Strategic Impact of Internet Referral Services on Channel Profits*

Anindya Ghose† New York University

Tridas Mukhopadhyay‡ Carnegie Mellon University

Uday Rajan§ University of Michigan

July 2004.

*We thank Ram Rao, Kannan Srinivasan, Ajay Kalra, Anthony Dukes, Philipp Afeche, seminar participants at Carnegie Mellon University, New York University, University of Maryland, University of Connecticut, University of California at Irvine, Tulane University, University of Southern California, University of Arizona and participants at *Conference on Information Systems & Technology (CIST) 2002, Workshop on Information Systems & Economics (WISE) 2002, and International Conference on E-Commerce (ICEC) 2003*, for extremely useful feedback.

†Stern School of Business, 44 W. 4th Street, New York, NY 10012-1126, Tel: (212)998-0800, E-mail:aghose@stern.nyu.edu.

‡Tepper School of Business, Tech & Frew Streets, Pittsburgh, PA 15213, Tel: (412) 268-2307, E-mail: tridas@andrew.cmu.edu.

§University of Michigan Business School, 701 Tappan Street, Ann Arbor, MI 48109, Tel: (734) 764-2310, E-mail: urajan@bus.umich.edu.

Strategic Impact of Internet Referral Services on Channel Profits

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. In a model of price dispersion with mixed strategy equilibria, we investigate the competitive implications of these institutions on retailer and manufacturer pricing strategies as well as their impact on channel structures and distribution of profits. Offline, retailers face a higher customer acquisition cost. In return, they can engage in price discrimination. Online, they save on the acquisition costs, but lose the ability to price discriminate. This critical tradeoff drives firms' equilibrium strategies. The establishment of a referral service is a strategic decision by the manufacturer, in response to a third-party infomediary. It leads to an increase in channel profits and a reallocation of the increased surplus to the manufacturer, via the franchise fees. Further, it enables the manufacturer to respond to an infomediary, by giving itself a wider leeway to set the unit wholesale fee to the profit maximizing level. We discuss implications of referral services on channel coordination issues, and whether a two part tariff can be successfully used to maximize channel profits. Contrary to prior literature, we find that when retailers can price discriminate among consumers, the manufacturer may not set the wholesale price to marginal cost to coordinate the channel. Consistent with anecdotal evidence, our model predicts that while it is optimal for an infomediary to enroll only one retailer, it is optimal for a manufacturer to enroll both retailers. Finally, our results show that under some circumstances, the manufacturer even benefits from the presence of the competing referral infomediary and hence, will not want to eliminate it.

Keywords: *Referral Services, Price Dispersion, Franchise Fees, Acquisition Costs, Infomediary, Channel Management.*

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.

Consider the auto industry in the U.S. - an industry with $ 500 billion in revenues. Auto manufacturers are prohibited by franchise laws 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.[1] In 2001, Autobytel generated an estimated $17 billion in car sales.[2]

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.[3] Crucially, manufacturers provide referrals to dealers free of cost, while third-party infomediaries charge referral fees to participating dealers.

Selling directly establishes the manufacturer as a direct competitor to its reseller partner, potentially leading to channel conflict. Hence, firms in other industries are also beginning to use their own websites to steer consumers to retailers. For example, IBM takes orders for PCs over the Web, but redirects the sales to its distributors. Hewlett-Packard's "Commerce Center" is not an on-line store per se—it simply gives business customers an easy, point-and-click way to order from an HP reseller.[4] On the other hand, manufacturers compete with third-party infomediaries

[1] "More Car Buyers Hitting the Web First," www.EcommerceTimes.com, 11/27/01.
[2] "Autobytel Survey," www.CNET.com, 06/25/02.
[3] "Get ROI From Design", Forrester Report, June 2001.
[4] Garner, R. (1999). "Mad as hell," June 1, 54, Sales & Marketing Management

like CNET.com in the lead generation business.

The conventional wisdom on Internet referral infomediaries (or online buying services as they are increasingly being called), is that they are valuable to consumers because they reduce the search costs of comparing prices in electronic markets and get binding price quotes from retailers. However the impact of these infomediaries on manufacturers is not very clear. 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 between a manufacturer and a third-party infomediary, on the division of channel profits has not been studied previously. Models that analyze firm conduct and coordination in distribution channels (Jeuland and Shugan, 1983; Moorthy, 1987; Ingene and Parry 1995; Coughlan 1995) typically do not consider the influence of third-party infomediaries on channel strategies. While Shaffer and Zettelmeyer (2003) consider the impact of third-party information on profits in a channel consisting of two manufacturers and one retailer, they do not consider the effect of profit-maximizing information intermediary, on a manufacturer's profits.

1.1 Research Questions

In this setting, we examine the following questions.

- What strategic implications does the entry of a referral infomediary have for an upstream manufacturer? How do referral services, both independent and manufacturer-sponsored, affect the optimal pricing strategies of retailers in a channel?
- If a manufacturer cannot sell directly to consumers, can it still extract higher profits from the channel by diverting traffic online? How does the two-part tariff (wholesale price and franchise fee) change these circumstances?
- Should the manufacturer follow an exclusive or a non-exclusive strategy of enrollment vis-a-vis an infomediary? Can, and should it eliminate the referral infomediary?

1.2 Prior Literature and Results

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. Since, consumers are heterogenous both in their valuations and in search behavior, 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). There is a growing literature on the impact of the Internet and Internet based institutions on price competition (Lal and Sarvary 1999, Baye and Morgan 2001, Iyer and Pazgal 2003). One goal of this paper is to bridge the vast literatures on channel management and price dispersion.

In a related paper, Chen, Iyer and Padmanabhan 2002 (hereafter CIP) examine how an infomediary affects the market competition between retailers, and the contractual arrangements that they should use in selling their services. They identify the conditions necessary for the infomediary to exist and explain how they would evolve with the growth of the Internet. Our paper differs from their work in many important areas. The most important difference is that our paper considers both infomediary owned as well as manufacturer owned referral services. The focus of our paper is on the overall impact of referral services on manufacturer profits. Further, we study the impact of an upstream manufacturer's referral service on the behavior of downstream retailers as well as on the infomediary. We also shed light on the consequences of referral services on closing ratios and channel coordination issues in our paper. There are several modelling differences as well. First, consumers in our model are heterogenous in two dimensions. While CIP (2002) consider heterogeneity only in consumer search behavior, we also consider heterogeneity in consumer valuations for the same product. Second, a key feature in our model is incorporation of a difference between online and offline acquisition costs incurred by retailers in serving each prospective customer. This is based on empirical evidence as pointed out by Scott-Morton and Zettelmeyer (2001). In fact, the presence of customer acquisition costs prevents the Infomediary from unravelling. Third, another critical aspect in our model is a retailer's ability to infer consumer valuations offline. In the offline channel, consumers physically walk into stores, and retailers are able to determine willingness to pay, via a costly interaction. This enables them to discriminate offline between high and low valuation consumers. However, online they lose this ability to price 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 consumer valuation information, online. Thus we model the critical tradeoff retailers face between lower customer acquisition costs online versus higher consumer information offline.

We find that, first, the establishment of manufacturer referral services, along with the strategic utilization of the wholesale price 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 three sources: (i) mitigation of price competition among downstream retailers by the adjustment of the wholesale price by the manufacturers, (ii) retailers' ability to price discriminate between informed and uninformed consumers, and (iii) by the lowering of acquisition costs of each retailer due to diversion of traffic from the offline to the online channel. Under some conditions (when offline acquisition costs are high enough), the two-part tariff is able to achieve higher channel profits than those under a vertically integrated system.

Second, we find that the manufacturer even benefits from the presence of the infomediary, once it has established its own referral service. Basically the infomediary' referral price prevents the enrolled retailer from spiralling into aggravated price competition with the other retailer, by creating sufficient differentiation in consumers' search behavior. This leads to higher prices on an average for both retailers. Consequently, the manufacturer might not want to strategically eliminate the infomediary. In fact, it cannot eliminate the infomediary even if it wants to. It can adjust the wholesale price to reduce the advantage that the infomediary-enrolled retailer has due to price discrimination. However, the presence of the infomediary also reduces acquisition costs for the enrolled retailer, allowing the infomediary to capture some of the gains. Consequently as long as consumers are widely heterogeneous in their search behavior, the referral infomediary will continue to survive.

Third, we show that the optimal wholesale price (W) of the manufacturer offering a two-part tariff, is not equal to its marginal cost. Rather, it is set to equal the valuation of the low type consumers in the market. This is in contrast to prior literature where it has been shown that in a two-part tariff setting the wholesale price to marginal costs achieves channel coordination. This is driven by the fact that retailers can price discriminate in the offline channels. Basically, by charging a higher wholesale price the upstream manufacturer is able to enforce an equilibrium which leads to higher profits for each retailer, by alleviating price competition among the downstream players. The establishment of a referral service by the manufacturer enables it to respond to the entry of an infomediary, by giving itself a wider leeway to set the unit wholesale fee to the profit maximizing level.

Fourth, average online prices offered by retailers to users of the manufacturer's referral service are higher than infomediary referral prices. This is similar in notion to an "MSRP" which is the highest possible price consumers are expected to pay under normal market conditions. Thus this result also reconciles well with practice and empirical evidence (Scott-Morton et al. 2003b).

Finally, we show that a manufacturer has an incentive to enroll both retailers in its referral service. This is in accordance with anecdotal evidence, which suggests that a manufacturer does not differentiate between its dealers in this regard. One possible explanation of this practice could simply be to avoid the Robinson-Patman Act which prohibits manufacturers from discriminating between retailers. Our model shows that there is also a strategic incentive for the manufacturer to adopt a non-discriminatory policy and enroll both retailers in its referral service.

This paper, therefore, offers a different viewpoint on how manufacturers can increase profits by diverting consumer traffic into online channels and optimally setting a two-part tariff. In the auto industry, manufacturers cannot directly sell to consumers. However, they can extract higher profits from the channel by increasing their franchise fee and changing their per-unit fee. This provides them with an incentive to reduce the acquisition costs in the channel by inducing more consumers to visit their online referral services. The tradeoff is that, since consumer purchases in this industry are infrequent, little information about consumers is available online without face-to-face interaction. Offline, a retailer is able to infer a consumer's willingness to pay by being exposed to cues like clothing and body language. We show that 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 service as a device to regain some control over the channel. While we touch upon the channel coordination problem for a manufacturer using a two-part tariff and highlight circumstances when it can coordinate the channel, we abstract away from offering any mechanisms as solutions to the coordination problem. A complete analysis of channel coordination mechanisms will require a downward sloping demand curve, which is beyond the scope of our model.

The rest of this paper is organized as follows. Section 2 reviews the related research and presents the basic model. Section 3 examines a benchmark case when no referral services exist, while Section 4 analyzes the effect of the infomediary on retail competition. In Section 5 we examine the impact of manufacturer referral services on equilibrium strategies and policies, and provide some empirical corroboration of our results. Section 6 provides some business implications, while Section 7 concludes with a brief summary of the main results and some possible extensions. 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 and optimally sets the wholesale price of the good charged to the retailers, W. 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 acquisition cost, δ, for each offline customer catered to. δ represents the difference in acquisition costs between offline and online customers. This includes the cost of time spent in providing product information and in negotiation, offering test drives, and completing paperwork. Ratchford, et al (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 cost is normalized to zero. The tradeoff faced by a retailer is that, offline, it can perfectly observe a consumer's valuation via the interaction process. Hence, the offline price offered to a consumer depends on this valuation, allowing for price discrimination.

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. 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). If the infomediary enrolled both retailers, Bertrand competition would prevail in the online segments, with prices equal to marginal cost, as shown in the Appendix B.[5] Therefore, the infomediary can charge a higher fee when it enrolls just one retailer. In practice, too, dealers are assigned exclusive geographic territories by infomediaries (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 $V^h > V^\ell > 0$. The proportion of high valuation consumers is λ_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 ($j = h, \ell$) 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.[6]

There are three distinct consumer segments: a proportion α_u of "uninformed" consumers who are unaware of the existence of an infomediary and obtain a price from just one retailer, a proportion α_p of "partially informed" consumers who obtain a price from one retailer and the referral infomediary (when it exists), and a proportion $1 - \alpha_u - \alpha_p$ of "fully informed" consumers, who

[5] Since this has also been shown by CIP 2002 in their model, we do not make it a focus of our paper.

[6] To keep the setup generalized, we do not assume any correlation between consumer valuations and search behavior. While there is empirical evidence that higher income people are more likely to have access to the Internet, there is also countervailing evidence that they have more search costs.

obtain prices from both retailers as well as the referral infomediary.

When a consumer approaches a retailer for a price quote, the retailer is unable to distinguish which market segment a consumer belongs to. In other words, either offline or online, a retailer cannot determine if a particular consumer belongs to the uninformed, partially or fully informed segments. Offline, the retailer is able to determine the consumer's valuation for the product.

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. In Stage 1, the manufacturer sets the franchise fee, F and the optimal wholesale price W for each retailer. In Stage 2, retailers simultaneously choose retail prices $(P_1(V^h), P_1(V^\ell))$ and $(P_2(V^h), P_2(V^\ell))$. In Stage 3, consumers decide which product to buy.

