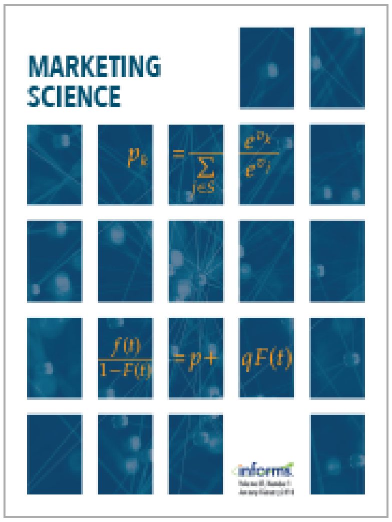

Marketing Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Internet Shopping Agents: Virtual Co-Location and Competition

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Internet Shopping Agents (ISAs) allow consumers to constlessly search many online retailers and buy as the lowest price. One would expect these ISAs to subject sellers to intense price competition that results in uniform low prices. Yet, Internet retailers have joined these ISAs. Furthermore, the prices charged by inside retailers can vary substantially. We examine the impact of ISAs on market competition. An ISA due to mass of consumers that they can potentially win, while others stay our and extract surplus from their loyal consumers. The equilibrium inside pricing is such that the average price charnged can increase or decrease when more retailers join, depending on whether or not the reach of the ISA is independent of the number of joining retailers. When the reach is endogenous, there exists a unique number of inside retailers.
(*Consumer Search; Comparison Shopping; Shopping Agents; Internet Intermediaries; Internet Retailing; Game Theory; Electronic Commerce*)

1. Introduction

The exponential growth of the Internet is perceived to be the single most important development in information technology in the last decade. Electronic commerce, which has been characterized as the process of carrying out business transactions over the Internet, has returned approximately 600 billion dollars for the 2001 fiscal year.[1] Initially, much of the Internet-based electronic commerce was restricted to online shops and services that were accessible via a Web browser. A consumer could search for a specific product using a browser and then purchase it by simply entering a valid credit card number. However, with the rapid evolution of Internet technology, online retailing quickly evolved beyond the straightforward adaptation of brick-and-mortar stores. In fact, the emerging generation of electronic shopping services are not retailers at all. Rather, they are websites that offer the use of a sophisticated "Internet Shopping Agent" (ISA) to prospective customers. These agents, also called shopping "bots" (an abbreviation for robots), are designed to take the legwork out of online shopping by escorting consumers through the purchasing process.

In 1995, Andersen Consulting developed the first example of a sophisticated shopping agent, *BargainFinder*. This agent accepts a request for a music CD from the consumer and searches a number of online CD stores for availability and prices. Over the last five years, a number of ISAs have been successfully established. Shopping agents, such as *mySimon.com*, Excite's *Jango*, or *EvenBetter.com*, allow consumers to search the Web for a fully specified product and then to tabulate the sites where the product can be bought and for what price. Generally, these agents are only sources of information—the consumer must link to the retailers listed by the agent to close the deal.

Figures 1a and 1b show the results of representative searches conducted by the authors using two

[1] Forrester Research has estimated the sales of consumer goods on the Internet to be $100 billion in 2001.

0732-2399/03/2201/0085$5.00
1526-548X electronic ISSN

Figure 1a **Search Results for "Dreaming of You" by Selena, Using Arthur Anderson's *BargainFinder***

Store	Price	Remarks
CDBargains	$8.99	Store special
CDBargains	$12.99	Regular price
CDLand	****	The search function is temporarily out of service (since at least 2/18/99).
CDMusic	$12.40	
CDnow	****	Blocking out our agents. You may want to try browsing there yourself.
CDworld	$13.47	
Emusic	$13.97	Good availability
MassMusic	****	Blocking out our agents. You may want to try browsing there yourself.
NetMarket	$11.99	Ships in 24 hours
SecondSpin	****	I could not find it. You may want to try browsing there yourself.

Figure 1b **Search Results for the Prices of "The Theory of Learning in Games" by Fudenberg and Levine, Using *MySymon.com***

Manufacturer suggested retail price: $32.95

Merchant	Price
Amazon.com	$32.95
All direct	$32.29
Kingbooks	$31.96
Varsitybooks.com	$28.01
a1Books	$32.95
BarnesandNoble.com	$32.95
Intertain.com	$26.95
AlphaCenter.com	$29.66
Books.com	$32.90

Min. Price: $26.95
Max. Price: $32.95
Average Price: $31.18

shopping agents. Figure 1a presents a tabulated result of a search for a CD titled "Dreaming of You" by Selena (which was one of the top 10 albums in *Billboard's* best-selling list at the time of our search) using Andersen Consulting's *BargainFinder*, whereas Figure 1b depicts the outcome of a search for the book *The Theory of Learning in Games* by Fudenberg and Levine, using *mySimon*. Some interesting aspects of these representative searches illustrate the issues examined in this paper:

• The goods in question are homogeneous search goods such as CDs, books, or video/audio cassettes (Nelson 1970). A consumer searching for a particular music CD or a specific best-selling novel knows even before to the actual consumption that she will get the same benefit from the good irrespective of the supplying retailer. The role of the ISA for goods such as CDs and books is the reduction of search costs for price information. Traditional wisdom suggests that shopping agents that reduce consumers' search costs for price (perhaps eliminating them altogether) should intensify price competition. In fact, the very nature of the ISA creates all-or-nothing competition in the following sense: Because consumers get to see all the retail prices with a single search, a retailer should get *all* the demand if it charged the lowest price in the ISA, but get *nothing* if it charged a price that was even slightly higher. Such intense price competition should drive down profits, and so the incentives of retailers should be clear. Still, many Internet retailers of goods such as CDs and books have rushed to join comparison shopping services.

• Given the environment with intense price competition, homogeneous goods, and the fact that the consumers' who use the agent face no search costs of obtaining price information, one does not expect to find large differences between the prices charged by retailers in the ISA. However, as the empirical data that we have shows, the prices charged by different retailers in the institution can differ substantially.

• Although retailers do join comparative shopping agents, there are also instances of retailers that are reluctant to let shopping agents into their sites. For example, *CDNow*, one of the largest music retailers on the Web, routinely blocks shopping agents.[2] Most retailers who indulge in blocking claim that they do not wish to reduce the competition to a single dimension (i.e., price) while ignoring other features, such as

[2] See "Web's Robot Shoppers Don't Roam Free," *The Wall Street Journal,* 3 September 1998.

the retailer's brand/store reputation, reliability, and quality of service. Can there be a different motive for this behavior? Alba et al. (1997) describe that an important research issue is to understand the factors that lead Internet retailers to inhibit search. Here, we examine the market factors that lead retailers to prevent ISA-based searches.

Software agents, by reducing the costs of price search, have the potential to improve consumer surplus. By scouring the Web, searching the relevant databases for product details, and synthesizing the results—from a simple price comparison on a CD to the complex details of a car insurance purchase—shopping agents provide information that search engines can miss and that shoppers could otherwise access only by visiting individual sites.

This paper focuses on the role of shopping agents in providing price comparisons for homogeneous goods, such as CDs, videos, or books. It is precisely in these situations that we expect the Internet institution to bring about a nearly perfect market, yet sellers of homogeneous goods do join ISAs. Furthermore, as the empirical evidence that we have gathered indicates, there can be substantial differences in the prices charged by retailers in an ISA.

To analyze these questions, we assume the following consumer characteristics and behavior. Consumers differ in their loyalty to the retailers and their propensity to use the ISA. The model captures consumer behavior through three segments. Each retailer enjoys a certain fraction of consumers who are "store loyals" and will only buy from that retailer (up to a reservation price). These consumers, possessing a high degree of retailer loyalty, do not use the ISA at all. This is consistent with the idea that the brand name and reputation of the retailer can play an important role in determining consumer preferences (Brynjolfsson and Smith 2000). In contrast to the store loyals, a second segment of consumers has no store loyalty at all and has negligible costs of searching the ISA. We label these consumers as "ISA loyals," and they use the comparative shopping agent to purchase the good for the lowest price inside the ISA. Finally, we assume a third segment of consumers who have some store loyalty but who also search the ISA, to capture the idea that the ISA is an institution that allows consumers to check whether firms indulge in price gouging. This segment of consumers that we label as "partial loyals" consists of consumers who visit the ISA but who might forego the opportunity to buy inside at the lowest price as long as their favorite store is reasonably priced. In other words, they use the ISA to monitor whether their favorite store is price gouging. In our model, these consumers buy at their favorite retailer as long as the price they are required to pay is not higher than the average price they can get from comparison shopping. This operationalization is motivated by the fact that several leading ISAs allow for calculation of the average/median price information of searches made by consumers.

The competitive environment consists of n retailers. After the emergence of the ISA, each retailer simultaneously decides whether or not to join, and a price strategy is contingent on this decision. We first examine the case in which the reach of the ISA (i.e., the number of consumers using the institution) is exogenous and independent of the number of retailers joining the shopping agent as a benchmark. In reality, this can represent the fact that many leading ISAs depend on their association with a leading portal site for traffic generation. Next, we analyze the case in which the reach is endogenously determined by the number of retailers joining the ISA in equilibrium (i.e., the reach of the ISA depends on the joining retailers). We also assume that the traffic at the ISA confers side benefits, such as advertising revenues to the owner of the ISA.

In equilibrium, an inside retailer (one that allows shopping agents access to its price data) will not charge a fixed price, but will instead use mixed price/promotional strategies. Next, we find that the average retail price charged by an inside retailer *increases* with the number of retailers that join the ISA, and this is reminiscent of Rosenthal (1980). Here, this result is linked to the formation of the Internet institution and to the all-or-nothing type of competition that it engenders. To understand this result, note that to win all the consumers who patronize the shopping agent, an inside retailer has to have the lowest price. This involves a clear trade-off. A decrease in price will increase the retailer's chance of winning all the consumers who shop using the ISA, but it also forces the retailer to subsidize its store loyals. As more retailers join the shopping agent, the chance of winning all the consumers decreases, and this motivates the inside retailer to focus strategically more on extracting surplus out of its loyal consumers by charging higher prices. Thus, the intense competition within the ISA leads to a higher average price as more retailers join. The average prices paid by the consumers who use the ISA (which is the average minimum price inside) is lower than that paid by the store loyals who buy from their favorite retailer. The average prices that consumers pay in the ISA can increase or decrease with the number of inside retailers: It increases when the reach is exogenous, but decreases when the reach of the ISA is endogenous.

The main results of this paper pertain to the entry equilibrium of retailers. In equilibrium, only some of the retailers choose to join the shopping agent, whereas others opt not to join. This is the case even though the retailers are ex ante identical. An outside retailer that does not join has two possible pricing strategies. It can focus exclusively on the store-loyal consumers by charging their reservation price, or it can lower the price to below the average price within the ISA and also attract its partial loyal segment. As more retailers join, the average price inside increases. This makes cutting the price to attract the partial loyals easier and less costly. Thus, the maximum number of inside retailers is determined by the following indifference condition: Retailers on the outside should be indifferent between charging the reservation price and lowering the price to also attract the partial loyals.

