Information Gatekeepers on the Internet and the Competitiveness of Homogeneous Product Markets

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Abstract

We examine the equilibrium interaction between a market for price information (controlled by a gatekeeper) and the homogenous product market it serves. The gatekeeper charges fees to firms that advertise prices on its Internet site and to consumers who access the list of advertised prices. Gatekeeper profits are maximized in an equilibrium where (a) the product market exhibits price dispersion; (b) access fees are sufficiently low that all consumers subscribe; (c) advertising fees exceed socially optimal levels, thus inducing partial firm participation; and (d) advertised prices are below unadvertised prices. Introducing the market for information has ambiguous social welfare effects.

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Our increasingly interconnected world has dramatically changed the marginal costs of acquiring and transmitting information. With a single mouse-click, consumers may now obtain a *list* of prices charged by different firms for products that range from computer hardware and software (Shopper.com) to mortgages (Mortagequotes.com). By purchasing the Sunday newspaper, consumers may obtain information about the prices different retailers charge for identical brands of groceries, office products, hardware, clothing, and automobiles. Modern markets for information tend to be dominated by "gatekeepers" who charge fees to firms and consumers who transmit and acquire information. For traditional gatekeepers, such as newspapers and magazines, these fees are simply advertising and subscription fees.

This paper examines how a gatekeeper's fee-setting decisions in a market for information impact (and are impacted by) the competitiveness of the product market it serves.[1] We introduce a market for price information – a clearing house where, at some cost, firms may post prices and consumers may examine the complete list of prices posted. The market for information has the feature that information flows are costless "inside" the market, but a profit-maximizing gatekeeper sets fees for both consumers and firms to obtain "entrance."

Our model sheds light on several characteristics of markets for information and the product markets served by them. First, despite the presence of lists of price information, price dispersion is frequently observed – even in homogeneous product markets. An examination of the prices posted at Shopper.com, for instance, reveals considerable variation in the prices of items such as Iomega Zip drives and Palm IIIs. Mortgage rates posted by different lenders on Mortgagequotes.com also tend to exhibit dispersion. To illustrate the nature of available price information and the significance of this price dispersion, consider a home buyer with qualifying ratios of

28/36 who wishes to obtain a zero-point, 30-year conventional fixed-rate mortgage in New Jersey. One click of the mouse on August 11, 1998 brought up the following list of mortgage rates:

Lender	*Phone Number*	*Rate*	*APR*
Executive Mortgage Bankers	(800) 651-1966	7.125	7.194
Source Financial Mortgage	(800) 696-1860	7.000	7.078
Security National Mortgage Corp.	(800) 887-7662	6.875	6.942

Given this information, a toll-free call to Security National Mortgage permits the consumer to lock in the lowest posted rate of 6 7/8 percent.[2]

The dispersion in mortgage rates is prevalent not only across time and across states, but also represents a sizeable difference in the dollar costs of mortgages obtained through different lenders. Figure 1 shows the spread in the distribution of mortgage rates (the difference between the highest and lowest posted rate in each state) and the imputed dollar value of this spread (the present value of the difference in mortgage payments over the life of a $100,000 mortgage) averaged across all 50 states and the District of Columbia for all business days in May, 1998. Two aspects of the figure are worth highlighting. First, the imputed dollar value of the interest rate spread is sizeable, averaging a little less than $1,400. Second, the daily interest rate spread varies considerably, with a peak that is more than four times as large as the trough.

Another characteristic of markets for information is that gatekeepers often derive more of their revenue from advertisements than from subscriptions. Indeed, the rates reported above from Mortgagequotes.com are "free" to consumers, as are price quotes obtained from Shopper.com. More broadly, there are significant differences in the fees charged for Internet browsers (essentially free to consumers) and Internet servers (expensive to firms); Adobe provides free software (the Acrobat Reader) for those wishing to read PDF documents, but charges those wishing to create PDF documents over $100 for the necessary software (Acrobat Exchange). Newspapers also derive the bulk of their revenues from advertisers.

These observations raise several questions about the interaction between information markets and associated product markets. Does a profit maximizing gatekeeper have an incentive to maximize consumer and firm participation in the market for information? Can price dispersion in the product market persist when all consumers have access to a list of firm prices? How much will a monopoly gatekeeper charge subscribers and advertisers, and are these fees socially optimal? Does the establishment of a market for information enhance social welfare? This paper offers some answers to these questions.

We endogenize information costs by allowing a profit-maximizing gatekeeper to set fees charged to firms and consumers for transmitting and acquiring information. We find that the gatekeeper's profits are maximized in a dispersed price equilibrium in which all consumers access the gatekeeper's site. In this equilibrium, advertised prices are lower than unadvertised prices, and furthermore, the gatekeeper sometimes finds it optimal to charge consumers less to acquire information than firms pay to transmit information. We show that this latter result stems from a "free rider" problem that is present on the consumer side of the market for information but absent on the firm side.

Establishing a market for information leads to more competitive pricing on the part of firms; prices posted on the market for information are closer to competitive levels but remain above marginal cost with probability one. The intuition is that, while the gatekeeper's profits are maximized with full consumer participation in the market for information, the same is not true of full firm participation. Full firm participation would lead to Bertrand competition in the product market and thus eliminate the rents the gatekeeper could otherwise extract from firms. Moreover, marginal cost pricing eliminates price dispersion in the product market, thus destroying the informational value of the gatekeeper's site. This reduces the rents the gatekeeper may extract from consumers. As a consequence, the gatekeeper finds it optimal to set subscription and advertising fees above welfare maximizing levels in order to induce price dispersion. This misalignment of gatekeeper and social incentives may be so severe that the gatekeeper finds it in her own interest to establish a market for information even when doing so reduces social welfare.

Our paper is related to an extensive literature on advertising and price competition in homogeneous product markets. One approach (cf. Steven C. Salop and Joseph E. Stiglitz (1977), Yuval Shilony (1977), and Hal R. Varian (1980)) assumes that consumers may choose to obtain price information from "advertisements" posted in a central clearing house (i.e., the newspaper). In these models, all firms are required to advertise, so advertising decisions are exogenous.[3] Another approach (cf. Gerard R. Butters (1977); Gene M. Grossman and Carl Shapiro (1984); Mark Stegeman (1991); Jacques Robert and Dale O. Stahl II (1993); R. Preston McAfee (1994); and Stahl (1994)) assumes that firms target their advertisements toward individual consumers (i.e., direct mail ads). Here, firms consciously make advertising decisions, but consumers passively receive advertisements.[4] Our model blends features from these strands of literature. The gatekeeper in our model is essentially the owner of the central clearing house for information, and as such can set the fees firms and consumers must pay to utilize her site. Given these fees for transmitting and acquiring information, consumers and firms decide whether to use the market for information to transmit or acquire price information. Consequently, our framework entails endogenous advertising decisions by firms, endogenous subscription decisions by consumers, and endogenous fee-setting decisions on the part of the gatekeeper.

The flavor of our model is as follows: Several geographically separate towns are each served by a local firm. Transaction costs preclude consumers living in one town from shopping in another town; thus each local firm is a monopolist. By creating a virtual market for information, a gatekeeper expands the options for both firms and consumers. In particular, each local firm can now pay to advertise its price over the Internet, potentially gaining access to consumers in distant towns. Likewise, consumers can pay to access the gatekeeper's site. This provides them with an option to purchase the product from a firm in a distant town if its price is listed at the site. The gatekeeper is a monopolist, who sets advertising and subscription fees in an attempt to maximize its expected profits. Given these fees, firms set prices and decide whether to advertise them on the gatekeeper's site; consumers decide whether to pay the subscription fee to gain access to the gatekeeper's site. Once these decisions are made, a consumer can simply click her mouse to research prices over the Internet (if she is a subscriber), incur the cost of driving to her local firm to obtain price information, or both. Once this information is gathered, the consumer decides whether or not to purchase the good.

We begin by laying out the formal model in Section I. Working backward, we show in Section II that optimal shopping by subscribing consumers entails first researching prices over the Internet, followed by possibly visiting the local store. Section III derives equilibrium pricing and advertising by firms when an exogenous fraction of consumers subscribe. Section IV endogenizes subscription decisions and characterizes symmetric equilibria in the product market for given advertising and subscription fees. Section V determines the advertising and subscription fees that maximize the gatekeeper's expected profits. The welfare implications of a monopoly-run market for information are examined in Section VI, while Section VII considers entry from rival gatekeepers. Section VIII offers some concluding remarks, and an Appendix provides proofs for those propositions not proved in the text.