Consider the three market segments:

(i) uninformed consumers, of market size α_u, 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 α_p, 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 $1 - \alpha_u - \alpha_p$, 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.

Types	$\frac{\alpha_u}{2}$	$\frac{\alpha_u}{2}$	$\frac{\alpha_p}{2}$	$\frac{\alpha_p}{2}$	$1 - \alpha_u - \alpha_p$
HV Consumers	$P_1(V^h)$	$P_2(V^h)$	$P_1(V^h)$	$P_2(V^h)$	$P_1(V^h), P_2(V^h)$
LV Consumers	$P_1(V^\ell)$	$P_2(V^\ell)$	$P_1(V^\ell)$	$P_2(V^\ell)$	$P_1(V^\ell), P_2(V^\ell)$

Figure 1: Prices observed by each consumer segment when no Referral Service exists

Since consumer valuations are observed offline, this basic model reduces to that of Varian (1980). Using similar arguments as in Varian (1980) and Narasimhan (1988), 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. 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 $i = \ell, h$. For example, $G_1^h(P) = \text{Prob}(P_1(V^h) \geq P)$ where $P_1(V^h)$ is the price offered by D_1 to consumer type V^h. Since the equilibrium we consider is symmetric, both dealers adopt the same price distribution, $G^i(P)$, for each consumer type.

Lemma 1 *(i) The manufacturer optimally sets* $W^o = V^\ell$.
(ii) In equilibrium, each retailer charges V^ℓ *to low-type consumers and randomly chooses a price from the interval* $[V^\ell, V^h]$ *for the high-type consumers, with* $G^h(P) = \frac{\alpha_u+\alpha_p}{2(1-\alpha_u-\alpha_p)}\left(\frac{V^h-P}{P-W}\right)$.
(iii) the expected profit of the manufacturer is $\pi^o = (\alpha_u + \alpha_p)\lambda_h(V^h - V^\ell) + V^\ell - \delta$.

The proof of this and all other results is in the Appendix. The market share of each retailer amongst consumers with valuation i is simply one-half. 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). In accordance with prior literature (for example, Rey and Stiglitz, 1995; Iyer 1998), we assume the large manufacturer wields bargaining power over the small retailers, who earn a reservation profit of zero.[7] Therefore, the optimal franchise fee charged by the manufacturer is equal to the profit of each retailer, i.e.,

$$F = \frac{\alpha_u + \alpha_p}{2}\,(\lambda_H V^h + \lambda_L V^\ell - V^\ell) - \delta(1 - \frac{\alpha_u}{2} - \frac{\alpha_p}{2}).$$

Thus total channel profits are equal to

$$2F + W = (\alpha_u + \alpha_p)\,\lambda_H(V^h - V^\ell) + V^\ell - \delta(2 - \alpha_u - \alpha_p). \tag{1}$$

Moorthy (1987) showed that in a channel, a simple contract (i.e., two-part tariff) consisting of a fixed fee and a variable wholesale price is sufficient for coordination. For the manufacturer,

[7] If, retailers had a positive reservation profit, R, the equilibrium franchise fee would be $F = \frac{\alpha_u+\alpha_p}{2}(\lambda_H V^h + \lambda_L V^\ell - W) - \delta(1 - \frac{\alpha_u}{2} - \frac{\alpha_p}{2}) - R$. 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.

coordination in distribution channels means designing a contract which (1) maximizes the total channel profits and (2) transfers the profits at the retail level back to the manufacturer. A vertically integrated manufacturer selling directly offline, would accrue total profits equal to

$$\lambda_H V^h + \lambda_L V^\ell - \delta = \lambda_H (V^h - V^\ell) + V^\ell - \delta. \tag{2}$$

This expression represents the maximum achievable channel profits offline. From a comparison of the profits under the integrated and the decentralized system, i.e., equations (1) and (2), it is immediate that the two part-tariff is unable to achieve channel coordination since $\alpha_u + \alpha_p < 1$.

4 Model with Referral Infomediary

Next, we consider a model in which a referral infomediary enrols 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. In stage 1, the manufacturer sets the franchise fee, F and wholesale price W. In stage 2, the referral infomediary enrolls D_2, and sets a referral fee, K. In stage 3, retailers simultaneously choose prices: D_1 chooses $(P_1(V^h), P_1(V^\ell))$, as before, and D_2 chooses $(P_2(V^h), P_2(V^\ell))$ for offline consumers, and P_2^r for online consumers (who access the retailer via the referral infomediary). Finally, consumers decide which retailer to buy from.

As before, α_u obtain just one offline price, and visit the two retailers in equal proportion. α_p consumers obtain an offline price from D_1, and an online price from D_2. Since their online price comes from D_2, they visit D_1 for an offline price. Thus each retailer now has a captive segment of size $\frac{\alpha_u}{2}$ while a proportion α_p of the population see two prices, $(P_2^r, P_1(V^h))$ or $(P_2^r, P_1(V^\ell))$, depending upon their types V_i. 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 receive a price independent of type.

Types	$\frac{\alpha_u}{2}$	$\frac{\alpha_u}{2}$	α_p	$1 - \alpha_u - \alpha_p$
HV Consumers	$P_1(V^h)$	$P_2(V^h)$	$P_1(V^h), P_2^r$	$P_1(V^h), P_2(V^h), P_2^r$
LV Consumers	$P_1(V^\ell)$	$P_2(V^\ell)$	$P_1(V^\ell), P_2^r$	$P_1(V^\ell), P_2(V^\ell), P_2^r$

Figure 2: Prices observed by each consumer segment when Infomediary enters

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. The model in this section is similar to CIP (2002), but with the multiple differences outlined in the Introduction.

Assumption 1 $\lambda_h \leq \frac{V^\ell}{V^h}$.

If the proportion of high-value consumers is very high, the retailers will find it optimal to ignore the low-value consumers, and sell only to the high-value consumers. In particular, the manufacturer will charge $W = V^h$ in the case that $\delta = 0$, or W as high as possible (but below V^h) when δ is positive. Define this latter value to be $\bar{W}$. For λ_H high enough, this will involve $W > V^\ell$, so no low-value consumers will be served. However, the more interesting case of our model is that both types of consumers are served.

Notice also that it cannot be optimal for the manufacturer to charge any $W \in (V^\ell, \bar{W})$, since again the low-value consumers will be shut out of the market (since retailers will charge a price no lower than W). Hence, consider the choice of W in the region $[0, V^\ell]$. The equilibrium here depends on whether the manufacturer chooses a low wholesale price (closer to zero) or a high one (closer to V^ℓ). For ease of comparison throughout the paper, we consider the choice among prices sufficiently close to V^ℓ. In particular, we show that there is a threshold value of W (which we call $\hat{W}$) such that the equilibrium strategies of the dealers for any wholesale price $W \in [\hat{W}, V^\ell]$ can be described in terms of W. This then allows us to determine the optimal wholesale price in this region.

We first exhibit the equilibrium that obtains if the manufacturer chooses a wholesale price in the range $[\hat{W}, V^\ell]$. Later, we argue that this choice is optimal.

Proposition 1 *There exists a wholesale price $\hat{W} < V^\ell$ with the following property: Suppose the manufacturer chooses a wholesale price $W \in [\hat{W}, V^\ell]$. Then, there is an equilibrium in which*
(i) $P_2(V^h) = V^h$, and the prices $P_1(V^h)$ and P_2^r are randomly chosen from $[\hat{P}^h, V^h]$ where $\hat{P}^h = W + \frac{\alpha_u(V^h - W)}{(2-\alpha_u)}$. Further, $G_2^r(P) = \frac{\alpha_u(V^h - P)}{2(1-\alpha_u)(P-W)}$ and $G_1^h(P) = \frac{\alpha_u(V^h - W)}{(2-\alpha_u)(P-W)}$, with a mass point at

V^h equal to $\frac{\alpha_u}{2-\alpha_u}$.
(ii) the prices $P_1(V^\ell)$ and $P_2(V^\ell)$ are randomly chosen from $[\hat{P}^\ell, V^\ell]$, where $\hat{P}^\ell = W + \frac{(\alpha_u+2\alpha_p)(V^\ell-W)}{2-\alpha_u}$. The price distributions satisfy $G_1^\ell(P) = \frac{\hat{P}^\ell-W}{P-W} - \frac{\alpha_u}{2(1-\alpha_u-\alpha_p)}\ \frac{P-\hat{P}^\ell}{P-W}$, with a mass point at V^ℓ equal to $\frac{2\alpha_p}{2-\alpha_u}$, and $G_2^\ell(P) = \frac{\alpha_u+2\alpha_p}{2(1-\alpha_u-\alpha_p)}\ \frac{V^\ell-P}{P-W}$.
(iii) D_2 has a higher gross profit than D_1.

The entry of the referral infomediary leads to an increase in competition between the two retailers. In equilibrium, D_2 uses the infomediary as a price discriminating mechanism. Essentially, D_2 now has two weapons: it uses P_2^r to compete with D_1, and $P_2(V^h)$ and $P_2(V^\ell)$ 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.

This result shows that by strategically choosing the wholesale price the manufacturer is able to enforce an equilibrium which gives it higher profits. Note that prior literature has shown that setting a per unit fee equal to the manufacturer's marginal cost (which is zero in our model) can maximize manufacturer and channel profits. However, we show that this policy does not hold in the case when retailers can price discriminate among consumers. In particular, setting a lower wholesale price leads to lower prices on an average, as retailers end up competing fiercely. Conversely, setting a higher wholesale price alleviates the extent of price competition between downstream retailers.

In equilibrium D_1 makes all its sales at its physical store. This includes a portion $\frac{\lambda_H \alpha_u}{2}$ made at V^h to the high valuation consumers in the uninformed segment, a portion $\frac{\lambda_L \alpha_u}{2}$ made at V^ℓ to the low valuation consumers in the uninformed segment and a portion $\lambda_L(\frac{1-\alpha_u+\alpha_p}{2})$ made at V^ℓ to the low valuation consumers in the partially and fully informed segments. Using $P_1(V^h)$, it also makes sales $\lambda_H(\frac{(1-\alpha_u)^2}{2-\alpha_u})$, to the high valuation consumers in the partially and fully informed segments. D_2 makes some online sales, $\lambda_H(\frac{1-\alpha_u}{2-\alpha_u})$, at the referral price, P_2^r, in the partially and fully informed segments, and some offline sales $\lambda_L(\frac{1-\alpha_u-\alpha_p}{2})$ to the low valuation segments, in these two segments. Further, it makes some sales at its physical store in the uninformed segment ($\frac{\lambda_H \alpha_u}{2}$ and $\frac{\lambda_L \alpha_u}{2}$, respectively, to the high and low valuation consumers in this segment). Thus the "reach" of the infomediary is equal $1 - \alpha_u$, 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 δ. 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) there is a reallocation in its total sales (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.

In equilibrium, the manufacturer will set its franchise fee, F, 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.

Hence, in equilibrium, the manufacturer chooses a wholesale price $W \geq \hat{W}$, rather than any price less than $\hat{W}$. When $W < \hat{W}$, the profit of D_1 decreases since prices $(P_1(V^h), P_1(V^\ell))$ decrease (due to aggravated price competition). Notice this occurs because with a reduction in W, the lower bound $(\hat{P}^h, \hat{P}^\ell)$ both decrease, thereby reducing the average prices. This leads to a reduction in the franchise fee. Further, it is immediate to see that since the market size is fixed, profits from the per unit wholesale price component decreases too. Since the manufacturer's profits are equal to $2F + W$, total manufacturer profits are lower when $W < \hat{W}$.

Given the equilibrium, we can now determine the sales and profit of each retailer. The superscripts m and I on expected profits, franchise and referral fees, denote the scenarios with and without manufacturer referral services. In equilibrium, when choosing from prices in the range $[\hat{W}, V^\ell]$, the manufacturer again sets $W = V^\ell$. Then, the total channel profits are given by

$$2F^I + W + K^I = (\frac{\alpha_u(3 - 2\alpha_u)}{2 - \alpha_u})(\lambda_H(V^h - V^\ell)) + V^\ell - \delta(2 - \alpha_u - \alpha_p). \tag{3}$$

Proposition 2 *Suppose* $(1 - \alpha_u - 2\alpha_p\lambda_L) > 0$. *Then,*
(i) The optimal wholesale price for the manufacturer is $W^I = V^\ell$. *This choice of* W *also maximizes total channel profits.*
(ii) The optimal franchise and referral fees, respectively, are
$F^I = \lambda_H(V^h - V^\ell)\,(\frac{\alpha_u}{2}) - \delta(1 - \frac{\alpha_u}{2})$.
$K^I = \frac{\lambda_H\ \alpha_u\ (1-\alpha_u)}{2-\alpha_u}(V^h - V^\ell) + \alpha_p\ \delta$.

