sup>1</sup> In 2001, Autobytel generated an estimated \$17 billion in car sales.<sup>2</sup>

Given the advent of such third-party referral brokers, the major OEMs like GM and Ford have set up their own referral websites such as GMBuyPower.com and FordDirect.com. From these sites, consumers can configure a new car, receive the list price and be led to a dealer site for inventory and quotes. The payoff to improving such a referral website can be substantial. It is estimated that an \$800,000 effort to fix common website problems can create \$250,000 of additional leads per month at an average manufacturer site.<sup>3</sup> Crucially, manufacturers provide referrals to dealers free of cost, while third-party infomediaries charge referral fees to participating dealers. Car makers like GM and Ford are routing traffic to their websites by extending a marketing and advertising alliance with portals such AOL & Yahoo. Companies such as BMW and Isuzu that instituted heavy offline promotions and campaigns to drive customers to their websites, have seen the largest increases in automotive Internet usage.<sup>4</sup>

The conventional wisdom on Internet referral infomediaries is that they are valuable to

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<sup>1</sup>"More Car Buyers Hitting the Web First," [www.EcommerceTimes.com](http://www.EcommerceTimes.com), 11/27/01.

<sup>2</sup>"Autobytel Survey," [www.CNET.com](http://www.CNET.com), 06/25/02.

<sup>3</sup>"Get ROI From Design", Forrester Report, June 2001.

<sup>4</sup>Reagan, K. (2001), "More Car Buyer Hitting the Web First", [www.EcommerceTimes.com](http://www.EcommerceTimes.com), November 27.

consumers because they can be used to compare prices and get binding price quotes from retailers. Less clear is the role of these infomediaries for the manufacturer and the retailers. In addition, a manufacturer's entry into the online referral business has implications for pricing, allocation of channel profits and retail competition. The effect of such referral competition on the division of channel profits has not been studied previously. Models that analyze firm conduct in distribution channels (Jeuland and Shugan, 1983; Moorthy, 1987) typically do not consider third-party infomediaries. In a paper related to ours, Chen, Iyer and Padmanabhan (2002) examine how an infomediary affects the market competition between retailers. However they do not consider the impact of an upstream manufacturer's referral services on the behavior of downstream players. Iyer and Pazgal (2002) study how an Internet Shopping Agent creates differentiation in ex-ante identical retailers.

We consider a model with a distribution channel consisting of a manufacturer, an infomediary, and two retailers. We focus, in particular, on the response of the manufacturer to the presence of an infomediary. Consumers are heterogenous both in their valuations and in search behavior, so that price dispersion exists in equilibrium. Price dispersion has been extensively studied, both theoretically (Varian, 1980, and Narasimhan, 1988, for example) and empirically. Brynjolfsson and Smith (2000) and Clemons, Hann and Hitt (2002) find that price dispersion continues to exist on the Internet.

In our model, the online sales environment results in lower customer acquisition costs. However, it also offers retailers less information about a consumer's willingness to pay. In the offline channel, consumers physically walk into stores, and retailers are able to determine willingness to pay, albeit via a costly process. This enables them to discriminate offline between high and low valuation consumers. Online, they lose this ability to discriminate.

In an industry such as the auto industry, purchases are infrequent, with significant time gaps. In such a setting, it is reasonable to think of consumer preferences changing from one purchase to the next, and hence of a lack of availability of information online. If purchases were more frequent (e.g., books or CDs), one can think of more information being available online rather than offline, providing an even stronger reason to divert traffic online. The impact of online information on pricing strategies has been studied by Ghose, et al (2002), Chen and Iyer (2002), Aron, Sunderarajan and Vishwanathan (2001).

## **1.1 Research Questions**

In this setting, we examine the following questions.

- How does the entry of a referral infomediary affect the optimal pricing strategies of

retailers in a channel? What strategic implications does it have for a manufacturer?

- If a manufacturer cannot sell directly to consumers, can it still extract higher profits from the channel by diverting traffic online?
- What is the impact of such referral services on the “closing efficiency”, i.e., the sales to leads ratio of retailers?

We find that, first, the establishment of manufacturer referral services leads to an increase in channel profits and a reallocation of some of the increased surplus, through its franchise fee, to the manufacturer. The impetus to increased profits comes from both retailers’ ability to price discriminate between informed and uninformed consumers, and by the lowering of acquisition costs due to diversion of traffic from the offline to the online channel.

Second, a higher offline customer acquisition cost (incurred by retailers) is beneficial to the infomediary, but detrimental for the manufacturer. Conversely, increasing heterogeneity in consumer valuations hurts the infomediary, but benefits the manufacturer.

Third, online prices are lower than offline prices for the retailer enrolled with the infomediary. The referral service is essentially used as a price discrimination mechanism, to distinguish between uninformed and informed consumers. The expected sales and profits of the infomediary enrolled retailer are higher than those of the other retailer.

Fourth, some of the online cost savings are transferred to the consumer, leading to an overall increase in consumer welfare. This happens both through heightened price competition and an increase in the segment of consumers which observe the largest set of prices.

Finally, our model provides some insights into the closing efficiency of such referral services. Since a referral request is not a costless process, a significant parameter which all players need to keep in mind is the average closing ratio of this mechanism. Our results are in accordance with empirical evidence.

This paper, therefore, offers a different viewpoint on how manufacturers can increase profits by diverting traffic into online channels. In the auto industry, manufacturers cannot directly sell to consumers. However, they can extract higher profits from the channel by increasing their franchise fee. This provides them with an incentive to reduce the acquisition costs in the channel. The tradeoff is that, since consumer purchases in this industry are infrequent, little information about consumers is available online. Offline, a retailer is able to infer a consumer’s willingness to pay. We show that, for a wide range of parameters, the cost savings dominate any losses due to the absence of online information. Further, in the presence of competition from a third party infomediary, a manufacturer can use a referral website as a device to regain some control over the channel.

The rest of this paper is organized as follows. Section 2 presents the basic model. In Section 3 we analyze the offline world without any referral service. Section 4 examines the effect of the infomediary on retail competition while Section 5 examines the impact of manufacturer referral services on equilibrium strategies and policies and provides some empirical corroboration of our results. Section 6 provide some business implications. Section 7 concludes with a brief summary of the main results. All proofs are relegated to the Appendix.

## **2 Model**

### **2.1 Retailers and Manufacturer**

We consider a market with a single manufacturer and two competing retailers,  $D_1$  and  $D_2$ . The manufacturer charges the retailers a franchise fee,  $F$ . The wholesale price of the good charged to the retailers,  $W$ , is treated as fixed.

We analyze the retailing world under three scenarios: (i) with no referral services (ii) with a referral infomediary, and (iii) with a referral infomediary as well as a manufacturer referral website. The referrals are online, so in scenarios (ii) and (iii), the retailers make some online sales in addition to offline ones. All sales are offline in scenario (i).

Retailers incur an additional acquisition cost,  $\delta$ , for each offline sale.  $\delta$  represents the difference in acquisition costs between offline and online sales. This includes the cost of time spent in providing information about the product when a consumer walks into a physical store. It also includes the cost of time involved in determining the willingness to pay of consumers, offering test drives, and paperwork. Ratchford (2002) shows that the Internet leads to a considerable reduction in consumer time spent with dealer/manufacturer sources. Since our results depend only on the difference between offline and online acquisition costs, the online is set to a benchmark of zero. The tradeoff faced by a retailer is that, offline, it can perfectly observe a consumer's valuation via face-face interaction. This is tied to the offline acquisition cost; the interaction process, while costly to the retailer, also yields greater information about a consumer's valuation for the good. Hence, the offline price offered to a consumer depends on this valuation, allowing for price discrimination. Online, the valuation is hidden from the retailer, so it loses the ability to price discriminate in this fashion.

## 2.2 Referral infomediary

The referral infomediary enrolls one retailer,  $D_2$ , and allows consumers to obtain an online price quote from this retailer. The infomediary charges the retailer a fixed referral fee of  $K$ .<sup>5</sup> If the infomediary enrolled both retailers, Bertrand competition would prevail in the online segments, with prices equal to marginal cost, as shown by Chen, Iyer and Padmanabhan (2002). Therefore, the infomediary can charge a higher fee when it enrolls just one retailer. In practice, too, dealers are assigned exclusive geographic territories by infomediaris (see Moon 2000).

## 2.3 Consumers

The market consists of a unit mass of consumers. Consumers are heterogenous both in terms of their valuation, and in their search behavior, which determines the market segment they belong to. A consumer's valuation for the good is either high,  $V_H$ , or low,  $V_L$ , where  $V_H > V_L > 0$ . The proportion of high valuation consumers is  $\lambda_H$ , and that of low valuation consumers is  $\lambda_L = 1 - \lambda_H$ . Each consumer buys either zero or one unit of the product.

Consumers belong to different market segments. The notion of market segments allows for the existence of consumers with both different levels of awareness about alternate avenues for price quotes, and different search behaviors. Depending on the segment she belongs to, a consumer observes a different set of prices for the good. A consumer with valuation  $j$  ( $j = H, L$ ) buys the product if her net utility is positive; i.e.,  $v_j - P_{\min} \geq 0$ , where  $P_{\min}$  is the minimum price offered to this consumer. To keep the setup generalized, we do not assume any correlation between consumer valuations and search behavior.

There are three distinct consumer segments: a proportion  $\alpha_1$  of "uninformed" consumers who are unaware of the existence of an infomediary and obtain a price from just one retailer, a proportion  $\alpha_2$  of "partially informed" consumers who obtain a price from one retailer and the referral infomediary (when it exists), and a proportion  $1 - \alpha_1 - \alpha_2$  of "fully informed" consumers, who obtain prices from both retailers as well as the referral infomediary. When the manufacturer has its own referral site, each of these three segments further subdivides into two: a proportion  $\beta$  of consumers in each segment behave exactly as before, whereas a proportion  $1 - \beta$  obtains online prices via the manufacturer's website. It is important to note that in our model the uninformed segment is "uninformed" only about the competitive prices, i.e. they do not search for more than one price because of high search costs. Hence

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<sup>5</sup>Firms like Autobytel.com and Carpoint.com charge an average fixed monthly fee of around \$1,000 depending on dealer size and sales (Moon 2000).

even online, the “uninformed” segment continues to search for one price. In comparison the “partially informed” and “fully informed” segments incur lower search costs and this explains their multiple “price search” behavior.

When a consumer approaches a retailer for a price quote, the retailer is unable to distinguish which market segment a consumer belongs to. However, offline the retailer is able to determine the consumer’s valuation for the product by virtue of the physical interaction as described before.

### 3 Offline World: No Referral Services Exist

We now analyze each of the three scenarios mentioned, in turn, starting with the case of no referral services. Each of the scenarios is described as a multi-stage game. We consider a subgame-perfect equilibrium of the game in each case, and therefore analyze the game via backward induction.

When neither the referral infomediary nor the manufacturer referral service exist, the stages in the game are as follows:

Stage 1: The manufacturer sets the franchise fee,  $F$ .

Stage 2: Retailers simultaneously choose retail prices  $(P_1(V_H), P_1(V_L))$  and  $(P_2(V_H), P_2(V_L))$ .

Stage 3: Consumers decide which product to buy.

Consider the three market segments:

(i) uninformed consumers, of market size  $\alpha_1$ , observe just one offline price from one retailer.

