Selling an Opaque Product through an Intermediary: The Case of Disguising One's Product*

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Abstract:

This paper models multiple service providers who use an intermediary to sell an opaque product. An opaque product is a product whose identity is concealed from consumers until after purchase. I find that an opaque good may allow finer segmentation of a service provider's customer base, lead to market expansion, and/or reduce price rivalry. However, if there is little brand-loyalty in an industry, an opaque good increases the degree of price rivalry and reduces total industry profit. The paper also discusses issues regarding channel structure and outlines managerial implications of this research.

Keywords: Opaque Products, Pricing, Channels, Intermediaries, Hotwire, Priceline, E-Commerce

Introduction

What is an Opaque Good?

Consider two service providers, *A* and *B*, selling their respective services at the prices P_A and P_B, respectively. Now suppose an intermediary has a third offering at a price P_I. The intermediary withholds the identity of this good and instead only informs a consumer that if P_I is paid, she will be the awarded either the service provided by firm *A* or the service provided by firm *B*. This stochastic offering by the intermediary is known as an "opaque" good.

Hotwire and Priceline are two prominent examples in the travel industry of intermediaries specializing in offering opaque goods. For example, one can reserve a rental car through traditional channels or one can purchase from hotwire.com and receive a car from Avis, Budget, or Hertz, where the supplier is not revealed until after purchase. Examples of non-travel opaque goods include: Priceline's (now discontinued) offerings of automobile insurance, gasoline, groceries, home financing, new-car sales, and pre-paid long distance service; in the consignment businesses, apparel manufacturers concealing their brand name by snipping off the tag; package-goods manufacturers of national brands serving as the (anonymous) suppliers of private labels.

Although both Hotwire and Priceline offer opaque travel products, they determine transaction prices differently. On Hotwire, consumers see a posted price. On Priceline, consumers place non-retractable bids ─ hence, the "Name-Your-Own-Price" slogan. The model presented in this paper is consistent with the posted price model employed by Hotwire. Previous papers (e.g., Hann and Terwiesch 2003; Fay 2004; Terwiesch, Savin, and Hann 2005) have studied the NYOP format, but none of these papers account for how product opacity affects the market.

Research Questions

The press has actively discussed the opaque channel, especially as exemplified by Priceline. However, there appears to be a divergence of opinions. Some argue that opaque products purely augment existing markets because they only sell to extremely price-sensitive consumers who would not have purchased through traditional channels (Coy and Moore 2000, Dolan 2001, Leo Mullin in Ross 2001). In fact, both Hotwire and Priceline make this argument in an effort to induce sellers to participate in their respective systems (Dolan and Moon 2000, McGarvey 2000). On the other hand, competition from yet another channel may further erode profit margins. Sviokla (2003) asserts that opaque sites will dramatically reduce the level of prices sustainable in the traditional channels: "Hotels, car-rental companies, and cruise lines are losing their pricing authority. In all of these industries, there is a strong incentive to provide last-minute inventory, which starts a cycle of price degradation that will eventually lead to the kind of price war that is destroying the airlines." These conflicting views lead to great ambiguity as to how an opaque product affects traditional channels and thus how potential suppliers should regard an intermediary. For instance, Leo Mullin, Chairman and CEO of Delta Airlines, says:

> "What *Priceline* really represented was taking inventory that would not otherwise be sold and placing it in the hands of another supplier... You wonder if you have created a channel of discount sales of your product that could substantially cause your product to ultimately be priced lower."

Although the topic of opaque goods is interesting to consumers, practitioners, and the popular press, very little formal modeling of opaque products has appeared in the academic literature. In a much different context, Fudenberg and Tirole (2000) note in passing that a monopolist could use a stochastic mechanism that offers a "randomization between *A* and *B*" to appeal to switchers. Several recent papers (Wang, Gal-Or, and Chatterjee 2005; Granados, Gupta, and Kauffman 2005; Fay and Xie 2007) introduce formal models of an opaque good.

However, these papers restrict attention to a monopolist. In contrast, this paper considers the case of multiple service providers. Modeling competition is important for several reasons. First, it increases consistency with current practice since most examples of opaque goods involve multiple providers who share a common intermediary. Second, since Fay and Xie (2007) show that offering an opaque good is most advantageous when the component goods are not too vertically-differentiated, a firm that does not produce multiple, horizontally-differentiated goods may need to utilize an intermediary in order to introduce an opaque product. For example, it may not make sense for Avis to create its own opaque product using only its own product offerings (e.g., an Avis compact car or an Avis midsize car). Instead, Avis may want to enlist the services of Hotwire so that the opaque good is either an Avis compact car or a Budget compact car. Third, there may be logistical advantages to using an intermediary rather than developing one's own opaque product. For example, an intermediary such as Hotwire has invested in developing awareness for what an opaque product is. New service providers are easily added to this system. On the other hand, to offer one's own opaque good, a service provider must educate its consumers and present the offering in a way that avoids confusion. This is not trivial since it may require placing additional restrictions on consumers who purchase the opaque good, e.g., a no-refund / non-transferable policy, which a retailer does not wish to impose on its other non-opaque services.

Consistent with Peterson and Salasbramanian (2002), this paper views the opaque channel as a complement to traditional channels. As such, the introduction of competing rival service providers and an intermediary leads to several interesting research questions:

1. How will the introduction of an opaque product affect the prices of non-opaque goods?
2. How will an opaque good affect industry profitability?
3. How many consumers and what types will be attracted to an opaque product?

4. How will answers to the previous questions depend on how many units are allocated to the opaque channel?
5. Under what conditions would a service provider choose to use the opaque channel?

Overview of Key Results

For a monopolist, adding an opaque good cannot reduce profits. Suppose a monopoly sells two different products in the absence of an opaque good. The firm could replicate this profit by setting the price of the opaque good high enough that no units of the opaque good are sold. However, the firm can usually do even better either by: a) introducing an opaque good at a discount sufficiently large to attract additional consumers but not so large as to cannibalize any existing sales; or b) introducing an opaque good at little, if any, discount and then raising the prices of the traditional goods. Thus, an opaque good can enhance profit through either market expansion or by enhancing price discrimination of one's existing customer base.

In the focal model of this paper, two service providers use an intermediary to sell the opaque product. I find that if there is little brand-loyalty in an industry, an opaque product magnifies price competition and thus reduces industry profits. However, if there is a significant amount of brand-loyalty in an industry, an opaque good curtails price competition and thus increases industry profits. Furthermore, the degree of price rivalry depends on how many units are allocated to the opaque channel. Interestingly, it is possible that industry profit falls if the opaque channel is given a small allocation but increases if given a large allocation.

Other Related Literature

The literature has considered many forms of price discrimination. If firms can identify individual consumers or their characteristics, e.g., new versus repeat customer, firms may be able to customize prices (Chen, Narasimhan, and Zhang 2001; Villas-Boas 1999, 2004). However, in this paper, I assume firms do not have such private information. Other mechanisms, e.g., coupons, may facilitate price discrimination via self-selection (Narasimhan 1984). Product lines can also lead to market segmentation (e.g., Moorthy 1984; Gerstner and Holthausen 1986; Desai 2001). Recent research has explored how the advent of the Internet can increase the ability and ease of such product differentiation. For example, Varian (2000) shows that manufacturers (especially those of information goods) can benefit from creating multiple versions of the same underlying product. An interesting result is that versioning can be profitable even if there is no cost-advantage from reducing quality (Deneckere and McAfee 1996). An opaque good could be viewed as an example of a lower-quality version of an existing product. Introducing an opaque good avoids many of the costs associated with developing a new product because none of the features of the product (or service) have themselves been altered but, instead, are simply hidden from consumers. Thus, this new product is relatively simple to introduce (e.g., signing up with a third-party site such as Hotwire) and technological advances such as enhanced computational speed make implementation feasible for a growing array of products and services since there are lower costs to aggregation and arbitrage can be eliminated (Shugan 2004). For example, technologies such as smart cards, RFID, and electronic tickets, allow for the enforcement of the no refund / non-transferable restrictions which are necessary for the opaque product to be viable. Furthermore, in contrast to the previous versioning literature, this paper introduces an intermediary and multiple service providers. Thus, the model enables exploration of how an intermediary's entry affects competition between firms.[1]

Previous studies have also considered how various types of intermediaries impact a market (e.g., referral infomediaries, Chen et al. 2002; mass customization, Chen and Iyer 2002). This current paper extends the literature to a type of intermediary that has not been previously considered. Furthermore, this paper joins a large literature that studies competition between channels (e.g., Balasubramanian 1998; Coughlan and Soberman 2005; Zettelmeyer 2000).[2] In these papers, as in this one, the appeal of each channel differs across consumers. However, in this paper, the product itself differs across channels; in the aforementioned papers, physical locations (or lack thereof when considering direct retailers) are the source of differentiation across channels.

The Model

Two service providers, *A* and *B*, have unlimited capacity and symmetric costs of production, which without loss of generality are assumed to be zero. Later, I discuss the impact of adding capacity constraints to the model. The sequence of the game is given in Figure 1. In the first stage, the service providers contract with the intermediary, that is, they decide how many units to allocate to the opaque channel and agree to transfer payments, if any. Both *A* and *B*, but not consumers, observe the outcome of stage I. In stage II, service providers simultaneously choose their respective prices, P_A and P_B. Then, having observed P_A and P_B, the intermediary chooses the price of the opaque good, P_I.[3] This sequential pricing framework, consistent with Wang et al. (2005), is used since a pure-play Internet intermediary may have more flexibility in pricing than traditional service providers (e.g., due to technological advantages and not being constrained by the need for consistency across multiple channels: Internet, phone, ticket counters). Furthermore, since in most observed situations the service providers (e.g., major airlines and hotel chains) are much larger and well-established than the intermediary (e.g., Hotwire), it seems likely that the intermediary responds to service providers' prices rather than vice-versa. In the final stage of the game, risk-neutral consumers make purchase decisions to maximize expected surplus. Consumers do not know the source of the opaque good. They expect to be assigned to provider *A* with probability ½ and to provider *B* with probability ½. Later, I discuss the incentive to keep the source hidden.