This choice of W goes some way towards channel coordination; total manufacturer and channel profits are maximized. However, since the infomediary is a competing third-party, the manufacturer cannot really extract all of the infomediary's profit. Even if the manufacturer adjusts the wholesale price to eliminate any advantage that the infomediary-enrolled retailer has due to price discrimination, it cannot eliminate acquisition costs that accrue in the offline channel. Consequently, the infomediary-enrolled retailer will benefit from enrollment and the infomediary will continue to survive, no matter how the manufacturer adjusts the two-part tariff. As a result, the manufacturer will be unable to extract all the channel profits. Thus this highlights that in the presence of third-party referral services, a two-part tariff is able to achieve only partial channel coordination.

Consider the condition $(1-\alpha_u-2\alpha_p\lambda_L)>0$ in the statement of Proposition 2. In the absence of the infomediary, by setting the wholesale price at V^ℓ, the manufacturer is able to prevent aggravated price competition between the retailers. This occurs because when $W=V^\ell$, the upper and lower bounds of the retailers' price distributions $P_1(V^\ell)$ and $P_2(V^\ell)$, collapse to a single monopoly price point of V^ℓ. This helps both the retailers to extract the whole consumer surplus from the low valuation consumers, even in the partially and fully informed segments. While this phenomenon still occurs in the presence of the infomediary, the wholesale price is set to V^ℓ only if the proportion of partially informed consumers or low valuation consumers is reasonably low. For instance, for any $\lambda_L \leq 0.5$, the optimality of this wholesale price will hold. In a similar manner if $\alpha_u+2\alpha_p$ increases, then it is immediate to see from the expression for $\hat{P}^\ell$ that the interval over which prices are being randomized for the low valuation consumers by both firms decreases. That is, price competition between the retailers is alleviated. Consequently, the manufacturer can now afford to decrease the wholesale price.

In sum, the presence of the infomediary leads to an increase in the gross profit of the enrolled retailer, and a corresponding decrease in the gross 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.

5 Manufacturer Establishes a Referral Service

Finally, we consider the scenario in which the manufacturer sets up its own referral website, in response to the presence of the infomediary. This game is derived from the previous game (which had the infomediary; see Figure 2 above) as follows. We assume that the manufacturer enrolls both retailers, such that at each of the four terminal nodes in Figure 2, a proportion β of the consumers (the "physical segment") continue to visit the physical stores, while the remaining proportion, $1-\beta$ (the "web segment"), go to the corresponding retailer via the manufacturer referral website. Later, we highlight why the manufacturer is content enrolling both retailers rather than just enrolling D_1, the retailer not enrolled with the infomediary.

The stages in this game are as follows: In stage 1, the manufacturer sets the franchise fee, F, the wholesale price W, and establishes a referral web site. In stage 2, the referral infomediary enrolls D_2, and sets a referral fee, K. Then in stage 3, retailers simultaneously choose prices. D_1 chooses $(P_1(V^h), P_1(V^\ell))$ for offline consumers, and P_1^m for online consumers who come through the manufacturer web site. D_2 chooses $(P_2(V^h), P_2(V^\ell))$ 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. In the final stage, 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.[8] The prices seen by consumers in different market segments are shown in Figure 3.

Types	$\frac{\beta\alpha_u}{2}$	$\frac{(1-\beta)\alpha_u}{2}$	$\frac{\beta\alpha_u}{2}$	$\frac{(1-\beta)\alpha_u}{2}$	$\beta\alpha_p$	$(1-\beta)\alpha_p$	$\beta(1-\alpha_u-\alpha_p)$	$(1-\beta)(1-\alpha_u-\alpha_p)$
HV	$P_1(V^h)$	P_1^m	$P_2(V^h)$	P_2^m	$P_1(V^h)$,P_2^r	P_1^m,P_2^r	$P_1(V^h)$,$P_2(V^h)$,P_2^r	P_1^m,P_2^m,P_2^r
LV	$P_1(V^\ell)$	P_1^m	$P_2(V^\ell)$	P_2^m	$P_1(V^\ell)$,P_2^r	P_2^m,P_2^r	$P_1(V^\ell)$,$P_2(V^\ell)$,P_2^r	P_1^m,P_2^m,P_2^r

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 the physical segment β), 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

[8]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.

via the manufacturer web site. Hence, in the web $(1-\beta)$ 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 web 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 $P_1(V^\ell), P_1(V^h), P_2(V^\ell), P_2(V^h)$ 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 $\beta = 1$).

Just as the equilibrium in Proposition 1 is valid when $W \geq \hat{W}$, the equilibrium exhibit below is valid when $W \geq \hat{W}_m$, where $\hat{W}_m$ is a sufficiently high wholesale price. Again, $\hat{W}_m$ is implicitly defined, given a no-deviation condition for D_2.

Proposition 3 *There exists a wholesale price $\hat{W}_m < V^\ell$ with the following property: Suppose the manufacturer chooses a wholesale price $W \in [\hat{W}_m, V^\ell]$. Then, there is an equilibrium in which:*
(i) $P_1(V^\ell), P_1(V^h), P_2(V^\ell), P_2(V^h)$ and P_2^r are set exactly as in Proposition 1,
(ii) $P_2^m = V^h$, and P_1^m is randomly chosen over $[\hat{P}^h, V^h]$, where $\hat{P}^h = W + \frac{\alpha_u(V^h - W)}{(2-\alpha_u)}$. Further, $G_1^m(P) = \frac{\alpha_u(V^h-W)}{(2-\alpha_u)(P-W)}$, with a mass point at V^h equal to $\frac{\alpha_u}{2-\alpha_u}$.

Notice that the expected infomediary referral price of D_2 is lower than its walk-in prices $P_2(V^h)$ 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.

We point out that there exists a critical value of $\beta, \hat{\beta}$ beyond which the manufacturer will choose $W > \hat{W}$. Intuitively, when the manufacturer chooses a higher wholesale price, retailers are forced to raise the minimum value of P_{1}^{m} higher than V^{ℓ}. Consequently the low valuation buyers who check online prices in the web segment are shut out off the market. Hence, depending on the proportion of consumers who check manufacturer referral prices, the manufacturer may chose a lower wholesale price. When $\beta \to 1$, that is, when the proportion of consumers in the "physical segment" becomes higher, the manufacturer chooses a higher W. Intuitively, with fewer consumers seeing the manufacturer's online prices, retailers are aware that they can price discriminate in the offline channels, without the fear of losing any of the low types. This enables the manufacturer to raise the wholesale price. Similarly, when $\lambda_{H} \to 1$, that is, when the proportion of higher valuation consumers increases, the optimal wholesale price is higher than $\hat{W}$. The intuition is similar: When the proportion of high type consumers in the market is sufficiently high, retailers' profits from the high types by charging a higher P_{1}^{m} (only the high types buy when $P_{1}^{m} > V^{\ell}$) is more than their loss from shutting out the low types. Consequently, the manufacturer can afford to raise its wholesale price.

In order to make analogous comparisons with the case when there are no manufacturer referral services, here onwards we focus on the equilibrium when the manufacturer chooses a wholesale price $W \geq \hat{W}_m$.

Proposition 4 *In equilibrium, the retailers' expected sales, prices, and profits in the physical segment are the same as in Proposition 1. In the web segment,*
(i) the retailers' expected sales are $E(S_1^m) = \lambda_{H}(\frac{1}{2-\alpha_u} - \frac{\alpha_u}{2})$, $E(S_2^m) = \lambda_{H}\left(\frac{1-\alpha_u}{2-\alpha_u} + \frac{\alpha_u}{2}\right)$.
(ii) The expected prices are:

$$
\begin{aligned}
E(P_{1}^{m}) &= \frac{4W(1-\alpha_{u})^2 + \alpha_{u}(2-\alpha_{u})V^h + 2\alpha_{u}(1-\alpha_{u})\,(\ln\frac{2-\alpha_u}{\alpha_u})\,(V^h - W)}{(2-\alpha_{u})^2} \\
E(P_{2}^{r}) &= W + \frac{\alpha_{u}\,(\ln\frac{2-\alpha_u}{\alpha_u})\,(V^h - W)}{2(1-\alpha_{u})}
\end{aligned}
$$

(iii) the retailers' expected gross profits from the segment are

$$
\begin{aligned}
E(\tilde{\pi}_1^m) &= (1-\beta)\,\lambda_{_H}\,\frac{\alpha_{_u}}{2}\,(V^h - W) \\
E(\tilde{\pi}_2^m) &= (1-\beta)\,\lambda_{_H}\,\frac{\alpha_{_u}}{2}\,\frac{4-3\alpha_{_u}}{2-\alpha_{_u}}\,(V^h - W)
\end{aligned}
$$

We observe that the expected price $E(P_{_2}^r)$ increases with the size of the captive segment $\alpha_{_u}$ (the increase is close to linear for higher values of $\alpha_{_u}$). An increase in the size of the captive segment $\alpha_{_u}$ 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). However this advantage is considerably reduced, resulting in lower referral fees for the infomediary. Notice that when $\alpha_{_u} = 1$, $E(P_{_1}^m)$ and $E(P_{_1}(V^h))$ are both equal to V^h. 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 from Proposition 4).

Corollary 4.1 *(i) In equilibrium, with the introduction of the manufacturer referral service, the retailer associated with the infomediary, D_2, has higher expected sales and gross profits in the web segment. However, in the physical segment, the sales of each retailer remain the same even after the introduction of the manufacturer referral service.*
(ii) The average manufacturer referral prices are higher than the average infomediary referral prices.

In the physical segments, the market shares of the two retailers remain the same as in the world with an infomediary, but no manufacturer referrals. However in the web segments, on comparing the performance of D_2 when it enrolls with the infomediary to that of D_1, we see that it experiences a higher market share. Hence, there is a strong incentive for D_2 (or more generally, for any one retailer) to enroll 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.

Recall that $G_1^h(P)$ has a positive mass at V^h which is exactly the same as that of $G_1^m(P)$. So that the expected sales of each retailer remain the same irrespective of manufacturer referral services. Since neither retailer wants to shut out the high valuation buyers, they do not charge more than V^h to online consumers. This is equivalent to assuming that all consumers have a high valuation. Therefore, since $G_2^r(P)$ follows the same distribution, we get the result that expected sales remain the same even with the entry of the manufacturer referral service.

Superficially, manufacturer and infomediary referrals are similar in that they put a customer in contact with a particular retailer. The difference between the two types of referral prices predicted by our model is consistent with empirical evidence found by Scott-Morton et al.(2003b). They find that while the referral process of third-party infomediaries helps consumers get lower prices, a referral from a manufacturer website to one of the manufacturer's dealerships does not help consumers obtain a lower price.

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 for any value of the offline acquisition cost δ, the manufacturer makes a higher profit when it offers its own referral web site.

Define $X = (\alpha_u + 2\alpha_p)$.

Proposition 5 *If* $(1 - \alpha_u\lambda_H - \beta\lambda_L X) > 0$,
(i) the optimal wholesale price for the manufacturer is $W^I = V^\ell$.
(ii) the optimal franchise and referral fees, respectively, are
$F^m = \beta F^I + (1-\beta)\lambda_H(\frac{\alpha_u}{2})(V^h - V^\ell)$.
$K^m = \beta K^I + (1-\beta)\lambda_H\frac{\alpha_u(1-\alpha_u)}{(2-\alpha_u)}(V^h - V^\ell)$.
(iii) the manufacturer earns a higher profit by opening up its own referral web site.

Consider the effects of the manufacturer referral service on the infomediary profit. Notice first that

K^m is always positive, for any value of δ. Secondly, when $\beta = 1$, this is exactly equal to K^I. As β decreases to zero (i.e., more consumers shop online), K^m decreases while F^m increases. Thus as the manufacturer is able to divert more traffic onto online channels, its profit increases while that of the infomediary decreases. Since the rate of increase in manufacturer profit is higher than the rate of decrease in infomediary profit, the total channel profits increase.[9]

Note that when $\beta = 0$, (that is, if all consumers were to search for prices on the online channels) the condition for the optimal wholesale price to be V^ℓ always holds since $(1 - \alpha_u \lambda_H) > 0$. In a similar vein, if $\beta = 1$, that is all consumers shift offline, $(1-\alpha_u \lambda_H - \beta\lambda_L X)$ reduces to $1-\alpha_u - 2\lambda_L \alpha_p$ as expected. This implies that for any $\beta \in (0, 1)$, the wholesale price will be set to V^ℓ for a much bigger region in the parameter space than the case when there is only an infomediary referral service. *Thus the establishment of a referral service by the manufacturer enables it to respond to the entry of an infomediary, by giving itself a wider leeway to set the unit fee to the earlier profit maximizing level.*

However for any value of δ, there is a reallocation of channel profits from the referral infomediary to the manufacturer, after the manufacturer introduces its own referral service. This results in higher manufacturer profits than in a world with only infomediary referral service.