We assume these consumers are equally likely to visit  $D_1$  and  $D_2$ .

(ii) partially informed consumers, of size  $\alpha_2$ , behave in exactly the same way as uninformed consumers when there is no infomediary. Hence, these consumers also visit  $D_1$  and  $D_2$  with equal probability.

(iii) informed consumers, of size  $1 - \alpha_1 - \alpha_2$ , obtain prices from both retailers.

The prices observed by consumers in different market segments are depicted in Figure 1. In the offline world, the retailers perfectly observe each consumer’s valuation. Hence, the prices offered to consumers depend on their valuations, as shown in the figure.

Since consumer valuations are observed offline, this basic model reduces to that of Varian (1980). Using similar arguments, we can show that no pure-strategy equilibrium exists in the subgame that starts at stage 2. There is, however, a symmetric mixed-strategy equilibrium in which both retailers have equal market shares and offer randomly chosen prices to the consumers. Retailers have monopoly power over those consumers who observe only one price, providing an incentive to charge higher prices. However, retailers also aim to attract

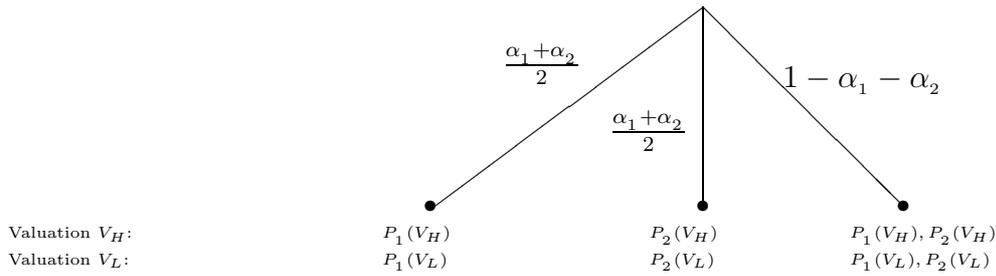


Figure 1: Prices observed by each consumer segment when no referral service exists

those customers who observe multiple prices, which in turn, offers an incentive to reduce prices. The interplay of these two forces results in price dispersion. Let  $G_j^i(P)$  denote the probability that retailer  $j$ , where  $j = 1, 2$ , sets a price higher than  $P$  for consumer type  $V_i$ , where  $i = L, H$ . For example,  $G_1^L(P) = \text{Prob}(P_1(V_L) \geq P)$  where  $P_1(V_L)$  is the price offered by  $D_1$  to consumer type  $V_L$ . Since the equilibrium we consider is symmetric, both dealers adopt the same price distribution,  $G^i(P)$ , for each consumer type.

**Lemma 1** *There exists a symmetric equilibrium in which*

- (i) *each retailer chooses a price for consumer type  $i$ ,  $i = L, H$ , randomly from the interval  $[\hat{P}_i, V_i]$ , where  $\hat{P}_i = W + \frac{\alpha_1 + \alpha_2}{2 - \alpha_1 - \alpha_2} (V_i - W)$ ,*
- (ii)  *$G^i(P) = \frac{\alpha_1 + \alpha_2}{2(1 - \alpha_1 - \alpha_2)} \left( \frac{V_i - P}{P - W} \right)$ , for  $P \in [\hat{P}_i, V_i]$ ,*
- (iii) *the expected profit of each retailer is  $E(\pi) = \frac{\alpha_1 + \alpha_2}{2} (\lambda_H V_H + \lambda_L V_L - W) - \frac{\delta}{2} - F$ ,*
- (iv) *The expected price offered to consumers with valuation  $V_i$ ,  $i = L, H$ , is  $E(P(V_i)) = W + \frac{(\alpha_1 + \alpha_2)(\ln \frac{2 - \alpha_1 - \alpha_2}{\alpha_1 + \alpha_2})}{2(1 - \alpha_1 - \alpha_2)} (V_i - W)$ .*

The proof of this and all other results is in the Appendix. The market share of each retailer amongst consumers with valuation  $i$  is

$$E(S_i) = \int_{\hat{P}_i}^{V_i} \left\{ \frac{\alpha_2 + \alpha_1}{2} + (1 - \alpha_2 - \alpha_1)G_i(P) \right\} \left( -\frac{dG_i}{dP} \right) dP = \frac{1}{2}$$

Now, at stage 1, the manufacturer chooses the maximum franchise fee such that the retailers earn a non-negative profit (else they will choose to not participate). Therefore, the optimal franchise fee charged by the manufacturer is

$$F = \frac{\alpha_1 + \alpha_2}{2} (\lambda_H V_H + \lambda_L V_L - W) - \frac{\delta}{2}$$

. In equilibrium, retailers earn a zero profit. In accordance with prior literature (for example, Rey and Stiglitz 1995, O' Brien and Shaffer 1993), we assume the large manufacturer yields

bargaining power over the small retailers, who earn a reservation profit of zero.<sup>6</sup> In later sections, this implies that the manufacturer and infomediary capture all the gains from increased channel profits. If the retailers also had some bargaining power, we would expect them to share in such gains.

## 4 Model with Referral Infomediary

Next, we consider a model in which a referral infomediary enrolls one retailer (specifically,  $D_2$ ), and enables some consumers to obtain an online price from this retailer. There are now four stages to the game:

Stage 1: The manufacturer sets the franchise fee,  $F$ .

Stage 2 : The referral infomediary enrolls  $D_2$ , and sets a referral fee,  $K$ .

Stage 3: Retailers simultaneously choose prices.  $D_1$  chooses  $(P_1(V_H), P_1(V_L))$ , as before, and  $D_2$  chooses  $(P_2(V_H), P_2(V_L))$  for offline consumers, and  $P_2^r$  for online consumers (who access the retailer via the referral infomediary).

Stage 4: Consumers decide which product to buy.

As before, uninformed consumers obtain just one offline price, and visit the two retailers in equal proportion. Partially informed consumers obtain an offline price from  $D_1$ , and an online price from  $D_2$ . These consumers find it easier to search online, so choose to obtain an online price, via the referral infomediary. Since this price comes from  $D_2$ , they visit  $D_1$  for an offline price. Fully informed consumers obtain an offline price from each retailer, as well as an online price from  $D_2$ . The prices observed by consumers in different market segments are depicted in Figure 2. Note the difference with the model with no infomediary: offline consumers still obtain a price that depends on type, but online consumers must receive a price independent of type.

Retailers are now asymmetric in terms of the number of consumers who observe their prices. This model, therefore, builds on Narasimhan (1988), who considers asymmetric firms. Further,  $D_2$  can now quote more than one price to consumers in fully informed segment, allowing for price discrimination across segments. This feature was pointed out by Chen, Iyer, and Padmanabhan (2002). The model in this section is similar to theirs, with a few important differences. We consider heterogenous consumer valuations, and a difference between online and offline acquisition costs. Conversely, Chen et al. consider the impact of changes in the reach of the infomediary, and also optimal contracts between the infomediary

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<sup>6</sup>If, retailers had a positive reservation profit,  $R$ , the equilibrium franchise fee would be  $F = \frac{\alpha_1 + \alpha_2}{2} (\lambda_H V_H + \lambda_L V_L - W) - \frac{\delta}{2} - R$ .

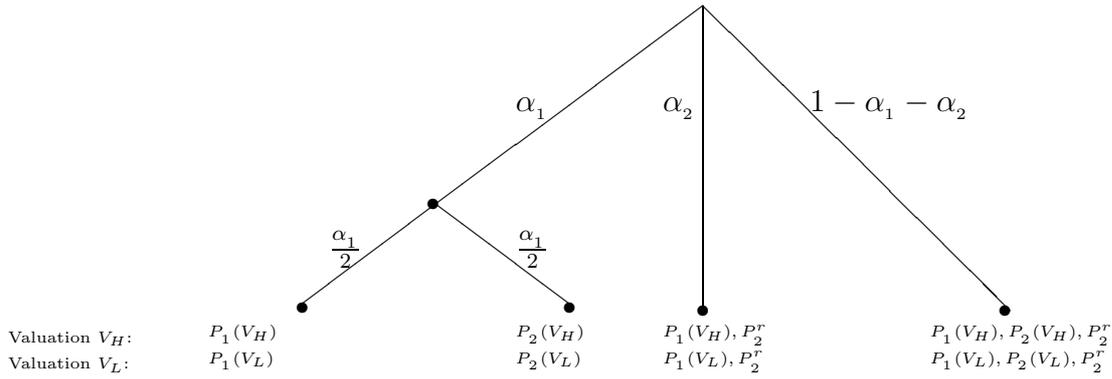


Figure 2: Different prices observed by each consumer segment

and enrolled retailer.

Each retailer now has a captive segment of size  $\frac{\alpha_1}{2}$  while a proportion  $\alpha_2$  of the population see two prices,  $(P_2^r, P_1(V_H))$  or  $(P_2^r, P_1(V_L))$ , depending upon their types  $V_i$ . In equilibrium,  $D_2$  uses the infomediary as a price discriminating mechanism: it extracts full surplus from all offline consumers (i.e., these consumers are just charged their valuations), and a lower (random) price to online consumers. We make the following assumptions about the relative proportion of high valuation consumers.

**Assumption 1** (i)  $\lambda_H \leq \frac{V_L - W}{V_H - W}$  (ii)  $\lambda_H \leq \frac{\alpha_1}{2 - \alpha_1}$ .

Intuitively, part (i) of the assumption ensures that there are fewer high value consumers than low value consumers in the market, such that online the highest price a retailer will charge is  $V_L$ , the reservation price of low type consumers. If the proportion of high value consumers is higher, online prices exceed  $V_L$ , so that low type consumers may be shut out of the online market. It is reasonable to assume that the retailer would want to sell to both consumer types and this assumption captures that aspect. Part (ii) of the assumption, is just a condition needed to have the price distribution  $G_1^L(P) > 0$  as can be seen below. Intuitively, this also ensures that the high value consumers do not constitute too large a proportion of the market. In particular, notice that if  $\alpha_1 = 1$ , then this assumption implies that the maximum value of  $\lambda_H = \frac{1}{2}$ . If this assumption fails to hold, then  $D_1$  charges  $V_L$  to low type consumers, and all partially and fully informed low type consumers buy via the infomediary. Further details of the implications of relaxing these assumptions are discussed in Section 7.

In equilibrium, offline high type consumers are charged  $V_H$ .  $D_2$ , in fact, captures the entire surplus from its captive uninformed segment, so that  $P_2(V_H) = V_H$  and  $P_2(V_L) = V_L$ . The price quoted to the infomediary consumers,  $P_2^r$  is randomly chosen, and is used to

compete against  $D_1$  in the informed segments.