Figure 1 Game Setup

I. Contracting

II. Service providers simultaneously choose prices

III. The intermediary chooses the price of the opaque good

IV. Consumers decide which service to purchase, if any

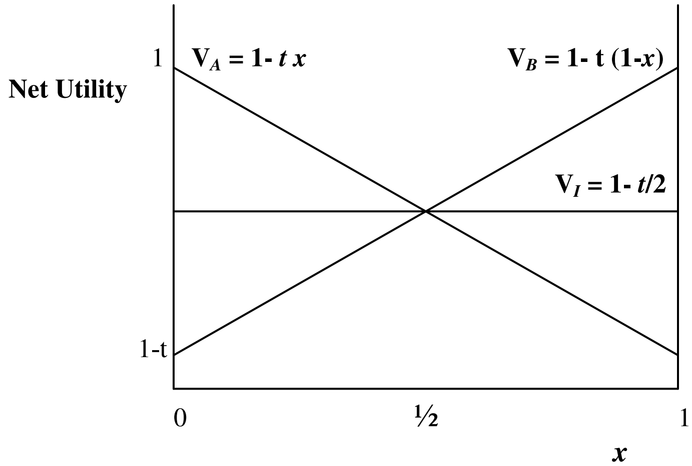
Consumer Demand

I use a generalization of the loyals/switchers model (Narasimhan 1988; Varian 1980; Chen, Narasimhan, and Zhang 2001).[4] There are two types of consumers, *brand-loyals* and *searchers*, each of whom purchases at most one unit. *Brand-loyals* make up ρ proportion of the population, which is normalized to one. A *brand-loyal* consumer does not consider all available product offerings but instead simply visits her preferred firm and purchases as long as the price does not exceed her reservation value, which is assumed to equal V_H (≥ 1) for all *brand-loyals*. The model is silent as to the source of this loyalty. For example, consumers could be loyal because they are not aware of the other product offerings, have very strong preferences for their preferred good, are locked-in to a loyalty program (e.g., frequent flier program), or face some other constraint (e.g., company policy or contract). See Srinivasan, Anderson, and Ponnavolu (2002) and the literature cited therein for a further discussion of potential sources of firm loyalty. A key question in this paper is how the magnitude of ρ impacts the pricing equilibrium and the profitability of the opaque product. To ease tractability and exposition, I assume a symmetric distribution of the *brand-loyals*, i.e., half $\left(\rho/2\right)$ are loyal to firm *A* and the other half are loyal to firm *B*.

The remaining 1- ρ consumers are *searchers*. This segment is represented by a Hotelling model in which consumers are uniformly distributed along a segment of length one. Each *searcher*'s location (x) represents that consumer's ideal product. Firms *A* and *B* are assumed to be located at the endpoints of the line segment, at 0 and 1, respectively. The reservation value of each *searcher*'s ideal product is normalized to one. Let t be the fit cost loss coefficient from not receiving one's ideal product. Thus, a consumer located at x incurs a disutility of $t\,x$ if she buys from firm *A* and a disutility of $t\,(1\text{-}x)$ if she buys from firm *B*. Each *searcher*'s expected disutility for the opaque good equals $t/2$: $\frac{tx}{2}+\frac{t(1-x)}{2}=\frac{t}{2}$.

Figure 2 illustrates consumers' expected net value for each of the three product offerings. All consumers to the left of $x = ½$ strictly prefer service *A* to service *B* or the opaque good; all consumers to the right of $x = ½$ strictly prefer service *B* to service *A* or the opaque good. No one strictly prefers the opaque good. Thus, although services *A* and *B* are only horizontally-differentiated, i.e., are of comparable quality, the intermediary's opaque product is perceived as being strictly inferior. This is not due to inferior quality because consumers who purchase the opaque good are assured of receiving either service *A* or service *B*, not some other sub-par service.[5] The opaque good is inferior because there is a positive probability of receiving one's less preferred product. Adding risk aversion to the model would further reduce the value of the opaque product. An obvious outcome of this tiered demand is that the intermediary must price below the traditional prices if it is to make any sales.

Figure 2 Net Utility of *Searchers*



This model allows for several dimensions of heterogeneity in demand. First, the division between *brand-loyals* and *searchers* captures the fact that firms may serve segments of users with different reservation values and very different degrees of price-sensitivity. Second, in contrast to the loyals/switchers models used in the previous literature, this model allows for heterogeneity within the price-sensitive segment, which is why these consumers are labeled "*searchers*" rather than "*switchers*". This allows for heterogeneity of tastes even among the segment of consumers that are open to purchasing either good "if the price is right."

When interpreting the model, ρ provides a measure of brand-loyalty within an industry (which may be a function of product differentiation but could also be influenced by other factors such as the prevalence of loyalty programs). The parameter *t* represents the strength of consumer tastes among those price-sensitive consumers and thus varies across product categories depending on the degree and importance of product differentiation. For example, the *t* in the market for hotel rooms is higher than the *t* in the market for rental cars since hotels naturally vary in locations and amenities offered whereas rental car companies offer rather homogenous services.[6] For the remainder of the paper, I assume the following two conditions hold:

$$t < \frac{2(1-\rho)}{3-\rho} \tag{1}$$

$$t > \rho(1-\rho)V_H \tag{2}$$

These conditions guarantee that duopoly competition results in full market coverage, i.e., all *searchers* will make a purchase. If these constraints were violated, there would be unmet demand that could be fulfilled by the intermediary without any potential cannibalization. Together, these assumptions imply that there are at least twice as many *searchers* as *brand-loyals* (ρ<1/3). Later, I discuss the impact of relaxing these conditions.

Demand Functions

A *searcher* located at *x* receives the following expected surplus from each purchase option:

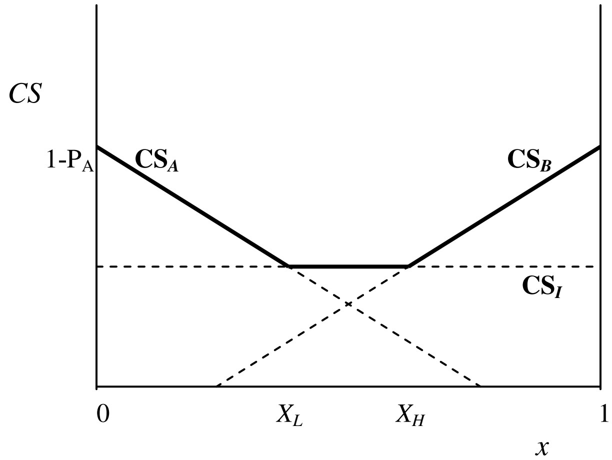
$$\begin{aligned} CS_A &= 1 - t\,x - P_A \\ CS_B &= 1 - t\,(1 - x) - P_B \\ CS_I &= 1 - \frac{t}{2} - P_I \end{aligned} \tag{3}$$

Each *searcher* chooses the option that yields the highest expected surplus with the default option being no purchase, which yields zero surplus. Figure 3 illustrates this choice. *Searchers* with $x \le X_L$ purchase good *A*, *searchers* with $x \ge X_H$ purchase good *B*, and *searchers* with $X_L < x < X_H$ purchase the opaque good where:

$$X_L = \frac{1}{2} - \frac{P_A - P_I}{t} \tag{4}$$

$$X_H = \frac{1}{2} + \frac{P_B - P_I}{t} \tag{5}$$

Figure 3 *Searchers'* Optimal Purchase



Monopoly

As a baseline case, consider a single firm that owns both brand *A* and brand *B*. Such a monopolist could offer its own opaque good and thus capture the entire profit available for the three product offerings.[7] Proposition 1 states the unambiguous benefit from the opaque good.

> ***Proposition 1:*** *A monopolist strictly improves its profits by offering an opaque product. The additional profit from adding the opaque good to the firm's product line is at least* $\frac{\rho}{2}\left(t+2\left(V_H-1\right)\right)$.

If the monopolist does not offer an opaque good, its optimal prices are $P_A = P_B = 1-\frac{t}{2}$, which results in complete market coverage. The profit to the monopolist is:

$$\Pi_M^{NI} = 1-\frac{t}{2} \tag{6}$$

Condition (1) guarantees that full coverage of the *searcher* market is more profitable than only partial coverage of this segment. Condition (2) ensures that it is not profitable to deviate to the prices of $P_A = P_B = V_H$ and thus only sell to *brand-loyals*.

Now suppose the monopolist also offers an opaque good. Notice that as P_I falls, the surplus from purchasing the opaque good rises and sales are shifted to the lower-margin opaque good. To minimize this cannibalization effect, a monopolist chooses P_I=1-t/2. This ensures that all consumers will purchase something (as long as $P_A \leq V_H$ and $P_B \leq V_H$ and thus *brand-loyals* also purchase). By choosing $P_A = P_B = V_H$, the monopolist would sell the opaque good to all *searchers* and sell traditional goods to the *brand-loyals*. These prices result in a profit of:

$$\Pi_M = \rho V_H + (1-\rho)\left(1-\frac{t}{2}\right) \tag{7}$$

The profit from (7) is strictly higher than (6) with the magnitude of this difference given in Proposition 1. Under some situations, the monopolist can earn profits in excess of (7) by selling traditional goods to some *searchers*, thus increasing the magnitude of the advantage of offering an opaque good above what is stated in Proposition 1. Details are provided in the appendix.

Competition

Opacity of the Intermediary's Product

So far, I have assumed the intermediary's product is opaque, i.e., consumers do not know if they will get service *A* or service *B* if they purchase from the intermediary. Suppose that in stage I, contracting with the intermediary results in Q_A (Q_B) units of service *A* (*B*) being made available to the intermediary. Obviously, these allotments and the marginal transfer price of each service affect the "true" probability that the opaque good will originate from a particular service provider. The model assumes consumers cannot observe this "true" probability and instead believe that each service is equally likely to be awarded. This subsection explores when such an assumption is plausible.

To begin the discussion, assume consumers cannot observe allocations by the service providers to the intermediary. This seems plausible. Contracts between businesses are proprietary information. In practice, neither customers nor researchers observe which supplier has made units of its inventory available to Hotwire.[8] Although allocations are not observable, one might wonder whether the intermediary or the service providers have an incentive to voluntarily disclose this information. There are several reasons to believe voluntary disclosure will not occur. First, contracts may contain non-disclosure clauses. In many various situations, we know contracts include such clauses and often with severe penalties for violations. Second, even in the absence of enforceable non-disclosure clauses, signaling is unlikely to be desirable or credible. Consider the intermediary. Its business model is predicated on selling an opaque good. Even if there were a short-term gain from signaling a product's identity, such disclosure would tarnish the intermediary's reputation and thus eliminate or significantly curtail its ability to make future sales (in this and other product categories). Now turn to the service providers. A service provider who signaled an opaque product's identity would hurt its relationship with the intermediary. Furthermore, even if the short-run advantage from signaling were sufficiently large, signals are unlikely to be credible. Specifically, provider A may gain from having consumers believe the opaque good comes from provider B (so that some consumers switch from the opaque good to good A). But, the same argument applies to provider B. If each firm tries to signal the opaque good comes from its rival, the message is mixed and consumers remain uninformed as to the source of the opaque product.