Proposition 6 *There exists a critical value of acquisition cost, $\hat{\delta}$, such that for any δ larger than $\hat{\delta}$, the channel profits under a two-part tariff exceed the channel profits achievable offline under a vertically integrated manufacturer.*

Recall equation (2) which gives the channel profits if the manufacturer were to sell directly. We show that when, the manufacturer's two part tariff can result in higher profits than those accrued under a direct selling manufacturer. From Proposition 5, the total channel profits $2F^m + W + K^m =$

$$(\frac{\alpha_u(3-2\alpha_u)}{2-\alpha_u})(\lambda_H(V^h - V^\ell)) + (1-\beta)\lambda_H V^\ell - \beta\delta(2 - \alpha_u - \alpha_p). \tag{4}$$

Compare this to equation (2). Notice that when $\beta = 0$ for instance, then channel profits with the two-part tariff can be higher than those achieved under a centralized system. In sum, savings from customer acquisition costs online, can enable a decentralized manufacturer achieve higher channel

[9]This follows from the fact that $\frac{\partial F^m}{\partial \beta} = \delta\,(1 - \frac{\alpha_u}{2}) > \frac{\partial K^m}{\partial \beta} = \delta\,\alpha_p$.

profits than those achieved through direct selling.

However, if acquisition cost savings are not high enough, then an alternate strategy for manufacturers is to invest in technologies which can facilitate price discrimination online for customers visiting their referral services. The upshot of losing information about consumer valuations online is that manufacturer referral prices are higher than V^{ℓ}. This results in a proportion $(1-\beta)\lambda_{L}$ of the consumers shut out from the market. If D_1 could identify consumers and set a price P_{1}^{m} based on their valuations, it would result in increased sales from the low valuation customers. While the franchise fees and referral fees would remain unchanged, it would lead to higher manufacturer and channel profits, by an amount equal to $V^{\ell}(1-\beta)\lambda_{L}$. This increase would accrue from the per-unit fee component of the two-part tariff. Thus online price discrimination can lead to even higher profits than those attainable in a vertically integrated manufacturer.

If all consumers who shift online are the high valuation customers, then the manufacturer gains even more by establishing its own referral service. We can show that in such a scenario, the optimal franchise and referral fees can be written as

$$\begin{aligned} F^{m^*} &= \frac{(1-\beta\lambda_{L})}{\lambda_{H}} F^{I} + \frac{(1-\beta)\delta}{\lambda_{H}} (1 - \frac{\alpha_{u}}{2}) \\ K^{m^*} &= \frac{(1-\beta\lambda_{L})}{\lambda_{H}} K^{I} - \frac{(1-\beta)\alpha_{p}\delta}{\lambda_{H}}. \end{aligned} \tag{5}$$

From this the total channel profits $2F^{m^*} + W + K^{m^*} =$

$$\frac{(1-\beta\lambda_{L})}{\lambda_{H}} (\frac{\alpha_{u}(3-2\alpha_{u})}{2-\alpha_{u}}) (\lambda_{H}(V^{h} - V^{\ell})) + V^{\ell} - \beta\delta(2 - \alpha_{u} - \alpha_{p}). \tag{6}$$

Compare this to equation (4). Notice that since $\beta < 1$ we have $\frac{(1-\beta\lambda_{L})}{\lambda_{H}} > 1$. Hence, $F^{m^*} > F^{m}$ and $K^{m^*} > K^{m}$.

The impetus toward an increased manufacturer profit comes from two sources. First, it levels the playing field between the two retailers by providing D_1 with a weapon to price discriminate between consumer segments online. Using the manufacturer's referral price P_{1}^{m}, D_1 is now able to compete more effectively against D_2's infomediary referral price P_{2}^{r} for the partially and fully informed consumer segments. Second, there is a reduction in $D_1's$ acquisition costs as some consumers are served online. 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.

5.1 Eliminating the Referral Infomediary

Is it possible for the manufacturer to drive the third-party infomediary out of the market? Rather, the more pertinent question is whether the manufacturer should try to do that? Recall that the infomediary's referral fee consists of two components, which creates an incentive for a retailer to enroll with the infomediary: (i) benefit from price discrimination and (ii) benefit from acquisition cost savings. Even if the manufacturer is willing to compensate retailers for all the acquisition costs incurred by them, i.e., $\delta = 0$, the referral fee still remains positive due to the price discrimination component. Hence, the infomediary will survive. Similarly, even if the wholesale price was strategically set to V^h, the referral fee would still be positive, due to the acquisition cost component. Hence, the only strategy for a manufacturer whose objective is to eliminate a third-party referral service, can adopt is a simultaneous two-pronged attack: (i) absorb all the acquisition costs and (ii) offer a wholesale price set to the valuation of the high type customer. Either one on its own is ineffective in unravelling the infomediary. Of course, this strategy comes at a price: both the manufacturer and channel profits are substantially lower. This implies that the manufacturer is content keeping the infomediary in business.

Types	$\frac{\beta\alpha_u}{2}$	$\frac{(1-\beta)\alpha_u}{2}$	$\frac{\beta\alpha_u}{2}$	$\frac{(1-\beta)\alpha_u}{2}$	$\beta\alpha_p$	$(1-\beta)\alpha_p$	$\beta(1-\alpha_u-\alpha_p)$	$(1-\beta)(1-\alpha_u-\alpha_p)$
HV	$P_1(V^h)$	P_1^m	$P_2(V^h)$	P_2^m	$P_1(V^h)$	P_1^m, P_2^m	$P_1(V^h), P_2(V^h)$	P_1^m, P_2^m
LV	$P_1(V^\ell)$	P_1^m	$P_2(V^\ell)$	P_2^m	$P_1(V^\ell)$	P_1^m, P_2^m	$P_1(V^\ell), P_2(V^\ell)$	P_1^m, P_2^m

Figure 4: Different prices observed by each consumer segment

Proposition 7 *There exists a critical value of β such that given the presence of its own referral service, the manufacturer benefits from the presence of the competing referral infomediary.*

In fact, we find that for a wide range in the parameter space, the manufacturer even benefits from the presence of the infomediary, once it has established its own referral service. Refer Figure

4.[10] Basically the infomediary's referral price P_2^r prevents the enrolled retailer, D_2 from spiralling into aggravated price competition with D_1, by creating sufficient differentiation in consumers'search behavior. In particular, the presence of the infomediary make D_2 asymmetric and stronger compared to D_1. This happens because D_2 now has two online pricing tools: one via the manufacturer referral (P_2^m) and the other via the infomediary referral (P_2^r). In contrast, D_1 only has one online pricing tool, that from the manufacturer referral service, (P_1^m). Consequently this asymmetry in the availability of online pricing tools, leads to higher prices on an average for the manufacturer referral prices of both retailers as well as for the high valuation consumers who come offline. Hence, the manufacturer might not want to strategically eliminate the infomediary.

5.2 Manufacturer Enrols Only One Retailer

It can be argued that the manufacturer's referral service by enrolling both retailers, indiscriminately skims off a fraction of all consumers. Hence, prima facie it is unclear that differences in performance/conduct do not arise from this mechanical asymmetry between the manufacturer's referral service and the infomediary referral service. In order to alleviate this concern, we consider the scenario when the manufacturer enrolls only one retailer, say D_1.[11] The resultant consumer search schema is shown in Appendix B. We state the following corollary.

Corollary 7.1 *The manufacturer is equally better off enrolling only D_1 as it is by enrolling both retailers.*

For brevity we avoid the math but provide the intuition here. Notice from the schema in the Appendix B, that in the absence of D_2 being enrolled by the manufacturer, the two segments which get affected are the uninformed (captive) segment of D_2 and the fully informed consumers in the β segment. While the former does not impact profits of D_1 in any way, it is presumable that the latter might do so. However, recall that P_2^m was priced at V^h, whereas P_1^m and P_2^r were randomized between $(\hat{P}^h, V^h)$. Consequently, D_1 was effectively competing only D_2' infomediary referral price, P_2^r and not with $D_2's$ manufacturer referral price, P_2^m. Hence, the absence of P_2^m does not affect

[10] Notice that when $\beta = 1$, this reduces to exactly the set up in Figure 1.

[11] It is trivial to show that enrolling only D_2, leads to a further decrease in $D_1's$ profits and results in lower manufacturer profits.

the profits of D_1 in any way and thus leaves the manufacturer's profits unchanged. However it does affect $D_2's$ profits. In fact it increases $D_2's$ profits by not enrolling it because in the captive segment D_2 can now sell to low valuation consumers offline using $P_2(V^\ell)$, rather than losing a proportion β of them online. But since the increase in profits of D_2 is captured by the infomediary, it leaves $D_2's$ net profits unchanged. In turn, this provides the manufacturer another incentive to decrease the infomediary's channel power.

This result reconciles itself very well with practice. Manufacturers like GM, Nissan and Ford follow a non-exclusive strategy of enrolling retailers in their referral services like GMbuypower.com, Nissandriven.com and Forddirect.com.[12] One reason for adopting this strategy could be to avoid negative ramifications from the Robinson-Patman Act.[13] Our model also provides an alternate rationale as to why a manufacturer may follow the non-exclusive practice of enrolling both retailers unlike a third-party infomediary which practices exclusivity.

5.3 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

$$CR = \frac{\text{Number of units sold}}{\text{Number of referrals received}}$$

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. 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 shows the closing ratio for the different price quotes offered by retailers to the pure online, that is, the $(1-\beta)$ segments. Comparing the online closing ratios for the retailers, we find that D_2 has a higher closing ratio for

[12]Clicking on the link to find a dealership on the Volvo design-and-build site, gets customers three dealer options, all with e-mail contacts.

[13]This Act prohibits manufacturers from discriminating between retailers unless explained by cost differences.

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	No. of Referrals	C.R.
D_1 manufacturer referral	$\lambda_H(\frac{1}{2-\alpha_u} - \frac{\alpha_u}{2})$	$1 - \frac{\alpha_u}{2}$	$\frac{\lambda_H((1-\alpha_u)^2+1)}{(2-\alpha_u)^2}$
D_2 manufacturer referral	$\frac{\lambda_H \alpha_u}{2}$	$1 - \frac{\alpha_u}{2} - \alpha_p$	$\frac{\lambda_H \alpha_u}{2-\alpha_u-2\alpha_p}$
D_2 infomediary referral (with manf. referral)	$\lambda_H(\frac{1-\alpha_u}{2-\alpha_u})$	$(1-\alpha_u)$	$\frac{\lambda_H}{2-\alpha_1}$
D_2 infomediary referral (w/o manf referral)	$E(S_1^I) - \frac{\alpha_u}{2}$	$(1-\alpha_u)$	$\frac{E(S_1^I)-\frac{\alpha_u}{2}}{(1-\alpha_u)}$

Anecdotal evidence suggests that, on the whole, manufacturer referral services experience a higher closing ratios than infomediaries.[14] 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.

5.4 Numerical Corroboration with Anecdotal Evidence

We show in this subsection that, over a wide range of parameters, our model generates propositions which are in accordance with anecdotal evidence. We discuss the parameter values used in this corroboration, followed by their implications for δ_c, K, and closing ratios.

First, consider the sizes of the different market segments. Klein and Ford (2001) in their survey of auto buyers point out 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.[15] Based on these data sources, we vary the value of α_u, 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 β from 0.6 to 1.

[14] "Car Dealers Fumbling Web Potential," www.ECommerceTimes.com, 06/21/01.
[15] "Microsoft CarPoint," HBS Case study, August 2000.

On acquisition costs, Scott-Morton, Zettelmeyer and Risso (2001) show that 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 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, λ_H, from zero to 0.4. Based on actual average gross margin of dealers (see Moon, 2000), we take $(V^h - W)$ to be 3500 and $(V^\ell - W)$ to be 1500.

Using these ranges for the parameters, we compute δ_c, the critical value of the acquisition cost, K, the infomediary referral fee, and closing ratios. We choose $\alpha_u \in [0, 0.5]$. We plot the critical value, δ_c. If the actual acquisition cost, δ, lies above the line, the manufacturer's profit increases after it establishes its own referral service. We find that the maximal δ_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).

Next we consider the price differences between offline and online channels. Scott-Morton, Zettelmeyer and Risso (2003a) show that the average Autobytel customer sees a contract price about \$500 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 \$400 and \$650.

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%. According to anecdotal evidence, Forddirect.com has a CR of 17% and GMBuypower.com has a CR of around 25%.[16] 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 between $20\% - 30\%$, slightly higher than industry evidence.[17] 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.

[16] www.trilogy.com/Sections/Industries/Automotive/Customers/FordDirect -Success-Story.cfm

[17] http://www.investorville.com/ubb/Forum2/HTML/000040.html

6 Business Implications, Conclusions and Extensions

We present a model with multiple consumer types, multiple information structures and multiple channels. 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 wholesale price set by the manufacturer. While both third-party and manufacturer referral services coexist today, anecdotal evidence suggests that infomediaries came into existence before manufacturers established their own referral services. One goal of our paper is to provide some insights into the evolvement of the current market structure.

Our analysis suggests that when manufacturers cannot directly sell to consumers, either due to legal restrictions or to avoid "channel conflict" with their retailers, the online referral model turns out to be a strategic tool for them to increase their channel power and profits. In particular, the referral mechanism by diverting traffic from offline to online channels leads to a reduction in retailers' acquisition costs, and increases their ability to price discriminate by exploiting the differences in consumers' price search behavior, both in terms of the number of prices they see and the channels (offline or online) in which the see them. The increase in profits happens despite retailers having to forgo information about consumer valuations online.