**Proposition 1** *There exists an equilibrium in which  $P_1(V_H) = P_2(V_H) = V_H$  and  $P_2(V_L) = V_L$ . The prices  $P_1(V_L)$  and  $P_2^r$  are randomly chosen from  $[\hat{P}, V_L]$  where  $\hat{P} = W + \frac{(V_L - W)\alpha_1}{(2 - \alpha_1)}$ . Further,  $G_2^r(P) = \frac{\alpha_1(V_L - P)}{2(1 - \alpha_1)(P - W)}$  and  $G_1^L(P) = \frac{\alpha_1(V_L - W)}{\lambda_L(2 - \alpha_1)(P - W)} - \frac{\lambda_H}{\lambda_L}$ , with a mass point at  $V_L$ .*

The entry of the referral infomediary leads to an increase in competition between the two retailers. Essentially,  $D_2$  now has two weapons: it uses  $P_2^r$  to compete with  $D_1$ , and  $P_2(V_H)$  and  $P_2(V_L)$  to capture the entire consumer surplus from its captive uninformed segment. The online infomediary referral price,  $P_2^r$ , is therefore used to discriminate between uninformed and informed consumers. Since  $P_2(V_L) = V_L$  and  $P_2(V_H) = V_H$ , it is immediate that the infomediary referral price is less than the offline price offered to consumers, regardless of their valuation. This is consistent with the results of Chen et al. (2002). Further, Scott-Morton and Zettelmeyer (2001) point out that the average customer of Autobyte pays approximately 2% less for her car which corresponds to about \$450 of savings.

The heightened competition results in the lowering of the minimum price  $\hat{P}$  charged by the retailers to the partially and fully informed segments, by an amount  $\frac{2\alpha_2(V_L - W)}{(2 - \alpha_1 - \alpha_2)(2 - \alpha_1)}$ . As the size of the partially informed segment  $\alpha_2$  increases, this minimum price falls. This is because, with the advent of the infomediary, the two firms compete more strongly for this particular segment.

Given the equilibrium, we can now determine the sales and profit of each retailer. The superscripts  $w$  and  $o$  on expected profits,  $E(\pi_i)$  denote the scenarios with and without manufacturer referral services, for retailer  $i$ .

**Proposition 2** *In equilibrium,*

- (i) *the retailers' expected sales are  $E(S_1) = \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} < \frac{1}{2} < E(S_2) = 1 - \left(\frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2}\right)$ ,*
- (ii) *the expected infomediary referral price and the expected price charged by  $D_1$  to the low type consumer are*

$$E(P_2^r) = W + \frac{\alpha_1 (\ln \frac{2 - \alpha_1}{\alpha_1}) (V_L - W)}{2(1 - \alpha_1)}$$

$$E(P_1(V_L)) = \frac{(2 - \alpha_1)(2\lambda_L + \alpha_1(2 - \lambda_L) - 2) \lambda_L V_L + 4(1 - \alpha_1)^2 W}{\lambda_L^2 (2 - \alpha_1)^2} + \frac{2\alpha_1(1 - \alpha_1)(\ln \frac{2 - \alpha_1}{\alpha_1})(V_L - W)}{\lambda_L^2 (2 - \alpha_1)^2}$$

- (iii) *the expected profits are*

$$E(\pi_1^o) = \frac{\alpha_1}{2} \lambda_H (V_H - W) + \frac{\alpha_1(1 - \alpha_1)}{2 - \alpha_1} (V_L - W) - \left(\frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2}\right)\delta - F$$

$$E(\pi_2^o) = \frac{\alpha_1}{2} (\lambda_H V_H + \lambda_L V_L - W) + \frac{\alpha_1(1 - \alpha_1)(V_L - W)}{2 - \alpha_1} - \frac{\alpha_1}{2}\delta - F - K.$$

In equilibrium  $D_1$  makes all its sales at its physical store. This includes a portion  $\frac{\lambda_H \alpha_1}{2}$  made at  $V_H$  to the high valuation consumers in the uninformed segment, a portion  $\frac{\lambda_L \alpha_1}{2}$  made at  $P_1(V_L)$  to the low valuation consumers in the uninformed segment and a portion  $\frac{(\frac{1}{2-\alpha_1}-\alpha_1)}{\lambda_L}$  made at  $P_1(V_L)$  to the low valuation consumers in the partially and fully informed segments.  $D_2$  makes some online sales,  $(1 - \frac{1}{2-\alpha_1})$ , at the referral price,  $P_2^r$ , in the partially and fully informed segments, and some sales at its physical store in the uninformed segment ( $\frac{\lambda_H \alpha_1}{2}$  and  $\frac{\lambda_L \alpha_1}{2}$ , respectively, to the high and low valuation consumers in this segment). Thus the “reach” of the infomediary is equal  $1 - \alpha_1$ , the sum of the partially and fully informed segments.

Sales made through the online referral mechanism incur no acquisition cost. However for every customer who walks in at the physical stores, retailers incur an acquisition cost of  $\delta$ . The gross profit of  $D_2$  (i.e., without accounting for the franchise and referral fees) is higher than that of  $D_1$  due to three reasons: (i) its total sales increase (ii) its acquisition costs decrease since some consumers shift online, and (iii) its ability to price discriminate improves, and it can charge a monopoly price to the uninformed segment.

Note that the expected referral price,  $P_2^r$ , is independent of the probability of the valuations of consumers who request a quote, whereas the average walk-in prices depend on the ratio of the low and high valuation consumers comprising the market. This is because, an increase in  $\lambda_L$  implies a corresponding increase in the number of low valuation users in its uninformed segment. It is now optimal for  $D_1$  to increase the offline price, so as to extract more surplus from the captive uninformed segment.

In equilibrium, the manufacturer will set its franchise fee equal to the lower of the two gross profits, that is, the expected gross profit of  $D_1$ . The optimal referral fee charged by the infomediary will be the difference in profits between  $D_2$  and  $D_1$ . Compared to the offline situation,  $D_1$  is now making fewer sales, at a smaller expected price for the low types. Although the reduction in sales also implies lower acquisition costs, if it was profitable to sell to the low types in the offline case, the gross profit of  $D_1$  (i.e., without subtracting off the fixed franchise fee) must have decreased. Hence the franchise fee of the manufacturer decreases with the entry of the infomediary.

**Proposition 3** *The optimal referral and franchise fees, respectively are*

$$F^o = \frac{\alpha_1}{2} \lambda_H (V_H - W) + \frac{\alpha_1(1-\alpha_1)}{2-\alpha_1} (V_L - W) - (\frac{1}{2-\alpha_1} - \frac{\alpha_1}{2})\delta$$

$$K^o = \frac{\lambda_L \alpha_1 (V_L - W)}{2} + \frac{(1-\alpha_1)^2}{2-\alpha_1} \delta.$$

Thus the presence of the infomediary leads to an increase in the sales of the enrolled retailer, and a corresponding decrease in the sales (and profit) of the other retailer. This, in turn, leads to a lower franchise fee, and a decrease in the profits of the manufacturer. As a response to this, the manufacturer establishes its own referral services. As we show, below this strategic decision leads to an increase in the profits of the manufacturer.

Notice that with an increase in the acquisition costs,  $\delta$ , there is an increase (decrease) in the referral (franchise) fee. This is because as  $\delta$  increases, the profit of the non-enrolled retailer (which makes all its sales offline), decreases resulting in lower franchise fees for the manufacturer. The profit of the enrolled retailer also decreases but by a lower amount since it now makes fewer offline sales. The difference between the profits of the retailers therefore increases, thereby leading to a higher referral fee for the infomediary. Thus, higher acquisition costs are beneficial to the infomediary but detrimental to the manufacturer.

## 5 Manufacturer Establishes a Referral Service

Finally, we consider the scenario in which the manufacturer sets up its own referral websites, in response to the presence of the infomediary. This game is derived from the previous game (which had only an infomediary; see Figure 2 above) as follows. We assume that, at each of the four terminal nodes in Figure 2, a proportion  $\beta$  of the consumers continue to visit the physical stores, while the remaining proportion,  $1 - \beta$ , go to the corresponding retailer web site (via a manufacturer referral).

The stages in this game are as follows:

Stage 1: The manufacturer sets the franchise fee,  $F$ , and establishes a referral web site.

Stage 2 : The referral infomediary enrolls  $D_2$ , and sets a referral fee,  $K$ .

Stage 3: Retailers simultaneously choose prices.  $D_1$  chooses  $(P_1(V_H), P_1(V_L))$  for offline consumers, and  $P_1^m$  for online consumers who come through the manufacturer web site.  $D_2$  chooses  $(P_2(V_H), P_2(V_L))$  for offline consumers,  $P_2^m$  for online consumers, who come via the manufacturer web site, and  $P_2^r$  for online consumers who come via the referral infomediary.

Stage 4: Consumers decide which product to buy.

In terms of the stages, we allow the manufacturer to move first to capture the notion that it has significant market power, and can establish its franchise fee to capture rents from the dealers. The infomediary has less market power, and is, in a sense, the residual claimant on the profit of  $D_2$ . The timing of the web site setup is not critical; we could alternatively have a stage 2.5 above, at which the manufacturer sets up its web site. In equilibrium, this will be anticipated by all players, and the fees set accordingly. The prices seen by consumers in

different market segments are shown in Figure 3.

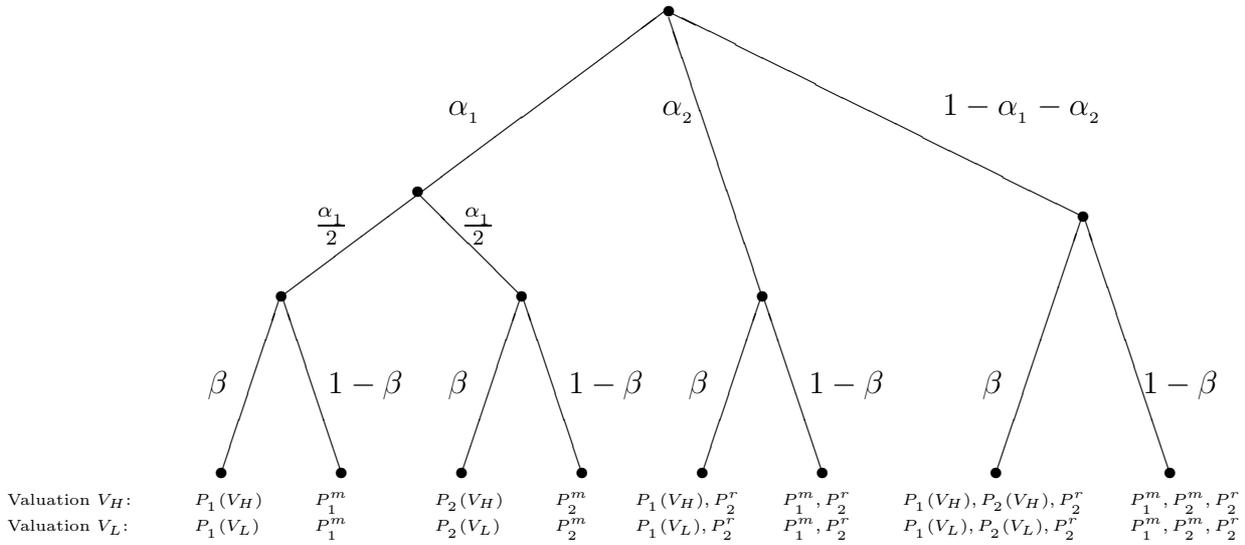


Figure 3: Different prices observed by each consumer segment

Each retailer continues to observe the type of the consumer at the physical store (i.e., in each of the four sub-segments of size  $\beta$ ), and can quote a price to these consumers that depends on their type. However, the retailers do not observe the types of the consumers who come via the manufacturer web site. Hence, in the  $(1 - \beta)$  sub-segments, the same prices must be quoted to both consumer types by a given retailer. We denote the online (manufacturer referral) prices of the two retailers as  $P_1^m$  and  $P_2^m$ .