As a result of this opacity, when deriving the pricing equilibrium, one only needs to consider the total number of units available to the intermediary $(Q_{TOT} = Q_A + Q_B)$, not the proportion that comes from each particular service provider.

Pricing: No Intermediary

In the absence of an intermediary (i.e., $Q_{TOT} = 0$), define $\hat{X}$ as the *searcher* who is indifferent between purchasing service A at P_A and purchasing service B at P_B:

$$\hat{X} = \frac{1}{2} + \frac{P_B - P_A}{t} \tag{8}$$

Firm A's profit is: $\Pi_A = P_A\left(\frac{\rho}{2} + (1-\rho)\hat{X}\right)$. Firm A's best response to P_B is: $P_A(P_B) = \frac{P_B(1-\rho)+t}{2(1-\rho)}$.

Firm B's best response is symmetric to A's. Thus, the equilibrium prices are:

$$P_A^{NI} = P_B^{NI} = \frac{t}{1-\rho} \tag{9}$$

Condition (1) guarantees a *searcher* located at x= ½ is willing to purchase in equilibrium. Thus, there is complete market coverage and profit is:

$$\Pi_A^{NI} = \Pi_B^{NI} = \frac{t}{2(1-\rho)} \tag{10}$$

Condition (2) guarantees each firm prefers this outcome to selling only to one's *brand-loyals* (at a price of V_H and a profit of $\frac{\rho V_H}{2}$).

Pricing: Active Intermediary

Now turn to the case where the intermediary is active in the market, i.e., $Q_{TOT} > 0$. In this section, I consider how prices depend on the level of Q_{TOT}. Then, in the subsequent sections, I calculate the associated profits and then derive the optimum contracts which will determine what Q_{TOT} will be the equilibrium for the full game.

Q_{TOT} and ρ control how aggressively the intermediary and service providers compete on prices. These parameters determine which of six different pricing outcomes occur. The appendix contains the derivation of equilibrium prices, with Table A1 reporting the six possible pure strategy equilibria. These equilibria differ according to whether the intermediary faces a binding constraint when choosing its price and whether both, only one, or neither service provider concedes the *searcher* market in order to focus on their *brand-loyals* (i.e., $P_i = V_H$). Throughout the analysis, I assume the intermediary does not pay per-unit fees to the service providers. This assumption will be justified later when contracts are discussed. Furthermore, transfer payments by the intermediary to the service providers are ignored since these are sunk costs at the time pricing decision are made.

Proposition 2 summarizes the impact of an opaque intermediary on prices and revenue from traditional sales:

> ***Proposition 2:*** *If an opaque intermediary has a positive market share, each service provider generates less revenue from sales of its traditional service.*
>
> *The impact of an opaque intermediary on prices is:*
>
> 1. *If the number of units allocated to the opaque channel is sufficiently small* ***or*** *if there is sufficiently little brand-loyalty in an industry, entry by an opaque intermediary reduces the prices of traditional services.*
> 2. *If the number of units allocated to the opaque channel is sufficiently large* ***and*** *there is sufficient brand-loyalty in an industry,*
>   a. *Entry by an opaque intermediary increases the prices of traditional services.*
>   b. *The price of the opaque good is higher than the prices of traditional services in the absence of the intermediary.*

The key result from Proposition 2 is that entry by an opaque intermediary may lead to reduced price competition. For example, in the "concession" equilibrium, both service providers find it more profitable to sell exclusively to their *brand-loyals* (at $P_A = P_B = V_H$) rather than compete for the *searchers* with the intermediary. Notice that the intermediary might be particularly aggressive since it does not have any brand-loyal segment of its own and thus must rely on a price advantage in order to attract customers. Furthermore, in the concession equilibrium, facing service providers with prices $P_A = P_B = V_H$, the intermediary maximizes its profit by selling the opaque product to all *searchers* at a price of $P_I = 1 - \frac{t}{2}$. Notice that relative to the no intermediary case, in this concession equilibrium *brand-loyals* end up paying a higher price for the same service. *Searchers* also pay higher prices (and now get an opaque product which may end up being their less-preferred service).

However, this effect of relaxing competition (as occurs in the concession equilibrium), will only occur under certain conditions. In particular, as the amount of inventory the intermediary has at its disposal decreases (i.e., Q_{TOT} falls), the intermediary will be less aggressive if a service provider were to attempt to sell to *searchers* since the intermediary only has the ability to serve a smaller number of *searchers*. Recognizing this, if Q_{TOT} is sufficiently small, either one or both service providers would earn more profit by selling to some *searchers* rather than selling exclusively to its *brand-loyals*. Furthermore, conceding all the *searchers* will not be the most profitable alternative for a service provider if there are few *brand-loyals* (ρ is relatively small). Thus, if either Q_{TOT} or ρ is sufficiently small, at least one of the service providers will compete for the *searchers* with the intermediary. For example, in the "strong competition" equilibria, all three firms sell to *searchers* as illustrated in Figure 3.
Entry by the intermediary causes prices to fall since each service provider competes for *searchers* against an additional product. The intermediary has to discount its prices even further to capture any market share.

Finally, Proposition 2 shows that, regardless of which equilibria results, an active intermediary reduces the revenue from traditional sales. For example, under "strong competition" service providers both get lower prices per unit sold and make fewer traditional sales. Under "concession," each service provider earns higher revenue per sale but makes drastically fewer sales.

Profitability

The previous section indicates sales of the opaque good come at the expense of traditional sales. However, the intermediary must induce service providers to participate in order to enter the market. Sufficient compensation is feasible (i.e., large enough to induce participation by the service provider, but small enough to be on net profitable for the intermediary) only if the combined profit of the intermediary and one service provider exceeds the profit a service provider earns in the absence of the opaque good:

$$E\left[\Pi_A\right]+\Pi_I > \Pi_A^{NI} \tag{11}$$

Lemma 1 summarizes when condition (11) is met:

> ***Lemma 1:*** *Condition (11) is satisfied only if*
>
> *(a) In equilibrium, both firms concede the searcher market and a sufficient number of units are allocated by the service providers to be sold as the opaque good;* ***or***
>
> *(b) In equilibrium, only one firm concedes the searcher market and the number of units allocated by the service providers is not too large and not too small.*
>
> ***Corollary 1:*** *Condition (11)* ***cannot*** *be satisfied if neither firm concedes the searcher market in equilibrium.*

The appendix provides the details supporting Lemma 1 and Corollary 1. Notice that the market is fully covered in the absence of the intermediary. Thus, for any symmetric equilibrium, condition (11) can be satisfied only if the average selling price increases with entry. If all firms compete for the *searchers*, e.g., "strong competition", the price paid by each consumer falls and thus condition (11) cannot be met. On the other hand, under "concession" each consumer ends up paying a higher price in equilibrium, thus ensuring condition (11) is satisfied. Finally, if only one firm concedes the *searcher* market, there will still be competition for *searchers* between the intermediary and the other firm. If Q_{TOT} is too small, the traditional firm that remains in the *searcher* market sets a very low price in order to capture the *searchers* who cannot be served by the intermediary. On the other hand, if Q_{TOT} is too large, competition between the intermediary and the remaining traditional firm will be fierce. Thus, when a single firm concedes, condition (11) is satisfied only for intermediate values of Q_{TOT}.

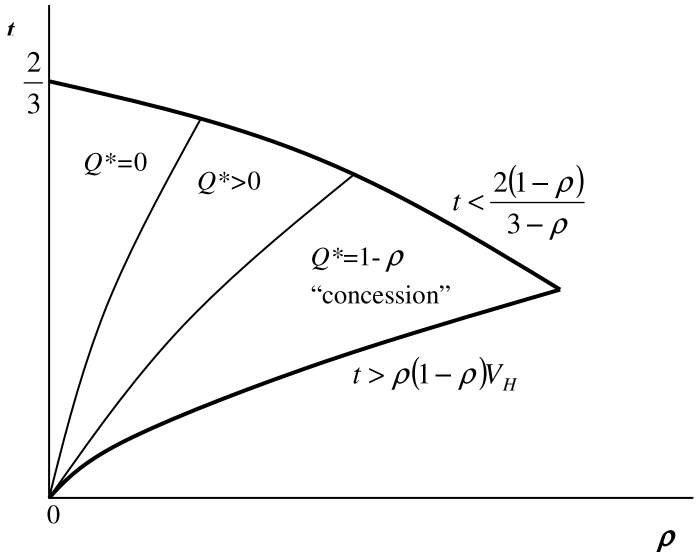
Joint-Profit Maximization

The service providers, through the choice of Q_{TOT}, can influence which equilibria will occur (and the level of prices and profit in the constrained equilibria). In this section, I present the Q_{TOT} that maximizes the LHS of (11), noting that one can reach Π_A^{NI} with Q_{TOT} =0. Define Q^* as the minimum Q_{TOT} such that:

$$E\left[\Pi_A(Q^*)\right]+\Pi_I(Q^*)\geq E\left[\Pi_A(Q_{TOT})\right]+\Pi_I(Q_{TOT}) \qquad \forall Q_{TOT}\geq 0 \tag{12}$$

Figure 4 illustrates the value of Q^* over the relevant parameter range. The bold lines represent conditions (1) and (2) which guarantee full coverage in the absence of the intermediary. In the left-most region (Q^*=0) where there is very little brand-loyalty, neither service provider would concede the *searcher* market regardless of the size of Q_{TOT}. Thus, joint profit is maximized at Q_{TOT} =0 where the competitive threat from the opaque intermediary is the lowest. In the far-right region $(Q^*=1-\rho)$ where brand-loyalty is rather sizable, both service providers will concede the *searcher* market if Q_{TOT} is large enough. Thus, joint-profit is maximized at a level that both induces concession and enables the intermediary to sell to all *searchers*. Finally, for intermediate levels of brand-loyalty, it is not possible to get both service providers to concede the *searcher* market but one firm would opt out of the *searcher* market if Q_{TOT} is sufficiently large. Lemma 1 (b) ensures that condition (11) can be satisfied when there is a single concession. Thus, Q^* must be strictly positive in this case.