I The Model

There is a continuum of consumers, each of whom has a demand function $q(p)$ that is continuous and non-increasing in price. We normalize the measure of consumers to be unity, assume that they are evenly divided among n local markets, and that each local market is served by a single local firm. Thus, there are a total of n firms. We assume that firms set linear prices and sell identical products at constant marginal cost ($c \geq 0$). For simplicity, the cost of delivering goods to consumers is zero.[5]

One of the key features of the Internet is that it offers the potential for a gatekeeper to eliminate geographic boundaries through the creation of a virtual marketplace. To capture this feature, we assume that local markets are completely segmented; that is, consumers in local market i only have access to firm i. Thus, the expected profits of firm i when it charges a price p to consumers in its local market is $\pi(p) \equiv (p-c)\,q(p)/n$. We suppose that expected profits are strictly increasing up to a unique monopoly price, $r \in (c, \infty)$.[6] It costs a consumer $\varepsilon > 0$ to visit a local store, and ε is sufficiently small that a consumer who is charged the monopoly price obtains sufficient surplus to make a visit worthwhile. If we define consumer surplus at price p to be $S(p) \equiv \int_p^\infty q(t)\,dt$, then this assumption is equivalent to $S(r) > \varepsilon$.[7, 8] For simplicity, we assume each firm can choose a price $p_i \in [c, r]$.[9]

In the absence of a virtual marketplace, each firm simply charges the monopoly price to all of its local customers to earn profits of $\pi(r) = (r-c)\,q(r)/n$. In contrast, the creation of a virtual marketplace permits firms and consumers to globally transmit and access price information. Information flows are controlled by a profit-maximizing gatekeeper who charges fees to firms and consumers who post and access information from her site. The fee paid by firms is called an advertising fee and denoted $\phi \geq 0$, while that paid by consumers is called a subscription fee and denoted $\kappa \geq 0$. The virtual marketplace potentially breaks down geographic boundaries since consumers who subscribe are permitted to buy from *any* of the firms whose prices are listed at the gatekeeper's site (as well as from the local firm).

The timing and nature of decisions by consumers, firms, and the gatekeeper are as follows. First, the gatekeeper announces advertising (ϕ) and subscription (κ) fees. Given these fees, consumers decide whether or not to subscribe to the gatekeeper's website; firms make pricing decisions and decide whether or not to post them on the gatekeeper's website.[10] Finally, consumers shop. The shopping and purchasing decisions of consumers obviously depend on whether or not they choose to participate in the virtual marketplace as well as on firms' advertising and pricing decisions.

We proceed to characterize equilibria arising in this game. Working backward, we first determine the optimal shopping decisions by consumers.

II Consumer Shopping Decisions

The following proposition characterizes optimal shopping by consumers.

Proposition 1 *In any shopping subgame that is reached in equilibrium, the behavior of subscribers and nonsubscribers is as follows:*

1. *Nonsubscribing consumers visit and purchase from their local firm.*

2. *Subscribing consumers (a) first visit the gatekeeper's site and (b) purchase at the lowest price available there. (c) If no prices are listed, subscribing consumers visit and purchase from their local firm.*

The proof of this proposition is straightforward. Part (1) follows from the fact that a nonsubscribing consumer earns surplus sufficient to cover the cost of physically visiting the local store: For all $p \leq r$, $S(p) \geq S(r) > \varepsilon$. To establish part (2a), note that the marginal cost to a subscriber of examining prices on the gatekeeper's website is zero, whereas the marginal cost of examining the local price is ε. Thus, it is a weakly dominant strategy for a subscriber to visit the gatekeeper's site first. In fact, if a subscriber ascribes even infinitesimal probability to the local firm advertising on the gatekeeper's site, she has a strict incentive to visit the gatekeeper's site first. Part (2c) also follows from the fact $S(p) \geq S(r) > \varepsilon$ for all $p \leq r$.

Finally, it remains to prove the optimality of part (2b). The prescribed strategy is clearly optimal when a subscriber observes the ad of her local firm on the gatekeeper's site, for in this case it does not pay to expend an additional ε to physically visit the local firm. Suppose that the local firm's price is not listed on the gatekeeper's site. Along the equilibrium path, the distribution of prices charged by firms must be consistent with the beliefs of consumers. Let $G(p)$ denote the equilibrium distribution of prices charged by the local firm when it does not advertise (or equivalently, equilibrium consumer beliefs about these prices), and let $p_{\min}$ denote the lowest observed advertised price. By way of contradiction, suppose a consumer observes $p_{\min}$ but then chooses to pay ε to obtain an additional price quote from a local store. For this to represent an optimal consumer choice,

$$\int_c^{p_{\min}} \left(S\left(t\right) - S\left(p_{\min}\right)\right) dG\left(t\right) - \varepsilon \geq 0. \tag{1}$$

Let $p^* \leq p_{\min}$ denote the lowest price such that

$$\int_c^{p^*} \left(S\left(t\right) - S\left(p^*\right)\right) dG\left(t\right) \geq \varepsilon. \tag{2}$$

Thus, a subscriber will visit the local store only if the best price observed on the gatekeeper's site exceeds p^*. Given this decision rule by consumers, the local firm will not charge prices below p^* when it does not advertise. This implies that for any $G\left(\cdot\right)$ consistent with equilibrium pricing,

$$\int_c^{p^*} \left(S\left(t\right) - S\left(p^*\right)\right) dG\left(t\right) = 0.$$

This contradicts the requirement for optimal consumer behavior given in equation (2), thus establishing the result.

III Firm Pricing and Advertising Decisions

We are now in a position to examine the pricing and advertising decisions of firms when the gatekeeper sets an advertising fee ϕ and a fraction μ of consumers subscribe to the gatekeeper's site. Consider a firm that does not advertise. Such a firm will only attract customers residing in its locale, and by Proposition 1, these customers will consist entirely of nonsubscribers and subscribers who have not observed any prices at the gatekeeper's site. By Proposition 1, both types of consumers will pay r for the good. It follows that:

Proposition 2 *A firm that does not advertise its price on the gatekeeper's site charges the monopoly price.*

We may use Propositions 1 and 2 to compactly describe the expected profits of firms in a symmetric equilibrium. Suppose that there is a fraction $\mu > 0$ of subscribers. Let $p_i \in [c, r]$ denote firm i's advertised price and $a_i \in \{A, N\}$ denote its advertising decision. Here, A represents the event where a firm chooses to advertise its price at the gatekeeper's site, and N is the event where it does not. A firm must balance the cost (ϕ) of participating in the market for information with the benefit of attracting consumers who participate. Suppose each firm $j \neq i$ advertises its price with probability α, and the advertised price has an atomless cdf, $F(p)$.

Using Proposition 2, a non-advertising firm (optimally) chooses the monopoly price (r). By Proposition 1, at this price it sells to $(1-\mu)/n$ local consumers who do not subscribe, and μ/n local subscribers in the event they do not find any prices on the gatekeeper's site. Since the latter occurs with probability $(1-\alpha)^{n-1}$, a non-advertising firm's expected profits are

$$E\pi_i(r, N) = (1-\alpha)^{n-1} \frac{\mu}{n} \pi(r) + \frac{(1-\mu)}{n} \pi(r). \tag{3}$$

The expected profit to firm i if it chooses to advertise a price of p depends on how many other firms decided to advertise as well as their advertised prices:

$$\begin{aligned} E\pi_i(p,A) &= \sum_{j=0}^{n-1} \binom{n-1}{j} \alpha^j (1-\alpha)^{n-1-j} \left(\mu\pi(p)(1-F(p))^j\right) \\ &\quad + \frac{(1-\mu)}{n}\pi(p) - \phi. \end{aligned} \tag{4}$$

The underlying economic trade-offs captured in equation (4) can more easily be seen for the special case where $n = 2$, $c = 0$, and $q(p) = 1$ up to the monopoly price, r. In this case, the expected profits to firm i if it advertises a price p are

$$E\pi_i(p,A) \equiv \alpha\left[\mu p(1-F(p)) + \tfrac{(1-\mu)}{2}p\right] + (1-\alpha)\left[\mu p + \tfrac{(1-\mu)}{2}p\right] - \phi.$$

In words, if firm i advertises a price p, it faces a chance α that the rival will also advertise. The first term in square brackets reflects firm i's expected profits conditional on this event. In particular, a fraction μ of consumers subscribe and, by Proposition 1, purchase from the firm offering the lower price. The remaining fraction $1-\mu$ of consumers do not subscribe, and half of these consumers visit local firm i. The second term in square brackets represents firm i's expected profits when the rival does not advertise. In this case, a fraction μ of consumers acquire information and purchase from firm i, while local customers who do not acquire information buy from local firm i, thus accounting for the $(1-\mu)/2$ term. Of course, firm i's expected profits are reduced by advertising costs, ϕ.