In equilibrium, the price offered by  $D_2$  to consumers who use the infomediary,  $P_2^r$ , follows the same distribution as before, in Proposition 1, in the world with only an infomediary and no manufacturer referrals. Consider the extreme case with only online consumers (i.e.,  $\beta = 0$ ). The structure of the game is then similar to the one with only an infomediary referral service. However since all consumers here are online, no information about consumer valuations is available. Since the proportion of high valuation consumers is low, both retailers act as if all consumers had low valuations and set a highest price of  $V_L$ , while randomizing prices in the partially and fully informed segments. Hence  $G_2^r(P)$  remains the same as in Proposition 1.

This property then helps determine the rest of the equilibrium strategies. In particular, given the structure of the new game, it implies that the prices  $P_1(V_L), P_1(V_H), P_2(V_L), P_2(V_H)$  are set as in the earlier game. Finally,  $P_1^m$  is chosen randomly over an interval as well. The equilibrium exhibited below holds for all values of  $\beta \in [0, 1]$ . Note that, if  $\beta = 1$ , we are back to the game of Figure 2, and the strategies shown below are equivalent to those in

Proposition 1 (since  $G_1^m(P)$  is not relevant when  $\beta = 1$ ).

**Proposition 4** *There exists an equilibrium in which:*

- (i)  $P_1(V_L), P_1(V_H), P_2(V_L), P_2(V_H)$  and  $P_2^r$  are set exactly as in Proposition 1,
- (ii)  $P_2^m = V_L$ , and  $P_1^m$  is randomly chosen over  $[\hat{P}, V_L]$ , where  $\hat{P} = W + \frac{\alpha_1(V_L - W)}{(2 - \alpha_1)}$ . Further,  $G_1^m(P) = \frac{\alpha_1(V_L - W)}{(2 - \alpha_1)(P - W)}$ .

The market shares of the two retailers remain the same as in the world with an infomediary, but no manufacturer referrals. Further, the expected infomediary referral price of  $D_2$  is lower than its walk-in prices  $P_2(V_H), P_2(V_L)$  or the manufacturer referral price  $P_2^m$ . There are two countervailing effects here. First, there is the price discrimination aspect:  $P_2^r$  is used as a competitive tool against  $D_1$ . Second, there is a loss of information about consumer willingness to pay on the Internet. This prevents the retailer from practising online price discrimination based on consumer valuations. These two effects act in tandem with each other and bring down the infomediary referral prices. However retailers also gain from the fact that there is a potential savings in the acquisition cost per online customer. In equilibrium, the gross profits of  $D_1$  increase, allowing for a higher franchise fee.

**Proposition 5** *In equilibrium,*

- (i) the retailers' expected sales are  $E(S_1) = \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2}$ ,  $E(S_2) = 1 - \left(\frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2}\right)$ .
- (ii) The expected prices are:

$$E(P_1^m) = \frac{4W(1 - \alpha_1)^2 + \alpha_1(2 - \alpha_1)V_L + 2\alpha_1(1 - \alpha_1) \left(\ln \frac{2 - \alpha_1}{\alpha_1}\right) (V_L - W)}{(2 - \alpha_1)^2}$$

$$E(P_2^r) = W + \frac{\alpha_1 \left(\ln \frac{2 - \alpha_1}{\alpha_1}\right) (V_L - W)}{2(1 - \alpha_1)}$$

- (iii) The expected profits are

$$E(\pi_1^m) = \beta E(\pi_1^o) + (1 - \beta) \left( \frac{\alpha_1(1 - \alpha_1)(V_L - W)}{(2 - \alpha_1)} - F \right)$$

$$E(\pi_2^m) = \beta E(\pi_2^o) + (1 - \beta) \left( \frac{\alpha_1(4 - 3\alpha_1)(V_L - W)}{2(2 - \alpha_1)} - F - K \right)$$

We observe that the expected price  $E(P_2^r)$  increases with the size of the captive segment  $\alpha_1$  (the increase is close to linear for higher values of  $\alpha_1$ ). An increase in the size of the captive segment  $\alpha_1$  implies a decrease in the reach of the referral service (there are fewer consumers in the partially and fully informed segments, the segments that use the infomediary). This

increase in the captive uninformed segment of  $D_1$  provides it an incentive to increase its online price,  $P_1^m$ . Now,  $D_2$  can utilize this fact to its advantage by increasing its infomediary referral price,  $P_2^r$ . It is still able to compete successfully with  $D_1$  in the partially and fully informed segments, thus increasing its profit. After the manufacturer adopts its own referral service,  $D_2$  still retains an advantage over  $D_1$ , both in terms of expected sales and gross profits (recall that these are the profits before the franchise fee and infomediary fee are subtracted out). Notice that when  $\alpha_1 = 1$ ,  $E(P_1^m)$  and  $E(P_1(V_L))$  are both equal to  $V_L$ . If all consumers are uninformed, then the retailers can charge monopoly prices to these captive consumers. We state the following corollary without proof (a proof is immediate by comparing the quantities in Propositions 2 and 5).

**Corollary 5.1** *In equilibrium, with or without the introduction of the manufacturer referral service, the retailer associated with the infomediary,  $D_2$ , has higher expected sales and gross profits. Further, the sales of each retailer remain the same after the introduction of the manufacturer referral service.*

Comparing the performance of  $D_2$  when it enrolls with the infomediary to its performance in the offline world, we see that it experiences a significant gain in market share, from  $\frac{1}{2}$  to  $(1 - \frac{1}{2-\alpha_1} + \frac{\alpha_1}{2})$ . Hence, there is a strong incentive for  $D_2$  (or more generally, for any one retailer) to enrol with the infomediary. An affiliation with the referral infomediary provides the retailer with the ability to price discriminate in its uninformed (captive) segment. It charges a monopoly price to all offline consumers, and uses the referral price to compete with the other retailer online. This increases its expected sales. Conversely, the retailer who remains out of the infomediary referral services incurs a significant loss in expected sales and profits. This highlights the “demand reallocation” mechanism of the referral service.

Recall that  $G_1^L(P)$  has a positive mass at  $V_L$ , whereas  $G_1^m(P)$  does not. Further, we can write  $G_1^L(P) = \frac{1}{\lambda_L}(G_1^m(P) - \lambda_H)$ . Thus, for low values of  $P$ ,  $G_1^L(P) < G_1^m(P)$ , resulting in higher sales by  $D_1$ . Conversely, for high values of  $P$  (including  $V_L$ ),  $G_1^L(P) > G_1^m(P)$ , resulting in lower sales by  $D_1$ . These two effects exactly offset each other, so that the expected sales of each retailer remain the same irrespective of manufacturer referral services.

Notice that  $G_1^m(P)$  reduces to  $G_1^L(P)$  when  $\lambda_L = 1$ , and  $\lambda_H = 0$ . Even when  $\lambda_L < 1$ , since neither retailer wants to shut out the low valuation buyers, the anonymity provided by the Internet leads to both retailers charging no more than  $V_L$  to all online consumers. This is equivalent to assuming that all consumers have a low valuation. Therefore,  $G_2^r(P)$  follows the same distribution, we get the result that expected sales remain the same even with the entry of the manufacturer referral service.

In equilibrium, the manufacturer again sets the franchise fee,  $F$ , so that the retailer with lower sales,  $D_1$ , makes a zero profit. The infomediary then sets its fee,  $K$ , to capture the remaining profit of  $D_2$ . Further, we show that if the offline acquisition cost,  $\delta$ , is large enough, the manufacturer makes a higher profit when it offers its own referral web site. Define this critical value,  $\delta_c$ , as follows:

$$\delta_c = \frac{\lambda_H \alpha_1 (2 - \alpha_1)}{2 - \alpha_1 (2 - \alpha_1)} (V_H - W)$$

Consider the term  $\frac{\alpha_1 (2 - \alpha_1)}{2 - \alpha_1 (2 - \alpha_1)}$ . This is just the ratio of the sales of  $D_1$  in its captive uninformed segment ( $\frac{\alpha_1}{2}$ ) to its total sales  $E(S_1)$ . The remainder of  $\delta_c$ ,  $\lambda_H (V_H - W)$  is the maximum margin from a high valuation consumer, weighted by the proportion of high valuation consumers in the market. This second term reflects the opportunity cost of online sales: The retailer loses information on consumer valuation. We show that, in equilibrium, total surplus in the channel increases when  $\delta$  exceeds this critical value,  $\delta_c$ . In particular, the manufacturer's profit increases, since the manufacturer extracts some of the higher channel surplus via the franchise fee. Further, consumer surplus also increases. The effects on the infomediary profit are discussed below.

Note that if  $\lambda_H = 0$ , i.e., if all consumers were homogeneous in their valuations then the critical value is  $\delta_c = 0$ . This implies that for any positive value of acquisition costs, manufacturers would benefit from establishing referral services. This is natural since the only benefit offered by the higher offline acquisition costs is that consumer valuations are determined exactly in the costly interaction process. In a world with homogeneous consumers, this benefit ceases to exist.

A lack of heterogeneity in consumer valuations leads to lower franchise fees for the manufacturer, but a higher referral fee for the infomediary. This is because  $E(\pi_1^m)$  decreases, while  $E(\pi_2^m)$  increases as  $\lambda_H$  tends to zero. The infomediary helps  $D_2$  in price discriminating across market segments and squeezing out the surplus from the low valuation consumers in its captive (uninformed) segment. When the proportion of high valuation consumers increases, both retailers make more profits because the size of the captive segment to whom they could charge  $V_H$  increases. However, this also implies that there are fewer low valuation captive consumers from whom  $D_2$  can extract more surplus, reducing the difference in profits between the retailers. Higher profits for  $D_1$  translate into higher franchise fees for the manufacturer, while the smaller difference in profits results in lower referral fees for the infomediary. Thus increasing consumer heterogeneity is beneficial for the manufacturer but detrimental for the infomediary.

**Proposition 6** (i) *The optimal franchise and referral fees, respectively, are*

$$F^m = \beta \left( \frac{\alpha_1}{2} \lambda_H (V_H - W) - \left( \frac{1}{2-\alpha_1} - \frac{\alpha_1}{2} \right) \delta \right) + \frac{\alpha_1(1-\alpha_1)}{2-\alpha_1} (V_L - W),$$

$$K^m = \frac{\alpha_1(1-\lambda_H\beta)}{2} (V_L - W) + \frac{(1-\alpha_1)^2\beta}{(2-\alpha_1)} \delta.$$

(ii) *If  $\delta \geq \delta_c$ , the manufacturer earns a higher profit by opening up its own referral web site.*

(iii) *Consumer surplus increases with the establishment of the manufacturer referral service.*

Consider the effects of the manufacturer referral service on the infomediary profit. The profit of the infomediary in this last case can be written as  $K^m = \beta K^o + (1-\beta) \frac{\alpha_1}{2} (V_L - W)$ . Notice first that this is always positive, for any value of  $\delta$ . Secondly, when  $\beta = 1$ , this is exactly equal to  $K^o$ . As  $\beta$  decreases to zero (i.e., more consumers shop online),  $K^m$  decreases when  $\delta$  is large enough (in particular,  $\delta \geq \frac{(2-\alpha_1)\alpha_1\lambda_H(V_L-W)}{2(1-\alpha_1)^2}$ ). Conversely, if  $\delta$  is small, the infomediary profit increases as  $\beta$  decreases.