We show that there is a unique number of retailers who enter the shopping agent in equilibrium when the reach of the institution is endogenous and when the traffic at the ISA confers complementary side benefits to the owner of the ISA. Side benefits, such as advertising revenues, have real impact on the equilibrium only when the reach of the shopping agent is endogenous. In particular, the ISA has an incentive to share some of the side benefits with the inside retailers. This result finds at least anecdotal support. For example, *mySimon*, which is a leading standalone ISA that is not linked to any portal sites, relies on the draw that its member retailers have. Consistent with our analysis, *mySimon* routinely offers free banner advertising space to its member retailers, whereas portal-owned ISAs, such as *Shopping.com* or *Jango*, do not. Furthermore, if the incremental advertising side benefits from additional retailers joining is substantial, the ISA can actually have the incentive to plow back a significant portion of these benefits into the retail market. This creates a situation benefiting not only the ISA and the inside retailers, but also the retailers who do not join.

We extend the analysis to the case of heterogeneous retailers and find that, if the difference in the retailers' loyal segments is sufficiently small, then the retailers with larger loyalty are likely to be the inside retailers. Finally, we provide empirical evidence for the inside pricing predictions of the model, using pricing data for 35 items in the music CD, books, and video categories that was gathered in searches made on seven leading ISAs (two portal-owned and five standalone ISAs). The data consisted of biweekly retail price time-series data. We find support for the prediction that retailers inside an ISA use probabilistic pricing, for the result that the average price is increasing in the number of retailers in an ISA, and for the prices that consumers pay. We find support for both these model predictions.

The remainder of the paper is organized in the following manner. Section 2 presents the basic model. Section 3 discusses the case of exogenous reach, and §4 develops the case of endogenous ISA reach. In §5, we discuss the impact of retailer heterogeneity. We present empirical evidence in §6 and discuss the institutional implications of the research in §7. Section 8 presents conclusions, limitations, and future research.

2. The Model

Consider an industry comprising n identical and risk-neutral online retailers. These retailers sell a homogeneous product, such as a music CD or a specific book to the end-consumer market. The product is produced and distributed at a constant marginal cost of c, which for the rest of the analysis is assumed to be zero without loss of generality. The market is comprised of a unit mass of identical consumers. Each consumer has a demand of at most one unit of the product. Consumers have a common reservation price for the product, which is normalized to 1 without loss of generality.

We now discuss the impact of an ISA that allows a consumer to compare costlessly the prices of all the retailers that join the ISA. Consumers who use the agent can identify the lowest-price store and purchase the product from it. Thus, given a homogeneous product, consumers who use the Internet agent will purchase from the lowest-priced retailer. The consumer segmentation that we use captures differences in the relative loyalty for the shopping institution versus individual online retailers. This is done by defining three consumer segments.[3]

Store Loyals

These consumers have a high degree of retailer loyalty and do not use the ISA. They form a fraction α of the total consumers and are symmetrically split between the retailers. Even in the presence of the Internet agent, this segment will continue to buy the good only from their favorite retailer (as long as it is priced below the reservation price). Several authors provide evidence and explanations for why consumers might have store loyalty in an electronic marketplace. Brynjolfsson and Smith (2000) provide evidence that store reputation can be important to Internet consumers. Similarly, satisfaction from previous experience might also be a determinant of store loyalty. Urban et al. (2000) have argued that trust and assuaging consumer privacy is one of the most important components of loyalty on the Internet. For instance, consumers who are new to Internet shopping are usually reluctant to give their credit card information to an unknown retailer even if they can get a cheaper price. Consumers may also develop loyalty to a particular retailer because of switching costs: i.e., the effort required to learn about and navigate through a retailer site or even the time cost of entering information with a new retailer. Any of these factors can lead to store loyalty among consumers. Thus, in the model, the ISA has no effect on the behavior of this store-loyal segment. Each retailer can charge the reservation price and still sell to its store-loyal customers, achieving a profit of $\alpha \times (1/n) \times 1 = \alpha/n$.

ISA Loyals

In contrast to the store-loyal consumers, we assume that a fraction β of consumers have negligible cost of an additional search at the ISA. These customers always search and use the ISA to find the store offering the cheapest price. In particular, they buy from the retailer that has the lowest price of the k retailers that joined the ISA. Nua Internet Surveys estimates that, on a worldwide basis, about one million consumers shop using ISAs.[4]

Partial Loyals

The remaining segment of size $\gamma = 1 - \alpha - \beta$ is comprised of consumers who have some store loyalty, but who also search at the ISA. This segment allows us to capture the fact that the ISA can be used by consumers to monitor whether their favorite firm is price gouging. We label these consumers as having an intermediate (or partial) level of retailer loyalty in the following sense: These consumers would like to shop from their preferred retailer but, unlike the store-loyal consumers, they search the ISA and are not willing to pay the full reservation price at their favorite store. Again we assume a symmetric split of these consumers between all retailers. Thus, these consumers visit the shopping agent to get price information. Then, if their favorite retailer is outside, they

[3] The important aspect that a model of an ISA should capture is that firms that are inside the ISA face consumers who are able to do more price search/comparisons than firms that are outside. In our model, the inside retailers face consumers who costlessly see k prices, while outside firms face consumers who go to their favorite store. However, even if the outside firms face searching consumers who search between stores, the insights will still hold as long as the outside firms face consumers who, on average, have comparative price information about fewer stores than the inside firms. Our consumer segmentation captures this aspect of the ISA.

[4] Another reason for differences between consumers in using the ISA can be awareness of the existence of the institution among consumers. A survey in March 2001 by Jupiter Communications found 18% of their respondents above the age of 16 in the United States to be currently unaware of the existence of any ISA. In the long run, it is possible for the bulk of online consumers to be aware of the existence of ISAs. In this case, other factors, such as the reputation of their favorite retailer or the cost of searching over and above their favorite store, can still prevent a significant proportion of consumers from being ISA loyal.

buy from that retailer only if it charges a price below the average price they saw in the ISA. Otherwise, they buy through the ISA at the lowest price.[5] Jupiter Research estimates that about 10% of ISA users' aim is to monitor their own favorite store. The assumption of the average price as the threshold for decision making by these consumers is motivated by the fact that several leading ISAs allow for the calculation and report of the average/median price on searches made by consumers. The main results of the model remain valid, even if we choose an exogenous price threshold instead of the average of the equilibrium prices.

Note that $r = \beta + \gamma$ represents the potential "reach" of the ISA. We will first analyze a simple model in which the reach r is assumed to be exogenous and independent of k, the number of retailers that join. The independence between r and k represents the institutional reality that the traffic to many of the major ISAs are currently driven by their link to portal sites. For example, *Jango* is linked to *Excite*, and its reach depends directly on the nature and the size of Web traffic that the portal generates.[6] An alternative interpretation of this assumption is that the reach is a direct consequence of the reputation and the promotional efforts of the ISA itself, and that it does not depend on the reputation of the member retailers that join.

However, the reach of the ISA can also be endogenous to the retailers that end up joining the ISA. Thus, the reputation and franchise of the joining retailers can benefit the ISA [i.e., $r = r(k)$]. This is clearly the case for standalone ISAs, such as *mySimon*. In §4, we analyze environments in which the reach of the ISA is a function of the number of retailers joining it. Clearly, this also means that the size of the store-loyal segment will also be dependent on the number of inside retailers [i.e., $\alpha = \alpha(k)$].

Finally, we assume that the owner of the ISA derives side benefits from increased traffic at the Web site. The most obvious side benefit of greater traffic is the increased advertising revenues that the owner of the institution can get. We denote the side benefit function as $B(r)$ and assume that $B'(r) > 0$ (the side benefits increase with the total reach of the ISA). As will be apparent, $B(r)$ has real impact on the equilibrium when the reach of the ISA is a function of the number of retailers joining the shopping agent.

Given this set up, each retailer independently decides whether or not to join the ISA. Then, conditional on the entry decision, retailers simultaneously choose a pricing strategy. A retailer that decides not to join and stays out of the ISA does not have access to the traffic of ISA-loyal consumers who use the ISA and buy at the lowest price. Such an outside retailer has two possible strategies: It can choose to sell only to its store loyals by charging the reservation price or it can choose to sell to both its store loyals and its partial loyals by charging a price at or below the expected inside price. An inside retailer that joins the ISA will get its store loyals; but, in addition, it can also win the ISA loyals and partial loyals if it has the lowest price.

The equilibrium is determined by the condition that retailers will join the ISA as long as the profits they can get from joining are greater than the profits they can achieve outside. Obviously, retailers will choose their prices conditional on whether they participate in the ISA or whether they are an "outside" retailer.

3. ISAs and Retail Competition

3.1. ISAs Reach Independent of k

We first analyze the impact of an Internet shopping institution on competition, given that its reach is independent of the number of retailers joining. To understand how retailers in the ISA behave, it is necessary to analyze the consequence for a retailer that happens to be an outside retailer. Clearly, a retailer will only join the ISA if, in equilibrium, it can guarantee itself at least as much (or more) profit as it

[5] This formulation implies that a firm that joins the ISA subjects itself to full comparison shopping among the partial loyals. We have also analyzed an alternative model in which the partial loyals, if their favorite firm is inside and charging below the average inside price, will buy from it. The main insights of the paper remain valid in this alternative model.

[6] One might think of the portal's reach as the total potential reach of the ISA. Clearly, some consumers who use *Excite* might not use *Jango*. However, as long as the actual traffic in *Jango* is increasing in the portal's traffic, the model and the results of the paper will continue to be valid.

could make by staying outside. By remaining outside, each retailer guarantees itself a profit of α/n by charging the store-loyal consumers their reservation price. In the proposition, we characterize the equilibrium number of retailers joining. We look for a symmetric price equilibrium of the competition in the institution, given that some k retailers have joined.[7]

Any pricing equilibrium of the retailers competing in the ISA cannot involve pure strategies. Suppose the retailers were to compete by choosing a pure-strategy price. Then, in a symmetric equilibrium, each retailer's demand will be made up of its store-loyal consumers α/n (i.e., the loyal consumers of the retailer that do not use the ISA) and possibly the $\beta+\gamma$ consumers who use the shopping agent. The consumers shopping in the ISA choose the retailer that offers the lowest price. This means that any given retailer in the ISA will always have an incentive to "undercut" the competition and attract the entire customer base $\beta+\gamma$ that uses the Internet institution. Furthermore, similar to Varian (1980) and Narasimhan (1988), the price equilibrium can only involve totally mixed strategies. The following proposition characterizes the equilibrium number of retailers joining the ISA and also the unique symmetric price equilibrium in the ISA. Proofs of all the propositions are provided in the Appendix.