Our model implies that the entry of third-party referral services have hurt manufacturers in both components of its contract with retailers- reducing its franchisee fee and squeezing its optimal wholesale price. Hence, the decision by a manufacturer to invest in its own online referral service, increases its overall profits by increasing the franchise fee as well expanding the wholesale price region which maximizes its profits. 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 power of each agent.

Another implication of our model is that in markets with relatively inelastic market demand or high brand loyalty, the optimal wholesale price to coordinate the channel can be higher than the manufacturer's marginal cost. In particular, in markets characterized by the presence of heterogeneity in consumer valuations, the manufacturer finds it optimal to set the wholesale price equal to the valuation of low type consumers, in order to alleviate price competition between downstream retailers.

An interesting implication from our results is that once manufacturers have established their referral services, it may be in their best interest to not strive to eliminate (or buy out) third-party referral services. The competing infomediary referral services can actually helps rather than necessarily hurt manufacturers, by preventing Bertrand pricing among manufacturer referral prices. This in turn leads to higher profits for the manufacturer.

Finally, our results imply that in the presence of a competing third-party, a manufacturer will be able to achieve full channel coordination using a two-part tariff only under either of two circumstances: First, the manufacturer may be able to influence consumer search behavior in a way that consumers increasingly visit manufacturer referral services. This could potentially be done through heavy investments in advertising or strategic alliances with portals such as those of GM with AOL and Ford's with Yahoo. However, since infomediaries then might experience fewer customer visits, these alliances need to be monitored carefully in order to prevent the infomediaries from unravelling. This then hints at the fact that a manufacturer may prefer having an uncoordinated channel in markets where there are competing infomediaries.

Second, if manufacturers invest in e-CRM packages to collect more information about consumers who visit their referral services. This can enable their dealers to practice price discrimination online by inferring consumer valuations. Increasingly, Nissan and GMBuypower.com also, are investing in technologies to enable such personalized pricing initiatives online.[18]

CIP (2002) is the first study of the interesting and growing phenomenon of referral services for retailers. This paper is an attempt at extending the insights gained from that paper, to understand the implications of referral services for upstream players, i.e. manufacturers. One can think of several extensions. 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. In this case, either a Bertrand equilibrium results, with both retailers pricing at marginal cost, or, if retailers adopt a price-matching guarantee, they

[18] www-scf.usc.edu/ whalley/GMBuypower.txt

can sustain a collusive outcome with prices equal to V^{ℓ}. A logical extension would be to examine inter-brand competition with two manufacturers in the given set up. The increased upstream competition might lead to both retailers garnering some of the channel profits, due to the enhanced bargaining power arising from the threat of defection to the other manufacturer.

7 Appendix

Details of some steps in the Proofs of Propositions 1 and 3 are available in the Technical Appendix for Reviewers.

Proof of Lemma 1

First, suppose the manufacturer chooses some $W \leq V^{\ell}$.[19] 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.

Each retailer observes the type of each consumer, and hence charges a price contingent on this type. If a retailer sold only to its monopoly segment, the optimal price to type i ($i = \ell, h$ is just V^i. Now, suppose, for each retailer, P_i^m $(i = \ell, h)$ 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 V^i. Define $\gamma = \frac{\alpha_u + \alpha_p}{2}$ (so that $1 - \alpha_{_u} - \alpha_{_p} = 1 - 2\gamma$). At the price V^i, a retailer sells only to its captive segment, and its profit from consumer type i is $\lambda_{_i}\, \gamma\, (V^i - W)$.

Suppose the mixed strategy has no mass points (the distribution we derive satisfies this property). 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. Hence, its profit from consumer type i is $\lambda_{_i}\, (\gamma + G_i(P)(1 - 2\gamma))\, (P - W)$. Hence, $(\gamma + G_i(P)(1 - 2\gamma))\, (P - W) = \gamma\, (V^i - W)$. This implies $G_i(P) = \frac{\gamma}{1-2\gamma}\, (\frac{V^i - P}{P - W})$ (where $\frac{\gamma}{1-2\gamma} = \frac{\alpha_u + \alpha_p}{2(1-\alpha_u - \alpha_p)}$).

The lower bound on the support of the mixed strategy is found by setting $G_i(\hat{P}_i^h) = 1$, which yields $\hat{P}_i^h = \frac{1-2\gamma}{1-\gamma}\, W + \frac{\gamma}{1-\gamma}\, V^i$. Substituting for γ, we have $\hat{P}_i^h = \frac{2(1-\alpha_u-\alpha_p)}{2-\alpha_u-\alpha_p}\, W + \frac{\alpha_u+\alpha_p}{2-\alpha_u-\alpha_p}\, V^i$.

Next, 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 $P \in [\hat{P}_i^h, P_i^m]$, 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 $P < \hat{P}_i^h$, it captures the same market share as at $\hat{P}_i^h$, $(1 - \frac{\alpha_u + \alpha_p}{2})$, at a lower price. Hence, it makes a lower profit than at $\hat{P}_i^h$. 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 $-\frac{\delta}{2}$. The expected profit of each retailer is

$$\begin{aligned}
\pi &= \lambda_{_L} \int_{\hat{P}_\ell^h}^{V^\ell} \left\{ \frac{\alpha_{_u} + \alpha_{_p}}{2} + (1 - \alpha_{_u} - \alpha_{_p}) G_\ell(P) \right\} (P - W)\, g_\ell(P) dP\ + \\
&\quad \lambda_{_H} \int_{\hat{P}_h^h}^{V^h} \left\{ \frac{\alpha_{_u} + \alpha_{_p}}{2} + (1 - \alpha_{_u} - \alpha_{_p}) G_h(P) \right\} (P - W)\, g_h(P)\, dP - \frac{\delta}{2} - F \\
&= \frac{\alpha_{_u} + \alpha_{_p}}{2}\, (\lambda_{_H} V^h + \lambda_{_L} V^\ell - W) - \frac{\delta}{2} - F.
\end{aligned}$$

[19] Note that it cannot be optimal for the manufacturer to choose $W > V^{\ell}$. The maximal channel profit in the latter case is $\lambda_h V^h$. As long as λ_h is lower than $\frac{V^\ell}{V^h}$, this is not optimal.

Now, the manufacturer's profit is $\Pi_o = 2F + W = (\alpha_u + \alpha_p)(\lambda_H V^h + \lambda_L V^\ell - W) - \delta + W = (\alpha_u + \alpha_p)(\lambda_H V^h + \lambda_L V^\ell) - \delta + (1 - \alpha_u - \alpha_p)W$. Since $W \leq V^\ell$, this is maximized at $W^* = V^\ell$. Substituting $W = V^\ell$ into the equilibrium pricing and profit expressions derived above yields the statement of the Lemma. ■

Proof of Proposition 1

The existence of a threshold wholesale price $\hat{W}$ is demonstrated in Step 2. First, we construct mixed strategies for the players in terms of a generic wholesale price W, and in Step 2 demonstrate that these constitute an equilibrium for W in the relevant range. At this step, requiring that D_2 not make a higher profit by deviating to some other strategy imposes restrictions on the wholesale price, which leads to an implicit definition of $\hat{W}$.

Step 1: Construction of mixed strategies.

Suppose the manufacturer charges some wholesale price W. Consider $P_1(V^h)$, the price charged by D_1 to the high 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^h. Hence, $\frac{\alpha_u}{2}(P - W) + (1 - \alpha_u - \alpha_p + \alpha_p)(P - W)G_2^r(P) - F = \frac{\alpha_u}{2}(V^h - W) - F$, which implies $G_2^r(P) = \frac{\alpha_u(V^h - P)}{2(1-\alpha_u)(P-W)}$.

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

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 $\hat{P}^h$. First, note that the highest price that P_2^r will be set to is V^h. Further, in equilibrium $P_1(V^h)$ is being randomized. Hence, consumers of type V^h who observe P_2^r will buy either at $P_1(V^h)$ or at P_2^r. Therefore, $\lambda_H(1-\alpha_u)(P - W)G_1^h = \lambda_H(1-\alpha_u)(\hat{P}^h - W)G_1^h$ which implies $G_1^h = \frac{(\hat{P}^h - W)}{(P-W)} = \frac{\alpha_u(V^h - W)}{(2-\alpha_u)(P-W)}$.

Now, consider $P_2(V^h)$ and $P_2(V^\ell)$. Since P_2^r is always greater than V^ℓ, no consumer of type V^ℓ will buy at P_2^r. Hence, the equilibrium strategies for consumers of type V^ℓ exactly parallel those demonstrated by Narasimhan (1988). From this we can derive that the price distributions satisfy $G_1^\ell(P) = \frac{\hat{P}^\ell - W}{P-W} - \frac{\alpha_u}{2(1-\alpha_u-\alpha_p)} \frac{P - \hat{P}^\ell}{P-W}$, with a mass point at V^ℓ equal to $\frac{2\alpha_p}{2-\alpha_u}$, and $G_2^\ell(P) = \frac{\alpha_u + 2\alpha_p}{2(1-\alpha_u-\alpha_p)} \frac{V^\ell - P}{P-W}$, where $\hat{P}^\ell = W + \frac{(\alpha_u+2\alpha_p)(V^\ell - W)}{2-\alpha_u}$.

Step 2: Checking no-deviation conditions given the above strategies.

Next, we prove that the conjectured strategies constitute an equilibrium. Since the details are somewhat lengthy, this proof is provided in the Technical Appendix.

The threshold value of W emerges from the no-deviation conditions for D_2. Suppose D_2 deviates and chooses $P_2(V^\ell) = V^\ell, P_2^r \leq V^\ell$ and $P_2(V^h) = V^h$. Then, comparing its profit after deviation to its equilibrium profit, we find that the deviation is unprofitable if and only if

$$(1-\alpha_u)(\hat{P}^\ell - W) \quad \leq \quad \lambda_H(1-\alpha_u)(\hat{P}^h - W) + (1-\alpha_u-\alpha_p)\lambda_L(V^\ell - W)\frac{2\alpha_u}{(2-\alpha_u)}.$$

Clearly, if $W = V^\ell$, the inequality above is strictly satisfied, since in this case $\hat{P}^\ell = V^\ell = W$, and the LHS is zero with the RHS strictly positive. Hence, for W sufficiently close to V^ℓ, it must be satisfied as well. Solving the equality for W yields the threshold value $\hat{W}$.

Step 3: Determining expected profit for retailers.

We now proceed to derive the expected profit of each retailer when $W \geq \hat{W}$. Retailer D_1 sells to all of its captive segment, of size $\frac{\alpha_u}{2}$. In the other two segments, of size $(1-\alpha_u)$, it sells to the high consumer type, and only if $P_2^r > P_1(V^h)$, which happens with probability $G_2^r(P_1(V^\ell))$ at a price $P_1(V^\ell)$. In the partially informed segment of size α_p it sells to all the low type consumers. In the fully informed segment of size $1-\alpha_u-\alpha_p$, it sells to the low types only if $P_1(V^\ell) < P_2(V^\ell)$ which happens with the probability $G_2^\ell(P_1(V^\ell))$. Therefore, the gross profit of retailer D_1 (i.e., ignoring acquisition costs and the franchise fee) may be written as

$$\begin{aligned} \pi_1(P_1(V^h), P_1(V^\ell)) \quad = \quad & \frac{\alpha_u}{2}(\lambda_H P_1(V^h) + \lambda_L P_1(V^\ell) - W) + \\ & \alpha_p\left(\lambda_H G_2^r(P_1(V^h))\,(P_1(V^h) - W) + \lambda_L(P_1(V^\ell) - W)\right) + \\ & (1-\alpha_u-\alpha_p)\left(\lambda_H G_2^r(P_1(V^h))\,(P_1(V^h) - W) + \lambda_L G_2^\ell(P_1(V^\ell))\,(P_1(V^\ell) - W)\right) \end{aligned} \tag{7}$$

Substituting $P_1(V^h) = V^h$ and $P_1(V^\ell) = V^\ell$, this reduces to

$$E(\tilde{\pi}_1^i) \quad = \quad \frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W) + \alpha_p\lambda_L(V^\ell - W). \tag{8}$$

Suppose D_2 chooses some prices $P_2^r, P_2(V^h), P_2(V^\ell)$. For now, ignore acquisition costs and franchise and referral fees—none of these terms change as the prices $P_2^r, P_2(V^h), P_2(V^\ell)$ change. Then, the gross profits for D_2 can be written as follows.

$$\begin{aligned} \pi_2(P_2^r, P_2(V^h), P_2(V^\ell)) \quad = \quad & \underbrace{\frac{\alpha_u}{2}(\lambda_H P_2(V^h) + \lambda_L P_2(V^\ell) - W)} + \\ & \underbrace{\alpha_p\left(\lambda_H G_1^h(P_2^r)(P_2^r - W) + \lambda_L G_1^\ell(P_2^r)(P_2^r - W)\,1_{P_2^r \leq V^\ell}\right)} + \\ & \left\{\begin{array}{r} (1-\alpha_u-\alpha_p)\left(\lambda_H G_1^h(\min\{P_2^r, P_2(V^h)\})(\min\{P_2^r, P_2(V^h)\} - W) \quad + \right. \\ \left. \lambda_L G_1^\ell(\min\{P_2^r, P_2(V^\ell)\})(\min\{P_2^r, P_2(V^\ell)\} - W)\right) \end{array}\right. \end{aligned} \tag{9}$$