Hence, when  $\delta$  is large enough, there is a reallocation of channel profits from the referral infomediary to the manufacturer, after the manufacturer introduces its own referral service. The impetus toward an increased manufacturer profit comes from a reduction in acquisition costs for the online segment of the market. This increases profit in the channel, and enables the manufacturer to extract this increased profit via an increase in the franchise fee that it charges the retailers. Since eventual profits of each retailer are non-negative, there is no conflict of interest here between channel members. Thus the strategic decision by the manufacturer to adopt an online referral service affects both channel profits achievable and the allocation of profits among channel members.

In our model, we consider acquisition costs only on the final sales made to the customers. One might argue that acquisition costs are incurred not on the final sales, but rather on all prospective customers who walk in to the physical store. Consider the effects of this on our model. Since the number of consumers who obtain offline prices falls after the manufacturer referral site is established, the total acquisition cost will still fall. This reduction in cost, in turn, represents an increase in channel profit that the manufacturer can then extract, preserving the qualitative features of the model.

## 5.1 Closing Ratios of Referral Services

In equilibrium, the number of online quotes provided to consumers exceeds the total number of sales via online referrals. A referral is not costless, since responding to an online request entails an investment in time for a retailer. A standard measure of sales efficiency in this context is the Closing Ratio ( $CR$ ), defined as follows:  $CR = \frac{\text{Number of units sold}}{\text{Number of referrals received}}$ .

This ratio is similar to the “Coverage Efficiency” ratio mentioned by Balasubramaniam (1998) in a paper on competition between retailers and a direct marketer.

A low closing ratio would imply an inability to convert referrals into sales, further suggesting high costs and low profits. This statistic also forms a pivotal basis on which a retailer is evaluated by the referral infomediary, thereby ensuring the viability of the referral institution. In particular, a low closing ratio implies low consumer satisfaction, and may lead to the retailer being dropped by the infomediary. For example, in 1998-99, Autobytel dropped around 250 dealers (10% of its dealer base) because of negative customer feedback and low closing ratios (see Moon, 2000).

Table 1 below shows the closing ratio for the different price quotes offered by retailers. Comparing the online closing ratios for the retailers, we find that  $D_2$  has a higher closing ratio for infomediary referrals than  $D_1$  for manufacturer referrals. This reflects the ability of  $D_2$  to price discriminate online as well, since this retailer obtains referrals via both the manufacturer and the infomediary.

Price Quote	Expected Sales	Number of Referrals	Closing ratio
$D_1$ manufacturer referral	$\frac{1}{2-\alpha_1} - \frac{\alpha_1}{2}$	$1 - \frac{\alpha_1}{2}$	$\frac{(1-\alpha_1)^2+1}{(2-\alpha_1)^2}$
$D_2$ manufacturer referral	$\frac{\alpha_1}{2}$	$1 - \frac{\alpha_1}{2} - \alpha_2$	$\frac{\alpha_1}{2-\alpha_1-2\alpha_2}$
$D_2$ infomediary referral	$\frac{1-\alpha_1}{2-\alpha_1}$	$(1 - \alpha_1)$	$\frac{1}{2-\alpha_1}$

Secondly, for  $D_2$ , the closing ratio from manufacturer referrals can be higher than the ratio from infomediary referrals. In particular, if the size of the partially informed market segment (which has mass  $\alpha_2$ ) is large, the fully informed segment decreases. A proportion  $(1 - \beta)$  of the latter segment obtains a quote from  $D_2$  via a manufacturer referral. The size of the uninformed segment (which represents a closing ratio of 1) remains the same. Hence, a decrease in the fully informed segment leads to an overall increase in efficiency for manufacturer referrals to  $D_2$ . Conversely, if the partially informed segment is small,  $D_2$  has a higher closing ratio for infomediary referrals.

Anecdotal evidence suggests that, on the whole, auto dealers have higher closing ratios than infomediaries.<sup>7</sup> For example, GM, has one of the highest closing ratios in the referral business, greater than 20% while Microsoft CarPoint and AutoWeb have a CR of between 12% and 19 %. However, Carsdirect.com has a higher closing ratio than any other service, including the OEMs. These comparisons are summarized in the next Proposition.

**Proposition 7** *The equilibrium closing ratios satisfy the following properties:*

<sup>7</sup>“Car Dealers Fumbling Web Potential,” www.ECommerceTimes.com, 06/21/01.

(i)  $CR_2^r > CR_1^m$ : the closing ratio for  $D_2$  for sales via the infomediary exceeds the closing ratio of  $D_1$  via the manufacturer referral site.

(ii) If  $\alpha_2 \geq \frac{(1-\alpha_1)(2-\alpha_1)}{2}$ , then  $CR_2^m > CR_2^r$ : if the partially informed segment is large enough, the closing ratio of  $D_2$  via the manufacturer referral site exceeds its closing ratio via the infomediary.

We also compare the conversion ratios for the offline consumers between the two retailers. For a reasonably wide range of  $\alpha_1, \alpha_2$  we find that  $D_2$  has a better conversion ratio than  $D_1$ . Since  $D_2$  is pricing at the monopoly price for the low valuation consumers, one would expect it to have been the other way around. The intuition behind this result is the fact even though  $D_1$  is randomizing  $P_1(V_L)$  between  $\hat{P}$  and  $V_L$ , it is competing head to head with  $P_2^r$  over the whole range of the  $1 - \alpha_1$  segment consisting of the partially and the fully informed consumers, who all get to see the infomediary referral price. Hence even though  $P_1(V_L)$  is on an average lower than  $P_2(V_L)$ , there are more people getting to observe  $P_1(V_L)$  than  $P_2(V_L)$ . The two competing factors result in a higher overall closing ratio of  $D_2$  than that of  $D_1$ .

## 5.2 Empirical Evidence

We show in this subsection that, over a wide range of parameters, our model generates propositions are empirically operationalizable. We discuss the parameter values used in this corroboration, followed by their implications for  $\delta_c, K$ , and closing ratios.

First, consider the sizes of the different market segments. Klein and Ford (2001) point out in their sample of Internet auto buyers that about 58% of consumers do not search at all. Additionally, about 22% of the buyers, exhibit moderate search behavior by searching some of the offline and online sources while about 20% are highly active information seekers who obtain multiple quotes from all possible sources. This sort of consumer search behavior is corroborated by a J.D.Powers study, which finds that about 41% of consumers surveyed used a referral service while buying a car, whereas the remaining 59% did not.<sup>8</sup> Based on these data sources, we vary the value of  $\alpha_1$ , the size of the uninformed segment in our model, from zero to 0.5. Further, Ratchford, Lee and Talukdar (2002) find that 40% of buyers used online sources (i.e., manufacturer and third-party websites). Based on this we vary the  $\beta$  from 0.5 to 1.

On acquisition costs, Scott-Morton, Zettelmeyer and Risso (2001) show that the between the average cost to a dealer of an offline sale (\$1,575) is \$675 higher than the cost to a sale via Autobytel (\$900). They further mention a NADA study, which shows that a dealer's

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<sup>8</sup>“Microsoft CarPoint,” HBS Case study, August 2000.

average new car sales personnel and marketing costs (\$1,275) are reduced by \$1,000 by virtue of sales through Internet referral services. We vary the proportion of high valuation buyers,  $\lambda_H$ , from zero to 0.4. Based on actual average gross margin of dealers (see Moon, 2000), we take  $(V_H - W)$  to be 3000 and  $(V_L - W)$  to be 1500.

Using these ranges for the parameters, we compute  $\delta_c$ , the critical value of the acquisition cost,  $K$ , the infomediary referral fee, and closing ratios. We choose  $\alpha_1 \in [0, 0.5]$ , and, for each  $\alpha_1$ , the maximal permissible value of  $\lambda_H$  under Assumption 1. Figure 4 below demonstrates the critical value,  $\delta_c$ . If the actual acquisition cost,  $\delta$ , lies above the line, the manufacturer's profit increases after it establishes its own referral service. As seen from the figure, the maximal  $\delta_c$  over this parameter range is \$700, close to the lower bound of empirically observed difference between offline and online acquisition costs (\$675–\$1,000).

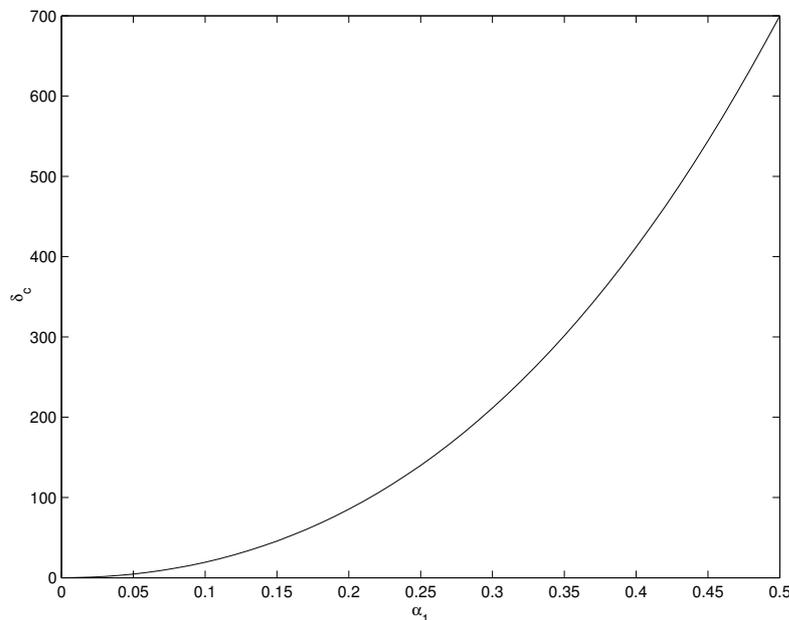


Figure 4: Critical Acquisition Costs,  $\delta_c$

Next, consider price differences between offline and online channels. Scott-Morton, Zettelmeyer and Risso (2001) show that the average Autobytel customer sees a contract price about \$800 less than the non-referral offline prices. For the parameters we consider, the difference between the expected low valuation offline and the expected online infomediary referral price quotes (for  $D_2$ , the retailer associated with the infomediary), ranges between \$900 and \$1500.

Finally, we numerically estimate the closing ratios of the referral services. We find that the CR of  $D_2$  via manufacturer referral services ranges between 10% and 30%, and is similar to the closing ratio for offline sales. According to anecdotal evidence, Forddirect.com has a

CR of 17% and GMBuypower.com has a CR of greater than 20%.<sup>9</sup> Between May through October, 2001 GM tested a system of providing sales leads or referrals to Chevrolet dealers in the Washington, D.C., area. According to GM, about 25% of such referrals were closed, which was roughly the same proportion as that of walk-in leads closed through physical showrooms. The numerical parameterization, therefore, highlights the robustness of the model and the main results.

The CR from the infomediary referral price in our model is 50–66%, higher than industry evidence.<sup>10</sup> One reason for this may be that we do not consider inter-brand competition in our model. If consumers search amongst multiple brands before completing a purchase, there will be multiple referrals for a single sale, thereby resulting in lower closing ratios.