[7] It is useful to specify formally the model of a market without an ISA and how it is consistent with the model of a market with an ISA that is analyzed in this section. A natural way to model a pre-ISA market is to assume that, in the pre-ISA world, a proportion of α consumers are store loyal and only search at their favorite store (as in the model of this paper). The remaining $1-\alpha$ consumers are searchers (who are analogous to the ISA-loyal and the partial-loyal consumers in the main model). In the absence of the ISA, the searchers indulge in a one additional search. They are able to search one additional store and get comparative prices from two stores. In the market with the ISA, the searchers use their one additional search for searching at the ISA. Thus, with one additional search, these searchers are now able to see k additional prices, rather than just one additional price. This captures the idea that the ISA allows consumers to get price information from more stores than in the pre-ISA world. Comparison with this pre-ISA model shows that the average price paid by searchers and the expected inside price with an ISA is lower when compared with the expected price in the pre-ISA market. The analysis of this pre-ISA model is available at http://mktsci.pubs.informs.org.

Proposition 1. *When* α, β *and* γ *are independent of* k,

1. *The equilibrium number of inside retailers can be any* $k \le k^*$, *where* k^* *solves the equality* $E_k^*(p) = \alpha/(\alpha+\gamma)$. *Furthermore, the ISA will get the entire advertising side benefit.*

2. *The equilibrium c.d.f of the prices charged by each of the* k *inside retailers in a symmetric equilibrium* $F^*(p)$ *is given by*

$$F^*(p) = \begin{cases} 0 & \text{if } p < z \\ 1-\left(\alpha \dfrac{1-p}{pn(\beta+\gamma)}\right)^{\frac{1}{k-1}} & \text{if } z \le p \le 1, \\ 1 & \text{if } 1 < p, \end{cases}$$

where z *is the minimum price of the mixed-strategy distribution and is given by* $z = \alpha/[\alpha+n(\beta+\gamma)] = \alpha/(\alpha+nr)$.

It is useful first to understand the inside price equilibrium before discussing the entry equilibrium. Retailers inside the ISA used mixed-pricing strategies. The mixed strategies in which retailers choose prices below the reservation price and according to the distribution $F^*(p)$ allows a retailer to trade-off between taking advantage of its store loyals (by charging reservation price 1) and charging lower prices for the chance of being the most attractive retailer for the customer base in the ISA.

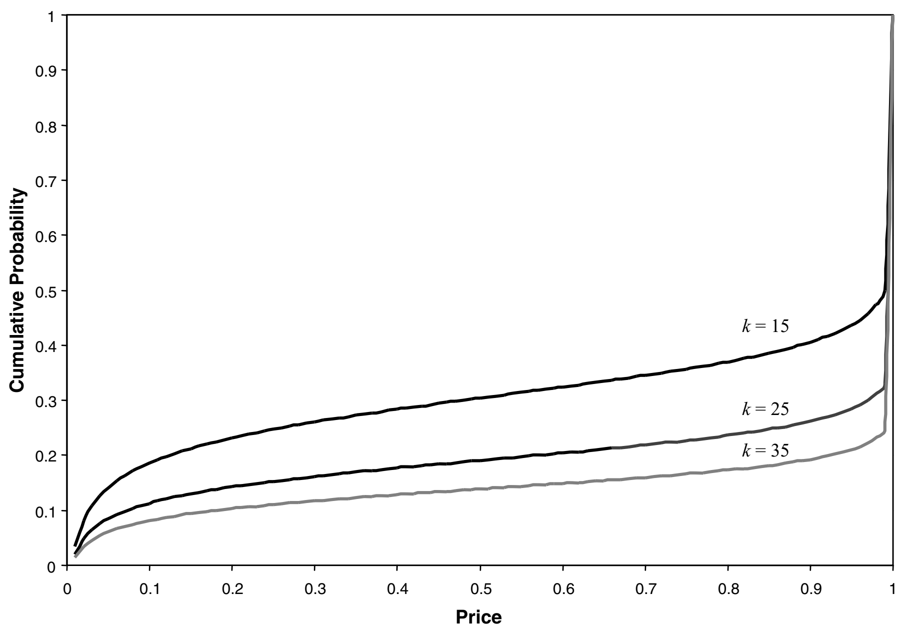
Note that the retailers choose prices between 1 and a minimum price $z = \alpha/[\alpha+n(\beta+\gamma)]$. This minimum price charged increases unambiguously with the degree of retailer loyalty (α) and decreases with the overall reach of the ISA ($\beta+\gamma$). Greater retailer loyalty increases the guaranteed profit of each retailer. This means that retailers who join the ISA would compete less aggressively for the inside consumers. Consequently, the minimum price increases with α. We now discuss the main implications of the pricing equilibrium.

3.2. Average Retail Prices in the ISA

Let us first define $W^*(p,k)$ as the equilibrium probability of charging a price above p [i.e., $W^*(p) = 1 - F^*(p)$]. From Proposition 1, this probability can be written as:

$$W^*(p,k) = \left(\frac{\alpha(1-p)}{pn(\beta+\gamma)}\right)^{\frac{1}{k-1}} = \left(\frac{\alpha(1-p)}{pn(1-\alpha)}\right)^{\frac{1}{k-1}}. \quad (1)$$

Figure 2 **Forty Firms: Thirty Percent Store-Loyal Customers Different Values of *k***



The first point to note is that $W^*(p, k)$ is an increasing function of k for every possible price.[8] Thus, $W^*(p, k_1)$ stochastically dominates $W^*(p, k_2)$ whenever $k_1 > k_2$. This is also evident from the plot of the c.d.f shown in Figure 2. This means that the average retail price charged by an inside retailer increases with the number of retailers that join. The traditional notion is that an increase in competition (due to the increase in the number of retailers) should have the effect of lowering prices. However, here, as in Rosenthal (1980), it is possible for average prices to go up with competition in the institution that the model represents.

Consider the incentives faced by an inside retailer. To win all the consumers who patronize the ISA, the retailer will have to be the one charging the minimum price. Thus, to increase its market share among the inside consumers, the retailer will have to indulge in intense price competition. Cutting prices, however, implies a clear trade-off. Although a decrease in price increases a retailer's chance of winning all the inside consumers, it also subsidizes the α/n store-loyal consumers who are willing to buy from the retailer even at the reservation price. As the number of inside retailers increases, all else being equal, any inside retailer will now have a lower chance of winning all the consumers for a given reduction in its price. The strategic response of a retailer to this is to focus relatively more on extracting surplus from its store-loyal customers. This leads to an increase in the average prices charged by an inside retailer. The closed-form expression for the average price with k inside retailers is:

$$E_k^* = \int_0^1 \frac{1}{n\,\frac{1-\alpha}{\alpha}\,p^{k-1}+1}\,dp.$$

3.3. Prices Paid by Consumers

Consider the probability that the minimum price is above a certain level p: $(W^*(p, k))^k = \left(\frac{\alpha(1-p)}{pn(1-\alpha)}\right)^{k/(k-1)}$. This probability is also an increasing function of k for every possible p. Once again, as the number of inside retailers increases, not only does each retailer charge a higher price on average, but the mean price paid by consumers also increases. Thus (paradoxically), greater competition in the form of more retailers does not benefit the consumer. With more retailers, each individual retailer cares more about extracting surplus from its loyal base than about competing for

[8] Note that $a^{1/b}$ is an increasing function of $b > 1$, as long as a is less than one. The argument in $W^*(p, k)$ is less than one by construction.

the consumers who patronize the ISA. Thus, it is possible for consumers to be worse off as more retailers join the ISA.

Nevertheless, the reader must note that the ISA has the potential to benefit consumers who are willing to search beyond their favorite retailer. The $\beta+\gamma$ consumers pay the minimum of all the posted prices in the shopping agent that therefore benefit from a substantially lower price than the store-loyal consumers: The ISA benefits the "inside" searching consumers. Note, though, that the size of this benefit diminishes as more retailers join an ISA.

3.4. Equilibrium Number of Inside Retailers

Proposition 1 states that some retailers in the industry will choose not to join the ISA, even if access is free. Indeed, as in the case of *CDNow*, these retailers will choose to block the ISA. The ISA endogenously creates differences in the price strategies among ex ante symmetric retailers. Only a fraction of the retailers will join the ISA and on joining will adopt different price strategies than that of an outside retailer.

To understand this result, consider the strategy of an outside retailer that does not join the ISA. Such a retailer has two possible strategies. It can charge the reservation price of 1. In this case it will only sell to its store-loyal consumers and get the (guaranteed) profit of $1\times(\alpha/n)$. Alternatively, the retailer can lower its price to E_k^* to increase its market share. In this case, the retailer will not only get its store-loyal consumers, but will also attract a mass γ/n of its partial-loyal consumers. Thus, whether an outside retailer will lower its price to E_k^* or not will depend on the size of the required price cut. Note also that, in our model, the outside retailers will not play a mixed strategy (i.e., they will not mix in the two possible prices). This is because in equilibrium ($k\le k^*$) the reservation price strategy is strictly dominating.[9]

Suppose that only a few retailers have joined the ISA. Consequently, E_k^* will be relatively small, making the price cut needed to attract the partially loyal consumers costly. As a result, the outside retailer will adopt the reservation price strategy. But, when a sufficiently large number of retailers have joined, E_k^* will be high enough to cause the outside retailer to deviate from the reservation price. Charging the reservation price can no longer be an equilibrium strategy for the outside retailer, because the profits from charging E_k^* are now higher. But this would imply that the inside retailers would have an incentive to leave the ISA, and the equilibrium unravels as a result.

Thus, the presence of only a few retailers makes joining the ISA attractive for an outside retailer because of less inside competition. As more retailers join, the average inside price charged increases, and this makes adopting the price-cutting strategy progressively easier for an outside retailer. Every retailer joining the ISA reduces the marginal benefit of joining for a succeeding retailer. In equilibrium, when a sufficient number of retailers have joined, an outside retailer becomes indifferent between charging the reservation price and lowering the price to also attract the partial-loyal consumers. This is the meaning of the equality condition in the proposition.

Proposition 1 focuses on only one of the two forces that characterize the ISA (i.e., that more retailers joining the institution results in higher average prices). This force only determines the maximum number of retailers k^* that can join the ISA. Notice, however, that for any $k<k^*$, the outside retailers will still not have an incentive to cut prices to E_k^*. For any $k<k^*$, the competition between the inside retailers will adjust to give each retailer its guaranteed profit of α/n from its store-loyal consumers, thus effectively preventing outside retailers from profitably joining the ISA. To identify a unique equilibrium number of inside retailers, we have to accommodate a second aspect of the ISA: the fact that the "reach" of the ISA can be

[9] In order to have the property that there are mixed strategies for outside retailers in equilibrium, it is necessary to construct a model in which outside firms also face searching consumers. In our model, the inside firms face consumers who see k prices, whereas outside firms face consumers who go to their favorite store in equilibrium. The results of this paper pertaining to average prices, as well as the entry of retailers, have to do with this essential characteristic that inside the ISA consumers are able to do more price comparisons. Even if the outside firms were to face searching consumers, the insights of our model will hold as long as firms outside face consumers who, on average, have comparative price information about fewer stores than firms inside the ISA, and any reasonable definition of an ISA should imply this characteristic.

endogenous and can depend on the number of retailers joining the ISA. We analyze this important aspect in the following section.