More generally, we may use the Binomial Theorem to write equation (4) as

$$E\pi_i(p,A) = \mu\pi(p)(1-\alpha F(p))^{n-1} + \frac{1-\mu}{n}\pi(p) - \phi. \tag{5}$$

In order for F in equation (5) to be part of a symmetric Nash equilibrium, firm i's expected profits must be constant for all prices in the support of F. Furthermore, for non-zero but non-prohibitive advertising fees, one can show that there does not exist a symmetric equilibrium in which firms always advertise or never advertise.[11] Hence, the expected profits from advertising a price p must equal the expected profits from not advertising and charging the monopoly price. Since $F(p)$ is atomless by hypothesis, a firm that charges a price equal to the upper support, $\bar{p}$, of $F(p)$ earns expected profits of $\mu\pi(\bar{p})(1-\alpha)^{n-1} + \frac{1-\mu}{n}\pi(\bar{p}) - \phi$. Since $\pi(p)$ is increasing up to the monopoly price, it follows that the upper support is the monopoly price: $\bar{p} = r$. Thus, equating expressions (5) and (3) and imposing the condition that $F(r) = 1$ yields a firm's propensity to advertise,

$$\alpha = 1 - \left(\frac{n\phi}{(n-1)\,\mu\pi(r)}\right)^{\frac{1}{n-1}}.$$

Notice that $\alpha \in (0,1)$ whenever $0 < \phi < \frac{n-1}{n}\mu\pi(r)$. Equating (5) and (3) and solving for F yields a candidate for the distribution of advertised prices in a symmetric equilibrium:

$$F(p) = \frac{1}{\alpha}\left(1 - \left(\frac{(1-\alpha)^{n-1}\,\mu\pi(r) + n\phi + (1-\mu)\,(\pi(r) - \pi(p))}{n\mu\pi(p)}\right)^{\frac{1}{n-1}}\right). \tag{6}$$

To show that F is part of an equilibrium, we must verify that it is an atomless distribution as hypothesized, and furthermore, that no firm can gain by pricing outside of the support of F. First, note that the lower support of F, denoted p_0, satisfies

$c < p_0 < r$. To see this, set $F(p_0) = 0$ in equation (6) and solve to obtain

$$p_0 = \pi^{-1}\left(\frac{n^2\frac{\phi}{n-1} + (1-\mu)\pi(r)}{(n-1)\mu + 1}\right).$$

Since $\phi < \frac{n-1}{n}\mu\pi(r)$, $\frac{n^2\frac{\phi}{n-1}+(1-\mu)\pi(r)}{(n-1)\mu+1} > 0$ and $\pi(p)$ is strictly increasing, $c < p_0 < r$. Second, $\pi(p)$ is continuous and increasing up to r, and therefore $F(p)$ is increasing. Thus, F is an atomless distribution with support $[p_0, r]$. Finally, it is clear that a firm earns strictly lower expected profits by advertising a price outside of the support of F when the other players price according to F, so the hypothesized strategies make up an equilibrium.[12]

Expressions for each firm's equilibrium payoffs may be obtained by substituting the above expression for α into equation (3). In particular, when $\phi < \frac{n-1}{n}\mu\pi(r)$, firms are indifferent between advertising and not advertising, and firms earn expected profits of $E\pi_i(p, A) = E\pi_i(r, N) = \frac{\phi}{(n-1)} + \frac{(1-\mu)}{n}\pi(r)$. In contrast, when $\phi > \frac{n-1}{n}\mu\pi(r)$, firms do not find it profitable to advertise, and equilibrium expected profits are $E\pi_i(r, N) = \frac{\pi(r)}{n} > E\pi_i(p, A)$.

Thus we have established

Proposition 3 *Suppose the gatekeeper sets an advertising fee ϕ, a fraction $\mu > 0$ of consumers subscribe to the gatekeeper's site, and firms optimally determine their advertising and pricing decisions. Then in a symmetric Nash equilibrium:*[13]

1. *Each firm advertises its price with probability*

$$\alpha^*(\mu, \phi) = \max(0, 1 - \left(\frac{n\phi}{(n-1)\mu\pi(r)}\right)^{\frac{1}{n-1}}).$$

2. *When a firm advertises, its distribution of advertised prices is given by the cdf*

$$F^{*}(p;\mu,\phi)=\frac{1}{\alpha^{*}}\left(1-\left(\frac{(1-\alpha^{*})^{n-1}\mu\pi(r)+n\phi+(1-\mu)(\pi(r)-\pi(p))}{n\mu\pi(p)}\right)^{\frac{1}{n-1}}\right)$$

defined on $[p_0, r]$ *, where*

$$p_0=\pi^{-1}\left(\frac{n^2\frac{\phi}{n-1}+(1-\mu)\pi(r)}{(n-1)\mu+1}\right).$$

3. *With probability* $(1-\alpha^{*})$*, a firm does not advertise and sets its price at* r*. Each firm earns expected profits of*

$$E\pi_i^{*}=\begin{cases}\frac{\phi}{(n-1)}+\frac{(1-\mu)}{n}\pi(r) & \text{if}\quad \phi<\frac{n-1}{n}\mu\pi(r)\\ \frac{\pi(r)}{n} & \text{otherwise}\end{cases}.$$

A key aspect of Proposition 3 is that advertised prices are always lower than non-advertised prices. The intuition is that the virtual marketplace eliminates geographic barriers, thus providing a mechanism for firms to steal market share from distant rivals. A firm that does not advertise cannot attract consumers from outside its local market by charging a low price. This, combined with optimal shopping on the part of local consumers, implies that the optimal price charged by such a firm is the monopoly price, r. A firm that advertises a price below r can potentially attract consumers from other locales, but must randomly select both the timing of advertisements and the level of "discount" to "hide" information from rivals who would otherwise be able to undercut systematically its advertised price. Notice that a dispersed price equilibrium exists even when all consumers subscribe to the gatekeeper's site ($\mu = 1$), provided that it is somewhat costly for firms to transmit information ($0<\phi<\frac{n-1}{n}\pi(r)$).

Second, notice that when $\mu = 1$, the dispersed price equilibrium described above persists even though every consumer purchases the product at the lowest price available globally. To see this, note that when one or more firms advertise, the firm charging the lowest advertised price necessarily provides a better deal for consumers than any firm that does not advertise, and by Proposition 1, all consumers will purchase from that firm. If no advertisements are observed, it follows from Proposition 2 that the monopoly price is the lowest price.

Third, $\alpha^*(\mu, \phi)$ in Proposition 3 may be viewed as a firm's demand for advertising. Straightforward calculations reveal that each firm's demand for advertising is decreasing in advertising fees (ϕ), increasing in the fraction of consumers who subscribe to the gatekeeper's site (μ), and decreasing in the number of firms. Moreover, lower advertising fees or greater consumer presence in the virtual marketplace lead to more aggressive discounting by firms when they place ads. The upshot is that firms' expected profits decline and consumers' surplus increases as advertising becomes more intense. Thus, for a given fraction of consumers who acquire information, increased advertising fees actually *raise* industry profits by reducing the intensity of advertising competition among firms. Firm profits are highest when advertising is so costly $\left(\phi \geq \frac{n-1}{n}\mu\pi\left(r\right)\right)$ that firms do not advertise. Expressed differently, the presence of an active market for information reduces firm profits relative to what they would have been in the absence of the market.

IV Consumer Subscription Decisions

The results presented above are valid in settings where consumers' shopping decisions are optimal, but where decisions to subscribe to the gatekeeper's site are determined by factors other than the informativeness of its advertisements. In many settings, however, the decision to acquire information will be guided by beliefs about the amount of information transmitted by firms as well as the cost of acquiring that information. We continue to assume that each consumer must pay a subscription fee, $\kappa \geq 0$, to acquire information, but now allow them to optimally choose whether to do so. In this setting, equilibrium requires that each consumer's decision to acquire information be determined optimally given the decisions of other consumers and firms; likewise, each firm's advertising and pricing decisions must be optimal given the fraction of consumers choosing to subscribe, and the pricing and advertising decisions of rival firms.