Figure 4 Illustration of *Q**



Contracts

From the intermediary's perspective, services *A* and *B* are perfect substitutes. Thus, if the service providers engage in linear pricing, the intermediary would satisfy its entire demand for the opaque good using the lower priced firm. As a result, equilibrium wholesale prices cannot exceed marginal costs. To allow for a richer set of contracts, this paper lets contracts include lump-sum transfer payments. However, as Shaffer and Zettelmeyer (2002) note on p. 279, when goods are perfect substitutes, there will be an extremely skewed division of profits. For example, in the current model, if the service providers make sequential contract offers to the intermediary, the first-mover receives the entire incremental profit associated with this additional channel. With such an asymmetric division of profit, one may question whether the results are unduly dependant upon the game's bargaining structure. I address this concern by considering a variety of bargaining structures. Proposition 3 summarizes the results of this analysis:

Proposition 3: *Regardless of whether the service providers make take-it-or-leave-it offers to the intermediary or whether the intermediary makes take-it-or-leave-it offers to the service provider, and regardless of whether these offers are made sequentially or simultaneously, there cannot be an equilibrium in which the number of units allocated to the intermediary is less than Q*.*

Lemma 2: *Define* $\Pi^{MAX} = E[\Pi_A(Q^*)] + \Pi_I(Q^*)$. *All subgame-perfect equilibria of the sequential contract games* (*with offers made either by the intermediary or by the service providers*) *result in a combined expected profit of* Π^{MAX} .

Lemma 3: *For simultaneous contract games (with offers made either by the intermediary or by the service providers), there always exists an equilibrium in which the intermediary is active* (*even if* $Q^* = 0$).

The proofs of Proposition 3 and the two lemmas are given in the appendix. Proposition 3 considers four variations of the contracting stage: sequential offers made by the service providers to the intermediary, sequential offers made by the intermediary to the service providers, simultaneous offers made by the service providers to the intermediary, and simultaneous offers made by the intermediary to the service providers. These various structures lead to dramatically different distributions of profit across the channel members (as outlined below). However, since it may be unclear which structure best represents an industry, it is important to derive results that do not rely on a particular bargaining structure.[9] Proposition 3 outlines one such result, namely the minimum number of units that will be allocated to the opaque channel. Suppose that $Q^* > 0$, i.e., there is a level of Q_{TOT} such that the addition of the opaque channel improves the expected joint profit of a service provider and the intermediary. Proposition 3 confirms that under any of these four contract variations, the intermediary will be active in the market having at least Q^* units at its disposal to sale as opaque goods.

The intuition for Proposition 3 is as follows. Suppose there is proposed equilibrium in which $Q_A + Q_B < Q^*$. Then, from the definition of Q^* given in (12), a partnership between the intermediary and one of the suppliers could be forged which would increase their combined profit by raising the service provider's allocation by $Q^* - Q_A - Q_B$ units. Thus, with appropriately defined transfer fees, it must be possible to increase the profits of each of the partner firms. Therefore, the original allocation must not have been an equilibrium.

It is also interesting to consider the equilibrium distribution of profits. Not surprisingly, it turns out that this distribution is heavily dependant on the underlying bargaining structure. Suppose, in equilibrium, firm *A* provides Q_A units to the intermediary for a transfer payment of α and firm *B* provides Q_B units to the intermediary for a transfer payment of β. Then, firm *A* earns a net profit of $E\left[\Pi_A(Q_A + Q_B)\right] + \alpha$, firm *B* earns a net profit of $E\left[\Pi_A(Q_A + Q_B)\right] + \beta$, and the intermediary earns a net profit of $\Pi_I(Q_A + Q_B) - \alpha - \beta$. Consider the following scenarios.

Sequential offers by the service providers: Suppose service provider *A* offers (Q_A, α), this offer is either accepted or rejected by the intermediary, then service provider *B* offers (Q_B, β), and then this offer is either accepted or rejected by the intermediary. The subgame perfect equilibrium results in net profit of $E\left[\Pi_A(Q^*)\right] + \Pi_I(Q^*)$ for firm *A*, a net profit of $E\left[\Pi_A(Q^*)\right]$ for firm *B*, and no net profit for the intermediary. Thus, the service provider that moves first is able to obtain the entire incremental benefit that comes from introducing an opaque good.[10]

Sequential offers by the intermediary: Suppose the intermediary makes sequential offers, first to service provider *A* (offering to pay α for Q_A units), then to *B* (offering to pay β for Q_B units). The subgame perfect equilibrium results in both firms *A* and *B* earning a net profit of $E\left[\Pi_A(Q^*)\right]$, and the intermediary earning a net profit of $\Pi_I(Q^*)$. This bargaining structure puts the intermediary in the position of power. The intermediary can effectively play the service providers off each other. Firm *A* knows that if it doesn't accept the intermediary's offer, its rival will. Since firm *A* views entry by the intermediary as inevitable, the intermediary can use its first contract offer to induce provider *A* to meet the entire demand, i.e., $Q_A = Q^*$, with only a token payment (and, in the process, eliminate the need to make any payment to service provider *B*).

Simultaneous offers: Modeling simultaneous rather than sequential contracts introduces additional complexities. Multiple equilibria can arise with the variations across equilibria not only in terms of how profits are allocated among the channel members and in the source of the opaque units but also in terms of market prices and overall market profitability. Expectations about a rival's action play a crucial element in the analysis. Take an extreme example where $Q^*=0$. With sequential offers, the unique equilibrium is for the intermediary to be inactive. However, with simultaneous offers (regardless of whether offers are made simultaneously by the service providers or by the intermediary) other equilibria also exist. Let $\tilde{Q}$ be the Q_{TOT} that maximizes $\Pi_I(Q_{TOT})$. There is an equilibrium in which $\tilde{Q}$ units are allocated to the intermediary. This equilibrium is sustained by each firm's belief that the other will contract with the intermediary. These beliefs are rational since if firm *A* believes that firm *B* will contract with the intermediary, then firm *A* would want to too (even with just an epsilon transfer payment from the intermediary) and vice-versa. In the limit, each service provider earns a net profit of $E\left[\Pi_A\left(\tilde{Q}\right)\right]$ and the intermediary earns a net profit of $\Pi_I\left(\tilde{Q}\right)$. The intermediary is able to retain the entire revenue from opaque good sales without making any substantial transfers to the service providers. Thus, when $Q^*=0$, we have an equilibrium in which the intermediary has no presence in the market and another where the intermediary has so many units at its disposal that it reaches the apex of the possible profit from opaque sales.

For this example, from *A* and *B*'s perspective, the active-intermediary equilibrium is Pareto-inferior since profits for each would strictly be higher if they could coordinate on the $Q_A = Q_B = 0$ equilibrium. The literature is divided on the likelihood of experiencing Pareto-inferior equilibria. On one hand, Anderlini (1999) argues that there is “consensus that the Pareto-inferior equilibrium ... is, in some sense, unlikely to prevail.” Research on the impact of pre-game cheap talk (Arvan, Cabral, and Santon 1999; Clark, Kay, and Sefton 2000), repeated play of a static game (with noise) (Lagunoff 2000) and the psychological salience of equilibria to decision makers (Colman 1997) lends support to this view. However, Anderlini (1999) also acknowledges that Pareto-inferior equilibria are stable and survive most refinements that have been put forward in the literature. Furthermore, Cooper and John (1988) provide a literature review containing many examples in which coordination failures arise. Such failures are frequently cited as the reason for macroeconomic underperformance (Azariadis 1981, Azariadis and Drazen 1990, Matsuyama 1991, Baland and Francois 1996). Thus, it seems possible that simultaneous contracts could result in participation by an opaque intermediary in cases where its impact unambiguously harms the service providers.

Discussion

The analysis thus far makes several important assumptions. First, I have restricted attention to situations when there is full coverage of the *searcher* market even in the absence of the opaque channel. Second, service providers are not capacity constrained. In this section, I discuss the impact of relaxing these assumptions and then provide an overview of the results, giving particular attention to outlining several managerial implications.

First, consider the assumption that there is full coverage in the absence of the opaque channel, i.e., conditions (1) and (2) are satisfied. If one of these conditions is violated, there is unmet demand in the absence of an opaque intermediary. Since the firms could allocate some units to the intermediary without having any impact on its traditional sales, it must be the case that $Q^* > 0$.[11] Furthermore, if fewer *searchers* are buying in the absence of an opaque good, service providers are more likely to focus on *brand-loyals* if an opaque intermediary becomes active. Thus, expanding consideration to parameters beyond the basic model increases the probability that an opaque intermediary will be active and that entry relaxes price competition.

Now turn to the assumption that service providers are not capacity constrained. Suppose each service provider has the capacity to produce T units at zero marginal cost. The base model assumes that either firm could serve the entire *searche*r market $\left(T \geq 1-\frac{\rho}{2}\right)$. This assumption can be relaxed without dramatically affecting results. For example, with weak capacity constraints $\left(\frac{1}{2} \leq T < 1-\frac{\rho}{2}\right)$, additional analysis shows that Q^* is not dependent on T. However, transfers from both service providers are needed to reach Q^*. Thus, one party cannot extract the entire incremental value of the opaque channel. Consequently, weak capacity constraints result in less skewed allocations to the intermediary and in a less skewed distribution of profit.

On the other hand, if capacity constraints are very severe $\left(T < \frac{\rho}{2}\right)$, $Q^* = 0$. Each firm cannot even meet the entire demand from its *brand-loyals*. Thus, there is no advantage to reserving any units for the opaque channel.

In between these two extremes $\left(\frac{\rho}{2} < T < \frac{1}{2}\right)$, the opaque good is less valuable relative to the base model. First, the potential number of units available to be sold to *searchers* falls as constraints become more severe (T falls). Suppose both service providers will concede the *searcher* market. After sales to *brand-loyals* have been subtracted, $2\left(T-\frac{\rho}{2}\right)$ total units are left over. As constraints become more severe, i.e., T approaches $\frac{\rho}{2}$, the number of units to be transferred to the intermediary falls. Second, the probability that $Q^* = 0$ increases as constraints become more severe. Suppose that in the absence of the intermediary, each firm would have sold to some *searchers* (at a price that exceeds any consumers' value for the opaque good). As constraints become more severe, this no-intermediary price increases. Thus, in contrast to Proposition 2b, when capacity constraints are rather severe, entry by an opaque intermediary necessarily decreases the revenue earned from each *searcher* and as constraints become even more severe service providers face a greater sacrifice per sale transferred to the intermediary.