4. Endogenous Reach of the ISA

Endogenizing reach helps us to capture the idea that the attractiveness of a shopping agent (as measured by the traffic that it generates) depends on how widely it is adopted by the industry. This leads to some of the main results of this paper. Assume now that the reach of the shopping agent is proportional to the number of retailers joining it. In particular, let $r(k) = tk/n$, where $0 < t < 1$ is the marginal effect of an additional inside retailer on the reach of the ISA. In other words, the size of the store-loyal segment is $\alpha(k) = 1 - tk/n$. Given this, the equilibrium price distribution of Proposition 1 can be rewritten as

$$F^*(p) = \begin{cases} 0 & \text{if } p < z \\ 1 - \left(\dfrac{tk(1-p)}{np\,(n-tk)}\right)^{\frac{1}{k-1}} & \text{if } z \le p \le 1, \\ 1 & \text{if } 1 < p \end{cases}$$

where $z = tk/[tk(1-n) + n^2]$.

We have the following result.

RESULT 1. *When the reach of the shopping agent is given by $r = tk/n$, there exists a critical t_c, such that, for every $t \le t_c$, the average price, $E_k^*(p)$, charged by a retailer is monotonically increasing in k, the number of retailers joining the ISA. Furthermore, $t_c = 0.841843$.*

Unlike the case of exogenous reach, the average price charged by an inside retailer can be nonmonotonic w.r.t k. This happens when the marginal effect of an additional inside retailer on the reach of the ISA is large ($t > t_c$) and when a sufficiently large number of retailers are already inside the ISA. In this situation, each inside retailer enjoys a very small segment of store loyals. This forces the inside retailers to compete more intensely for the consumers who patronize the ISA. We will first discuss the main points of this section through Proposition 2 for the case of $t \le t_c$ and then discuss what happens when $t > t_c$.

PROPOSITION 2. *Let $t \le t_c$, and the side-benefit function be regular ($B(r) > 0$, $dB/dr > 0$). Define k^*, which solves the equality $E_k^* = (n-k)/[n - k(1-\delta)]$. In this expression, $\delta = \gamma/(\beta+\gamma)$ is the proportion of the partial loyals of all the consumers who use the ISA. The entry equilibrium of retailers will be as follows:*

1. *Let $m > k^*$, and $L(m) = (\gamma(m)/n)E_m(p)$. If the shape of $B(r)$ obeys an "increasing sufficiently slowly" (i.s.s) property defined by $B(r(m)) - B(r(k^*)) < L(m)m$ $\forall m$, then the unique entry equilibrium involves k^* retailers. In this equilibrium, the outside retailers charge the reservation price. In addition, the lump-sum side payment made by the ISA to each inside retailer will be arbitrarily small.*

2. *However, if $B(r)$ "increases quickly enough" and $B(r(m)) - B(r(k^*)) > L(m)m$ for some nonempty set M of all $m > k^*$, then the unique entry equilibrium is $m^* > k^*$, where $m^* = \text{argmax}_{m \in M}[B(r(m)) - L(m)m]$. In this equilibrium, the prices charged by the outside retailers are lower than the reservation price and equal to $E_{m^*}(p)$. The ISA will make nonnegligible lump-sum payments $L(m^*)$ to each of the m^* inside retailers.*

In the previous case of exogenous reach, the side benefit enjoyed by the ISA had no impact either on the equilibrium entry or on the price strategies of the retailers. This is no longer the case with endogenous reach. The manner in which the side-benefit $B(r(k))$ increases with the number of retailers affects the entry equilibrium.

The first part of the proposition represents the case where every additional joining retailer adds a sufficiently small incremental value to the side benefit enjoyed by the ISA. In the previous discussion of exogenous reach, any $k \le k^*$ can be part of an equilibrium. However, when the reach depends on the number of retailers joining, the owner of the Internet institution will be strictly better off if the maximum number of retailers are motivated to join because this maximizes the reach and the corresponding advertising side benefits. The owner of the ISA therefore has an incentive to make a payment to retailers for joining the ISA. Thus, it can indeed be optimal for the owner to pay some retailers to sign up. Proposition 2.1 indicates that these payments to retailers will be negligibly small if the *i.s.s* property $B(r(m)) - B(r(k^*)) < L(m)m$ $\forall m$ holds. Given this, exactly k^* will join in equilibrium, and the remaining outside retailers will charge the reservation price.[10] In contrast, if the *i.s.s* condition is not satisfied, then it will be attractive for the owner of the ISA to motivate an even larger number of retailers $m > k^*$ to join.

Recall from our previous discussion in §3.4 that the equilibrium k^* represents the maximum number of retailers beyond which the outside retailers will have an incentive to charge lower than the reservation price (and attract the partial loyals). The owner of the ISA faces a distinct trade-off. The ISA will have the incentive to motivate the maximum number of retailers to join as the reach and the side benefit increase monotonically with the number of joining retailers. However, if the number of inside retailers becomes too large (and in particular if the number of inside retailers is any $m > k^*$), then the outside retailers will have the incentive to cut the price to attract the partial loyals and thereby increase their profits to $[\alpha(m) + \gamma(m)]E_m$. This would mean no retailer would want to join the ISA unless the ISA can subsidize it through a nonnegligible lump-sum side payment that covers the difference between the inside and outside profits; i.e., $L(m) = (\gamma(m)/n)E_m$. Clearly, making this payment $L(m)$ to each of the inside retailers is only attractive for the ISA if the side benefit enjoyed is substantially higher for additional retailers joining beyond k^*. This is the intuition for *i.s.s* property and the first part of Proposition 2. When the side benefit does not increase fast enough, the ISA prefers to restrict entry to only k^* retailers and make negligible side payments. Note that, in this case, the outside retailers follow the reservation price strategy, and the equilibrium profits of all retailers will be $\alpha(k^*)/n$.

However, when the advertising side benefit enjoyed by the ISA increases substantially with additional retailers joining, the ISA has the incentive to make positive side payments of $L(m^*)$ and motivate $m^* > k^*$ retailers to join. Interestingly, the outside retailers charge less than the reservation price (i.e., they charge E_{m^*}) and get the benefit of selling to the partial loyals. The inside retailers benefit from the positive side payment. Thus, the ISA plows back part of the advertising revenues back into the retail market if the increase in the reach-dependent benefits are sufficiently large. In doing so, the ISA makes all firms better off: Not only do the owner of the ISA and the inside retailers benefit but also the retailers who do not join enjoy greater profitability than in a world without an ISA. The reason for this as follows: Because the advertising side benefit increases substantially with respect to additional reach, the ISA would like more firms to join. The resulting increase in the side benefits can create a Pareto improvement: The ISA is better off even after making side payments to the additional joining firms (and making them better off). Thus, if the advertising side benefits enjoyed by the ISA increase at a sufficiently fast rate with additional retailers joining, then the ISA can afford to share the advertising benefits with the joining retailers and still be better off. Additional profits accrue because it is optimal for the ISA to make more than k^* retailers to join which creates more advertising benefits. Also, these advertising benefits enable a Pareto improvement for the ISA and all the inside retailers. The plowing back of advertising side benefits also has a strategic effect on the behavior of the outside retailers and causes them to lower prices to the expected inside price and thereby raises their profits beyond the guaranteed profit of α/n.

This proposition also highlights the effect of price-monitoring intensity on equilibrium behavior. Recall that the size of the partial-loyal segment represents the extent of price monitoring that inside retailers will be subjected to. Proposition 2 shows that, if the size of this segment is small enough (i.e., price monitoring is not too intense), the ISA will find it beneficial to share the advertising side benefits and motivate additional retailers to join in equilibrium. When additional retailers join the ISA, the expected inside price increases and outside retailers will cut price to attract their partial-loyal consumers. Consequently, to keep the inside retailers from defecting, the ISA will have to make suitable side payments to each inside retailer. When the size of the partial-loyal segment is small, the side payments needed are also small.

[10] Note that, in this case, it is not an equilibrium for a retailer to join the ISA but continue to charge the reservation price (i.e., behave like an outside retailer). This is because the ISA has the incentive to ensure that the inside retailers do not adopt the "reservation price only" strategy by offering small payments. If inside retailers charge only the reservation price, then there will be fewer inside retailers in equilibrium, and this implies lower side benefits for the ISA.

The reader must also note some interesting institutional aspects of side payments made by the ISA to the inside retailers. In actual practice, the side payments can be in the form of free advertising offered by the ISA to its member retailers. Our results predict that such payments are most likely to be made by standalone ISAs that are not attached to any portal sites. In fact, *mySimon*, which is a standalone ISA, provides advertising space for its participating merchants at no additional cost, whereas *Yahoo*, *Lycos*, or *Excite* do not provide such free space to retailers that are associated with their respective ISAs. The results also highlight the importance of advertising and other side benefits that Web traffic generates. It provides a perspective on the idea that site-traffic investments that result in future payoffs in advertising revenues and other complementary benefits can be a feasible revenue model for leading B2C Internet companies.

In sum, whereas the outside retailers prefer a strategy of extracting surplus from their store loyals, the inside retailers move to the ISA, motivated by the traffic of consumers that they can attract inside the institution. Furthermore, this discussion of endogenous reach provides a rationale for why some retailers will stay out and "block" the ISA and others prefer to join. In our model, a retailer who elects to block the ISA imposes a positive externality on all other retailers because this reduces the size of the consumer segment that comparison shops through the ISA (or by effectively increasing the set of store-loyal consumers). Thus, blocking or staying out can be seen as attempts made by retailers to reduce the traffic at the ISA, thereby preventing the ISA from being too successful. In fact, attempts made by retailers such as *CDNow* were considered by analysts as attempts at reducing the legitimacy of ISAs.