Given the proportion of other subscribing consumers, μ, and the pricing and advertising strategies of firms (α, F) as per Proposition 3, each consumer faces the choice of subscribing or not. A consumer's expected purchase price depends upon her subscription decision as well as the intensity of advertising and the aggressiveness of advertised prices. For instance, if $n = 2$, a consumer who subscribes faces probability α^2 that both firms advertise, in which case the purchase price is the lower of two draws from F. With probability $(1 - \alpha)^2$, neither firm advertises and in this instance the purchase price is r plus the cost ε of visiting the local firm. With the remaining probability only one firm advertises, and the purchase price is a draw from F. More generally in the n firm case, there is a $(1-\alpha)^n$ chance that no prices will be listed, in which case she must pay ε to visit the local firm which charges r. With probability $\binom{n}{j}\alpha^j (1-\alpha)^{n-j}$ exactly j firms will advertise. The expected surplus to a consumer conditional on this event is $\int_{p_0}^{r} S(p)\, h_j(p)\, dp$, where h_j is the density of the lowest price in j draws from F. Thus, the expected surplus of a subscriber is

$$U_{Subscribe} = \sum_{j=1}^{n} \binom{n}{j} \alpha^j (1-\alpha)^{n-j} \int_{p_0}^{r} S(p)\, h_j(p)\, dp + (1-\alpha)^n (S(r) - \varepsilon) - \kappa.$$

A consumer who does not subscribe economizes on information costs, but incurs the transaction cost ε of visiting her local store and loses the opportunity to "comparison shop" among firms advertising on the gatekeeper's site. With probability α, the consumer's local firm chooses to advertise, in which case the price distribution is F. With probability $(1-\alpha)$, a consumer's local firm chooses not to advertise and charges the monopoly price. Thus, the expected surplus of a non-subscribing consumer is

$$U_{Not\ Subscribe} = \alpha \int_{p_0}^{r} S(p)\, dF(p)\, dp + (1-\alpha)\, S(r) - \varepsilon.$$

The difference, $U_{Subscribe} - U_{Not\ Subscribe}$, represents a consumer's expected net gain (or loss) from subscribing. Setting this difference equal to zero and solving for κ yields the maximum amount a consumer would be willing to pay for a subscription when advertising fees are ϕ and a fraction μ of all consumers subscribe. Let $\beta(\phi, \mu)$ denote this subscription fee (Lemma 1 in the Appendix provides a useful form for this expression). The maximum amount an optimizing consumer would pay for a subscription when all consumers subscribe ($\mu = 1$) and the gatekeeper charges firms ϕ to advertise is given by $\kappa^* (\phi) \equiv \beta (\phi, 1)$.

We are now in a position to characterize symmetric equilibria when consumers and firms optimally determine whether to subscribe to and advertise on the gatekeeper's site, firms optimally price, and consumers optimally shop. Clearly, if advertising and subscription fees are too high, consumers and firms will opt out of the market for information altogether. In this case, the unique equilibrium entails monopoly pricing by each firm. The following Proposition, which is proved in the Appendix, characterizes the symmetric equilibria that arise when advertising and subscription fees are not prohibitive.[14]

Proposition 4 *Suppose the gatekeeper sets advertising and subscription fees* $\phi \in \left[0, \frac{n-1}{n}\pi (r)\right]$, $\kappa \in [0, \kappa^*(\phi)]$, *and firms and consumers act optimally. Then only the following types of symmetric equilibria may arise:*

(*a*) ***Inactive Market for Information:*** *For each* $\phi \in \left[0, \frac{n-1}{n}\pi (r)\right)$ *and* $\kappa \in [0, \kappa^*(\phi)]$, *there exists an equilibrium in which no consumers subscribe* ($\mu^* = 0$) *and firms do not advertise* ($\alpha^* = 0$). *In this equilibrium, all firms charge the monopoly price* r, *and each firm earns expected profits of* $\frac{\pi(r)}{n}$.

(*b*) ***Active Market for Information with Partial Consumer Participation:*** *For each* $\phi \in \left(0, \frac{n-1}{n}\pi (r)\right)$ *and* $\kappa \in (0, \kappa^*(\phi))$, *there exists an equilibrium in which a fraction* $\mu^* \in \left(\frac{n\phi}{(n-1)\pi(r)}, 1\right)$ *of consumers subscribe, where* μ^* *solves*

$$\beta (\phi, \mu^*) = \kappa.$$

Each firm advertises with probability $\alpha^* = 1 - \left(\frac{n\phi}{(n-1)\mu^*\pi(r)}\right)^{\frac{1}{n-1}}$, *and the advertised price is drawn at random from the cumulative distribution function* $F^*(p; \mu^*, \phi)$ *defined in Proposition 3. Firms that do not advertise charge the monopoly price* r, *and each firm earns expected profits of* $\frac{\phi}{(n-1)} + \frac{(1-\mu^*)}{n}\pi(r)$.

(c) ***Active Market for Information with Full Consumer Participation:*** *For each* $\phi \in \left[0, \frac{n-1}{n}\pi(r)\right]$ *and* $\kappa \in [0, \kappa^*(\phi)]$, *there exists an equilibrium in which all consumers subscribe* ($\mu^* = 1$). *Each firm advertises with probability* $\alpha^* = 1 - \left(\frac{n\phi}{(n-1)\pi(r)}\right)^{\frac{1}{n-1}}$, *and each advertised price has a cumulative distribution function* $F^*(p; 1, \phi)$ *defined in Proposition 3. Firms that do not advertise charge the monopoly price* r, *and each firm earns expected profits of* $\frac{\phi}{(n-1)}$.

Our results highlight the interaction between the market for information and the product market. As noted earlier, when advertising fees are sufficiently high ($\phi > \frac{n-1}{n}\pi(r)$), firms completely opt out of the market for information, and this induces consumers to do likewise. An inactive market for information permits firms to price as local monopolists. Proposition 4 reveals that when advertising fees are lower ($\phi < \frac{n-1}{n}\mu\pi(r)$), two additional types of equilibria emerge, both of which entail active participation by consumers and firms in the virtual marketplace. Advertised prices are dispersed in both of these equilibria, but prices are more competitive with full consumer participation than with partial consumer participation: the greater the fraction of consumers who subscribe, the lower the expected profits of firms and the greater the expected consumer surplus in the product market. Consumers earn the lowest utility with an inactive market for information and the highest expected utility in an active market for information with full consumer participation. The opposite is true for firms, who earn the greatest profits with an inactive market for information (since they price as local monopolists) and the lowest expected profits when there is an active market for information with full consumer participation. Expressed differently, the creation of a virtual marketplace results in lower average prices for consumers and increased consumer surplus. This comes at the expense of firms, who earn lower profits because the virtual marketplace erodes their local market power.

Intuitively, an increase in the fraction of consumers who have access to price information heightens competition among firms in the product market. Thus, the expected surplus of a consumer choosing *not* to subscribe also increases as she faces a higher probability of obtaining a low price from her local firm. Since a consumer's utility from subscribing must be at least as great as from not subscribing, it follows that all consumers benefit by increased participation in the virtual marketplace. The converse is true of firms. Both firms that actively advertise and those that do not are harmed by increased consumer participation. In the next section we will see how the information gatekeeper may exploit this effect to increase expected profits.

V Gatekeeper Fee-Setting Decisions

The above analysis treats subscription and advertising fees (κ and ϕ) as exogenous. We now endogenize these fees by permitting a monopoly gatekeeper to set them in an attempt to maximize her expected profits. Given these fees, firms and consumers make advertising and subscription decisions as in Section IV, and consumers make shopping decisions as in Section II.

In practice, setting up price listing services on the Internet and other markets for information entails large fixed costs and rather small marginal costs. To capture this feature, we assume that the only cost to the gatekeeper of establishing a market for information is a fixed setup cost, K. We assume that $K > \varepsilon$; that is, the cost to the gatekeeper of setting up a market for information exceeds the transaction cost to a consumer of visiting her local store.[15] If the gatekeeper establishes a market for information, her expected profits consist of expected advertising and subscription revenues less the fixed setup cost:

$$E\Pi = n\alpha\phi + \mu\kappa - K.$$

Notice that, for a given κ and ϕ, the gatekeeper's expected profits depend on the equilibrium (see Proposition 4) being played. Our next proposition, which is proved in the Appendix, describes the outcome that is best from the gatekeeper's perspective.