## 6 Business Implications

We present a model with multiple consumer types, multiple information structures and multiple channels. Our analysis suggests that manufacturers who cannot directly sell to consumers for some reason can still gain from adopting an online referral model. In particular, diverting traffic from offline to online channels leads to a reduction in retailers' acquisition costs, and increases the channel profits. This happens despite retailers having to forgo information about consumer types online, though this information can be acquired offline. That is, selling online results in the loss of the ability to distinguish between the high and the low valuation customers. On the other hand, acquisition costs borne by dealers are much lower for online customers. This critical tradeoff, between higher information offline versus lower acquisition costs online, determines the equilibrium results.

We find that Internet referral services have the potential to solve customer, retailer and manufacturer problems. On the demand side, the referral services help consumers to costlessly get an additional retail price quote before purchase. On the firm side, a referral mechanism endows enrolled retailers with a tool to practice price discrimination (between online and walk-in customers) and enable a significant reduction of their acquisition costs.

The strategic decision by the manufacturer to invest in the online referral marketplace, therefore, increases the overall profits in the channel. The extent to which overall profits increase depend on the relative composition of consumer types in the market and their valuations. While, in our model, the manufacturer captures this increase, we expect the actual allocation of profits among channel members to vary, depending on the bargaining

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<sup>9</sup>[www.trilogy.com/Sections/Industries/Automotive/Customers/FordDirect -Success-Story.cfm](http://www.trilogy.com/Sections/Industries/Automotive/Customers/FordDirect -Success-Story.cfm)

<sup>10</sup><http://www.investorville.com/ubb/Forum2/HTML/000040.html>

power of each agent. Since each retailer accrues an increase in gross profits, there need not be a conflict of interest between channel members.

In the presence of intra-brand competition, some of the increased profit from diverting traffic online may be used to provide higher service levels offline. If, for example, there is self-selection into online versus offline channels, the consumers who stay offline may be more service conscious. This creates an incentive to provide high levels of end-to-end service by dealers, and has recently been an important issue with auto manufacturers. Since service satisfaction often translates to repeat sales in the future, online manufacturer referrals can be a significant tool to ensure increased profits by maximizing a “customer’s life time value.”

## **7 Conclusion and Extensions**

In today’s environment of IT-intensive marketing, the Internet is dramatically changing traditional channels of sales and distribution. New players enter and existing structures and roles change, leaving traditional players struggling to decide which strategy to pursue. The auto industry, for example, has witnessed some restructuring of business models, such that manufacturers can gain a stronger toehold in the distribution chain instead of allowing third-party intermediaries to dictate terms. Using a game-theoretic model, we investigate the competitive implications of these newly emerging technology-based institutions on retailer prices and their impact on channel structures and profits. We show that channel profits are a function of acquisition costs, heterogeneity in consumer valuations and search behavior, retailers’ inter-channel price discrimination opportunities and the reach of referral services.

Referral services are becoming increasingly popular and this paper is an attempt at understanding such business models and their implications. It is important to note that, although our analysis is conducted in the context of a simple model, many of our assumptions can be relaxed without altering the nature of our conclusions. For example, the model can be extended to the case in which the informed segment decide to get both prices from the same retailer: its infomediary referral price and the manufacturer referral price or walk-in price. Second, we could allow for a possibility of bargaining or sequential search behavior amongst consumers. This feature of consumer behavior however brings in multiple equilibria into existence. In this case, either a Bertrand equilibrium results, with both retailers pricing at marginal cost, or if retailers adopt a price-matching guarantee, they can sustain a collusive outcome with prices equal to  $V_L$ .

Finally, we do not allow the manufacturer to choose a wholesale price  $W$  to implicitly factor in the fact that in the real world, extensive inter-manufacturer competition will debar

firms from changing the wholesale price by large amounts. In our model, if the wholesale price,  $W$ , is also chosen by the manufacturer, the equilibrium in the offline case would have the manufacturer fixing  $W = V_L$ . In such a scenario, both retailers would randomize the prices for the high valuation customers, charging the low valuation customers exactly  $V_L$ . A logical extension would be to examine inter-brand competition with two manufacturers in the given set up. The equilibrium solutions with two manufacturers become quite complicated. Nonetheless we provide some intuition as to what may happen. In our model the manufacturer enjoys a very high bargaining power due to the absence of inter-brand competition. This makes the retailers thrive with a non-zero reservation profit, thereby facilitating the siphoning of the entire surplus by the manufacturer. However if there is one more manufacturer, the increased competition between manufacturers would then lead to both retailers garnering some of the increased channel profits, due to the enhanced bargaining power arising from the threat of defection by the retailers.<sup>11</sup>

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<sup>11</sup>We are grateful to Kannan Srinivasan, Ajay Kalra, Anthony Dukes, Philipp Afeche, seminar participants at Carnegie Mellon University, participants at CIST-INFORMS 2002 and WISE 2002 and the Editor and an anonymous reviewer at ROMS, for helpful comments. All errors remain our own responsibility.

## 8 Appendix

### Proof of Lemma 1

We present a constructive proof of the equilibrium. Suppose there is a symmetric equilibrium, so that both retailers use the same strategy. We construct this strategy, and then show it satisfies the required properties of an equilibrium.

First, note that each retailer observes the type of each consumer, and hence charges a price contingent on this type. Suppose a retailer ignores the competitive segment of the market (that has mass  $(1 - \gamma)$ ), and charges a monopoly price,  $P_i^m$ , to its captive segment of type  $i$  ( $i = L, H$ ). Then, it is clear that  $P_i^m = V_i$ . Choosing  $P_i^m < V_i$  does not increase demand in the captive segment, so yields lower profit.

Suppose, for each retailer,  $P_i^m$  ( $i = L, H$ ) is randomly chosen over  $[\hat{P}_i, P_i^m]$ . Then, its profit from consumer type  $i$  at any price in this interval must be the same, and must equal the profit at price  $P_i^m$ . Suppose the mixed strategy has no mass points (we will show later that the distribution we derive satisfies this property). Define  $\gamma = \frac{\alpha_1 + \alpha_2}{2}$  (so that  $1 - \alpha_1 - \alpha_2 = 1 - 2\gamma$ ). Then, at the price  $P_i^m$ , a retailer sells only to its captive segment, and its profit from consumer type  $i$  is  $\lambda_i \gamma (V_i - W)$ .

At some price  $P$  in the support of its mixed strategy, a retailer sells to its captive segment, and also captures  $G_i(P)$  of the competitive segment (since the equilibrium is symmetric). Hence, its profit from consumer type  $i$  is  $\lambda_i (\gamma + G_i(P)(1 - 2\gamma)) (P - W)$ . This profit must equal the profit from charging  $P_i^m$ , if the retailer randomizes over  $P$  and  $P_i^m$ . Hence,  $(\gamma + G_i(P)(1 - 2\gamma)) (P - W) = \gamma (V_i - W)$ . This implies  $G_i(P) = \frac{\gamma}{1 - 2\gamma} \left( \frac{V_i - P}{P - W} \right)$ . Noting that  $\frac{\gamma}{1 - 2\gamma} = \frac{\alpha_1 + \alpha_2}{2(1 - \alpha_1 - \alpha_2)}$ , we have the form of  $G_i(P)$  in the statement of the Lemma.

Now, the lower bound on the support of the mixed strategy is found by setting  $G_i(\hat{P}_i) = 1$ . This yields

$$\hat{P}_i = \frac{1 - 2\gamma}{1 - \gamma} W + \frac{\gamma}{1 - \gamma} V_i$$

Substituting for  $\gamma$ , we have

$$\hat{P}_i = \frac{2(1 - \alpha_1 - \alpha_2)}{2 - \alpha_1 - \alpha_2} W + \frac{\alpha_1 + \alpha_2}{2 - \alpha_1 - \alpha_2} V_i$$

Finally, we show that this is an equilibrium. Note that  $G_i(P^m) = 0$ , so the mixed strategy has no mass points. Consider retailer 1. For all prices  $P \in [\hat{P}_i, P_i^m]$ , retailer 1 earns the same profit from consumer type  $i$  (by construction). If it charges  $P > P_i^m$ , it loses all consumers of type  $i$ , leading to a lower profit. If it charges  $P < \hat{P}_i$ , it captures the same market share

as at  $\hat{P}_i$ ,  $(1 - \frac{\alpha_1 + \alpha_2}{2})$ , at a lower price. Hence, it makes a lower profit than at  $\hat{P}_i$ . Therefore, retailer 1 has no profitable deviation. By symmetry, neither does retailer 2. Hence, the strategies postulated constitute an equilibrium.

Let  $g_i = -\frac{dG_i}{dP}$ . Note that the market share of each retailer is  $\frac{1}{2}$  (by symmetry). Hence, for each retailer, the consumer acquisition cost is  $-\frac{\delta}{2}$ , and the franchise fee is  $F$ . Then, the expected profits of each retailer are

$$\begin{aligned} \pi &= \lambda_L \int_{\hat{P}_L}^{V_L} \left\{ \frac{\alpha_1 + \alpha_2}{2} + (1 - \alpha_1 - \alpha_2)G_L(P) \right\} (P - W) g_L(P) dP + \\ &\lambda_H \int_{\hat{P}_H}^{V_H} \left\{ \frac{\alpha_1 + \alpha_2}{2} + (1 - \alpha_1 - \alpha_2)G_H(P) \right\} (P - W) g_H(P) dP - \frac{\delta}{2} - F \\ &= \frac{\alpha_1 + \alpha_2}{2} (\lambda_H V_H + \lambda_L V_L - W) - \frac{\delta}{2} - F \end{aligned}$$

The expected price faced by consumer type  $i$ ,  $E(P(V_i))$ , is given by

$$\int_{\hat{P}_i}^{V_i} P dg_i = W + \frac{(\alpha_1 + \alpha_2)(\ln \frac{2 - \alpha_1 - \alpha_2}{\alpha_1 + \alpha_2})}{2(1 - \alpha_1 - \alpha_2)} (V_i - W)$$

■

**Proof of Proposition 1**

(i) As in Lemma 1, we first derive the mixed strategies for the players and then demonstrate that these constitute an equilibrium. Consider  $P_1(V_L)$ , the price charged by  $D_1$  to the low consumer type. In equilibrium,  $D_1$  should make the same profit by charging any price  $P$  in the support of the mixed strategy as from charging a monopoly price  $V_L$ . Hence,  $\frac{\alpha_1}{2}(P - W) + (1 - \alpha_1 - \alpha_2 + \alpha_2)(P - W)G_2^r(P) - F = \frac{\alpha_1}{2}(V_L - W) - F$ , which implies

$$G_2^r(P) = \frac{\alpha_1(V_L - P)}{2(1 - \alpha_1)(P - W)}$$

Setting  $G_2^r(P) = 1$  yields the lower bound, of the support of the equilibrium strategy,  $\hat{P} = \frac{(V_L - W)\alpha_1}{2 - \alpha_1} + W$ . Note that this lower bound,  $\hat{P}$ , must be the same for each firm. Suppose  $\hat{P}_1 < \hat{P}_2$ . Then, by charging  $\hat{P}_1 + \epsilon$  (for some  $\epsilon \in (0, \hat{P}_2 - \hat{P}_1)$ ),  $D_1$  earns a higher profit than from any price  $P \in (\hat{P}_1, \hat{P}_1 + \epsilon)$ . Hence, it cannot be an equilibrium to have  $\hat{P}_1 < \hat{P}_2$ . By the same logic, it cannot be that  $\hat{P}_2 < \hat{P}_1$ , so it must be that  $\hat{P}_1 = \hat{P}_2 = \hat{P}$ .