Summary of Results

To summarize, this paper includes findings involving on four dimensions:

1. *Appeal to consumers:* An opaque good appeals to consumers with weak preferences. Only a consumer who is indifferent between the two traditional goods will be willing to pay as much for an opaque good as she would for a traditional good. Other consumers purchase the opaque good only if it is offered at a sufficient discount.
2. *Effect on prices:* Entry by an opaque intermediary can either intensify competition or relax it. More fierce competition results if there is little brand-loyalty in the marketplace. However, if there is at least a moderate amount of brand-loyalty, entry by an intermediary induces service providers to raise prices. In fact, the opaque product may sell at prices higher than what traditional prices would have been in the absence of an opaque intermediary. In this moderate-to-strong brand-loyalty case, prices are not monotonic in the level of the intermediary's activity. When market share of the intermediary is low, as the intermediary grows, market prices fall. But, if the intermediary becomes sufficiently large, all prices (both for the opaque good and for the traditional goods) rise.
3. *Allocation of units by the service providers:* Service providers have an incentive to contract with an opaque intermediary if there is enough brand-loyalty in an industry. Here, an

intermediary with more units at its disposal induces less price rivalry between service providers and allows the intermediary to better serve the price-sensitive segment of the market. Furthermore, even if the absence of this competition-mitigating effect, a service provider would use an opaque intermediary if it expects its rival to do so. Finally, the opaque channel can lead to market expansion. However, market expansion is only profitable if firms are not capacity-constrained.

4. *Technical Barriers:* Successful introduction of an opaque good requires that consumers cannot observe its source prior to purchase, purchases are non-refundable, and purchases are non-transferable. The sale of services through the Internet represents an environment where these conditions are likely to be met—Intermediaries specializing in opaque goods can arise which have an incentive to maintain opacity and technologies such as e-tickets or smart cards can be used to eliminate arbitrage.

Managerial Implications for Service Providers

Benefits from an opaque channel arise for service providers that have excess capacity or for firms with consumers who vary in the strength of their preferences, especially when a significant number of customers, but not all, are brand-loyal. Even though the opaque channel may increase industry profits, all service providers do not necessarily benefit from its presence. From the intermediary's perspective, rival service providers offer perfect substitutes. This drives down wholesale prices. To maximize revenue from the opaque channel, service providers should sell bundles rather than sell on a per-unit basis, e.g., offering a block of hotel rooms for a single price rather than selling these rooms on an individual basis. Furthermore, service providers are often negatively impacted by a rival's use of the opaque channel. Thus, there is a first-mover advantage, i.e., one wants to sell inventory to the intermediary before its rival does. To capitalize on the first-mover advantage, a firm needs to commit to a "now-or-never" strategy. If the intermediary knows these units will be available at a later date, it can avoid agreeing to such an initial offer and instead play the service providers off each other in order to negotiate better terms for itself. This suggests that a service provider may benefit from advance selling its traditional services in order to exhaust its capacity and thus commit itself to not offering units to the intermediary at a future date.

The discussion above suggests several negative consequences for service providers. In order to preempt rivals, service providers may end up engaging in a competition to be first. This could lead to suboptimal decisions. For example, selling units to the intermediary before demand uncertainty has been resolved can lead to ex post unappealing outcomes. For instance, in the market for air travel, an airline that sells too many tickets in advance to Priceline may have to refuse sales to last-minute travelers with high reservation values and/or overbook the airplane (and thus be saddled with providing compensation to bumped passengers). Furthermore, the use of the opaque channel may become a defensive strategy. For example, Leo Mullin, Chairman and CEO of Delta Airlines, ends the commentary quoted earlier by saying, "There were a lot of safeguards to keep that [cannibalization] from happening, and oh, by the way it was going to happen anyway." This last clause suggests that Delta Airlines considers Priceline's presence in the market as inevitable and thus has an incentive to use Priceline even if cannibalization is sizeable.

Managerial Implications for an Opaque Intermediary

This paper also offers several managerial implications for an opaque intermediary. In order to induce on-going participation by suppliers, it is essential for the intermediary to maintain the opacity of its products. When the same service category is sold repeatedly, the intermediary will want to vary its provider over time. Even in a given period, the intermediary may need to procure units from a second service provider. To what extent such steps are necessary could be determined by monitoring message boards (e.g., biddingfortravel.com and betterbidding.com which compile ex post outcomes at Hotwire and Priceline) to see how much and how fast information about past assignments is being transmitted.[12] Also, to ensure that the right consumers are targeted, marketing materials should stress the inherent uncertainty from purchasing through this channel even though this reduces consumers' values for the intermediary's product.[13]

This paper also helps identify markets an opaque intermediary should target. The intermediary should seek to enter markets where there is heterogeneity in the strength of preferences. An intermediary is unlikely to be successful in markets with either a very high or a very low amount of brand-loyalty. In the first case, the intermediary will not be able to attract many customers with an opaque product. In the second case, the intermediary will find it difficult to secure contracts with service providers. Attracting service providers will also be difficult if potential suppliers face strong capacity constraints. Furthermore, an intermediary needs to find markets where arbitrage can be prevented. Thus, it is not surprising existing opaque intermediaries, such as Hotwire and Priceline, arose by targeting the travel industry, i.e., markets where loyalty programs and heterogeneity in use (business travel vs. leisure travel) contribute to vast differences in the strength of consumer preferences for the existing alternatives and markets where non-transferable reservations are the norm. The results involving capacity constraints are also consistent with empirical trends, as Priceline's sales have shifted away from air travel towards hotel rooms as the airlines' passenger loads have increased.

Finally, due to the important role played by expectations, it is likely to be much more difficult to attract the first service provider for a market than to attract additional suppliers to that same market. Therefore, the intermediary should fight aggressively to secure a foothold in an industry, even if this initially results in negative profit. As service providers increasingly believe the intermediary's presence is inevitable, the intermediary can negotiate more aggressively to procure a higher percentage of the available surplus and thus recuperate its investment.

Concluding Comments and Areas for Future Research

This is the first paper to model an intermediary selling an opaque good. As such, many interesting directions remain for future research. It is important for future research to consider alternative modeling assumptions. Notable limitations of the current model include: the loyal market is perfectly sealed (i.e., the opaque product will not cannibalize any loyal consumers), consumers are risk neutral, demand is known with certainty, there are no costs (fixed or variable) associated with operating the opaque channel, services are only horizontally (not vertically) differentiated, marginal production costs are zero, there are only two service providers, this is a one-period game, and there is a single opaque intermediary.

By relaxing these assumptions one could address other important research questions. For example, it would be interesting to explicitly incorporate vertical differentiation into the model. For instance, consumers might uniformly agree that one itinerary is strictly preferred to another, e.g., due to a short layover or fewer stops. In this case, it seems feasible for the opaque itinerary to be higher priced than the less-preferred itinerary, e.g., a consumer might be willing to pay more for a ticket that may turn out to be for a non-stop flight rather than getting the one-stop flight for certain. See Fay and Xie (2007) for an example of when this can be the equilibrium outcome for a multi-product monopolist.

Another interesting research question is the optimal degree of opacity. For instance, using the market for airline travel as an example, the pool of allowable itineraries determines the possible departure times, maximum length of layover, and the number (and location) of connections of the opaque good. One interesting research question is whether an intermediary should specify a narrow or wide window for travel. Since a narrow window is likely to increase the attractiveness of the opaque product to consumers, but at the same time may increase the cannibalization of traditional channels, it is not clear what is the optimal window size. Existing opaque sites seem to be experimenting on this issue. Although Priceline and Hotwire have traditionally sold opaque airline tickets that involved travel at any time of day (excluding red-eyes), recently Hotwire added an additional choice, "FlexSaver Fares", which specify a more narrow departure or arrival window, e.g., "morning" departures for which the flight must be scheduled to leave sometime between 6 a.m. and 11 a.m. Another interesting extension would be to consider which attributes of the product to conceal from consumers and which to reveal. For example, revealing the specific amenities of a hotel property (e.g., pool, restaurant, golf nearby, etc.), as Hotwire does, may increase the attractiveness of the opaque product. But, concealing these amenities (as Priceline does) may cause less cannibalization of traditional channels.

It would also be interesting to allow for multiple opaque intermediaries in order to study competition among opaque sites. One would expect that the price of the opaque good would be pushed downward by such competition. It would be interesting to see how an opaque site can best differentiate itself from other opaque sites (e.g., by using a distinct pricing mechanism such as NYOP, varying which product characteristics are hidden from consumers, and/or contracting with a different set of suppliers).

Furthermore, by extending the model to a dynamic setting, one could explore how pricing and availability of an opaque good affects the timing of purchases. Here, it would be important to determine the optimal allocation of inventory to the intermediary at a particular point in time, noting that this decision will impact the demand for the traditional goods (and for the opaque good) in future periods. In such a setting, it would also be important to consider how beliefs about the identity of the opaque good evolve over time.

Finally, future research may also identify alternative rationale for opaque goods and additional complicating factors. One benefit of an opaque good is that it may allow a firm to offer products that may not have been feasible previously due to technological or business constraints. For example, an intermediary could combine flight segments from competing firms in order to create a multi-supplier itinerary.[14] It would also be interesting to consider how the intangibility of the opaque product might affect perceived risk (Laroche et. al. 2005), or whether an opaque product mitigates or exacerbates regret – either “at least I wasn’t the one that chose this dreadful hotel” or “I shouldn’t have risked getting a 6 a.m. flight.” Furthermore, over optimism or pessimism (Parducci 1995) and like or dislike of surprises (Bless and Forgas 2000) could bias consumers in favor or against opaque sites.