Proposition 5 *Suppose the gatekeeper can select any* $(\phi, \kappa) \in \left[0, \frac{n-1}{n}\pi(r)\right] \times [0, \kappa^*(\phi)]$, *participants in the product market behave optimally, and* K *is sufficiently small. Then* *the symmetric equilibrium that maximizes the gatekeeper's payoff entails:*

(*a*) *Full consumer participation in the market for information* ($\mu = 1$)*;*

(*b*) *Firm behavior in accordance with Proposition 3;*

(*c*) *An advertising fee*

$$\phi^* = \arg\max_{\phi \in \left[0, \frac{n-1}{n}\pi(r)\right]} \{S(p_0(\phi)) - S(r) + \varepsilon(1 - (1 - \alpha(\phi))^n) + n\alpha(\phi)\phi$$
$$- \int_{p_0(\phi)}^{r} ((1 - \alpha(\phi) F^*(p; 1, \phi))^n + \alpha(\phi) F^*(p; 1, \phi)) q(p) dp\}; \text{ and}$$

(*d*) *A subscription fee*

$$\kappa^*(\phi^*) = S(p_0(\phi^*)) - S(r) + \varepsilon(1 - (1 - \alpha(\phi^*))^n)$$
$$- \int_{p_0(\phi^*)}^{r} ((1 - \alpha(\phi^*) F^*(p; 1, \phi^*))^n + \alpha(\phi^*) F^*(p; 1, \phi^*)) q(p) dp.$$

Proposition 5 suggests that the gatekeeper finds it profitable to continue lowering the subscription fee until all consumers subscribe.[16] Intuitively, a lower subscription fee induces consumers to participate more actively in the market for information, and this in turn forces firms to advertise more intensely. For a given advertising fee, the corresponding gain in advertising revenues induced by the lower subscription fee more than offsets any loss in subscription revenues. In fact, if consumers also face non-pecuniary costs of acquiring information (such as the hassle of logging on to the Internet or traveling to the store to buy a newspaper), the gatekeeper might find it in her interest to *subsidize* information acquisition in order to induce consumers to participate in the market for information.

For the reasons stated after Proposition 4, it follows that the creation of a market for information results in lower average prices and greater surplus for consumers –

even when it is run by a monopolist. However, in an attempt to extract surplus from consumers and firms, the gatekeeper sets advertising and subscription fees at levels that induce price dispersion in the product market. The gatekeeper maximizes expected profits when all consumers subscribe, but could kill this "golden goose" by setting advertising fees that are too high or too low. If the gatekeeper sets the advertising fee too high, firms would be better off charging the monopoly price and avoiding advertising altogether. In this case, the gatekeeper would earn nothing, as no information is transmitted in the market for information and hence consumers would be unwilling to pay for a subscription. If the advertising fee were set at zero, price dispersion would vanish. The only possible benefit from subscribing would be the ε savings in transactions costs, so the gatekeeper would be forced to set subscription fees below ε to induce any consumer participation. Since $K > \varepsilon$, the gatekeeper would be uninterested in doing so. Thus, price dispersion is a *necessary* condition for a profitable market for information; a profit-maximizing gatekeeper essentially sets fees at levels that induce the profit-maximizing level of price dispersion in the product market. We will see in Section VI that these fees are not optimal from a societal perspective.

It is important to point out that a "free rider" problem on the consumer side of the market limits the ability of the gatekeeper to capture all of the consumer surplus obtained through lower product prices. To see this, recall that the gatekeeper's ability to extract rents from participants in the market for information depends on the value of their outside options, and these differ among firms and consumers. The more a firm or consumer can earn by shunning the market for information, the lower the fees the gatekeeper can charge them. Increased participation in the market for information (i.e., higher μ and α) leads to a more valuable outside option for consumers and a less valuable one for firms. In particular, while consumers who *actively* acquire information benefit from the heightened competition that accompanies increased participation by firms, so do consumers who do not choose to acquire information. In contrast, a more active market for information reduces the likelihood that a firm shunning the market for information gets traffic from local consumers. Thus, to maximize profits, the gatekeeper is forced to reduce the rents extracted from active consumers by a sufficient amount to prevent them from attempting to "free ride" on the generally lower prices that prevail. No "free rider" problem is present on the firm side; in fact, greater participation permits *greater* rent extraction from firms, as they are induced to compete more vigorously for better informed consumers.

The free rider problem may be so severe that the gatekeeper finds it optimal to charge consumers less for information than it charges firms. For instance, with unit demand and two firms, numerical analysis reveals that the gatekeeper's profits are maximized by setting $\kappa^* = .14 < \phi^* = .18$. In this case, the equilibrium ratio of advertising revenues to total revenues is about 63 percent. In general, however, the impact of the free rider problem on the gatekeeper's subscription and advertising fees is ambiguous and depends on the shape of demand and the number of firms in the product market. With linear demand and two firms, for instance, numerical analysis reveals that $\kappa^* = .06 > \phi^* = .05$, and the gatekeeper earns about half of her revenues from advertisements.

Table 1 provides comparative static results for the unit demand and linear demand cases. The greater the number of firms in the product market, the lower the profit-maximizing advertising fee. Despite this, each firm's intensity of advertising is decreasing in n, although the expected amount of advertising by the entire industry ($n\alpha^*$) is increasing in the number of firms. Furthermore, an increase in the number of firms leads to higher subscription fees paid by consumers. The intuition is that an increase in the number of firms in the product market decreases the likelihood that any one firm advertises the lowest price. Consequently, firms find it increasingly attractive to shun advertising altogether and charge the monopoly price. Thus, each firm's propensity to advertise (α^*) is decreasing in n. Nonetheless, the decrease in α^* is more than offset by the increase in the number of firms in the market; the average number of ads ($n\alpha^*$) increases in n. Taken together, this means that each consumer's incentive to free ride has fallen since their local firm is more likely to be charging the monopoly price while the attractiveness of the prices listed on the market for information has increased. This reduction in free rider incentives permits the gatekeeper to charge consumers higher subscription fees. The ultimate effect of an increase in n is to decrease advertising revenues as a share of total gatekeeper revenues.

We conclude this section by noting that, while the profits of the gatekeeper are maximized in an equilibrium where all consumers subscribe to her service, the multiplicity of equilibria for a given ϕ and κ means that a gatekeeper cannot be guaranteed these profits. There are three reasons why it may be reasonable to expect this outcome to emerge.

First, the gatekeeper might ultimately achieve the outcome described in Proposition 5 by setting subscription fees and advertising fees as in the Proposition, but then giving away or even subsidizing subscriptions to a fraction of consumers. This creates a virtuous circle: The initial consumer participation in the market for information makes firms willing to pay for advertising space, as per Proposition 3. This, in turn, generates price dispersion, thus ensuring that the market for information is valuable to *all* consumers. In this manner, a gatekeeper can guarantee an *active* market for information and earn revenues through advertisements and subscriptions. Or, the gatekeeper might "jump start" the market for information by offering free or subsidized introductory subscriptions to all consumers. To the extent that full consumer participation becomes a "focal point" for the long-run expectations of firms and consumers, the gatekeeper can ultimately increase fees to the levels identified in Proposition 5. This may explain why established media typically charge consumers for subscriptions whereas new media frequently offer free subscriptions. Second, the equilibrium with partial consumer participation is locally unstable, which arguably makes it an unlikely outcome.[17] Finally, note that the gatekeeper *and* consumers prefer the equilibrium with full consumer participation. Thus, if equilibrium selection is controlled by either or both of these parties (perhaps through the sequencing of moves), the outcome described in Proposition 5 obtains.

VI Welfare Issues

We have already noted that consumers gain and firms lose from the creation of a market for information. In this section, we compare social welfare arising from a monopoly run market for information (characterized in Proposition 5) with two benchmarks: the absence of a market for information, and a market for information operated by a benevolent social planner.

We first show that a monopoly gatekeeper sets advertising and subscription fees that are higher than the socially optimal levels. To see this, note that once the market for information is established, all costs are sunk and payments for advertising and subscriptions are merely transfers from participants in the product market to the gatekeeper. Social optimality requires that ϕ and κ be set so as to maximize surplus in the product market. This occurs when all transactions in the product market take place at marginal cost and occur through the market for information (avoiding transactions costs of ε). Thus, social optimality requires that all consumers subscribe ($\mu = 1$) and purchase through the market for information at marginal cost with probability one. It follows from Proposition 3 that the socially optimal advertising fee is 0, for in this case firms advertise with certainty and price at marginal cost. However, since all firms price at marginal cost, consumers are willing to pay no more than ε to participate in the market for information. Thus, socially optimal subscription fees cannot exceed ε.