Now, for  $D_2$ , the profit from any price  $P$  in the support of its mixed strategy  $P_2^r$  should be equal to that from charging the lower bound  $\hat{P}$ . First, note that, given assumption 1 (i), the highest that  $P_2^r$  will be set to is  $V_L$ .<sup>12</sup> Further, in equilibrium  $P_1(V_H) = V_H$ . Hence, all

<sup>12</sup>Since  $(\lambda_H + \lambda_L)V_L \geq \lambda_H V_H$ , charging any price in the region  $(V_L, V_H]$  leads to lower profit, since no lower valuation consumers will buy at such a price.

consumers of type  $V_H$  who observe  $P_2^r$  will buy at the latter price. Therefore,

$$\lambda_H(1 - \alpha_1)(P_2^r - W) + \lambda_L(1 - \alpha_1)(P_2^r - W)G_1^L(P) = (\lambda_H + \lambda_L)(1 - \alpha_1)(\hat{P} - W)$$

which implies

$$G_1^L(P) = \frac{(\hat{P} - W)}{\lambda_L(P - W)} - \frac{\lambda_H}{\lambda_L}$$

(ii) Next, we prove that the conjectured strategies constitute an equilibrium. By construction,  $G_1^L(P)$  and  $G_2^r(P)$  are best responses. Hence, neither retailer can gain by charging any other price  $P_1(V_L)$  and  $P_2^r$ . Now, suppose firm 1 sets  $P_1(V_H) < V_H$ . Since, at any price in the region  $[V_L, V_H]$ , it obtains the same sales amongst high value consumers as at  $V_H$ , this prices lead to lower profits, and will not be chosen. Suppose it chooses a price  $P_1(V_H) = P < V_L$ . Then, compared to charging  $P_1(V_H) = V_H$ , in its own captive segment it loses an amount  $\lambda_H \frac{\alpha_1}{2} (V_H - P)$ . In the other two segments, it wins over some sales from  $D_2$ . Specifically, in these segments, it gains  $\lambda_H(1 - \alpha_1)G_2^r(P)(P - W)$ . To sustain the equilibrium, we require the net gain to be non-positive. Substituting  $G_2^r(P) = \frac{\alpha_1(V_L - P)}{2(1 - \alpha_1)(P - W)}$ , this implies  $V_L \leq V_H$ , which is true by assumption. Hence, no deviation from  $P_1(V_H) = V_H$  is profitable.

Next we show that  $P_2(V_H) = V_H$ . At any price  $P \in [V_L, V_H]$ ,  $D_2$  sells only to its own captive segment,  $\frac{\alpha_1}{2}$ , of the high type consumer. Since sales are unchanged at all these prices,  $V_H$  is optimal in this set.

Now, consider  $D_2$  charging a price  $\tilde{P} < V_L$  to the high type consumers. Compared to setting  $P_2(V_H) = V_L$ , in its captive segment it loses  $\lambda_H \frac{\alpha_1}{2} (V_H - \tilde{P})$ . In the non-captive segments (of total mass  $(1 - \alpha_1)$ ), it is already capturing the entire market for the high types, since  $\max P_2^r = V_L < P_1(V_H) = V_H$ . Hence, it merely cannibalizes its own sales in this segment, for an additional loss of  $\lambda_H(1 - \alpha_1) G_2^r(P) (V_L - P)$ . Therefore, this is not a profitable deviation.

Finally we show that it is not optimal for  $D_2$  to set  $P_2(V_L) < V_L$ . Suppose it does charge  $P_2(V_L) < V_L$ . There are three effects on profit, compared to charging  $P_2(V_L) = V_L$ :

- (a) in its captive segment, it loses  $\lambda_L \frac{\alpha_1}{2} (V_L - P_2(V_L))$ ,
- (b) in the segment of mass  $(1 - \alpha_1 - \alpha_2)$ , if  $P < P_2^r < V_L$ , it cannibalizes its own sales, and loses an amount  $\lambda_L (1 - \alpha_1 - \alpha_2) G_1^L(P) G_2^e(P) \text{Prob}(P_2^r < P_1(V_L) | P_2^r > P) \{E(P_2^r | P < P_2^r < P_1(V_L)) - P_2(V_L)\}$ , where  $E(P_2^r | P < P_2^r < P_1(V_L))$  is the expected price at which the cannibalized sales were being made (the conditioning event is that  $P < P_2^r < P_1(V_L)$ ).
- (c) finally, in the segment of mass  $(1 - \alpha_1 - \alpha_2)$ , if  $P < V_L < P_2^r$ , it wins some sales over from  $D_1$ , leading to a gain  $\lambda_L (1 - \alpha_1 - \alpha_2) G_1^L(P) G_2^e(P) \text{Prob}(P_1(V_L) < P_2^r | P < P_1(V_L)) (P - W)$ .

Replacing the relevant expressions for  $G_1^L(P)$  and  $G_2^r(P)$ , and evaluating the conditional probabilities and expectations, we find that, in overall terms, the firm loses some profit.<sup>13</sup> Hence, it will not deviate to  $P_2(V_H) < V_L$ . Since neither retailers has a profitable deviation, the specified strategies constitute an equilibrium. ■

**Proof of Proposition 2**

(i) As before, let  $g_i = -\frac{dG_i}{dP}$ . Retailer  $D_1$  sells to all of its captive segment, of size  $\frac{\alpha_1}{2}$ . In other two segments, of size  $(1 - \alpha_1)$ , it sells only to the low consumer type, and only if  $P_2^r > P_1(V_L)$ , which happens with probability  $G_2^r(P)$  for any price  $P$  in the support of  $G_1^L(P)$ . Therefore, the expected sales of  $D_1$  are given by

$$E(S_1) = \frac{\alpha_1}{2} + \lambda_L \int_{\hat{P}}^{P^m} (1 - \alpha_1) G_2^r(P) g_1^L(P) dP = \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2}. \tag{1}$$

Similarly, we can derive the expected sales of retailer  $D_2$  as

$$E(S_2) = \frac{\alpha_1}{2} + \lambda_L \int_{\hat{P}}^{P^m} (1 - \alpha_1) G_1^L(P) g_2^e(P) dP + \lambda_H (1 - \alpha_1) = 1 - \left( \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \right) \tag{2}$$

As expected, the retailers' total sales sum to 1.

Finally, we show that  $E(S_1) < \frac{1}{2} < E(S_2)$ . This will be true as long as  $E(S_1) < E(S_2)$ , since  $E(S_1) + E(S_2) = 1$ . Now,  $E(S_1) < E(S_2)$  if and only if

$$1 - \frac{1}{2 - \alpha_1} + \frac{\alpha_1}{2} > \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \iff 1 > \frac{2}{2 - \alpha_1} - \alpha_1,$$

or,  $\alpha_1^2 - \alpha_1 < 0$ , which is true since  $0 < \alpha_1 < 1$ .

(ii) The expected infomediary referral price is

$$E(P_2^r) = \int_{\hat{P}}^{P^m} P g_2^e(P) dP = W + \frac{\alpha_1 (\ln \frac{2 - \alpha_1}{\alpha_1}) (V_L - W)}{2(1 - \alpha_1)}$$

and the expected price charged by  $D_1$  to the low consumer type is

$$E(P_1(V_L)) = (1 - G_1^L(P^m)) \int_{\hat{P}}^{P^m} P g_1^L(P) dP + G_1^L(P^m) P^m$$

Here, we account for the mass point (of mass  $G_1^L(P^m)$ ) at  $P^m = V_L$ . Carrying out the integration for these last two equations yields the statements in the proposition.

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<sup>13</sup>For brevity, algebraic details that do not provide insight into the model are omitted here and in a few other places of the appendix, and are available from the authors on request.

(iii) Similarly, the expected profit of retailer  $D_1$ ,  $E(\pi_1^o)$ , is

$$\begin{aligned} \lambda_L \int_{\hat{P}}^{P^m} \left( \frac{\alpha_1}{2} + (1 - \alpha_1)G_2^r(P) \right) (P - W) g_1^L(P) dP + \lambda_H \frac{\alpha_1}{2} (V_H - W) - \left( \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \right) \delta - F \\ = \frac{\alpha_1}{2} \lambda_H (V_H - W) + \frac{\alpha_1(1 - \alpha_1)}{2 - \alpha_1} (V_L - W) - \left( \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \right) \delta - F, \end{aligned}$$

and the expected profit of retailer  $D_2$  is

$$\begin{aligned} E(\pi_2^o) &= \frac{\alpha_1}{2} (\lambda_H V_H + \lambda_L V_L - W) + \lambda_L \int_{\hat{P}}^{P^m} (1 - \alpha_1) G_1^L(P) (P - W) g_2^e(P) dP + \\ &\quad \lambda_H (1 - \alpha_1) \int_{\hat{P}}^{P^m} (P - W) g_2^e(P) dP - \frac{\alpha_1}{2} \delta - F - K \\ &= \frac{\alpha_1}{2} (\lambda_H V_H + \lambda_L V_L - W) + \frac{\alpha_1(1 - \alpha_1)(V_L - W)}{2 - \alpha_1} - \frac{\alpha_1}{2} \delta - F - K. \quad \blacksquare \end{aligned}$$

### Proof of Proposition 3

The manufacturer optimally maximizes its franchise fee, subject to the condition that both dealers must earn a non-negative expected profit (else they will exit the market). Let  $\tilde{\pi}_i$  be the gross profits of retailer  $i$  (that is, without subtracting off the franchise or infomediary fees). Then, in equilibrium,

$$F^* = \min\{E(\tilde{\pi}_1), E(\tilde{\pi}_2)\} = \frac{\alpha_1}{2} \lambda_H (V_H - W) + \frac{\alpha_1}{2 - \alpha_1} (V_L - W)(1 - \alpha_1) - \left( \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \right) \delta.$$

Now, the infomediary sets the maximum referral fee at which  $D_2$  earns a non-negative profit. This is defined by the  $K^*$  at which  $E(\tilde{\pi}_2) - F^* - K^* = 0$ , or

$$K^* = E(\tilde{\pi}_2) - F^* = \frac{\lambda_L \alpha_1 (V_L - W)}{2} + \frac{(1 - \alpha_1)^2}{2 - \alpha_1} \delta.$$

Note that  $K^* > 0$  (since both terms are positive), which confirms that  $E(\tilde{\pi}_1) < E(\tilde{\pi}_2)$ .  $\blacksquare$

### Proof of Proposition 4

We proceed with a series of steps.

*Step 1* First, suppose  $\beta = 0$ , so that there are no consumers at the physical stores. We derive the equilibrium strategies for this case, and show that  $G_2^r(P)$  is the same as in the world with only an infomediary.