The gross profit in equilibrium of D_2 can be determined by substituting $P_2^r = V^h$, $P_2(V^h) = V^h$, and $P_2(V^\ell) = V^\ell$ (since any choice of $P_2^r, P_2(V^\ell)$ in the stated range leads to the same profit). This leads to an equilibrium gross profit for D_2 given by

$$\begin{aligned} E(\tilde{\pi}_2^i) \quad = \quad & \underbrace{\frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W)} + \underbrace{\alpha_p\left(\frac{\alpha_u}{2-\alpha_u}\right)\lambda_H(V^h - W)} + \\ + \quad & (1-\alpha_u-\alpha_p)\left(\lambda_H\frac{\alpha_u}{2-\alpha_u}(V^h - W) + \lambda_L\frac{2\alpha_p}{2-\alpha_u}(V^\ell - W)\right). \end{aligned} \tag{10}$$

Hence, $E(\tilde{\pi}_2^i) > E(\tilde{\pi}_1^i)$. ■

Proof of Proposition 2

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,

$$F^* = \min\{E(\tilde{\pi}_1^i),\ E(\tilde{\pi}_2^i)\} = \frac{\alpha_u}{2}\,\lambda_H(V^h - V^\ell) - \delta(1 - \frac{\alpha_u}{2}).$$

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 $E(\tilde{\pi}_2^i) - F^* - K^* = 0$, or

$$K^* \;=\; E(\tilde{\pi}_2^i) - F^* = \frac{\lambda_H\ \alpha_u(1-\alpha_u)}{2-\alpha_u}(V^h - V^\ell) + \alpha_p\ \delta.$$

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

The total profits of the manufacturer $2F + W = \alpha_u\ \lambda_H(V^h - W) + \lambda_L\ (\alpha_u + 2\alpha_p)(V^\ell - W) + W - \delta(2-\alpha_u)$. This expression is increasing in W if $(1-\alpha_u - 2\lambda_L\alpha_p) > 0$. Hence the manufacturer should charge W as high as possible if $(1-\alpha_u-2\lambda_L\alpha_p) > 0$. At $W = V^\ell$, the manufacturer's total profit is $= \alpha_u\lambda_H(V^h - V^\ell) + V^\ell - \delta(2-\alpha_u)$.

If the manufacturer were to charge $W = V^h$, then its total profits would be equal to $\lambda_H V^h - 2\delta(1 - \frac{\alpha_u}{2})$. Hence, the optimal $W = V^\ell$ iff

$$\alpha_u\lambda_H(V^h - V^\ell) + V^\ell \geq \lambda_H V^h \Longleftrightarrow \lambda_H \leq \frac{V^\ell}{\alpha_u V^\ell + (1-\alpha_u)V^h}.$$

which is true since $\lambda_H \leq \frac{V^\ell}{V^h}$.

This choice of W also maximizes total channel profits. This follows from comparing $2F^I + K^I + W$ at $W = V^\ell$ with the total channel profits when $W = V^h$.

Now total channel profits =

$$\frac{\alpha_u\lambda_H(3-2\alpha_u)}{(2-\alpha_u)}\,(V^h - V^\ell) + V^\ell - \delta(2 - \alpha_u - \alpha_p).$$

For this to be greater than $\lambda_H V^h - \delta(2-\alpha_u-\alpha_p)$, we need $\lambda_H \leq \frac{V^\ell}{V^h}$ which is true. ■

Proof of Proposition 3

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 $\beta = 0$, it must be the case that its monopoly price is $P_1^m = V^h$ (as shown in Proposition 1, this yields a higher profit than V^ℓ). Hence, $(\lambda_L + \lambda_H)\ \frac{\alpha_u}{2}(P - W) + (1 - \alpha_u)(P - W)G_2^r(P) - F = (\lambda_L + \lambda_H)\ \frac{\alpha_u}{2}(V^h - W) - F$ and $G_2^r(P) = \frac{\alpha_u(V^h - P)}{2(1-\alpha_u)(P-W)}$ Therefore, the distribution of P_2^r, $G_2^r(P)$, is identical to that in Proposition 1. This further yields that $\hat{P}^h = \frac{\alpha_u(V^h - W)}{2-\alpha_u} + W$, as before. Similarly for D_2, profit from pricing at any $P \in [\hat{P}^h, V^h]$ should be the same as the profit from pricing at $\hat{P}^h$. Hence, $(\lambda_L + \lambda_H)\ (\frac{\alpha_u}{2}(P_2^m - W) + (1 - \alpha_u)\ G_1^m(P)\ (P - W)) - K = (\lambda_L + \lambda_H)\ (\frac{\alpha_u}{2}(P_2^m - W) + (1 - \alpha_u)\ G_1^m(\hat{P}^h)\ (\hat{P}^h - W)) - K$ which implies $G_1^m(P) = \frac{(\hat{P}^h - W)}{(P_2^r - W)} = \frac{\alpha_u(V^h - W)}{(2-\alpha_u)(P-W)}$.

Next, for the $\beta = 0$ case, we show that the strategies exhibited in the Proposition do constitute an equilibrium. Note that $P_1^m = V^h$ 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^h. Further, by construction, $G_1^m(P)$ and $G_2^r(P)$ are best responses by the dealers, so a deviation to prices below $\hat{P}^h$ is not profitable either.

Finally, consider $G_2^m(P)$. First, observe that any price above V^h is sub-optimal, compared to V^h, since it loses all consumers in this segment. Suppose D_2 sets $P_2^m = P < V^h$. There are three effects on profit, as compared to charging $P_2^m = V^h$.
(a) in its captive segment, of size $\frac{\alpha_u}{2}$, it loses $(\lambda_L + \lambda_H)\ \frac{\alpha_u}{2}(V^h - P) = \frac{\alpha_u}{2}(V^h - P)$,
(b) in the segment of mass $(1 - \alpha_u - \alpha_p)$, if $P < P_2^r < P_1^m$, it cannibalizes its own sales, and loses an amount $(\lambda_L + \lambda_H)\ (1 - \alpha_u - \alpha_p)\ G_1^m(P)\ G_2^r(P)\ \text{Prob}(P_2^r < P_1^m \mid P_2^r > P)\ \{E(P_2^r \mid P < P_2^r < P_1^m) - P\}$, where $E(P_2^r \mid P < P_2^r < P_1^m)$ 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 $(1 - \alpha_u - \alpha_p)$, if $P < P_1^m < P_2^r$, it wins some sales over from D_1, leading to a gain $(\lambda_L + \lambda_H)\ (1 - \alpha_u - \alpha_p)\ G_1^m(P)\ G_2^r(P)\ \text{Prob}(P_1^m < P_2^r \mid P < P_1^m)\ (P - W)$.

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 $P_2^m < V^h$.

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, $P_1(V^h), P_1(V^\ell), P_2(V^h), P_2(V^\ell)$ 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 $\beta > 0$,

$P_1(V^h), G_1^\ell(P), P_2(V^h), P_2(V^\ell)$, 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 $\beta \in (0,1)$.

Step 4: Neither dealer has an incentive to deviate.

The details of this step are provided in the Technical Appendix.

As in Proposition 1, the threshold wholesale price $\hat{W}_m$ comes from a no-deviation condition on D_2. In Proposition 4, we show that the expected gross profit of D_2 in equilibrium in the web segment is $(1-\beta)\lambda_H \frac{\alpha_u}{2} \frac{4-3\alpha_u}{2-\alpha_u} (V^h - W)$. Since the strategies in the physical segment are unchanged, the gross profit of D_2 is

$$\beta E(\tilde{\pi}_2^i) + (1-\beta)\lambda_H \frac{\alpha_u}{2} \frac{4-3\alpha_u}{2-\alpha_u} (V^h - W),, \tag{11}$$

where $E(\tilde{\pi}_2^i)$ is as defined by equation (16).

As we show in the Technical Appendix, if D_2 instead deviates to a strategy with $P_2(V^\ell) = V^\ell, P_2^m = V^\ell, P_2(V^h) = V^h$, and P_2^r randomized over $[\hat{P}^\ell, V^\ell]$, the profit after deviation is

$$\begin{aligned} &\beta \frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W) + \beta\, \alpha_p(V^\ell - W) + \\ &+\beta\,(1-\alpha_u-\alpha_p)(V^\ell - W) + (1-\beta)(1-\frac{\alpha_u}{2})(V^\ell - W). \end{aligned} \tag{12}$$

If $W = V^\ell$, the expression in equation (12) reduces to $\beta\, \lambda_H\, \frac{\alpha_u}{2}(V^h - V^\ell)$, and exactly equals the first term in equation (11). Since the second term in (11) are also positive, the equilibrium profit is strictly higher. Hence, for values of W close enough to V^ℓ, the deviated profit must continue to be less than the equilibrium profit. Setting the expressions in equations (11) and (12) equal yields the threshold value $\hat{W}_m$. ∎

Proof of Proposition 4

(i) First, note that the strategies of both firms in the β segments of the market have not changed. Hence, the expected sales of D_1 in these segments amount to as those from before (from Proposition 1). Consider the sales of D_1 in the $(1-\beta)$ segments. Its expected sales here amount to $\lambda_H(1-\beta)\left(\frac{\alpha_u}{2} + \int_{\hat{P}^h}^{V^h}(1-\alpha_u)\, G_2^r(P)\, g_1^m(P)dP\right) = \lambda_H(1-\beta)\left(\frac{1}{2-\alpha_u} - \frac{\alpha_u}{2}\right)$. Since the total size of the market is constant, the expected sales of D_2 are $E(S_2^m) = 1 - E(S_1^m) = 1 - \lambda_H(1-\beta)\left(\frac{1}{2-\alpha_u} - \frac{\alpha_u}{2}\right)$.

(ii) The expected manufacturer referral price of D_1 (accounting for the mass point at P^m) is $E(P_1^m) = (1 - G_1^m(V^h)) \int_{\hat{P}^h}^{V^h} P g_1^m(P)\, dP + G_1^m(V^h)\, V^h$, which yields the expression in the statement of the Proposition. The expected infomediary price of D_2, $E(P_2^r)$ does not change, compared to Proposition 1, since the distribution of P_2^r is the same in equilibrium. Hence it is given by $E(P_2^r) = \int_{\hat{P}^h}^{P^m} P\, g_2^r(P)dP = W + \frac{\alpha_u\, (\ln \frac{2-\alpha_u}{\alpha_u})\, (V^h - W)}{2(1-\alpha_u)}$.

(iii) The profit of D_1 from the web segment is

$$E(\pi_1^m) \;=\; (1-\beta)\, \lambda_H \int_{\hat{P}^h}^{P^m} \left(\frac{\alpha_u}{2} + (1-\alpha_u) G_2^r(P)\right)\, (P - W)\, g_1^m(P)dP$$

$$= \quad (1-\beta)\lambda_{H}(\frac{\alpha_{u}\,(V^h - W)}{2}).$$

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

$$(1-\beta)\lambda_{H}\left\{\frac{\alpha_{u}}{2}(V^{\ell} - W) + \int_{\hat{P}^h}^{P^m} (1-\alpha_{u})G_1^m(P)\,(P-W); g_2^r(P)dP\right\}$$
$$= (1-\beta)\lambda_{H}(\frac{\alpha_{u}(4-3\alpha_{u})\,(V^h - W)}{2(2-\alpha_{u})}. \qquad \blacksquare$$

Proof of Proposition 5

(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 4, following the same logic as in Proposition 2. Hence

$$F^m = \beta F^I + (1-\beta)\lambda_{H}(\frac{\alpha_{u}\,(V^h - V^{\ell})}{2}) \tag{13}$$
$$K^m = \beta K^I + (1-\beta)\lambda_{H}(\frac{\alpha_{u}(1-\alpha_{u})\,(V^h - V^{\ell})}{2-\alpha_{u}}). \tag{14}$$

(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 $F^m - F^I$. 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 $F^m > F^I$, we show that the difference in the gross profits of D_1 is positive.