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Appendix

Monopoly selling traditional goods to some searchers

Suppose the monopolist chooses traditional prices below one (and sets P_I=1-t/2). The firm's profit is:

$$\Pi_M = P_A\left(\frac{\rho}{2}+(1-\rho)X_L\right)+P_B\left(\frac{\rho}{2}+(1-\rho)(1-X_H)\right)+(1-\rho)\left(1-\frac{t}{2}\right)(X_H-X_L) \quad \text{(A1)}$$

where X_L and X_H are given in equations (4) and (5). Profit at the optimal prices, $P_A = P_B = 1-\frac{t(1-2\rho)}{4(1-\rho)}$, is:

$$\Pi_M = 1-\frac{t(3-4\rho)}{8(1-\rho)} \quad \text{(A2)}$$

This exceeds the profit given in equation (7) if:

$$t > \frac{8(1-\rho)\rho(V_H-1)}{(1-2\rho)^2} \quad \text{(A3)}$$

Under condition (A3), the additional profit from adding the opaque good ((A2)-(6)) is:

$$\Pi_M - \Pi_M^{NI} = \frac{t}{8(1-\rho)} \quad \text{(A4)}$$

Pricing: Active Intermediary

First, consider the situation in which all three firms sell to *searchers*. The profit earned by each entity is:

$$\Pi_A = P_A\left(\frac{\rho}{2}+(1-\rho)X_L\right) \quad \text{(A5)}$$

$$\Pi_B = P_B\left(\frac{\rho}{2}+(1-\rho)(1-X_H)\right) \quad \text{(A6)}$$

$$\Pi_I = P_I(1-\rho)(X_H-X_L) \quad \text{(A7)}$$

where X_L and X_H are given in equations (4) and (5) and the intermediary is subject to the constraint:

$$Q_{TOT} \geq (1-\rho)(X_H-X_L) \quad \text{(A8)}$$

It is possible that either a) Q_{TOT} is sufficiently large that constraint (A8) is not binding; or b) equation (A8) is a binding constraint. Consider the first scenario, labeled "strong competition." According to Figure 1, the intermediary chooses P_I given P_A and P_B to maximize its profit:

$$P_I(P_A,P_B) = \frac{P_A+P_B}{4} \quad \text{(A9)}$$

Firms A and B choose their prices simultaneously taking into account the intermediary's best response. Firm A's best response function is: $P_A(P_B) = \frac{P_B(1-\rho)+2t}{6(1-\rho)}$. Thus, at the symmetric equilibrium: $P_A = P_B = \frac{2t}{5(1-\rho)}$. At these prices, the intermediary chooses $P_I = \frac{t}{5(1-\rho)}$ and equation (A8) will not be binding if $Q_{TOT} \geq \frac{2}{5}$. The profit earned in equilibrium is given in Table A1.

If $Q_{TOT} < \frac{2}{5}$, the intermediary chooses P_I such that (A8) is binding: $Q_{TOT} = (1-\rho)(X_H-X_L)$. This case is termed "constrained competition". This leads to the response function:

$$P_I(P_A,P_B) = \frac{(1-\rho)(P_A+P_B)-tQ_{TOT}}{2(1-\rho)} \quad \text{(A10)}$$

The equilibrium prices and profit are derived following the same logic as above and are reported in the column "constrained competition" in Table A1.

The above outcomes are equilibria only if the profit earned by each service provider is at least as high as the profit a firm would earn from conceding the *searcher* market $\left(\frac{\rho V_H}{2}\right)$. Table A1 presents the pure-strategy equilibrium prices and profit if one or both service providers concede the *searcher* market.

Table A1 Pure Strategy Pricing Equilibria
(a) Intermediary is not quantity-constrained

	Neither Firm Concedes "Strong Competition"	**Firm *A* Concedes "Single Concession"**	**Both Firms *A* and *B* Concede "Concession"**
P_A	$\frac{2t}{5(1-\rho)}$	V_H	V_H
P_B	$\frac{2t}{5(1-\rho)}$	$\frac{t(3-\rho)}{4(1-\rho)}$	V_H
P_I	$\frac{t}{5(1-\rho)}$	$\frac{t(5-3\rho)}{8(1-\rho)}$	$1-\frac{t}{2}$
Π_A	$\frac{3t}{25(1-\rho)}$	$\frac{\rho V_H}{2}$	$\frac{\rho V_H}{2}$
Π_B	$\frac{3t}{25(1-\rho)}$	$\frac{t(3-\rho)^2}{32(1-\rho)}$	$\frac{\rho V_H}{2}$
Π_I	$\frac{2t}{25(1-\rho)}$	$\frac{t(5-3\rho)^2}{64(1-\rho)}$	$(1-\rho)\left(1-\frac{t}{2}\right)$

(b) Intermediary is quantity-constrained

	Neither Firm Concedes "Constrained Competition"	**Firm *A* Concedes "Constrained Single Concession"**	**Firms A and B both Concede "Constrained Concession"**
P_A	$\frac{t(1-Q_{TOT})}{1-\rho}$	V_H	V_H
P_B	$\frac{t(1-Q_{TOT})}{1-\rho}$	$1-t(1-Q_{TOT})$	V_H
P_I	$\frac{t(2-3Q_{TOT})}{2(1-\rho)}$	$1-\frac{t}{2}$	$1-\frac{t}{2}$
Π_A	$\frac{t(1-Q_{TOT})^2}{2(1-\rho)}$	$\frac{\rho V_H}{2}$	$\frac{\rho V_H}{2}$
Π_B	$\frac{t(1-Q_{TOT})^2}{2(1-\rho)}$	$(1-t(1-Q_{TOT}))\left(1-\frac{\rho}{2}-Q_{TOT}\right)$	$\frac{\rho V_H}{2}$
Π_I	$\frac{tQ_{TOT}(2-3Q_{TOT})}{2(1-\rho)}$	$Q_{TOT}\left(1-\frac{t}{2}\right)$	$Q_{TOT}\left(1-\frac{t}{2}\right)$

Proof of Lemma 1 and Corollary 1

In each of the asymmetric cases, "Single Concession" and "Constrained Single Concession", listed in Table A1, there are actually 2 equilibria: one in which *A* concedes and one in which *B* concedes (Table A1 reports the prices and profit for the equilibrium in which *A* concedes). At the contracting stage, firms do not know which equilibria would result. Thus, in the appendix, I rewrite condition (11) as:

$$\frac{\Pi_A+\Pi_B}{2}+\Pi_I>\Pi_A^{NI} \tag{A11}$$

where Π_A, Π_B and Π_I refer to the values reported in Table A1.

For "Strong Competition," $\frac{\Pi_A+\Pi_B}{2}+\Pi_I=\frac{t}{5(1-\rho)}$. Since $\Pi_A^{NI}=\frac{t}{2(1-\rho)}$, condition (Al1) is violated.

For "Constrained Competition," $\frac{\Pi_A+\Pi_B}{2}+\Pi_I=\frac{t\left(1-2(Q_{TOT})^2\right)}{2(1-\rho)}$. Condition (A11) is violated for all $Q_{TOT} > 0$. For "Concession," $\frac{\Pi_A+\Pi_B}{2}+\Pi_I-\Pi_A^{NI}=\frac{\rho V_H}{2}+(1-\rho)\left(1-\frac{t}{2}\right)-\frac{t}{2(1-\rho)}$. This function is decreasing in t. Thus, using (1), we know $\Pi_A+\Pi_I-\Pi_A^{NI}>\frac{\rho V_H}{2}+2-\frac{5}{3-\rho}$. The RHS of this equation is strictly positive since $\rho<1$ and $V_H\geq 1$. Thus, condition (Al1) is met. For "Constrained Concession" it is easy to see that condition (A11) will not be met if Q_{TOT} is sufficiently small. However, if both firms will concede, there is no reason not to allocate enough units to the intermediary to meet demand by the *searchers*. Thus, this outcome will never occur under optimal contracts. Finally, consider the "Single Concession" and "Constrained Single Concession" cases. For "Constrained Single Concession", $P_A>P_A^{NI}$ and $P_I>P_A^{NI}$. Furthermore, $P_B>P_B^{NI}$ if $Q_{TOT}>$ ½. Thus, if Q_{TOT} is sufficiently large, each consumer will be paying a higher price when there is an intermediary. This implies a higher total profit for the firms, i.e., $\Pi_A+\Pi_B+\Pi_I>2\Pi_A^{NI}$, and thus condition (A11) is met.[15] If Q_{TOT} is so large that the intermediary will not be constrained, competition between the intermediary and the non-conceding firm drives down prices, e.g., $P_I<1-\frac{t}{2}$. Thus, total profit is larger under "Constrained Single Concession" than under "Single Concession."

Definition of regions in Figure 4

The bold lines in Figure 4 represent conditions (1) and (2). The far-left triangular region (Q*=0) is defined by $t>\frac{25\rho(1-\rho)V_H}{6}$. Under this condition, even with $Q_{TOT}=1-\rho$, neither service provider would concede the *searcher* market. The far-right triangular region $(Q^*=1-\rho)$ is defined by $t<\frac{16\rho(1-\rho)V_H}{(3-\rho)^2}$. Under this condition, with $Q_{TOT}=1-\rho$, both service providers would concede the *searcher* market, i.e., "concession" would be the equilibrium. Note, joint profit under "concession" is higher than either the joint profit under "constrained concession" or either of the single concession cases.

Proof of Proposition 3

Proposition 3 considers four variations of the contracting stage. These cases are outlined in Table A2. Consider an outcome ($\hat{Q}_A$, $\hat{Q}_B$, $\hat{\alpha}$, $\hat{\beta}$) where service provider *A* transfers $\hat{Q}_A$ units to the intermediary and receives a transfer payment of $\hat{\alpha}$ and service provider *B* transfers $\hat{Q}_B$ units to the intermediary and receives a transfer payment of $\hat{\beta}$. This leads to an expected profit of $\frac{\Pi_A\left(\hat{Q}_A+\hat{Q}_B\right)+\Pi_B\left(\hat{Q}_A+\hat{Q}_B\right)}{2}+\hat{\alpha}$ for service provider *A*, an expected profit of $\frac{\Pi_A\left(\hat{Q}_A+\hat{Q}_B\right)+\Pi_B\left(\hat{Q}_A+\hat{Q}_B\right)}{2}+\hat{\beta}$ for service provider *B*, and a profit of $\Pi_I\left(\hat{Q}_A+\hat{Q}_B\right)-\hat{\alpha}-\hat{\beta}$ for the intermediary. If $\hat{Q}_A+\hat{Q}_B<Q^*$, from (12), we have:

$$\frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}+\Pi_I(Q^*)-\left[\frac{\Pi_A\left(\hat{Q}_A+\hat{Q}_B\right)+\Pi_B\left(\hat{Q}_A+\hat{Q}_B\right)}{2}+\Pi_I\left(\hat{Q}_A+\hat{Q}_B\right)\right]\equiv\gamma>0 \qquad \text{(A12)}$$

Table A2 Four Variations of the Contracting Stage

(a) sequential offers by the service providers	**(b) sequential offers by the intermediary**
i. Nature chooses $F=\{A, B\}$. ii. Service provider F makes an offer to transfer Q_F units to the intermediary in exchange for transfer payment TP_F. iii. The intermediary either accepts or rejects F's offer. iv. Service provider ~F makes an offer to transfer $Q_{\sim F}$ units to the intermediary in exchange for transfer payment $TP_{\sim F}$. v. The intermediary either accepts or rejects ~F's offer.	i. Nature chooses $F=\{A, B\}$. ii. The intermediary offers to make a transfer payment TP_F to service provider F in exchange for Q_F units. iii. Service provider F either accepts or rejects the intermediary's offer. iv. The intermediary offers to make a transfer payment $TP_{\sim F}$ to service provider ~F in exchange for $Q_{\sim F}$ units. v. Service provider ~F either accepts or rejects the intermediary's offer.
(c) simultaneous offers by the service providers	**(d) simultaneous offers by the intermediary**
i. Service providers independently make contract offers of (Q_A, α) and (Q_B, β), respectively, to the intermediary. ii. The intermediary accepts both offers, accepts only A's offer, accepts only B's offer, or rejects both offers.	i. The intermediary makes contract offers of (Q_A, α) and (Q_B, β) to the two service providers, respectively. ii. Each service provider independently decides whether to accept or reject its respective offer.