To establish that the advertising fee charged in Proposition 5 exceeds the socially optimal level, suppose by way of contradiction that $\phi^* = 0$. Proposition 3 then implies there is no price dispersion in the product market. Consequently, consumers do not obtain any useful information about prices from the gatekeeper's site; the only benefit from subscribing is the elimination of the cost of physically visiting the local store, ε. It follows that $\kappa^* = \varepsilon$, since this is the highest subscription fee consistent with $\mu = 1$. Thus, the gatekeeper's expected revenues are ε when $\phi^* = 0$. Suppose the gatekeeper deviates by charging a ϕ' slightly above zero and setting the subscription fee at $\kappa' = \beta(\phi', 1)$. Then, by part (c) of Proposition 4, there exists a dispersed price equilibrium with full consumer participation. Since price dispersion persists when $\varepsilon \to 0$, it follows that $\kappa' > 0$ as $\varepsilon \to 0$. Thus, for sufficiently small ε, the gatekeeper's expected revenues in this equilibrium are at least $\kappa' > \varepsilon$. This contradicts the hypothesis that the gatekeeper's profits are maximized in an equilibrium where $\phi^* = 0$. We conclude that $\phi^* > 0$. Furthermore, since $\phi^* > 0$ implies $\kappa^* > \varepsilon$ for sufficiently small ε, κ^* also exceeds the socially optimal level. Thus we have established

Proposition 6 *Suppose frictions in the product market are negligible (ε is sufficiently small). In the equilibrium that maximizes a monopoly gatekeeper's expected profits, the fees charged for advertising and subscriptions exceed the socially optimal levels.*

The fact that the advertising fee set by a monopoly gatekeeper exceeds the social optimum implies that firms participate in the market for information ($\alpha > 0$), but at a rate that is less than the social optimum ($\alpha < 1$). This leads to two potential inefficiencies. First, when demand is strictly decreasing in price, there is deadweight loss in the product market (since prices exceed marginal cost with probability one). Second, for all demand specifications, there is a positive probability that consumers observe no prices in the market for information, and in this case an additional ε must be paid to transact locally.

However, any deadweight loss arising in a product market served by a monopoly gatekeeper is less than that arising in the absence of a market for information. This follows from the fact that, in the absence of a market for information, all transactions take place at the monopoly price, whereas with a market for information there is a positive probability that consumers will pay lower prices. Further, even with inefficient participation in the market for information by firms, $(\alpha < 1)$, the presence of this market reduces average transaction costs since there is a positive probability transactions occur through the gatekeeper's site (thus eliminating the ε required by consumers to shop locally). For these reasons, one might be tempted to conclude that a movement from an environment with n segmented local monopolies to one in which the n firms are linked through a market for information that is run by a monopoly gatekeeper would unambiguously improve social welfare. Our next propositions shows that this need not be the case. To be welfare enhancing, efficiency gains must large enough to offset the cost, K, of establishing the market for information. Furthermore, the gatekeeper's decision to establish a market for information depends on the magnitude of subscription and advertising revenues relative to K—not social efficiency gains. Consequently, a profit-maximizing gatekeeper may establish a market for information when doing so reduces social welfare.

Proposition 7 *(a) The establishment of a market for information increases (decreases) social welfare when*

$$K \leq (>) \, \Delta + \left(1 - \left(\frac{n\phi^*}{(n-1)\,\pi(r)}\right)^{\frac{n}{n-1}}\right)\varepsilon \tag{7}$$

where

$$\begin{aligned}\Delta = & \int_{p_0}^{r} (S(p) + \pi(p))\, n\alpha\, (1 - \alpha F(p))^{n-1} f(p)\, dp \\ & + (1-\alpha)^n (S(r) + \pi(r)) - (S(r) + \pi(r)) \\ & \geq 0.\end{aligned}$$

Furthermore, (b) a profit-maximizing monopoly gatekeeper may establish a market for information even though doing so reduces social welfare.

Part (a) of this proposition, which is proved in the Appendix, has a straightforward interpretation. The right-hand-side of (7) consists of two terms that capture the benefits from the creation of a market for information. The first term, Δ, represents the expected reduction in deadweight loss in the product market, while the second term, $\left(1 - \left(\frac{n\phi^*}{(n-1)\pi(r)}\right)^{\frac{n}{n-1}}\right)\varepsilon$, is the expected reduction in transaction costs. The left-hand side of the inequality is the cost of establishing a market for information, K.

Notice that, since $K > \varepsilon > \left(1 - \left(\frac{n\phi^*}{(n-1)\pi(r)}\right)^{\frac{n}{n-1}}\right)\varepsilon$, the reduction in transaction costs does not by itself offset the cost of establishing the market for information. Thus, the magnitude of the reduction in deadweight loss is pivotal in determining whether the creation of a market for information increases social welfare.

When demand in the product market is strictly decreasing in price, the creation of a market for information strictly reduces deadweight loss: $\Delta > 0$. In this case, the establishment of a market for information by a monopoly gatekeeper increases social welfare if the cost of creating the virtual marketplace is not too large. With constant demand up to the monopoly price, however, $\Delta = 0$. Hence, even when the cost of creating the market for information is arbitrarily small, its establishment may be welfare reducing.

Part (b) of the proposition indicates that there are circumstances where the creation of a market for information reduces social welfare, but a monopoly gatekeeper profits by establishing one. To see this, consider the case where demand is unity up to the monopoly price and there are two firms in the product market. As we established above, in this case the creation of the market for information reduces social welfare. However, one can show that as $\varepsilon \to 0$, the gatekeeper's expected profits tend to $\frac{r}{e} - K$.[18] Hence, for sufficiently small ε, when $K < \frac{r}{e}$ the gatekeeper finds it profitable to establish a market for information even though doing so reduces social welfare.

VII Competing Gatekeepers

Proposition 6 showed that a monopoly gatekeeper charges advertising and subscription fees that exceed the socially optimal levels. If there are multiple gatekeepers, one might expect competition to lead to lower fees. While a complete analysis of the effects of competing gatekeepers is beyond the scope of the present paper, a simple extension of our existing framework suggests that this need not be the case.

Suppose an incumbent gatekeeper has already established a market for information and enjoys the payoff maximizing equilibrium described in Proposition 5. At a cost K, a rival gatekeeper can set up a competing site and choose non-negative advertising and subscription fees. Suppose that the prospective gatekeeper enters and undercuts both the advertising and subscription fees of the incumbent. Notice that, unless consumers anticipate a migration to the entrant's site by firms, they have no incentive to switch even though the entrant offers a lower subscription fee than the incumbent. The same reasoning holds for firms: Even if the advertising fee is lower at the entrant's site, if firms do not expect consumers to subscribe to that site, they will not switch. In this way, the first-mover advantage of an incumbent gatekeeper can be self-sustaining even if an entrant offers lower fees. In short, the equilibrium identified in Proposition 5 remains an equilibrium when there is competition among gatekeepers.

This result is analogous to well-known (but sometimes controversial) anecdotes which suggest that network externalities, path dependence, and focal points play an important role in determining market outcomes (e.g., Beta/VHS; Windows/OS2;

QWERTY/Dvorak keyboards). A more recent example of this phenomenon is the Internet auction market. In terms of gross transactions, eBay dominates this market despite the fact that it charges significantly more than new entrants like Yahoo! and Amazon. Yahoo! provides the same service as eBay for *free*, but the fact that eBay was first in this market apparently leads buyers and sellers to coordinate on its site.

VIII Conclusions

We consider a market for information controlled by a profit-maximizing gatekeeper and a product market with homogeneous product firms. The gatekeeper charges fees to firms who wish to advertise their prices and to consumers who wish to obtain access to the list of advertised prices. The level of activity in the market for information directly impacts the competitiveness of the product market, and this in turn affects the willingness of consumers and firms to participate in the market for information. Our main findings (Propositions 5 and 7) are that with optimizing firms and consumers, the gatekeeper's profits are maximized in an equilibrium where (a) fees charged for consumer access are set low enough to induce all consumers to subscribe; (b) advertising fees are set above socially optimal levels, thus inducing only partial participation by firms and price dispersion in the product market; and (c) advertised prices are lower than unadvertised prices. Paradoxically, price dispersion persists even though, in equilibrium, all consumers purchase from a firm offering the lowest price.

Differences in the treatment of firms and consumers by the gatekeeper stem largely from a free rider problem present on the consumer side of the market but absent on the firm side. Encouraging too much firm participation in the market for information leads to competitive pricing in the product market and reduces the degree of price dispersion. This has two adverse effects from the gatekeeper's perspective. First, firm profits are lower, so there is less available surplus on the firm side for the gatekeeper to extract. Second, the value to consumers of *not* subscribing to the market for information increases since it is more likely that, by simply shopping locally, a consumer can secure a favorable price. Thus, consumers will only pay low subscription fees to gain access to the market for information.

In contrast, increased consumer participation in the market for information makes it less likely that a non-advertising firm will attract customers. Further, increased consumer participation increases firms' incentives to attempt to "capture" subscribers by offering the lowest price. Both of these factors enhance the ability of the gatekeeper to extract rents from firms. Thus, it pays for the gatekeeper to maximize consumer participation in the market but not firm participation. This in turn implies that, despite the fact that total surplus is maximized by inducing competitive pricing in the product market, the free riding by consumers ensures that this is never profit maximizing for the gatekeeper. In short, social and gatekeeper incentives in the market for information are never fully aligned: a monopoly gatekeeper charges firms and consumers too much to transmit and access information.