From Proposition 2 and Proposition 4, the difference in the gross profits of D_1 after the establishment of the manufacturer's referral service is

$$(1-\beta)\left(\frac{\alpha_{u}\,\lambda_H(V^h - V^{\ell})}{2} - E(\pi_1^o)\right) \quad = \quad (1-\beta)\left(1 - \frac{\alpha_{u}}{2}\right)\delta.$$

Since $(1-\beta) > 0$, this difference is positive. $\blacksquare$

Proof of Proposition 6

Recall equation (4). Compare this to equation (2) and take the difference. We get

$$\left(\alpha_{u}\frac{(3-2\alpha_{u})}{(2-\alpha_{u})} - 1\right)(\lambda_{H}(V^h - V^{\ell})) + \delta(1-\beta)(2-\alpha_{u}-\alpha_{p}) + V^{\ell}((1-\beta)\lambda_{H} - 1).$$

Now $\frac{\alpha_u(3-2\alpha_u)}{2-\alpha_u} < 1$, so the first term is always negative. The third term is also always negative. However, $\beta < 1$ and $(2-\alpha_{u}-\alpha_{p}) > 1$, so the second term could be positive or negative. Since the equation is linear, one can find a critical value of δ or a critical value of β, beyond which this difference is always positive. $\blacksquare$

Proof of Proposition 7

In the absence of the referral price from the Infomediary, both dealers become symmetric: Each has two offline prices (for high and low valuation customers) and 1 manufacturer referral price. Following the steps outlined in the Proof of Proposition 1 and 2, one can show that the equilibrium pricing strategies consists of the following: The manufacturer chooses a wholesale price $W \geq \hat{W}$ and there exists an equilibrium in which:
(i) $P_1(V^h), P_1(V^\ell), P_2(V^h)$, and $P_2(V^\ell)$ are set exactly as in Lemma 1 (a),
(ii) P_1^m and P_2^m are randomly chosen over $[\hat{P}^h, V^h]$, where $\hat{P}^h = W + \frac{(\alpha_u+\alpha_p)(V^h-W)}{(2-\alpha_u-\alpha_p)}$. Further, $G_1^m(P) = \frac{\alpha_u(V^h-P)}{2(\alpha_u+\alpha_p)(P-W)}$.

The total profits of the manufacturer are $2F + W =$

$$2\left(\beta(\frac{(\alpha_u+\alpha_p)\lambda_H(V^h-W)}{2} - \delta) + (1-\beta)\frac{(1-\alpha_u-\alpha_p){\alpha_u}^2\lambda_H(V^h-W)}{(\alpha_u+\alpha_p)(1-\alpha_u)}\right) + (\beta + \lambda_H(1-\beta)V^\ell).$$

Comparing this to the total profits of the Manufacturer given by $2F^m + W$ from (13), we find that the difference is always positive when $\beta = 0$, while the difference can be negative when $\beta = 1$. Given that the expression is linear in β, we can then find the critical value of β such that the Proposition then follows. ∎

Appendix B

7.1 Suppose the Infomediary Enrols both Retailers

Types	$\frac{\alpha_u}{2}$	$\frac{\alpha_u}{2}$	α_p	$1-\alpha_u-\alpha_p$
HV Consumers	$P_1(V^h)$	$P_2(V^h)$	$P_1(V^h), P_1^r, P_2^r$	$P_1(V^h), P_2(V^h), P_1^r, P_2^r$
LV Consumers	$P_1(V^\ell)$	$P_2(V^\ell)$	$P_2(V^\ell), P_1^r, P_2^r$	$P_1(V^h), P_2(V^h), P_1^r, P_2^r$

Table 1: Different prices observed by each consumer segment

In this case the equilibrium prices are $P_1(V^h) = P_2(V^h) = V^h$ and $P_1(V^\ell) = P_2(V^\ell) = V^\ell$. $P_1^r = P_2^r = W$. This gives profits of each retailer $= \lambda_H(\frac{\alpha_u}{2}(V^h - W) + \lambda_L(\frac{\alpha_u}{2}(V^\ell - W) + \alpha_p(W - W) + (1-\alpha_u-\alpha_p)(W-W) - \delta(1-\frac{\alpha_u}{2}) = \frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W) - \delta(1-\frac{\alpha_u}{2})$. It is immediate to show that the gross profits of each retailer are either less than (for D_2) or equal to (for D_1) the profits when neither of them are enrolled with the infomediary. *Hence the infomediary will enroll only one retailer. This also implies that only one retailer will wish to enroll with the infomediary.*

7.2 Suppose the Manufacturer Enrols One Retailer

Notice from Tables (2) and (3) that the prices observed by the α_p segment remain unchanged, when the manufacturer enrolls only the non-Infomediary enrolled dealer. Further, the $(1-\beta)(1-\alpha_u-\alpha_p)$ segment becomes equivalent to the $(1-\beta)\alpha_p$ segment, in terms of the prices they observe. This prevents the non-enrollment of D_2 by the manufacturer referral service, from having any impact on $D_1's$, and consequently, the manufacturer's own profits.

Types	$\frac{\beta\alpha_u}{2}$	$\frac{(1-\beta)\alpha_u}{2}$	$\frac{\alpha_u}{2}$	$\beta\alpha_p$	$(1-\beta)\alpha_p$	$\beta(1-\alpha_u-\alpha_p)$	$(1-\beta)(1-\alpha_u-\alpha_p)$
HV	$P_1(V^h)$	P_1^m	$P_2(V^h)$	$P_1(V^h)$,P_2^r	P_1^m,P_2^r	$P_1(V^h)$,$P_2(V^h)$,P_2^r	P_1^m,P_2^r
LV	$P_1(V^\ell)$	P_1^m	$P_2(V^\ell)$	$P_1(V^\ell)$,P_2^r	P_2^m,P_2^r	$P_1(V^\ell)$,$P_2(V^\ell)$,P_2^r	P_1^m,P_2^r

Table 2: Different Prices Observed by Each Segment if Manufacturer Enrols One Retailer

References

[1] Brynjolfsson, Erik and Michael Smith. 2000. Frictionless Commerce? A Comparison of Internet and Conventional Retailers. *Management Science*, 46(4): 563–585.

[2] Chen Yuxin, Ganesh Iyer and V. Padmanabhan. 2002. Referral Infomediaries. *Marketing Science*, 21(4): 412–434.

[3] Clemons, Eric, Il-Horn Hann and Lorin Hitt. 2002. Price Dispersion and Differentiation in Online Travel: An Empirical Investigation. *Management Science*, 48(4): 534–549.

[4] Coughlan, Anne. 1995. Competition and Cooperation in Marketing Channel Choice. *Marketing Science*, 2 110–129.

[5] Ingene, Chuck and Mark Parry. 1995. Channel Coordination When Retailers Compete. *Marketing Science*, 14(4) 360–377.

[6] Iyer, Ganesh and Amit Pazgal. 2003. Internet shopping agents: Virtual colocation and competition. *Marketing Science*, 22 (1) 85–106.

[7] Klein, Lisa and G. Ford. 2001. Consumer Search for Information in the Digital Age: An Empirical Study of Pre-Purchase Search for Automobiles. working paper, Rice University.

[8] Lal Rajiv and Miklos Sarvary. 1999. When and how is the Internet likely to decrease price competition. *Marketing Science*, 18 485?-503.

[9] Moon Y. Autobytel.com. HBS Case study, May 2000.

[10] Moorthy, K. Sridhar. 1987. Managing Channel Profits: Comments. *Marketing Science*, 6, 375–379.

[11] Narasimhan, Chakravarthi. 1988. Competitive Promotional Strategies. *Journal of Business*, 61, 427–449.

[12] Ratchford, Brian, M. Lee, and Debabrata Talukdar. 2002. The Impact of the Internet on Information Search for Automobiles. working paper, University of Maryland.

[13] Rey, P. and Joseph Stiglitz. 1995. The Role of Exclusive Territories in Producers' Competition. *RAND Journal of Economics*, 26, 431–451.

[14] Scott-Morton Fiona, Florian Zettlemeyer, and Jorge-Silvo Risso 2001. Internet Car Retailing. *Journal of Industrial Economics*, 49(4): 501–519.

[15] Scott-Morton Fiona, Florian Zettlemeyer, and Jorge-Silvo Risso 2003a. Consumer Information and Discrimination: Does the Internet Affect the Pricing of New Cars to Women and Minorities?. *Quantitative Marketing and Economics*, 1(1): 65–92.

[16] Scott-Morton Fiona, Florian Zettlemeyer, and Jorge-Silvo Risso. 2003b. The Effect of Information and Institutions on Price Negotiations: Evidence from Matched Survey and Auto Transaction Data. working paper, Yale University.

[17] Shaffer, Greg and Florian Zettelmeyer. 2002. When Good News about Your Rival is Good for You: The Effect of Third-Party Information on the Division of Channel Profits. *Marketing Science* 21 (3): 273–293.

[18] Florian Zettlemeyer, Fiona Scott-Morton and Jorge-Silvo Risso. 2003a. Cowboys or Cowards: Why are Internet Car Prices Lower?. working paper, UC Berkeley.

[19] Varian, Hal. 1980. A Model of Sales. *American Economic Review*, 70(4) 651–659.

8 Technical Appendix for Reviewers

Proof of Proposition 1

Details of Step 2:

Having constructed the equilibrium, we prove that the conjectured strategies constitute an equilibrium. Consider D_1 first. Since all its sales are offline, it knows the consumer type before it chooses its price for each consumer. Hence, a deviation in $P_1(V^h)$ or $P_1(V^\ell)$ does not affect its profit from consumers of type V^ℓ or V^h, respectively. That is, it is sufficient to rule out deviations in each of $P_1(V^h)$ and $P_1(V^\ell)$ in isolation. By construction, G_1^h and G_1^ℓ are best responses, ruling out such deviations.

Next, consider firm 2. This dealer is choosing three prices, $P_2(V^h), P_2(V^\ell), P_2^r$. Since all three are chosen jointly to maximize its profits, to show that its choices are optimal, we must consider joint deviations in these prices.

For clarity, we first show that each price is optimal given the other two prices D_2 charges, and then consider joint deviations in two or more prices.

First, consider $P_2(V^h)$. At any price $P \in [V^\ell, V^h]$, D_2 sells only to its own captive segment, $\frac{\alpha_u}{2}$, of the high type consumer. Since sales are unchanged at all these prices, V^h is optimal in this set.

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

(a) in its captive segment, it loses $\lambda_H \frac{\alpha_u}{2} (V^h - P_2(V^h))$,

(b) In the fully informed segment (of mass $(1 - \alpha_u - \alpha_p)$), it was not making sales at all; it was fighting for the high types using P_2^r by randomizing it between $(\hat{P}^h, V^h)$. By reducing its price below V^h, in the segment of mass $(1 - \alpha_u - \alpha_p)$, if $P < P_2^r < V^h$, it cannibalizes its own sales, and loses an amount $\lambda_H (1 - \alpha_u - \alpha_p) G_1^h(P) G_2^r(P) \text{Prob}(P_2^r < P_1(V^h) \mid P_2^r > P) \{E(P_2^r - P_2(V^h))\}$, where $E(P_2^r \mid P < P_2^r < P_2(V^h)$ is the expected price at which the cannibalized sales were being made (the conditioning event is that $P < P_2^r < P_1(V^h)$).

(c) finally, in the segment of mass $(1 - \alpha_u - \alpha_p)$, if $P < P_1(V^h) < P_2^r$, it wins some sales over from D_1, leading to a gain $\lambda_H (1 - \alpha_u - \alpha_p) G_1^h(P) G_2^r(P) \text{Prob}(P_1(V^h) < P_2^r \mid P < P_1(V^h)) (P - W)$.

Replacing the relevant expressions for $G_1^h(P)$ and $G_2^r(P)$, and evaluating the conditional probabilities and expectations, we find that, in overall terms, the firm incurs a net loss from deviation, given by

$$\alpha_u (\frac{V^h - P}{2})(1 + \frac{(\alpha_u(1 - \alpha_u - \alpha_p)(V^h - W)(2(V^h - P)(V^h + P - 2W)}{2(2 - \alpha_u)(1 - \alpha_u)(V^\ell - W)(V^h + P - 2W)(P - W)} + \frac{(3P + V^h - 4W)(V^h - W)(Log\frac{(P-W)}{(V^h-W)})}{2(2 - \alpha_u)(1 - \alpha_u)(V^h - W)(V^h + P - 2W)(P - W)}).$$

[20] Hence, it will not deviate to $P_2(V^h) < V^h$.

[20]For brevity, algebraic details that do not provide insight into the model are omitted here but are available from

By construction, $P_2(V^\ell)$ and P_2^r are best responses. Hence, deviating in one of these alone cannot improve the profit of D_2.