Without loss of generality, assume that in a sequential game, service provider A moves first (either making an offer to the intermediary or fielding an offer from the intermediary), i.e., $F=A$. From (A12), a contract transferring $Q^*-\hat{Q}_A$ ($>\hat{Q}_B$) units of provider B's product could improve expected profit for both firm B and the intermediary. For example, suppose the transfer payment for $Q^*-\hat{Q}_A$ units were specified to be $\hat{\beta}+\Pi_I(Q^*)-\Pi_I(\hat{Q}_A+\hat{Q}_B)-\varepsilon$, where ε is some small, but strictly positive number. The intermediary's expected profit would rise:

$$\Pi_I(Q^*)-\hat{\alpha}-\hat{\beta}-\Pi_I(Q^*)+\Pi_I(\hat{Q}_A+\hat{Q}_B)+\varepsilon-\left(\Pi_I(\hat{Q}_A+\hat{Q}_B)-\hat{\alpha}-\hat{\beta}\right)=\varepsilon>0 \tag{A13}$$

Firm B's expected profit would change by:

$$\left(\frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}+\hat{\beta}+\Pi_I(Q^*)-\Pi_I(\hat{Q}_A+\hat{Q}_B)-\varepsilon\right)-\left(\frac{\Pi_A(\hat{Q}_A+\hat{Q}_B)+\Pi_B(\hat{Q}_A+\hat{Q}_B)}{2}+\hat{\beta}\right)=\gamma-\varepsilon$$

which is strictly positive as long as ε is sufficiently small. Thus, in either a sequential or a simultaneous game, ($\hat{Q}_A, \hat{Q}_B, \hat{\alpha}, \hat{\beta}$) cannot be an equilibrium outcome because a mutually beneficial deviation is possible.

Proof of Lemma 2

Define **Q** as the set of all Q_{TOT} that yield the same expected combined profit as Q^*: $Q_{TOT}\in$ **Q** iff $\frac{\Pi_A(Q_{TOT})+\Pi_B(Q_{TOT})}{2}+\Pi_I(Q_{TOT})=\frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}+\Pi_I(Q^*)$. For example, if $Q^*=1-\rho$, then **Q** is the set of all values in the interval $[1-\rho, 1]$ since all Q_{TOT} in excess of $1-\rho$ result in "concession". Note that although Q_{TOT} may exceed $1-\rho$, sales of the opaque good will remain equal to $1-\rho$. On the other hand, in the intermediate region of Figure 4 where $0<Q^*<1-\rho$, **Q** will be a singleton, i.e. **Q** $=\{Q^*\}$.

First, consider the case where contract offers are made sequentially by the service providers, described in Table A2(a). Without loss of generality, assume service provider A makes the first offer, i.e., $F=A$. I restrict attention to sub-game perfect equilibria and use backwards induction to solve for these equilibria. Let (Q_A, α) represent the outcome of the first contract offer, letting $Q_A=\alpha=0$ if the intermediary rejects this offer. The intermediary either accepts or rejects B's offer (Q_B, β). If the intermediary accepts B's offer, it earns a net profit net of $\Pi_I(Q_A+Q_B)-\alpha-\beta$. On the other hand, if the intermediary rejects B's offer, it earns a net profit of $\Pi_I(Q_A)-\alpha$.

The intermediary accepts the offer if $\beta \leq \Pi_I\left(Q_A+Q_B\right)-\Pi_I\left(Q_A\right)$, else it rejects B's offer. Now turn to stage (iv). For a given Q_B, B extracts the maximum transfer payment possible, i.e., $\beta=\Pi_I\left(Q_A+Q_B\right)-\Pi_I\left(Q_A\right)$. Thus, Firm B net expected profit is $\frac{\Pi_A\left(Q_A+Q_B\right)+\Pi_B\left(Q_A+Q_B\right)}{2}+\Pi_I\left(Q_A+Q_B\right)-\Pi_I\left(Q_A\right)$. Note that the last term is not a function of Q_B. Thus, from the definition of Q^* and $\mathbf{Q}$, to maximize its expected payoff, firm B chooses Q_B such that $Q_{TOT} \in \mathbf{Q}$. Now consider stage (iii). The intermediary must decide whether to accept or reject A's offer (Q_A, α). From the preceding analysis, the intermediately anticipates that if it rejects A's offer, it will end up getting zero expected surplus. If the intermediary accepts A's offer it earns an expected net profit of $\Pi_I\left(Q_A\right)-\alpha$. Thus, the intermediary accepts any offer such that $\alpha \leq \Pi_I\left(Q_A\right)$. Now, turn to the initial decision by service provider A in stage (ii). Provider A anticipates that if it offers $Q_A < Q^*$, then supplier B will augment the intermediary's supply so that $Q_{TOT} \in \mathbf{Q}$. Thus, choosing the maximum transfer possible given Q_A, i.e., $\alpha=\Pi_I\left(Q_A\right)$, firm A obtains a net expected profit of $\frac{\Pi_A\left(Q^*\right)+\Pi_B\left(Q^*\right)}{2}+\Pi_I\left(Q_A\right)$ if $Q_A < Q^*$ or if $Q_A \in \mathbf{Q}$. Since only the second term is a function of Q_A and $\Pi_I\left(Q_A\right)$ is increasing in Q_A for $Q_A < Q^*$, the optimal offer must have $Q_A \in \mathbf{Q}$. On the other hand, if $Q_A > Q^*$ and $Q_A \notin \mathbf{Q}$, then firm A's expected profit is $\frac{\Pi_A\left(Q_A\right)+\Pi_B\left(Q_A\right)}{2}+\Pi_I\left(Q_A\right)$. By the definition of Q^*, this leads to a strictly lower profit than is attainable with $Q_A \in \mathbf{Q}$. Recalling the solutions for each of the following stages of the game, service provider A receives an expected net profit of $\frac{\Pi_A\left(Q^*\right)+\Pi_B\left(Q^*\right)}{2}+\Pi_I\left(Q^*\right)$, service provider B receives an expected net profit of $\frac{\Pi_A\left(Q^*\right)+\Pi_B\left(Q^*\right)}{2}$, and the intermediary receives zero expected surplus.

Second, consider the case where contract offers are made sequentially to the service providers, described in Table A2(b). Without loss of generality, assume the intermediary makes its first offer to service provider A, i.e., $F=A$. Looking for sub-game perfect equilibria, I solve the game backwards. Let (Q_A, α) represent the outcome of the first contract offer where $Q_A=\alpha=0$ if service provider A rejects this offer. Service provider B either accepts or rejects the intermediary's offer (Q_B, β). If B accepts the offer, it earns a net profit net of $\frac{\Pi_A\left(Q_A+Q_B\right)+\Pi_B\left(Q_A+Q_B\right)}{2}+\beta$. On the other hand, if B rejects the intermediary's offer, it earns a profit net of $\frac{\Pi_A\left(Q_A\right)+\Pi_B\left(Q_A\right)}{2}$. Thus, the intermediary accepts the offer if $\beta \geq \frac{\Pi_A\left(Q_A\right)+\Pi_B\left(Q_A\right)}{2}-\left(\frac{\Pi_A\left(Q_A+Q_B\right)+\Pi_B\left(Q_A+Q_B\right)}{2}\right)$, else it rejects the offer. Now turn to stage (iv). For a given Q_B, the intermediary wants to pay as small of transfer payment as possible, i.e., $\beta=\frac{\Pi_A\left(Q_A\right)+\Pi_B\left(Q_A\right)}{2}-\left(\frac{\Pi_A\left(Q_A+Q_B\right)+\Pi_B\left(Q_A+Q_B\right)}{2}\right)$. Thus, the intermediary obtains a net expected profit of $\Pi_I\left(Q_A+Q_B\right)-\alpha-\frac{\Pi_A\left(Q_A\right)+\Pi_B\left(Q_A\right)}{2}+\left(\frac{\Pi_A\left(Q_A+Q_B\right)+\Pi_B\left(Q_A+Q_B\right)}{2}\right)$. Note that the second and third terms are not a function of Q_B. Thus, from the definition of Q^* and $\mathbf{Q}$, to maximize its expected payoff, the intermediary chooses Q_B such that $Q_{TOT} \in \mathbf{Q}$. Now consider stage (iii). Service provider A must decide whether to accept the intermediary's offer (Q_A, α). From the preceding analysis, A anticipates that if it rejects the offer, $Q_B \in \mathbf{Q}$ units will still get allocated to the opaque channel. Thus, rejecting the offer gives A an expected profit of $\frac{\Pi_A\left(Q^*\right)+\Pi_B\left(Q^*\right)}{2}$. If A accepts the intermediary's offer and either $Q_A < Q^*$ or $Q_A \in \mathbf{Q}$, it earns an expected surplus net of transfer payments of $\frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}+\alpha$. Thus, if $Q_A < Q^*$ or $Q_A \in$ **Q**, A accepts the offer as long as $\alpha \geq 0$. On the other hand, if $Q_A > Q^*$ and $Q_A \notin$ **Q**, acceptance of the contract leads to an expected surplus of $\frac{\Pi_A(Q_A)+\Pi_B(Q_A)}{2}+\alpha$. Firm A accepts the offer if $\alpha \geq \frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}-\left(\frac{\Pi_A(Q_A)+\Pi_B(Q_A)}{2}\right)$. Now, turn to the initial decision by the intermediary in stage (ii). Again, the intermediary wants to pay as low of transfer as possible, i.e., $\alpha = 0$ if either $Q_A < Q^*$ or $Q_A \in$ **Q**, or $\alpha = \frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}-\left(\frac{\Pi_A(Q_A)+\Pi_B(Q_A)}{2}\right)$ if $Q_A > Q^*$ and $Q_A \notin$ **Q**. Thus, by choosing $Q_A < Q^*$ or $Q_A \in$ **Q**, the intermediary earns a net profit of $\Pi_I(Q^*)-(0)-\frac{\Pi_A(Q_A)+\Pi_B(Q_A)}{2}+\left(\frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}\right)$. Only this third term is a function of Q_A. Since $\frac{\Pi_A(Q_A)+\Pi_B(Q_A)}{2}$ is decreasing in Q_A for $Q_A < Q^*$, the optimal offer must have $Q_A \in$ **Q**. On the other hand, if $Q_A > Q^*$ and $Q_A \notin$ **Q**, the intermediary's net profit is $\Pi_I(Q_A)-\frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}+\left(\frac{\Pi_A(Q_A)+\Pi_B(Q_A)}{2}\right)$. Note that only the first and last terms are a function of Q_A. By the definition of Q^*, this leads to a strictly lower profit than is attainable with $Q_A \in$ **Q**. Recalling the solutions for each of the following stages of the game, the intermediary receives a net profit of $\Pi_I(Q^*)$. Service provider A and B each earn an expected profit of $\frac{\Pi_A(Q^*)+\Pi_B(Q^*)}{2}$.