Figure 3a shows the impact of the number of retailers that join the average price charged by the inside retailers. As before, the average price charged by the retailers increases with k. But, unlike the previous case of exogenous reach, the minimum price paid by consumers decreases with k. Thus, with endogenous

Figure 3a **Average and Minimum Prices**

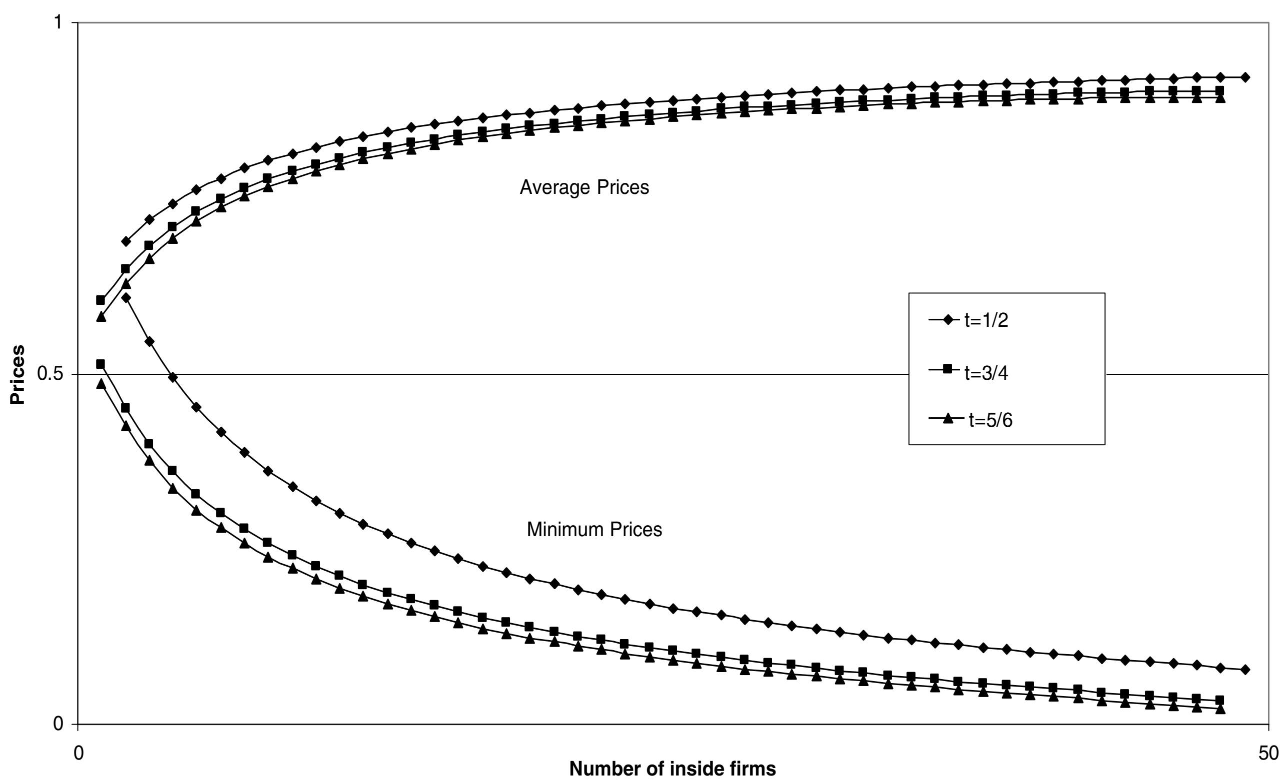
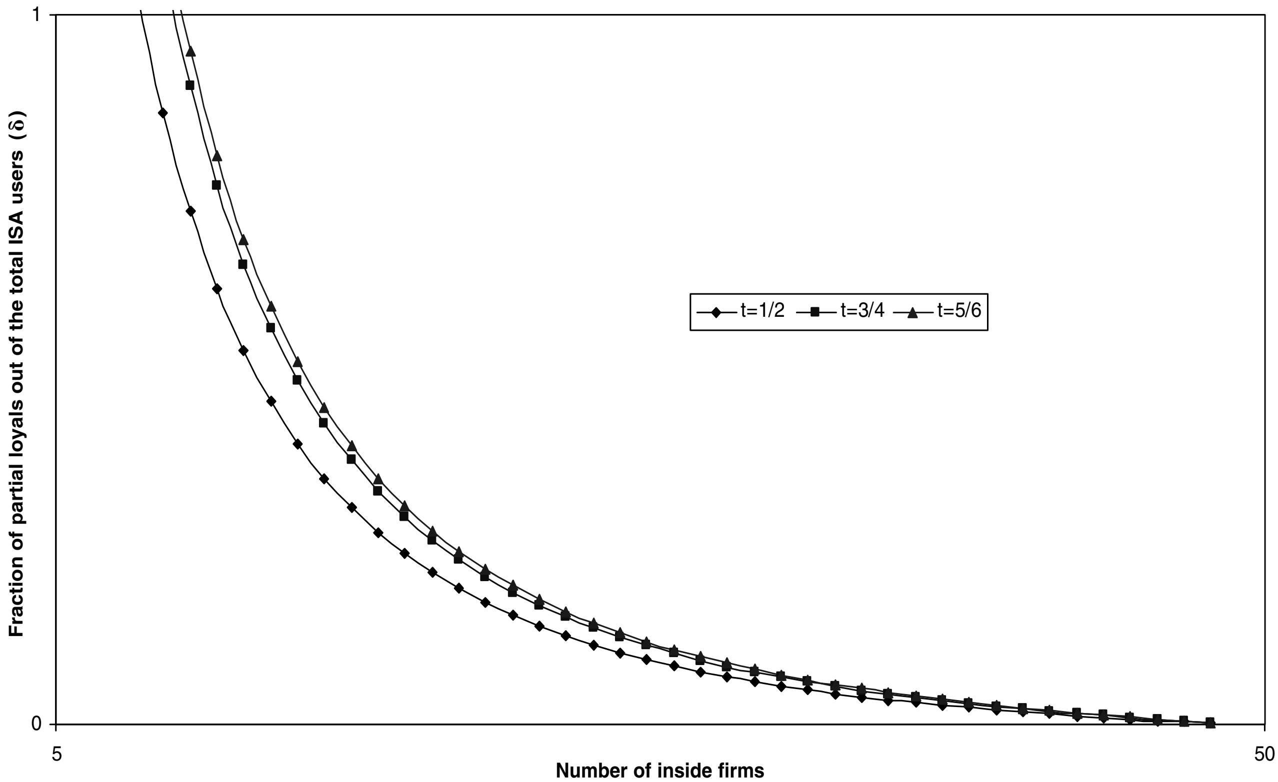


Figure 3b **Equilibrium Number of Inside Firms**



reach, consumer surplus will keep increasing as more retailers join. This is because the number of consumers drawn to the ISA increases with k. Therefore, the gain from charging the lowest price is also increasing in k. Consequently, the greater the number of inside retailers, the greater will be the motivation of each retailer to win all the consumers. This results in a lower average minimum price being charged.

Figure 3b shows how the equilibrium number of inside retailers is affected by some of the important parameters of the model. It can be seen that the equilibrium number of inside retailers decreases with δ the proportion of partial loyals (of all the consumers who use the ISA). As δ increases, there are fewer consumers who are completely loyal to the ISA and more who are willing to consider both. This makes the ISA less attractive for an outside retailer. Furthermore, an increase in the marginal effect of an inside retailer (t) causes more retailers to join the ISA. Larger t implies that each inside retailer brings more shoppers to the institution. The positive externality that this places on all the other inside retailers outweighs the cost of increased competition.

Finally, we briefly discuss the case when $t > t_c$. The condition $t \leq t_c$ ensures that the expected price is increasing in the number of inside firms. However, for the case of $t > t_c$ (i.e., small segment of store loyals), the expected inside price might behave nonmonotonically w.r.t the number of inside firms (i.e., it can increase and then decrease). Now, there are two possible cases. Either the equilibrium k^* occurs in the rising part of the expected inside price curve, in which case all the results are exactly as in Proposition 2, or (when t is very large), all the firms will want to join the ISA. This makes intuitive sense, because if the marginal effect on reach of an additional retailer joining is extremely large, we should naturally expect all retailers to want to join the ISA.

5. The Impact of Retailer Heterogeneity

It is possible that retailers might differ in their reputation or the extent of their store loyalty. For example, *CDNow* enjoys a much greater loyal segment than *MuZicDepot.com*. This can be modeled by assuming differences in the sizes of the store-loyal segments across retailers. In this section, we examine the role of loyalty differences in determining retailer strategies with respect to an ISA. An important objective of extending the model to retailer heterogeneity is to understand when a retailer with large loyalty would want to join the ISA. We examine this question in the context of portal-owned ISAs with exogenous reach.

Consider the following extension to the basic model. Let there be two types of retailers that differ in the sizes of their store-loyal segments. For generality, we also allow for the two types of retailers to have different sizes of partial loyals. The first type consists of n_1 retailers, each having a store-loyal segment of size α_1 and a partial-loyal segment of size γ_1. The second type consists of n_2 retailers, with each retailer having a *larger* store-loyal segment of size α_2 and a partial-loyal segment of γ_2. The total size of the store-loyal segment is $\alpha = n_1\alpha_1 + n_2\alpha_2$. We will refer to a retailer of the first type as a "small" retailer and to its counterpart from the second type as a "large" retailer.

We examine the incentive of the different types of retailers to join the ISA. Thus, the difference in store loyalties between the two groups determines the type of inside equilibrium that results. We will first analyze a case in which the difference in store loyalty between the groups is sufficiently large.

5.1. Sufficiently Large Difference in Store Loyalties

PROPOSITION 3. *As long as the difference in store loyalty is sufficiently large (sufficiency condition being $\alpha_2 - \alpha_1 > \gamma_1$), then*

1. *If there is only one small retailer in the industry (i.e., $n_1 = 1$), then this small retailer will always join the ISA. The small retailer will make a profit of $[\alpha_2/(\alpha_2+S)]\cdot(S+\alpha_1) > \alpha_1$.*

2. *If $n_1 \geq 2$, then there will always be at least two small retailers joining the ISA. In this case, the small inside retailers will make only their guaranteed profits α_1.*

In this proposition, $S = 1-\alpha$.

From Proposition 3.1, we have that a sole small retailer will always join the ISA as long as the difference in the store loyalties is sufficiently large. The small retailer will always make a profit greater than α_1 by joining the institution, though this means competing with the inside large retailers. This is because the small retailer now benefits from the consumer traffic it can win within the ISA. In addition, because the small retailer competes with retailers who have a larger pool of guaranteed consumers, it faces less aggressive price competition (than if it were to compete with other small retailers) and therefore does not compete away all the profits gained on the consumers in the ISA. The greater the difference in the store loyalties, the greater is the equilibrium profit of the small inside retailer.

To understand this result, suppose the small retailer stays out. Then the outside small retailer has two options. It can either charge the reservation price and get the guaranteed profit of α_1, or it can cut the price to the average inside price and attract the partial loyals. This means that the small retailer will always join under the condition that the inside profits are greater than what it could get by staying outside and cutting the price to the expected inside price. When the difference in store loyalty is sufficiently large, the inside profit of the small retailer is large enough for this condition to be satisfied.