From the profit invariance condition of a mixed strategy equilibrium,  $D_1$  should make the same profit from any price  $P$  in the support of its mixed strategy as it would at a monopoly price. Since  $D_1$  cannot differentiate across consumer types when  $\beta = 1$ , it must be the case

that its monopoly price is  $P^m = V_L$  (as shown in Proposition 1, this yields a higher profit than  $V_H$ ). Hence,

$$(\lambda_L + \lambda_H) \frac{\alpha_1}{2}(P - W) + (1 - \alpha_1)(P - W)G_2^r(P) - F = (\lambda_L + \lambda_H) \frac{\alpha_1}{2}(P^m - W) - F$$

and

$$G_2^r(P) = \frac{\alpha_1(V_L - P)}{2(1 - \alpha_1)(P - W)}$$

Therefore, the distribution of  $P_2^r$ ,  $G_2^r(P)$ , is identical to that in Proposition 1. This further yields that  $\hat{P} = \frac{\alpha_1(V_L - W)}{2 - \alpha_1} + W$ , as before. Similarly for  $D_2$ , profit from pricing at any  $P \in [\hat{P}, V_L]$  should be the same as the profit from pricing at  $\hat{P}$ . Hence,

$$\begin{aligned} & (\lambda_L + \lambda_H) \left( \frac{\alpha_1}{2}(P_2^m - W) + (1 - \alpha_1) G_1^m(P) (P - W) \right) - K = \\ & (\lambda_L + \lambda_H) \left( \frac{\alpha_1}{2}(P_2^m - W) + (1 - \alpha_1) G_1^w(\hat{P}) (\hat{P} - W) \right) - K \end{aligned}$$

which implies

$$G_1^m(P) = \frac{(\hat{P} - W)}{(P_2^r - W)} = \frac{\alpha_1(V_L - W)}{(2 - \alpha_1)(P - W)}$$

Next, for the  $\beta = 0$  case, we show that the strategies exhibited in the Proposition do constitute an equilibrium. Note that  $P^m = V_L$  is the monopoly price that for  $D_1$  in its captive segment. If  $P_2^r$  is set to any price above this,  $D_2$  will make no sales at  $P_2^r$ , so it must price at or below  $V_L$ . Further, by construction,  $G_1^m(P)$  and  $G_2^r(P)$  are best responses by the dealers, so a deviation to prices below  $\hat{P}$  is not profitable either.

Finally, consider  $G_2^m(P)$ . First, observe that any price above  $V_L$  is sub-optimal, compared to  $V_L$ , since it loses all the low type consumers in this segment.<sup>14</sup> Suppose  $D_2$  sets  $P_2^m = P < V_L$ . There are three effects on profit, as compared to charging  $P_2^m = V_L$ .

- (a) in its captive segment, of size  $\frac{\alpha_1}{2}$ , it loses  $(\lambda_L + \lambda_H) \frac{\alpha_1}{2}(V_L - P) = \frac{\alpha_1}{2}(V_L - P)$ ,
- (b) in the segment of mass  $(1 - \alpha_1 - \alpha_2)$ , if  $P < P_2^r < P_1^m$ , it cannibalizes its own sales, and loses an amount  $(\lambda_L + \lambda_H) (1 - \alpha_1 - \alpha_2) G_1^m(P) G_2^e(P) \text{Prob}(P_2^r < P_1^m | P_2^r > P) \{E(P_2^r | P < P_2^r < P_1^m) - P\}$ , where  $E(P_2^r | P < P_2^r < P_1^m)$  is the expected price at which the cannibalized sales were being made (the conditioning event is that  $P < P_2^r < P_1^m$ ),
- (c) finally, in the segment of mass  $(1 - \alpha_1 - \alpha_2)$ , if  $P < P_1^m < P_2^r$ , it wins some sales over from  $D_1$ , leading to a gain  $(\lambda_L + \lambda_H) (1 - \alpha_1 - \alpha_2) G_1^m(P) G_2^e(P) \text{Prob}(P_1^m < P_2^r | P < P_1^m) (P - W)$ .

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<sup>14</sup>The same argument as in footnote 12 works here.

Replacing the relevant expressions for  $G_1^m(P)$  and  $G_2^r(P)$ , and evaluating the conditional probabilities and expectations, we find that, in overall terms, the firm loses some profit. Hence, it will not deviate to  $P_2^m < V_L$ .

*Step 2* Suppose  $\beta = 1$ . Then, the strategies exhibited constitute an equilibrium.

This step follows immediately from Proposition 1; for  $\beta = 1$ , the game reduces to the game in Figure 2.

*Step 3:* For all values of  $\beta \in (0, 1)$ , the strategies exhibited constitute an equilibrium.

Notice that  $G_2^r(P)$ , the distribution of  $P_2^r$ , is exactly identical in the two cases  $\beta = 0$  and  $\beta = 1$ . Further, there is no consumer who observes both an offline price and a manufacturer referral price. That is,  $P_1(V_H), P_1(V_L), P_2(V_H), P_2(V_L)$  are set as best responses only to each other and  $P_2^r$ , and are not affected by  $P_1^m, P_2^m$ . Similarly,  $P_1^m, P_2^m$  are set as best responses only to each other and  $P_2^r$ . Hence, it is immediate that, given that  $G_2^r(P)$  is the same in both cases, when  $\beta > 0$ ,  $P_1(V_H), G_1^L(P), P_2(V_H), P_2(V_L)$ , and  $G_1^m(P), P_2^m$ , are mutual best responses. Finally, since  $G_2^r(P)$  is a best response for both the  $\beta = 0$  and  $\beta = 1$  cases, it must continue to be so when  $\beta \in (0, 1)$ . ■

### Proof of Proposition 5

(i) First, note that the strategies of both firms in the  $\beta$  segments of the market have not changed. Hence, the expected sales of  $D_1$  in these segments amount to (from Proposition 2)  $\beta \left( \frac{1}{2-\alpha_1} - \frac{\alpha_1}{2} \right)$ . Consider the sales of  $D_1$  in the  $(1 - \beta)$  segments. Its expected sales here amount to

$$(1 - \beta) \left( \frac{\alpha_1}{2} + \int_{\hat{P}}^{V_L} (1 - \alpha_1) G_2^r(P) g_1^m(P) dP \right) = (1 - \beta) \left( \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \right)$$

Hence, the total expected sales of  $D_1$  (across both sets of segments) are  $E(S_1) = \frac{1}{2-\alpha_1} - \frac{\alpha_1}{2}$ . Since the total size of the market is constant, the expected sales of  $D_2$  are  $E(S_2) = 1 - E(S_1) = 1 - \left( \frac{1}{2-\alpha_1} - \frac{\alpha_1}{2} \right)$ .

(ii) The expected manufacturer referral price of  $D_1$  (accounting for the mass point at  $P^m$ ) is

$$E(P_1^m) = (1 - G_1^m(V_L)) \int_{\hat{P}}^{V_L} P g_1^m(P) dP + G_1^m(V_L) V_L$$

, which yields the expression in the statement of the Proposition. The expected intermediary price of  $D_2$ ,  $E(P_2^r)$  does not change, compared to Proposition 2, since the distribution of  $P_2^r$  is the same in equilibrium.

(iii) The profit of  $D_1$  is

$$E(\pi_1^m) = \beta E(\pi_1^o) + (1 - \beta) \int_{\hat{P}}^{P^m} \left( \frac{\alpha_1}{2} + (1 - \alpha_1) G_2^r(P) \right) (P - W) g_1^m(P) dP - F^w$$

$$= \beta E(\pi_1^o) + (1 - \beta) \left( \frac{\alpha_1(1 - \alpha_1)(V_L - W)}{(2 - \alpha_1)} \right) - F^m.$$

The profit of  $D_2$ ,  $E(\pi_2^m)$ , is

$$\begin{aligned} & \beta E(\pi_1^o) + (1 - \beta) \left\{ \frac{\alpha_1}{2}(V_L - W) + \int_{\hat{P}}^{P^m} (1 - \alpha_1)G_1^m(P)(P - W); g_2^e(P)dP \right\} - F^m - K^m \\ &= \beta E(\pi_1^o) + (1 - \beta) \left( \frac{\alpha_1(4 - 3\alpha_1)(V_L - W)}{2(2 - \alpha_1)} \right) - F^m - K^m. \quad \blacksquare \end{aligned}$$

**Proof of Proposition 6**

(i) The optimal values of  $F^m$  and  $K^m$  follow immediately from the expressions for  $E(\pi_1^m)$  and  $E(\pi_2^m)$  in Proposition 5, following the same logic as in Proposition 3.

(ii) Note that the total sales of the product are the same in both cases, with and without manufacturer referrals. Hence, the difference in the manufacturer’s profit is just  $F^m - F^o$ . Further, in each case, the optimal franchise fee is exactly equal to the gross profits of retailer 1 (that is, the profits without subtracting out the franchise fee). To show that  $F^m > F^o$ , we show that the difference in the gross profits of  $D_1$  is positive.

From Proposition 2 and Proposition 5, the difference in the gross profits of  $D_1$  is

$$(1 - \beta) \left( \frac{\alpha_1(1 - \alpha_1)(V_L - W)}{(2 - \alpha_1)} - E(\pi_1^o) \right) = (1 - \beta) \left\{ \left( \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \right) \delta - \lambda_H(V_H - W) \right\}$$

Since  $(1 - \beta) > 0$ , this difference is weakly positive if and only if  $\left( \frac{1}{2 - \alpha_1} - \frac{\alpha_1}{2} \right) \delta - \lambda_H(V_H - W) \geq 0$ , or  $\delta \geq \frac{(2 - \alpha_1)\alpha_1}{2 - (2 - \alpha_1)\alpha_1} \lambda_H(V_H - W) = \delta_c$ .

(iii) Recall that acquisition costs are incurred only for consumers who are walking-in offline. Hence the net increase in channel profits accruing due to savings in acquisition costs is  $(1 - \beta)\delta$ . The net change in manufacturer franchise fees and infomediary referral fees are:

$$F^m - F^o = (1 - \beta) \left( \frac{(2 - (2 - \alpha_1)\alpha_1)\delta}{2(2 - \alpha_1)} - \frac{\alpha_1\lambda_H(V_H - W)}{2} \right) \tag{3}$$

$$K^m - K^o = (1 - \beta) \left( \frac{\alpha_1\lambda_H(V_L - W)}{2} - \frac{2(1 - \alpha_1)^2\delta}{2(2 - \alpha_1)} \right) \tag{4}$$

The amount  $(1 - \beta)\delta - (F^m - F^o) - (K^m - K^o)$  represents the change in consumer surplus. This is equal to  $\frac{(1 - \beta)}{2} ((2 - \alpha_1)\delta + \alpha_1\lambda_H(V_H - V_L)) > 0$ . ■

**Proof of Proposition 7**

(i) From Table 5.1,  $CR(P_1^m) \leq CR(P_2^r)$  if and only if

$$\frac{(1 - \alpha_1)^2 + 1}{(2 - \alpha_1)^2} \leq \frac{1}{2 - \alpha_1} \iff (1 - \alpha_1)^2 + 1 \leq 2 - \alpha_1,$$

or,  $\alpha_1 - \alpha_1^2 \geq 0$ , which is true since  $0 \leq \alpha_1 \leq 1$ .

(ii) From Table 5.1,  $CR(P_2^m) \geq CR(P_2^r)$  if and only if

$$\alpha_1(2 - \alpha_1) > 2 - \alpha_1 - 2\alpha_2 \implies \alpha_2 \geq \frac{(1 - \alpha_1)(2 - \alpha_1)}{2} \quad \blacksquare$$

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