Proof of Lemma 3

Let $\varepsilon > 0$ be the smallest possible positive payment and $\tilde{Q}$ be the Q_{TOT} that maximizes $\Pi_I(Q_{TOT})$. $\tilde{Q}$ is strictly positive since $\Pi_I(0)=0$ and Table A1 verifies that for all pricing equilibria, an active intermediary generates non-negative profit at least for some positive Q_{TOT}. Lemma 3 asserts that there always exists an equilibrium in which the intermediary is active if contract offers are made simultaneously. To prove this, I will demonstrate that the set of contract offers ($\tilde{Q}$, ε) and ($\tilde{Q}$, ε) are an equilibrium if offers are made simultaneously by the service providers or if offers are made simultaneously by the intermediary to the service providers. Note, uniqueness is not claimed. In fact, multiple equilibria will be shown to exist in certain cases. First, consider the situation where the service providers make simultaneous offers to the intermediary as is described in Table A2(c). If service provider A expects that service provider B will offer the contract ($\tilde{Q}$, ε), then provider A should counter with the contract ($\tilde{Q}$, ε). To see this, note that if provider A does not make an acceptable offer, the intermediary will accept B's offer since $\Pi_I(\tilde{Q}) > \varepsilon$ for sufficiently small ε. Thus, service provider A would earn an expected profit of $\frac{\Pi_A(\tilde{Q})+\Pi_B(\tilde{Q})}{2}$. On the other hand, service provider A could offer an acceptable contract. By definition, $\tilde{Q}$ is the intermediary's most preferred quantity. Thus, if A is offering ($\tilde{Q}$, ε), the best B can do is match this offer. The intermediary randomizes over which contract is accepted, thus netting service provider A an expected surplus of $\frac{\Pi_A(\tilde{Q})+\Pi_B(\tilde{Q})}{2}+\frac{\varepsilon}{2}$, which is strictly preferred to not making an acceptable offer. The same logic holds for service provider B, i.e., if A offers ($\tilde{Q}$, ε), then B's best response is ($\tilde{Q}$, ε).

Other equilibria are also possible. For instance, if $Q^* = 0$, there also exists an equilibrium in which no units are transferred to the intermediary. For example, the contract offers (0, α) and (0, β) are an equilibrium for any $\alpha \geq 0$ and $\beta \geq 0$. To see this, note that if provider B is not transferring any units to the intermediary, even if provider A can extract the entire value of the opaque sales, i.e., $\alpha = \Pi_I(Q_A)$, the expected profit (net of transfers) for service provider A is $\frac{\Pi_A(Q_A)+\Pi_B(Q_A)}{2}+\Pi_I(Q_A)$. If $Q^* = 0$, then this expected profit is maximized at $Q_A = 0$.

Now consider the situation where the intermediary makes simultaneous offers to the service providers as described in Table A2(d). Each service provider must decide whether to accept or reject its offer without knowing the decision made by the other service provider. There exists an equilibrium in which the intermediary offers the same contract ($\tilde{Q}$, ε) to each provider with a conditional clause that the offer is subject to expire at any moment. In this equilibrium, each provider believes that the other will accept the contract, and thus both service providers accept the contract. To see this, note that if service provider A does not accept the contract, the intermediary will contract only with service provider B. Thus, service provider A would earn an expected profit of $\frac{\Pi_A(\tilde{Q})+\Pi_B(\tilde{Q})}{2}$. On the other hand, if service provider A accepts the contract, the intermediary will have two offers of acceptance, and will choose to unilaterally void one of the contracts. The intermediary randomizes over which contract offer to void and thus service provider A earns an expected surplus of $\frac{\Pi_A(\tilde{Q})+\Pi_B(\tilde{Q})}{2}+\frac{\varepsilon}{2}$ from accepting the offer. Therefore, it is strictly more profitable for A to accept the offer. Following the same logic, service provider B will accept the offer if it expects A to do so.[16] As ε goes to zero, the intermediary expected profit converges to $\Pi_I(\tilde{Q})$ and each of the service providers' expected profit converges to $\frac{\Pi_A(\tilde{Q})+\Pi_B(\tilde{Q})}{2}$.

[1] Branded variants are another example where introduction of versioning can affect the amount of rivalry between firms (Shugan 1989; Bergen, Dutta, and Shugan 1996). But, a branded variant is horizontally differentiated (rather than an inferior good) and usually requires additional investment in product development to create meaningful differences.

[2] Much interest has been drawn to e-commerce, with a chief focus being how the Internet allows for different business models than what is traditionally observed in the brick-and-mortar world and how these models allow firms to appeal to distinct segments of consumers. For example, recent research has studied Internet shopping agents a.k.a. "shop bots" (Smith and Brynjolfsson 2001; Iyer and Pazgal 2003) and a wide range of dynamic pricing mechanisms (Kanna and Kopalle 2001). A central issue has been how consumer behavior differs in electronic marketplaces (Alba et al. 1997), especially as to degree of price sensitivity (Lal and Sarvary 1999; Lynch and Ariely 2000; Brynjolfsson and Smith 2000; Smith and Brynjolfsson 2001; Morton et al. 2001).

[3] The author has explored a model in which all pricing decisions are made simultaneously. This leads to more aggressive pricing and lower profit. Under the parameters considered, the "concession" equilibrium cannot exist. In its place, there is a mixed equilibrium in which the service providers charge the concession price with a probability greater than zero, but strictly less than 1. Thus, introduction of an opaque good substantially erodes the degree of price competition as long as the number of *brand-loyals* is sufficiently large.

[4] The models employed in these cited papers are special cases of this current model in which $V_H = 1$ and t=0.

[5] This accords well with what is observed in practice. All of Hotwire's suppliers of air travel are major airlines. For hotels, a comprehensive list of suppliers is not provided, but a sampling of hotel partners reveals participation by respected, major brands in the industry (e.g., Sheraton, Hilton, and Holiday Inn (http://www.hotwire.com/travel-information/partners/hotel-partners.jsp)). Furthermore, before making a purchase, the consumer is given the property's star rating (with specific amenities listed) even though the property's name and exact location remain concealed. Thus, the major source of uncertainty is not likely to be the quality of good provided by Hotwire but rather characteristics along some horizontal dimension.

[6] For example, Mohl (2003) argues that purchasing rental cars through Priceline or Hotwire is not very risky because "a Hertz compact car is pretty much like an Alamo compact."

[7] Even if a monopolist uses an intermediary, it can perfectly coordinate pricing of the opaque good by setting a wholesale price of 1-t/2. This ensures the intermediary will not add any markup since any higher price exceeds all consumers' values for the opaque good.

[8] Hotwire and Priceline often announce their participating partners (e.g., with rental cars, Hotwire's suppliers are Avis, Budget, and Hertz). But, when Hotwire offers a particular opaque good (e.g., a compact car rental originating at PHL from May 17, 2006 to May 19, 2006), it does not imply that all of its partners are willing to supply this particular service. Even though consumers presumably are aware of this (e.g., either Avis is supplying the car, Budget is supplying the car, or Hertz is supplying the car), uncertainty remains unresolved and it is still valid to assume consumers believe there is an equal probability of getting each of the goods.

[9] Reviewers and audiences of this paper have provided various arguments in support of either the simultaneous or the sequential structure. I am grateful for these many varied comments. For example, a sequential set-up is appealing for practical reasons since acceptance/rejection of contract terms occurs in real-time, i.e., it is impossible to offer contracts at exactly the same time. Also, a sequential set-up may provide a opportunity for the intermediary to play one service provider off the other one. On the other hand, since service providers are symmetric, it may seem strange to endow one service provider with a privileged position in the contracting stage (which might exogenously shift the balance of competition in an industry), thus suggesting a simultaneous set-up is preferred.

[10] Although the level of transfer payments and ultimate distribution of surplus is unique, the number of units transferred is not necessarily unique. For example, suppose $Q^*=1-\rho$. Allocating additional units to the intermediary would have no effect on prices. Thus, since marginal costs are zero, there exists a subgame-perfect equilibrium for any $Q_A \geq Q^*$ and $Q_B \geq 0$.

[11] This result relies on the assumption that *t* is not too large ($t < 1$) so that it is possible for the opaque intermediary to appeal to the median *searcher* without cannibalizing sales to *brand loyals*.

[12] Virtual communities are becoming increasingly important to marketers. For example, see Gopal et. al. (2006) for a discussion of the role of virtual communities in resale markets.

[13] Early commentators on Priceline asserted opacity was an undesirable property from consumers' and suppliers' perspective (Morris and Maes 2000, Meehan 2000, Turner 2000). For example, Morris and Maes (2000) claimed that Priceline's restrictive system "is both a disservice to the buyer and the seller – robbing the buyer of an opportunity to pay more for the 'ideal' flight and preventing the airline from selling their more desirable flights at higher prices." However, such analysis fails to recognize that consumers have multiple channels from which to purchase airline tickets and that an opaque product can be a valuable differentiation technique which allows for enhanced market segmentation.

[14] I wish to thank an anonymous reviewer for this interesting possibility.

[15] The condition that $Q_{TOT} > ½$ is a sufficient, but not necessary condition for (A11) to be met. Even if fewer units are allocated to the intermediary it is likely that condition (A11) will be satisfied. The algebraic expression of the necessary condition on Q_{TOT} is rather complex so I only report this simple sufficient condition.

[16] This is obviously the best possible outcome for the intermediary since it secures the number of units that maximizes its profit from opaque sales while making only a token payment to induce this transfer of units.