For the more general case, when the industry has two or more small retailers, Proposition 3.2 shows that at least two small retailers will always join the ISA. A small retailer has the incentive to join the ISA when other small retailers have not entered. Suppose that only one small retailer joins in equilibrium. Then, such a retailer will make a profit of $[\alpha_2/(\alpha_2+S)](S+\alpha_1) > \alpha_1$. Now, consider the outside small retailer(s). If they were charging the reservation price, then any one of these retailer(s) could improve their profits to $[\alpha_2/(\alpha_2+S)](S+\alpha_1)$ by joining the ISA. On the other hand, if the outside small retailers were cutting the price to the expected inside price in equilibrium, then two possibilities exist. Either the profit made by an outside retailer will be higher (in which case the inside small retailer will deviate and move out), or the profit of the inside small retailer is higher and the outside small retailers will want to join the ISA.[11]

Thus when the difference in store loyalty is large enough, any feasible equilibrium will be characterized by at least two small retailers and some k_2 large retailers. The price equilibrium inside the ISA for any feasible configuration of large and small retailers is detailed in the following proposition.

Proposition 4. *If there are $k_1 \geq 2$ small and some k_2 large retailer(s) inside the ISA, then in a nondegenerate equilibrium,*

1. *The small retailers will adopt a mixed strategy in price according to the equilibrium c.d.f $F^*(p)$ where,*

$$F^*(p) = \begin{cases} 0 & \text{if } p < z \\ 1 - \left(\alpha_1 \dfrac{(1-p)}{pS}\right)^{\frac{1}{k_1-1}} & \text{if } z = \dfrac{\alpha_1}{\alpha_1 + S} \leq p \leq 1 \\ 1 & \text{if } 1 < p. \end{cases}$$

Furthermore, the small retailers will make their guaranteed profit α_1.

2. *The large inside retailers charge the reservation price and their equilibrium profit will be α_2.*

In a nondegenerate equilibrium, the inside small retailers will play a mixed strategy in equilibrium. Following a logic similar to that of Proposition 1 (and given at least two small inside retailers), the price competition between the small retailers forces them to compete away all but their guaranteed profits α_1 in equilibrium. The more interesting point is that the large inside retailers play the reservation price. Thus, the large inside retailers continue to behave as if they were outside retailers. This result has an analogue in the observed behavior of Internet retailers. When the difference in the store loyalties is sufficiently large, larger retailers, such as *Amazon.com*, can be inside the ISA and can continue to charge high prices.

[11] Only under the knife-edged condition that $E_{1,k_2}(\alpha_1 + \gamma_1) = [\alpha_2/(\alpha_2 + S_{new})](S_{new} + \alpha_1)$ is it possible for an equilibrium to exist with only one small inside retailer, even though the outside small retailers are cutting the price to the average inside price. Under this condition, $S_{new} = \beta + \gamma_1 + n_2\gamma_2$ is the reach of the ISA when the outside small retailers are the cutting price to the expected inside price.

5.2. Store Loyalty Difference Not Large Enough

Let us now consider the case in which the difference in the store loyalty of the two types of retailers is not very large.

Proposition 5. *If the difference in the store loyalty is not large enough $(\alpha_1 + \gamma_1)E_{k_2} > [\alpha_2/(\alpha_2 + \tilde{S})](\tilde{S} + \alpha_1 + \gamma_1)$, then there can exist an equilibrium with only large retailers inside (at least some k_{2min} or more large retailers). The large inside retailers play mixed strategies in prices. The large outside retailers charge the reservation price, and the small outside retailers charge the expected inside price. In this equilibrium, the large retailers will make their guaranteed profit of α_2, and the small (outside) retailers make a profit $E_{k_2}(\alpha_1 + \gamma_1) > \alpha_1$. The relevant reach of the ISA for this proposition is $\tilde{S} = \beta + n_2\gamma_2$.*

The purpose of this proposition is to identify the strongest possible equilibrium condition for large retailers to join the ISA. This condition is obviously the one that pertains to the extreme case in which only large retailers are inside the ISA in equilibrium. If the difference in loyalty is not too large, only the large retailers patronize the institution. With smaller difference in store loyalty, a small retailer entering the ISA faces price competition from other retailers that are similar to itself. This reduces the potential gain for the small retailer from joining the ISA. The small retailers make greater profits staying out and charging the average inside price to attract their partial loyals. Therefore, even though the small retailers do not join, the ISA has a strategic effect on the market that allows the small retailers to make more than their guaranteed profits (i.e., more profit than they would have made in a world without the ISA).

6. Institutional Implications

There is an ongoing debate about the benefits of ISAs for consumers. Many analysts agree that comparison shopping should, in general, allow consumers to find deals for search goods, such as CDs, videos, or books. However, others point out that, despite the rush of retailers to join shopping agents such as *mySimon* and *Jango*, these shopping agents do not necessarily give consumers the best deal.[12] Furthermore, it has been noted that, from a consumer's perspective, the prevailing prices within ISAs have not improved (and might have actually gone up) even as retailer participation has increased over time. The preceding analysis clarifies this debate. As shown in §3.3, an increase in consumer prices might be a natural consequence of the all-or-nothing type of competition in the electronic institution, when its reach is independent of the number of inside retailers. This implies that, within ISAs such as *Jango*, whose reach is primarily determined by portal sites, average consumer prices can go up with more inside retailers. On the other hand, in ISAs in which the inside retailers have a role in drawing consumer traffic, average minimum prices can go down with the number of inside retailers (as in Figure 3a).

This paper highlights a central trade-off created by the ISA. Only some retailers decide to join the ISA, and others simultaneously choose to stay out. The question of which of these strategies is the best for a retailer has been a subject of much controversy among industry experts. Glover Ferguson, a director of the e-commerce program at Andersen Consulting, has described that retailers would balk at joining an ISA because "…nobody wants to be reduced to a commodity…" However, a contrary view that retailers have no choice but to join bots is presented by Venky Harinarayan of *Junglee* "…as consumers start moving to the medium, you have to follow them if you are a retailer…".[13] Our paper indicates that the extreme scenarios painted by analysts are unlikely to be the ultimate outcome as the ISA institution takes root. We provide a rationale for why some retailers that join the institution might continue to coexist in equilibrium with retailers that choose to stay out. After the emergence of the ISA institution, the inside and outside retailers endogenously segment the consumer market.

This paper also shows that retailers of search goods, such as CDs and books, can immunize themselves against ISAs only by protecting their store loyals. Recent articles in the trade press discuss this issue and note that retailers will have to improve services and offer added values to their shoppers if they want to keep them (see "The Attack of the Robots," *The Wall Street Journal*, 7 December 1998). However, fewer online merchants currently block successful ISAs, such as *mySimon*, than even a year ago. This has been attributed to the fact that these ISAs have invested in increasing the traffic to their sites (see "Agents Go Price Shopping," *InternetWeek*, 7 December 1998). Consistent with the predictions of this paper, if the ISAs are successful in attracting shoppers to their sites and chiseling away at the store loyals, we should expect fewer Internet merchants to resist moving over to the ISA.

It is useful to link certain aspects of competition in an ISA to competition in the brick-and-mortar world. The ISA brings the k retailers returned in a search into direct competition with each other, because it allows the consumers to see in a single search the prices of all the retailers. There are similarities between an ISA and the phenomenon in the brick-and-mortar world of a central market or bazaar in which all retailers of a given type cluster together in physical location. However, this phenomenon is a somewhat different problem, because in the conventional world, colocation acts as a commitment mechanism for sellers. As in Dudey (1990) and Wernerfelt (1994), competing sellers might voluntarily colocate to commit not to charge high prices to consumers who have already invested in the sunk cost of travel.

7. Empirical Evidence

To test some of the predictions of the theory, we collected data on the pricing behavior of retailers in two leading portal-owned ISAs (*Yahoo!Shopping* and Alta Vista's *Shopping.com.*) between March–July 2001, and also five standalone ISAs (*mySimon, BottomDollar, EvenBetter, Bsilly*, and *PriceScan*) between April and October 2000. The pricing data were collected on a biweekly basis in three different categories of homogeneous goods, namely music CDs, movie videos, and books.

[12] See "Bots Don't Make Great Shoppers: Intelligent Agents That Search the Net Often Miss Out on the Best Bargains," Stephen Wildstrom, *Business Week*, 7 December 1998.

[13] See "Web's Robot Shoppers Don't Roam Free." *The Wall Street Journal*, 3 September 1998.

7.1. Data Collection Methodology

For both the portal-owned and the standalone ISAs, a set of 35 items were chosen in the three categories as follows. For the CD category, we randomly selected 10 titles using *Billboard*'s top 50 list. Similarly, 10 movie video titles were chosen from *CDNow*'s movie list (titles were chosen from the children's, comedy, and drama genres). Finally, for books, the following criteria were used. We chose only hardcover titles. A total of fifteen titles were randomly chosen: five from the *New York Times* bestseller lists (fiction and nonfiction), five general fiction books, and five popular college textbooks. Note that, because the data were collected in different time periods, the set of items in the standalone and the portal-owned ISAs are not exactly identical.

For these items, searches were conducted on all the chosen ISAs on a biweekly basis. For each search, we collected the entire distribution of prices charged by the retailers returned in the search. All the ISAs report and tabulate the basic price net of shipping and handling, and this is the price that is used for the analysis. We also captured the identity of the retailers in each search. A total of 50 such searches were conducted for each of the items over the seven-month period in the standalone ISAs, whereas a total of 35 searches were conducted over the five-month period in the portal-based ISAs. Thus, data consisted of $35(\textit{items}) \times 5(\textit{ISAs}) = 175$ time series each containing 50 observations (snapshots) of prices in participating stores for the standalone ISAs and $35(\textit{items}) \times 2(\textit{ISAs}) = 70$ time series each containing 35 observations for the portal-owned ISAs.[14]

7.2. Testing the Predictions

We use this data to test the model prediction pertaining to probabilistic pricing by the inside retailers and the behavior of the inside prices.

7.2.1. Identity of the Retailer Charging the Minimum Price. The first objective of the exercise is to validate the prediction that retailers inside the ISA engage in mixed-strategy pricing and do not adopt a fixed-pricing strategy. An empirical consequence of mixed-strategy pricing is that retailers change prices over time and there is no one single store that is constantly charging the minimum price. Therefore, the store charging the minimum price in the ISA changes across the periods.

We construct three specific measures from the dataset to test this prediction. A simple measure is the average number of stores charging the lowest price at least once in the collection period. However, a more comprehensive measure will be one that not only captures the "number" of retailers in a time series that had the lowest price, but also the share of each retailer. Such a measure will therefore be a form of concentration ratio similar to the *Herfindahl Index*, which is used to measure industry concentration (see Tirole 1988, p. 221). To obtain such a measure, within each time series and for each store that charged the lowest price, we calculate its proportion of the total times it was indeed the cheapest. Formally, the concentration index is the sum of the squares of these proportions for all the retailers. The inverse of the concentration index could be viewed as the "effective" number of stores with the lowest price.