A Appendix

This Appendix provides proofs of Propositions 4, 5, and 7. We begin with the following lemma.

Lemma 1 *For a given ϕ and μ, a consumer's maximal willingness to pay for access to the gatekeeper's site may be written as:*

$$\beta(\phi,\mu) = S(p_0) - S(r) - \int_{p_0}^{r} \left((1-\alpha F(p))^n + \alpha F(p) \right) q(p)\, dp + \varepsilon \left(1-(1-\alpha)^n\right).$$

Proof of Lemma 1.

By definition,

$$\begin{aligned} \beta(\phi,\mu) &= \sum_{j=1}^{n} \binom{n}{j} \alpha^j (1-\alpha)^{n-j} \int_{p_0}^{r} S(p)\, h_j(p)\, dp + (1-\alpha)^n (S(r)-\varepsilon) \\ &\quad -\alpha \int_{p_0}^{r} S(p) f(p)\, dp - (1-\alpha) S(r) + \varepsilon \end{aligned}$$

where

$$h_j(p) \equiv j (1-F(p))^{j-1} f(p).$$

Hence, we may substitute for h_j to obtain

$$\begin{aligned} \beta(\phi,\mu) &= \sum_{j=1}^{n} \binom{n}{j} \alpha^j (1-\alpha)^{n-j} \int_{p_0}^{r} S(p)\, j (1-F(p))^{j-1} f(p)\, dp + (1-\alpha)^n S(r) \\ &\quad -\alpha \int_{p_0}^{r} S(p) f(p)\, dp - (1-\alpha) S(r) + \varepsilon \left(1-(1-\alpha)^n\right) \\ &= \int_{p_0}^{r} \frac{S(p)}{1-F(p)} \left\{ \sum_{j=1}^{n} \binom{n}{j} \left(\alpha (1-F(p))\right)^j (1-\alpha)^{n-j} j \right\} f(p)\, dp + (1-\alpha)^n S(r) \\ &\quad -\alpha \int_{p_0}^{r} S(p) f(p)\, dp - (1-\alpha) S(r) + \varepsilon \left(1-(1-\alpha)^n\right) \end{aligned}$$

For any $y, z > 0$

$$\sum_{j=1}^{n} \binom{n}{j} (z)^j (y)^{n-j} j = nz (y+z)^{n-1},$$

so we may rewrite β as

$$\begin{aligned}
\beta(\phi,\mu) &= \int_{p_0}^{r} \frac{S(p)}{1-F(p)} \left\{ n\alpha (1-F)(1-\alpha F)^{n-1} \right\} f(p)\, dp + (1-\alpha)^n S(r) \\
&\quad -\alpha \int_{p_0}^{r} S(p) f(p)\, dp - (1-\alpha) S(r) + \varepsilon (1-(1-\alpha)^n) \\
&= \int_{p_0}^{r} \frac{S(p)}{1-F(p)} \left\{ n\alpha (1-F(p)) \left(1 + \frac{\alpha(1-F(p))}{1-\alpha}\right)^{n-1} (1-\alpha)^{n-1} \right\} f(p)\, dp \\
&\quad + (1-\alpha)^n S(r) - \alpha \int_{p_0}^{r} S(p) f(p)\, dp - (1-\alpha) S(r) + \varepsilon (1-(1-\alpha)^n) \\
&= \int_{p_0}^{r} S(p)\, n\alpha (1-\alpha F(p))^{n-1} f(p)\, dp + (1-\alpha)^n S(r) \\
&\quad -\alpha \int_{p_0}^{r} S(p) f(p)\, dp - (1-\alpha) S(r) + \varepsilon (1-(1-\alpha)^n).
\end{aligned}$$

Next, we integrate by parts. Notice that

$$\int n\alpha (1-\alpha F(p))^{n-1} f(p)\, dp = -(1-\alpha F(p))^n,$$

and $S'(p) = -q(p)$. Hence

$$\begin{aligned}
\beta(\phi,\mu) &= -S(p)\left((1-\alpha F(p))^n\right)|_{p_0}^{r} - \int_{p_0}^{r} (1-\alpha F(p))^n q(p)\, dp + (1-\alpha)^n S(r) \\
&\quad -\alpha S(p) F(p)|_{p_0}^{r} - \alpha \int_{p_0}^{r} q(p) F(p)\, dp - (1-\alpha) S(r) + \varepsilon (1-(1-\alpha)^n) \\
&= -S(r)(1-\alpha)^n + S(p_0) - \int_{p_0}^{r} (1-\alpha F(p))^n q(p)\, dp + (1-\alpha)^n S(r) \\
&\quad -\alpha S(r) - \alpha \int_{p_0}^{r} q(p) F(p)\, dp - (1-\alpha) S(r) + \varepsilon (1-(1-\alpha)^n) \\
&= S(p_0) - S(r) - \int_{p_0}^{r} (1-\alpha F(p))^n q(p)\, dp - \alpha \int_{p_0}^{r} q(p) F(p)\, dp + \varepsilon (1-(1-\alpha)^n) \\
&= S(p_0) - S(r) - \int_{p_0}^{r} \left((1-\alpha F(p))^n + \alpha F(p)\right) q(p)\, dp + \varepsilon (1-(1-\alpha)^n).
\end{aligned}$$

Proof of Proposition 4.

a) If $\alpha = 0$, no consumer benefits from subscribing, hence $\mu = 0$. Given $\mu = 0$, a dominant strategy for each firm is to price at r and not advertise.

b) For $\phi \in \left(0, \frac{n-1}{n}\pi(r)\right)$, $\beta(\phi, \mu)$ is continuous in μ. Noting that $\lim_{\mu \to \frac{n\phi}{(n-1)\pi(r)}} \beta(\phi, \mu) = 0$ and $\beta(\phi, 1) = \kappa^*(\phi) > 0$, it follows that there exists a value $\mu^* \in \left(\frac{n\phi}{(n-1)\pi(r)}, 1\right)$ such that $\beta(\phi, \mu^*) = \kappa \in (0, \kappa^*(\phi))$. In this case, consumers are indifferent between subscribing or not. Given that a fraction $\mu^* > 0$ of consumers subscribe, the optimality of firm strategies follows from Proposition 3.

c) Given that firms are pricing and advertising as in the Proposition, since $\kappa \leq \kappa^*(\phi)$, it follows that the benefits from subscribing, $\beta(\phi, 1) - \kappa$, are non-negative. Hence, it is optimal for all consumers to subscribe. Given that all consumers subscribe, the optimality of firm strategies follows from Proposition 3.

Proof of Proposition 5

We begin by establishing that $\mu = 1$. By Proposition 4, there are only three types of symmetric equilibrium. In an inactive market equilibrium, neither firms nor consumers participate in the virtual marketplace, and the gatekeeper earns zero revenues in that equilibrium for any choice of κ and ϕ. Thus, it is sufficient to show that expected profits are higher when $\mu = 1$ than when $\mu < 1$.

By way of contradiction, suppose the gatekeeper maximizes profits by charging $\left(\bar{\phi}, \bar{\kappa}\right) \in \left[0, \frac{n-1}{n}\pi(r)\right] \times [0, \kappa^*]$ in an equilibrium where $\mu^* < 1$ consumers subscribe. Then by part (c) of Proposition 4, for these values of κ and ϕ, there also exists a dispersed price equilibrium with complete subscriptions ($\mu = 1$). Since α^* is increasing in μ, it follows that $n\alpha^*\left(\mu^*, \bar{\phi}\right)\bar{\phi} + \bar{\kappa}\mu^* < n\alpha^*\left(1, \bar{\phi}\right)\bar{\phi} + \bar{\kappa}$. This contradicts the hypothesis that the gatekeeper's expected profits are maximized in an equilibrium where $\mu^* < 1$.

Given that $\mu = 1$, part (b) follows from Proposition 3.

Next we establish the optimality of the expressions given in parts (c) and (d). Since $\mu = 1$, it is clearly optimal for the gatekeeper to charge consumers a fee that exactly equals their benefit of subscribing. Further, the optimal ϕ maximizes

$$n\alpha(\phi)\phi + \beta(\phi, 1).$$

Using Lemma 1, we obtain the expressions for $\kappa^*(\phi^*)$ and ϕ^* given in the Proposition. Finally, note that it is profitable to establish a market for information is profitable if the cost of setting up the market is sufficiently small, i.e.,

$$K \leq n\left(1 - \left(\frac{n\phi^*}{(n-1)\pi(r)}\right)^{\frac{1}{n-1}}\right)\phi^* + \kappa^*(\phi^*).$$

The following Lemma is used in the proof of Proposition 7.