Next, we look at possible joint deviations for D_2. Suppose D_2 chooses some prices $P_2^r, P_2(V^h), P_2(V^\ell)$. For now, ignore acquisition costs and franchise and referral fees—none of these terms change as the prices $P_2^r, P_2(V^h), P_2(V^\ell)$ change. Then, the gross profits for D_2 can be written as follows.

$$
\begin{aligned}
\pi_2(P_2^r, P_2(V^h), P_2(V^\ell)) \quad = \quad & \underbrace{\frac{\alpha_u}{2}(\lambda_H P_2(V^h) + \lambda_L P_2(V^\ell) - W)}+ \\
& \underbrace{\alpha_p \left(\lambda_H G_1^h(P_2^r)(P_2^r - W) + \lambda_L G_1^\ell(P_2^r)(P_2^r - W)\ 1_{P_2^r \le V^\ell}\right)}+ \\
& \left\{ \begin{array}{lr} (1-\alpha_u-\alpha_p)\left(\lambda_H G_1^h(\min\{P_2^r, P_2(V^h)\})(\min\{P_2^r, P_2(V^h)\} - W)\right. & + \\ \left.\qquad\qquad \lambda_L G_1^\ell(\min\{P_2^r, P_2(V^\ell)\})(\min\{P_2^r, P_2(V^\ell)\} - W)\right) & \end{array}\right.
\end{aligned} \tag{15}
$$

The *first* term is the profits of the dealer from the high and low valuation customers in the uninformed segment of mass α_u. The *second* term indicates its profit from the low valuation and high valuation customers in the partially informed segment of mass α_p. Recall that in this segment, the consumers are seeing two prices, P_2^r and $P_1(V^h)$ or P_2^r and $P_1(V^\ell)$ (depending on whether they are high types or low types). Hence for D_2 to make any sales, there should exist a positive probability that $P_2^r > P_1(V^h)$ and $P_2^r > P_1(V^\ell)$. The *third* term indicates its profits from the high valuation and low valuation customers in the fully informed segment. Recall that in this segment, the consumers are seeing two prices of D_2, $P_2^r, P_2(V^h)$ or $P_2^r, P_2(V^\ell)$ (depending on whether they are high types or low types). Hence any sales that D_2 makes in these segments will occur only at the *minimum* of $(P_2^r, P_2(V^h))$ for the high types and *minimum* of $(P_2^r, P_2(V^h))$ for the low types.

The gross profit in equilibrium of D_2 can be determined by substituting $P_2^r = V^h$, $P_2(V^h) = V^h$, and $P_2(V^\ell) = V^\ell$ (since any choice of $P_2^r, P_2(V^\ell)$ in the stated range leads to the same profit). This

the authors on request.

leads to an equilibrium gross profit for D_2 given by

$$\pi_2^* = \underbrace{\frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W)}+\underbrace{\alpha_p\left(\frac{\alpha_u}{2-\alpha_u}\right)\lambda_H(V^h - W)}+ \\ +\Big\{ \quad (1-\alpha_u-\alpha_p)\left(\lambda_H \frac{\alpha_u}{2-\alpha_u}(V^h - W) + \lambda_L \frac{2\alpha_p}{2-\alpha_u}(V^\ell - W)\right) \tag{16}$$

Now, consider a deviation by firm 2. Note that it will never choose $P_2(V^\ell)$ outside the range $[\hat{P}^\ell, V^\ell]$. Any price higher than V^ℓ leads to no sales at the price $P_2(V^\ell)$, so such prices are dominated by V^ℓ. Similarly, any price lower than $\hat{P}^\ell$, given the strategy of D_1, is dominated by $\hat{P}^\ell$. Hence, we consider deviations by firm 2 in P_2^r and $P_2(V^h)$. The following deviations are feasible:

1. Suppose $V^\ell < P_2^r < \hat{P}^h$ and $P_2(V^h) < V^h$. There could be two possibilities here:

   (i) $P_2^r < P_2(V^h)$

   (ii) $P_2^r > P_2(V^h)$.

   Consider equation (15) and case (i) first. From the first scenario, it turns out that $\min\{P_2^r, P_2(V^h)\}$ is less than $\hat{P}^h$. So $G_1^h(\min\{P_2^r, P_2(V^h)\}) = 1$. In the same vein, $G_1^\ell(\min\{P_2^r, P_2(V^\ell)\}) = 0$ and $(\min P - W) < (\hat{P}^h - W)$. If the deviation occurs, the deviated profits are given by

   $$\pi_2 = \frac{\alpha_u}{2}(\lambda_H P + \lambda_L V^\ell - W) + \alpha_p \lambda_H (P - W) + (1-\alpha_u-\alpha_p)\lambda_H (P - W). \tag{17}$$

   Since $P < \hat{P}^h$, $\frac{V^h - W}{P - W} \geq \frac{2-\alpha_u}{\alpha_u}$, from the definition of $\hat{P}^h$. Thus it is shown that each of the terms in equation (17) turn out to be lower than or equal to the corresponding terms in equation (16). Hence, D_2 does not have a profitable deviation.

   From the second scenario, in the claimed equilibrium, we have P_2^r being randomized between $(\hat{P}^h, V^h)$. Hence, it again turns out that $\min\{P_2^r, P_2(V^h)\}$ is less than $\hat{P}^h$. Thus, D_2 does not have a profitable deviation.

2. Suppose $P_2^r \leq V^\ell$. Then, it cannot be profitable to set $P_2(V^h)$ such that $V^\ell < P_2(V^h) < V^h$. This is because, in the fully informed segment, no consumer buys at the price $P_2(V^h)$ (since

all these consumers also see the lower price P_2^r). Further, in the uninformed segment, this leads to lower profit from the high valuation consumers.

Further, if $P_2^r < V^\ell$, it cannot be profitable to set $P_2(V^h) < V^\ell$. Again, D_2 earns less in the uninformed segment; in the remaining fully informed segment, at best, it cannibalizes sales it would otherwise have made at the price P_2^r (if $P_2(V^h) < P_2^r$).

3. Next, suppose that $P_2^r \leq V^\ell$, and $P_2(V^\ell) < P_2^r$, with $P_2(V^h) = V^h$. In a similar manner to (1) above, it can be shown that D_2 cannot deviate to any profitable equilibrium since it only loses profits in the uninformed segments.

4. Finally we check for the case when $P_2(V^\ell) = V^\ell, P_2^r \leq V^\ell$ and $P_2(V^h) = V^h$. From equation (15) and (16) we find that the deviation is unprofitable iff $(1-\alpha_u)(\hat{P}^\ell - W) \leq \lambda_H(1-\alpha_u)(\hat{P}^h - W) + (1-\alpha_u-\alpha_p)\lambda_L(V^\ell - W)\frac{2\alpha_u}{(2-\alpha_u)}$. Solving the equality for W leads to the threshold value of $\hat{W}$.

Thus, the specified strategies constitute an equilibrium, as long as $W \geq \hat{W}$.

Proof of Proposition 3

Details of Step 4

Consider D_1 first. In the physical (β) segment, since all its sales are offline, it knows the consumer type before it chooses its price for each consumer. Hence, a deviation in $P_1(V^h)$ or $P_1(V^\ell)$ does not affect its profit from consumers of type V^ℓ or V^h, respectively. That is, it is sufficient to rule out deviations in each of $P_1(V^h)$ and $P_1(V^\ell)$ in isolation. Similarly, any deviation in P_1^m does not affect its profit in the physical segment. In the web $(1-\beta)$ segment, by construction, G_1^m is a best responses, ruling out such deviations. Finally, since any change in $P_1(V^h)$ or $P_1(V^\ell)$

does not impact sales made by D_1 at P_1^m in the web segment, any joint deviation in all 3 prices does not fetch higher profits.

Next we rule out possible joint deviations for D_2. Suppose D_2 chooses some prices $P_2^r, P_2(V^h), P_2(V^\ell), P_2^m$. For now, ignore acquisition costs and franchise and referral fees—none of these terms change as the prices $P_2^r, P_2(V^h), P_2(V^\ell), P_2^m$ change. Then, the gross profits for D_2 can be written as follows.

$$\begin{aligned}
\pi_2(P_2^r, P_2(V^h), P_2(V^\ell), P_2^m) \quad = \quad & \beta(\underbrace{\frac{\alpha_u}{2}(\lambda_H P_2(V^h) + \lambda_L P_2(V^\ell) - W)}) + \\
& \beta(\underbrace{\alpha_p \left(\lambda_H G_1^h(P_2^r)(P_2^r - W) + \lambda_L G_1^\ell(P_2^r)(P_2^r - W)\, 1_{P_2^r \le V^\ell}\right)}) + \\
& \left\{ \begin{array}{ll} \beta((1-\alpha_u-\alpha_p)\left(\lambda_H G_1^h(\min\{P_2^r, P_2(V^h)\})(\min\{P_2^r, P_2(V^h)\} - W) \right. & + \\ \left. \qquad \lambda_L G_1^\ell(\min\{P_2^r, P_2(V^\ell)\})(\min\{P_2^r, P_2(V^\ell)\} - W)\right)) & \end{array} \right\}
\end{aligned} \tag{18}$$

$$\begin{aligned}
+ \quad & (1-\beta)(\underbrace{\frac{\alpha_u}{2}(\lambda_H P_2^m + \lambda_L P_2^m - W)}) + \\
& (1-\beta)(\underbrace{\alpha_p \left(\lambda_H G_1^m(P_2^r)(P_2^r - W) + \lambda_L G_1^m(P_2^r)(P_2^r - W)\, 1_{P_2^r \le V^\ell}\right)}) + \\
& \left\{ \begin{array}{ll} (1-\beta)(1-\alpha_u-\alpha_p)\,(\lambda_H G_1^m(\min\{P_2^r, P_2^m\})(\min\{P_2^r, P_2^m\} - W) & + \\ \qquad \lambda_L G_1^m(\min\{P_2^r, P_2^m\})(\min\{P_2^r, P_2^m\} - W)) & \end{array} \right\}
\end{aligned} \tag{19}$$

The gross profit in equilibrium of D_2 can be determined by substituting $P_2^r = V^h$, $P_2^m = V^h$, $P_2(V^h) = V^h$, and $P_2(V^\ell) = V^\ell$ (since any choice of $P_2^r, P_2(V^\ell)$ in the stated range leads to the same profit). This leads to an equilibrium gross profit for D_2 given by

$$\begin{aligned}
\pi_2^* \quad = \quad & \beta\,\underbrace{\frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W)} + \beta\,\underbrace{\alpha_p \left(\frac{\alpha_u}{2-\alpha_u}\right)\lambda_H (V^h - W)} + \\
& + \left\{\beta(1-\alpha_u-\alpha_p)\left(\lambda_H \frac{\alpha_u}{2-\alpha_u}(V^h - W) + \lambda_L \frac{2\alpha_p}{2-\alpha_u}(V^\ell - W)\right)\right. \\
+ \quad & (1-\beta)\,\underbrace{\frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W)} + (1-\beta)\,\underbrace{\alpha_p \left(\frac{\alpha_u}{2-\alpha_u}\right)\lambda_H (V^h - W)} + \\
& + \left\{(1-\beta)(1-\alpha_u-\alpha_p)\left(\lambda_H \frac{\alpha_u}{2-\alpha_u}(V^h - W) + \lambda_L \frac{\alpha_u}{2-\alpha_u}(V^h - W)\right)\right.
\end{aligned} \tag{20}$$

1. In the β segment, deviations in $P_2(V^h), P_2(V^\ell), P_2^r$ can be ruled out as done earlier in Proposition 1.

2. Consider the $(1-\beta)$ segment. D_2 has two strategies P_2^r and P_2^m. Suppose $V^\ell < P_2^r < \hat{P}^h$ and $P_2^m < V^h$. There could be two possibilities here:

   (i) $P_2^r < P_2^m$

   (ii) $P_2^r > P_2^m$.

   Consider equation (19) and case (i) first. From the first scenario, it turns out that $\min P_2^r, P_2^m$ is less than $\hat{P}^h$. So $G_1^m(\min P_2^r, P_2^m) = 1$ and $(\min P - W) < (\hat{P}^h - W)$. Then it can be shown, similar to the Proof of Proposition 1 that each of the terms in equation (19) turn out to be lower than or equal to the corresponding terms in equation (20). Hence, D_2 does not have a profitable deviation.

   From the second scenario, in the claimed equilibrium, we have P_2^r being randomized between $(\hat{P}^h, V^h)$. Hence, it again turns out that $\min\{P_2^r, P_2^m\}$ is less than $\hat{P}^h$. Thus, D_2 does not have a profitable deviation.

3. Suppose $P_2^r \leq V^\ell$. Then, it cannot be profitable to set P_2^m such that $V^\ell < P_2^m < V^h$. This is because, in the fully informed segment, no consumer buys at the price P_2^m (since all these consumers also see the lower price P_2^r). Further, in the uninformed segment, this leads to lower profit from the high valuation consumers. Further, if $P_2^r < V^\ell$, it cannot be profitable to set $P_2^m < V^\ell$. Again, D_2 earns less in the uninformed segment; in the remaining fully informed segment, at best, it cannibalizes sales it would otherwise have made at the price P_2^r (if $P_2^m < P_2^r$).

4. Finally we check for the case when $P_2(V^\ell) = V^\ell, P_2^r \leq V^\ell$, $P_2^m = V^\ell$ and $P_2(V^h) = V^h$. The deviated profits are given by

$$\beta \, \frac{\alpha_u}{2}(\lambda_H V^h + \lambda_L V^\ell - W) + \beta \, \alpha_p (V^\ell - W) +$$

$$+\beta\,(1-\alpha_u-\alpha_p)(V^\ell-W)+(1-\beta)(1-\frac{\alpha_u}{2})(V^\ell-W).$$

Comparing this with equation (20), leads us to the critical value of the wholesale price $\hat{W}_m$. For wholesale prices $W \geq \hat{W}_m$, the deviation is not profitable. Thus, the specified strategies constitute an equilibrium for all $W \geq \hat{W}_m$. ∎