The concentration index defined previously does not capture one more aspect that is important for testing the prediction pertaining to the identity of the lowest price. Consider the following two hypothetical sequences of lowest-price stores: *AAAAABBBBBCC* and *ABABABCABABC*. Both sequences have three stores charging the minimum price and have identical concentration indices of $(5/12)^2 + (5/12)^2 + (2/12)^2 = 54/144 = 0.375$. However, the two sequences differ in the amount of "switching" that exists in the identity of the lowest-price retailer from one period to the next. Accordingly, consider a third measure, that is, switching index, which records the number of times the identity of the lowest-priced retailer changed (from one period to the next) in a sequence relative to the maximum number of such changes possible. The closer this index is to 1, the greater is the variability in the identity of the lowest-priced retailer across the periods. The first sequence has a switching index of $2/11$, whereas the second has an index of $11/11 = 1$.

We compute all of the three types of measures described. Table 1a summarizes the three indices

[14] Note that each snapshot consists of the prices charged by all the retailers returned by the search.

Table 1a Measures to Test Probabilistic Pricing in Standalone ISAs

	Books	Music CD	Movie Videos
Mean number of lowest-priced stores (per time series)	6.4 (2.6)	4.8 (1.8)	5.5 (2.1)
Concentration index	0.45 (0.19)	0.52 (0.17)	0.43 (0.22)
Switching index	0.74 (0.30)	0.65 (0.19)	0.70 (0.22)

Table 1b Measures to Test Probabilistic Pricing in Portal-Based ISAs

	Books	Music CD	Movie Videos
Yahoo!Shopping			
Mean number of lowest-priced stores (per time series)	6.2 (2.8)	5.2 (2.1)	6.0 (2.5)
Concentration index	0.51 (0.30)	0.61 (0.20)	0.53 (0.25)
Switching index	0.67 (0.27)	0.62 (0.20)	0.65 (0.21)
Shopping.com			
Mean number of lowest-priced stores (per time series)	2.9 (1.1)	4.3 (1.5)	4.1 (1.6)
Concentration index	0.70 (0.32)	0.65 (0.23)	0.66 (0.24)
Switching index	0.55 (0.31)	0.58 (0.24)	0.62 (0.19)

averaged over the standalone ISAs and for all items within a category, and Table 1b does the same for the portal-owned ISAs. For the standalone ISAs, the mean number of lowest-price stores across all the categories is 5.7, ranging from a high of 6.4 for books to a low of 4.8 for music CDs. Thus, across all categories and all standalone ISAs, there was an average of about six different retailers charging the lowest price for the six-month period in our dataset. For the portal-owned ISAs, we get similar results. The mean number of retailers across the three categories in *Yahoo!Shopping* is 5.8 and in *Shopping.com* is 3.9 (categorywise details are in the table).

The concentration indices also provide support for the fact that no single store is the minimum-priced store. The concentration index ranges from 0.43 for movie videos to 0.52 for music CDs for the standalone ISAs. Recall that the inverse of the concentration index is the effective number of stores with the lowest price, which is around two stores for the three categories investigated here. In *Yahoo!Shopping*, the index ranges from 0.51 to 0.61, whereas in *Shopping.com* it is slightly higher. Finally, the switching indices for the three categories in both Table 1a and Table 1b indicate that there is considerable switching in the identity of the minimum-priced retailer from one period to another.

7.2.2. Investigating the Inside Pricing. The pricing result of the paper that we test is the behavior of the average inside price charged by the firms with respect to the number of firms in an ISA. We used the following procedure to investigate average pricing behavior: First, of the total 175 time series pertaining to the standalone ISAs, 11 did not have enough variation in the number of inside retailers. The difference between the minimum and the maximum number of retailers in these time series was less than or equal to 3. We ignored them and used the remaining 164 time series for the test. For each time series, we calculated $\bar{n}$, the average number of participating stores.[15] Next, we calculated the average price (p^L) for all the time periods in which the number of stores was $\bar{n}-1$ or lower and compared it to the average price (p^H) for the time periods in which there were $\bar{n}+1$ stores or higher. According to the model, we would expect $(p^H - p^L)$ to be significantly greater than zero. We therefore conducted t-tests for the differences in the means for each of the 164 time series. Table 2a reports the results. The results as shown in Table 2a provide support for the average price result of the model. Across the three categories, 77% of the t-tests for $(p^H - p^L) > 0$ were significant at the 5% confidence level. Furthermore, there is support in each of the three individual categories. The percentage of significant t-tests varies from a low of 72% for music CDs to a high of 79% for books. Among portal-owned ISAs, 61 time series were usable (i.e., had enough variation in the number of retailers). As shown in Table 2b, there is support for the hypothesis that the average price increases with the number of inside firms. Across the three categories, 69% of the t-tests (for $p^H - p^L > 0$) were significant at the 5% level.

[15] $\bar{n}$ was rounded to the nearest integer.

Table 2a Average Retail Price Behavior in Stand-Alone ISAs

	Books	Music CD	Movie Videos	Overall (Across All Categories)
Number of series with significant $p^H > p^L$ at ($\alpha < 0.05$)	56	34	36	126
Total number of time series in the category	71	47	47	164
% of time series with significant $p^H > p^L$	79	72	77	77

Table 2b Average Retail Price Behavior in Portal-Based ISAs

	Books	Music CD	Movie Videos	Overall (Across All Categories)
Number of series with significant $p^H > p^L$ at ($\alpha < 0.05$)	14	9	7	30
Number of series with significant $p^H > p^L$ at ($\alpha < 0.10$)	19	12	11	42
Total number of time series in the category	27	17	17	61
% of time series with significant $p^H > p^L$	70	71	65	69

Finally, we also investigated the effect of the number of participating retailers on the average minimum prices for each category. As before, for each time series, we calculated the average minimum price ($p^L_{\min}$) for all the time periods in which the number of stores was $\bar{n}-1$ or lower and compared it to the average minimum price ($p^H_{\min}$) for the time periods when there were $\bar{n}+1$ stores or higher. For a standalone ISA, the theory predicts that $p^L_{\min}$ will be significantly greater than $p^H_{\min}$. Across the three categories for the standalone ISAs, about four-fifths of the t-tests pertaining to this prediction were significant at the 5% level. For the portal-owned ISAs, the theory in §3 predicts that the average minimum price for ISAs, with exogenous reach should be increasing in the number of inside retailers. However, with respect to this prediction, we find that only 48% of the t-tests are significant at the 5% level. (We also checked at the 10% significance level and found 61% of the t-tests to be significant.)

8. Conclusion, Limitations, and Future Research

Comparative shopping agents allow consumers to costlessly search across many retailers and buy at the lowest price. This would lead one to speculate that these agents should reduce frictions in Internet marketplaces and would lead to all sellers charging uniformly low prices. However, there is ample evidence that there can be large variations in the prices offered by sellers who participate in an ISA. Also, we find retailers rushing to join leading ISAs, but even the most popular ISAs have not been successful in attracting all the retailers in the industry. Large retailers such as *CDNow* continue to block some shopping agents, even as other retailers join the institution and subject themselves to price competition.

Several research studies have examined the overall effect of the Internet on retail competition. Lal and Sarvary (1999) show that the impact of the Internet on price competition would depend on the salience of attributes that are easily communicated through the Internet. Baye and Morgan (2001) study the interaction between a market for price information on the Internet and an associated homogeneous product market. Zettelmeyer (2000) shows how price competition between Internet retailers can be affected by the expanding reach of the Internet. This paper focuses on the emergence of a specific Internet institution and traces its impact on retail competition. We explain why retailers might join a comparative shopping institution and how price competition between retailers would be affected by an ISA. This institution is particularly interesting because of the all-or-nothing type of competition that it creates. The paper traces out the set of economic forces that govern the emergence and functioning of an ISA.

We show that an ISA creates differentiation in pricing strategies between ex ante identical retailers. Some retailers join the ISA motivated by the lucrative mass of consumers that they can win, whereas others simultaneously elect to stay out and focus on extracting surplus from their store loyals. This explains why retailers block ISAs even as others have joined. One aspect of the competition that leads to this outcome is the nature of pricing practiced by the retailers that join the ISA. The average price charged by retailers inside the ISA goes up with the number of joining retailers.

The analysis indicates that consumers who use the ISA get substantially lower prices than consumers who do not. However, the average prices paid (minimum posted prices) by consumers inside the ISA can increase or decrease when more retailers join the ISA, depending on whether or not the reach of the ISA is independent of the number of joining retailers. We also show that, when the reach of the ISA is endogenous and when the traffic in the ISA confers complementary side benefits, there can exist a unique number of retailers who will join the institution. If the incremental side benefits from additional retailers joining is substantial, the ISA will strategically plow back a portion of the side benefits into the retail market, creating a situation in which not only the ISA and the inside retailers gain, but also the outside retailers are better off than in a world without the ISA. Our analysis of retailer heterogeneity helps to specify what type of retailers might join the ISA. We identify conditions under which retailers with smaller store loyalty are more likely to join, as opposed to conditions in which only large retailers join the ISA.

Several interesting issues can be explored further. One such issue is the impact of an ISA on the incentives of retailers to endogenously invest in loyalty. Internet retailers invest in customer service, efficient delivery, site reviews, etc. in an attempt to generate customer loyalty. One can think of an extension to our model, wherein retailers decide on costly investments in loyalty, as well as on whether or not to join the ISA (where joining implies a payment to the ISA). An interesting task would be to analyze the conditions under which the ISA creates asymmetric behavior among retailers: Some retailers invest less in loyalty, but pay to join the ISA and take advantage of the traffic within, whereas others invest more and stay out. Another interesting issue is the analysis of dynamic competition in an ISA. As in switching-cost models, each retailer might compete for old consumers who have previously purchased from the retailer, as well as new consumers who have not (as in Klemperer 1987). Old consumers have costs of switching away from their current firm. Retailers can use the institution to attract customers in a current-period who then are willing to pay more in a future period. Retailers might charge low current-period prices in the ISA to lock up consumers. Additionally, as the number of inside retailers increases, competition for consumers who will be valuable in the future can become more intense, leading to lower prices in the ISA. Another interesting issue not addressed in this paper is accounting for the nonprice aspects of competition among Internet retailers. These include dimensions such as shipping quality and costs, return policies, and payment options. On the empirical side, data on these variables will be useful to investigate their impact on retail pricing in the ISA. The role of nonprice competition among retailers and the fact that some retailers might have cost advantages for providing nonprice attributes would also be useful to investigate. Finally, other questions for future research include investigating competition between several ISAs, as well as the effect of the recent practice by some retailers, such as *Amazon.com*, of allowing for limited price comparisons within their website.

Acknowledgments

The authors thank Severin Borenstein, Yuxin Chen, Eitan Gerstner, Michael Katz, Dmitri Kuksov, David Levine, V. Padmanabhan, Duncan Simester, David Soberman, Jereon Swinkels, J. Miguel Villas-Boas, Florian Zettelmeyer, and seminar participants at the Berkeley Industrial Organization seminar, University of Chicago, University of Florida, Insead, Berkeley/Davis/Santa Clara/Stanford colloquium, and UCLA for their comments. The authors also thank the editor, the area editor, and the reviewers of this journal.

Appendix

Proof of Proposition 1.

Price Equilibrium Given k Inside Retailers. First, we look for a symmetric equilibrium of the competition between the "inside" retailers given that k of them have joined. The guaranteed profit of each of the k retailers if they charge the reservation price will be $\alpha(k)/n$.

A possible totally mixed equilibrium strategy is the following: Retailer j can charge a price according to some continuous c.d.f $F_j(p)$ with support between 1 and a lower bound z_j. Let $W_j(p)$ be the probability that retailer j charges a price above p $[W_j(p) = 1 - F_j(p)]$. Assume that the partial-loyal segment of size γ buys from within the institution.[16] Given this, retailer j when charging a price p makes an expected profit of:

$$p\frac{\alpha(k)}{n} + pr(k)\prod_{h\neq j} W_h(p). \tag{A1}$$

[16] Later on, we prove that this indeed is the case in the equilibrium.

The first term in the expression is the profit a retailer makes from its store-loyal customers, whereas the second term is the profit that the retailer makes provided it had the lowest price among that k retailers in the ISA [in which case it will capture the entire customer base $r(k)$].

For any mixed-strategy profile to be a Nash equilibrium, it is required that each retailer, given the distribution of strategies chosen by the other retailers, is indifferent between all possible pure-strategy prices [i.e., the retailer must make the exact same profit for each price it charges in the support of the distribution $F_j(p)$]. In a symmetric equilibrium, we have $W_j(p) = W(p)$ and $z_j = z$ for all j. Therefore, we have,

$$p\frac{\alpha(k)}{n} + pr(k)(W(p))^{k-1} = c, \tag{A2}$$

where c is a constant.

If retailer j charges the reservation price 1, it will not sell to the $r(k)$ ISA shoppers and will make a profit of $\alpha(k)/n$. Therefore, $c = \alpha(k)/n$. By charging the lower bound z, the retailer will get:

$$z\frac{\alpha(k)}{n} + zr(k)(1)^{k-1} = c = \frac{\alpha(k)}{n}. \tag{A3}$$

Solving for z and $W(p)$, we get the expressions given in the proposition.

Equilibrium Entry of Retailers. Assume that there are k that have joined the ISA in equilibrium. Now, consider a retailer that decides to stay out. To show this, note first that the retailer has two possible pure strategies. It can charge the reservation price and sell only to its store loyals for a profit of α/n. Alternatively, it can reduce its price to just below the average inside equilibrium price, $E_k^*(p)$, in which case it will attract its partial-loyal consumers (whose size is γ/n) for a profit of $E_k^*(p) \times [(\alpha+\gamma)/n]$. In equilibrium, the outside retailer will choose the reservation price as long as

$$\frac{\alpha}{\alpha+\gamma} \geq E_k^*(p). \tag{A4}$$

Let k^* solve (A4) with equality. Then, the condition holds for every $k < k^*$ because $E_k^*(p)$ is increasing in k. Suppose (A4) does not hold. Then, the outside retailer will choose to cut its price to just below $E_k^*(p)$, preventing the reservation price for the outside retailer from being a part of the equilibrium strategy. However, charging just below $E_k^*(p)$ cannot be part of an equilibrium strategy for an outside retailer, because it will induce the inside retailers, that make only α/n to leave. Thus, (A4) and the inside price distribution given in Proposition 1 determine the equilibria. Note that (A4) guarantees that all the partial loyals will indeed find the prices inside cheap enough to shop within the ISA. This establishes the remark in Footnote 16.

Finally, in this model, the outside retailers cannot mix between the two possible pure strategies in equilibrium. In equilibrium $k \leq k^*$, and this ensures that the reservation price strategy is always strictly dominating.

Proof of Result 1. It follows from direct differentiation of the expression for $E_k^*(p)$. □

Proof of Proposition 2. In this case, the condition in (A4) reduces to $E_k^*(p) \leq (n-k)/[n-k(1-\delta)]$. As before, we can determine a k^* that is the maximum possible number of inside retailers. However, given that $B(r(k)) > 0$ and increasing in k, the ISA has the incentive to ensure that the maximum number of retailers join the ISA. This can be achieved by the ISA announcing the following side payment schedule: For every $k \leq k^*$, each retailer joining will receive a side payment of arbitrarily small size $\epsilon > 0$. This is a necessary condition to ensure that k^* will strictly prefer to join.

Next, we establish the sufficient condition for k^* to be an equilibrium. This requires establishing the condition that ensures that the ISA does not find it optimal to induce any $m > k^*$ retailers to join. Suppose some $m > k^*$ retailers were to join. Then, by the definition of k^*, the expected inside price will be so large that the outside retailers will find it optimal to deviate from the reservation price strategy and charge $E_m(p)$. In this case, any outside retailer will make profits of $[(\alpha(m)+\gamma(m))/n]E_m(p)$, which is greater than the inside profit. Therefore, no retailer will want to join unless the ISA makes a nonnegligible lump-sum side payment that equalizes the inside and outside profits. Therefore, the equilibrium side payment will have to be $L(m) = (\gamma(m)/n)E_m(p)$. For k^* to be an equilibrium, the ISA must not find it profitable to offer $L(m)$. This will be the case if $B(r(m)) - L(m)m < B(r(k^*)) - \epsilon\ \forall m$. Given that ϵ is arbitrarily small, we get the sufficient condition reported in part "a" of the Proposition. Part "2" of the proposition is obvious for the case when $B(r(m)) - L(m)m > B(r(k^*)) - \epsilon$ for a nonempty set M of all possible $m > k^*$. □

Proof of Proposition 3. Assume to the contrary that there are only some k_2 retailers that are all of the "large" type inside. Then, using arguments that are analogous to that in Proposition 1, each will make a guaranteed profit of α_2. Furthermore, at least a subset of the retailers will mix according to the distribution function specified in the proposition with lower support $z = \alpha_2/(\alpha_2+S)$, in which S is the number of consumers who shop in the ISA in equilibrium ($S \geq \beta$). Consider now the incentive of a small (outside) retailer. It can charge the reservation price and make a profit of α_1. In this case, joining the ISA and pricing at z will guarantee that this retailer will win all of $S = (1-\alpha)$, yielding a profit of $z(S+\alpha_1) = [\alpha_2/(\alpha_2+S)](S+\alpha_1) > \alpha_1$. Alternatively, it can charge $E_{k_2}^*$ and make a profit of $(\alpha_1+\gamma_1)E_{k_2}^*$. In this case, joining the ISA and pricing at z will guarantee that this retailer will win all of S, yielding a profit of $z(S+\alpha_1+\gamma_1)$. Therefore, this retailer will join if $z(S+\alpha_1+\gamma_1) > (\alpha_1+\gamma_1)E_{k_2}^*$, which holds given the sufficient condition in the proposition. This proves the first part of the proposition.

Consider now the case in which there are two or more small retailers. Using arguments exactly identical to those above, at least one of them will go in. Suppose it was the case that only one small retailer is in. Then, this small retailer will behave exactly as described in Proposition 1 and charge the minimum price of $z = \alpha_2/(\alpha_2+S)$. However, if only one small retailer is in, any one of the other small retailers has an incentive to join as well and price at $z-\epsilon$, because this will get a profit higher than α_1. Hence, in equilibrium, at least two small retailers will join. Using standard arguments, it can be easily shown that the inside retailers will compete away all but their guaranteed profits α_1, which completes the proof. □

Proof of Proposition 4. We provide a sketch of the proof. The proof is best illustrated using the example of two small and one large inside retailer. The proof for the general case of $k_1 \geq 2$ small retailers and k_2 large retailers is completely analogous. It can be shown that not all the retailers can charge a mass point. Otherwise, as in Varian (1980), one of the retailers will have the incentive to undercut when the others are charging the mass point and win all the consumers. Similarly, it cannot be the case that a small retailer charges the mass point while the other small retailer(s) do not, because then the focal small retailer can improve its expected profit by cutting price. So, no small inside retailer can have a mass point in equilibrium. Similar to Varian (1980), each small retailer charges a price according to $W(p)$: $p \in (1, z_1)$, where $z_1 = \alpha_1/(\alpha_1 + s)$ and s is the relevant reach of the institution. [Note: $W(p)$ is the probability of charging a price above p.]

Suppose that the large inside retailer charges according to some distribution $[V(p)$: $p \in (1, z)$, where $z_1 < z_2 < z$, $z_2 = \alpha_2/(\alpha_2 + s)$. $[V(p)$ is the probability of charging a price above p.] Note that the guaranteed profits are exactly α_1 for the small retailers (because any excess profits will be competed away) and at least α_2 for the large retailer. Now consider that a large inside retailer charges ϵ above z. Then, we have $z(\alpha_2 + sW^2(z)) \geq \alpha_2$, which implies

$$\alpha_2 \leq \frac{sW^2(z)}{1-z}. \tag{A5}$$

Now consider a small retailer charging ϵ above z. From the property of the mixed-strategy equilibrium $z(\alpha_1 + sW(z)V(z)) = \alpha_1$, which implies

$$\alpha_1 = \frac{sW(z)V(z)}{1-z}. \tag{A6}$$

For arbitrarily small ϵ, $V(z) \to 1$. This combined with (A5) and (A6) implies $\alpha_1 > \alpha_2$, which is a contradiction. This contradiction holds for every $z \in (1, z_2)$. Thus, the large retailer must charge the reservation price with probability 1. The same method of proof can be used for the general case of $k_1 \geq 2$ small retailers and k_2 large retailers reported in the proposition. A detailed proof of this is available from the authors on request. □

Proof of Proposition 5. Suppose the equilibrium has only some k_2 inside large retailers playing a mixed strategy with the lower support at $z = \alpha_2/(\alpha_2 + \tilde{S})$ guaranteeing a profit of α_2 to each, where $\tilde{S}$ is the reach of the institution in equilibrium. The large outside retailers have no incentive to deviate from their strategy of charging the reservation price. The small outside retailers, by charging E_{k_2}, make a profit of $E_{k_2}(\alpha_1 + \gamma_1)$. If they decide to enter, the best they can do is charge a price of z, in which case they will get all the inside customers and a profit of $[\alpha_2/(\alpha_2 + \tilde{S})](\tilde{S} + \alpha_1 + \gamma_1)$. Given the condition in the proposition, this deviation is not profitable. We must now guarantee that the small outside retailers do not want to stay out and price at the reservation value. In this case, their profit will be just α_1. Hence, as long as $E_{k_2}(\alpha_1 + \gamma_1) \geq \alpha_1$, they have no incentive to deviate. As E_{k_2} is increasing in k_2, there is a minimum number of inside retailers $k_{2\min}$, such that for every $k_2 > k_{2\min}$, the equilibrium holds. Finally, if the equilibrium holds, the reach of the ISA can be easily computed to be $\tilde{S} = \beta + n_2\gamma_2$ from the assumption of consumer behavior in the model.

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This paper was received November 15, 1999, and was with the authors 18 months for 3 revisions; processed by Ganesh Iyer.