Lemma 2 *With a monopolized market for information, social welfare is*

$$SW^M = \int_{p_0}^{r} (S(p) + \pi(p))\, n\alpha(1 - \alpha F)^{n-1} f dp + (1 - \alpha)^n (S(r) - \varepsilon + n\pi(r)) - K.$$

Proof. In a monopolized market for information, expected consumer surplus is

$$CS = \sum \binom{n}{j}\alpha^j (1 - \alpha)^{n-j} \int_{p_0}^{r} S(p)\, h_j(p)\, dp + (1 - \alpha)^n (S(r) - \varepsilon) - \kappa^*.$$

Using the fact that

$$\sum_{j=1}^{n}\binom{n}{j}nz\left(z\right)^{j}\left(y\right)^{n-j}=nz\left(y+z\right)^{n-1},$$

we may rewrite this as

$$CS=\int S\left(p\right)n\alpha\left(1-\alpha F\right)^{n-1}fdp+\left(1-\alpha\right)^{n}\left(S\left(r\right)-\varepsilon\right)-\kappa^{*}.$$

Next consider the expected profits of firms in the product market. For any $p\in$ $\left[p_{0},r\right],$

$$E\pi_{i}=\alpha\left(\sum_{j=0}^{n-1}\binom{n-1}{j}\alpha^{j}\left(1-\alpha\right)^{n-1-j}\left(\pi\left(p\right)\left(1-F\left(p\right)\right)^{j}\right)-\phi^{*}\right)+\left(1-\alpha\right)\left(1-\alpha\right)^{n-1}\frac{\pi\left(r\right)}{n}$$

Recall the Binomial Theorem:

$$\sum_{j=0}^{n-1}\binom{n-1}{j}\left(z\right)^{j}\left(y\right)^{n-1-j}=\left(y+z\right)^{n-1}.$$

Hence,

$$E\pi_{i}=\alpha\pi\left(p\right)\left(1-\alpha F\left(p\right)\right)^{n-1}-\alpha\phi^{*}+\left(1-\alpha\right)^{n}\frac{\pi\left(r\right)}{n}.$$

Summing over all n firms

$$E\left(\sum_{i=1}^{n}\pi_{i}\right)=n\alpha\pi\left(p\right)\left(1-\alpha F\left(p\right)\right)^{n-1}+\left(1-\alpha\right)^{n}\pi\left(r\right)-n\alpha\phi^{*}.$$

Since $n\alpha\pi\left(p\right)\left(1-\alpha F\left(p\right)\right)^{n-1}$ is constant over $\left[p_{0},r\right]$, we may also write this as

$$E\left(\sum_{i=1}^{n}\pi_{i}\right)=\int_{p_{0}}^{r}n\alpha\pi\left(p\right)\left(1-\alpha F\left(p\right)\right)^{n-1}f\left(p\right)dp+\left(1-\alpha\right)^{n}\pi\left(r\right)-n\alpha\phi^{*}.$$

Finally, gatekeeper profits are $E\Pi=n\alpha\phi^{*}+\kappa^{*}$. Summing gives us

$$CS+E\left(\sum_{i=1}^{n}\pi_{i}\right)+E\Pi=\int_{p_{0}}^{r}\left(S\left(p\right)+\pi\left(p\right)\right)n\alpha\left(1-\alpha F\right)^{n-1}fdp+\left(1-\alpha\right)^{n}\left(S\left(r\right)-\varepsilon+n\pi\left(r\right)\right)-K.$$

Proof of (a) in Proposition 7

Note that social welfare in the absence of a market for information is

$$SW^0 = S(r) + n\pi(r) - \varepsilon.$$

Using the expression for SW^M given in Lemma 2, we have that

$$\begin{aligned} & SW^M - SW^0 \\ = \; & \int_{p_0}^{r} (S(p) + \pi(p))\, n\alpha (1-\alpha F)^{n-1} f dp + (1-\alpha)^n (S(r) + \pi(r)) - (S(r) + \pi(r)) \\ & -K + (1-(1-\alpha)^n)\,\varepsilon \end{aligned}$$

It is useful to define the expected reduction in deadweight loss in the product market from establishing a monopoly market for information as

$$\Delta = \int_{p_0}^{r} (S(p) + \pi(p))\, n\alpha (1-\alpha F)^{n-1} f dp + (1-\alpha)^n (S(r) + \pi(r)) - (S(r) + \pi(r)).$$

Thus,

$$SW^M - SW^0 = \Delta + (1-(1-\alpha)^n)\,\varepsilon - K.$$

Hence, social welfare is higher with a monopoly market for information provided that

$$\Delta \geq K - (1-(1-\alpha)^n)\,\varepsilon,$$

or equivalently,

$$\Delta \geq K - \left(1 - \left(\frac{n\phi^*}{(n-1)\,\pi(r)}\right)^{\frac{n}{n-1}}\right)\varepsilon.$$

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Figure 1: Average Spread in the Distribution of Mortgage Rates, 50 U.S. States and the District of Columbia, May 1998. Source: Computed from data obtained at www.mortgagequotes.com.

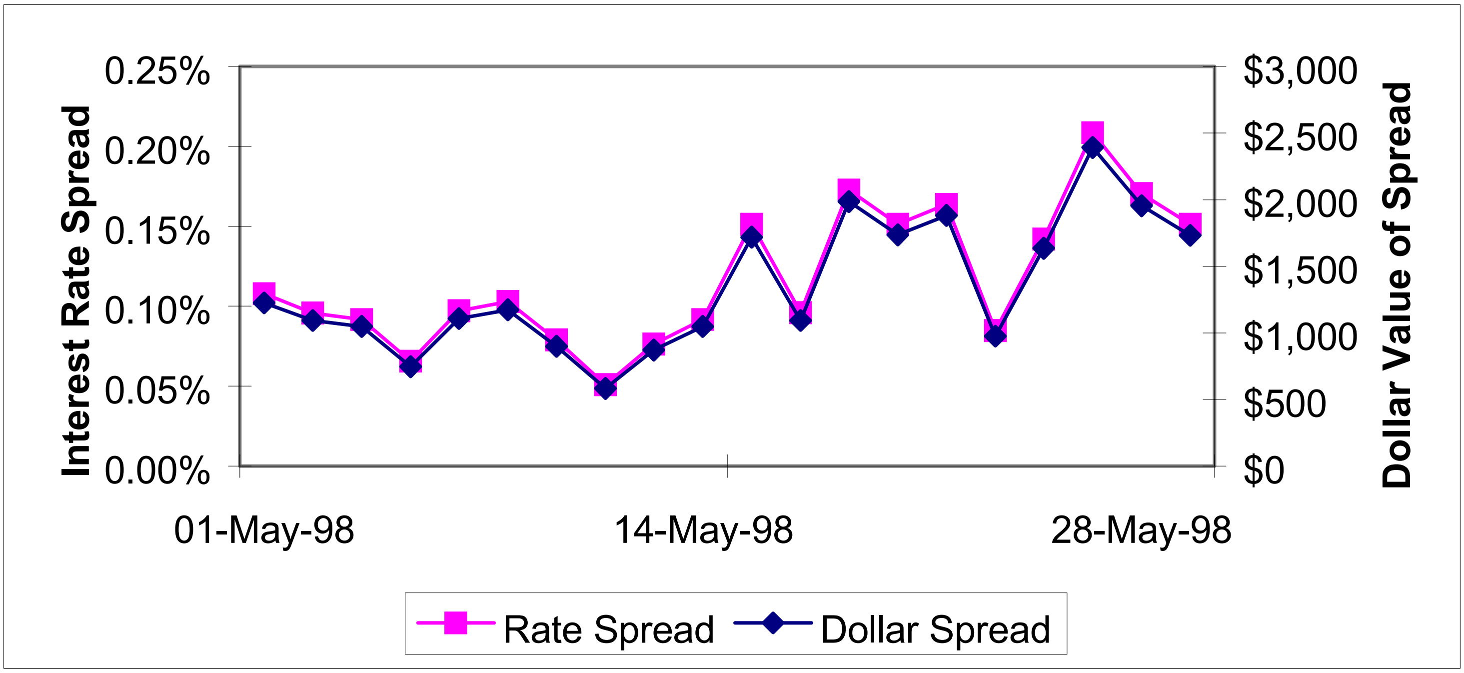

Table 1: Comparative Statics For Unit and Linear Demand

$\Delta\phi^*/\Delta n$	$-$
$\Delta\alpha^*/\Delta n$	$-$
$\Delta n\alpha^*/\Delta n$	$+$
$\Delta\kappa^*/\Delta n$	$+$
$\Delta\left[n\alpha^*\phi^*/\left(n\alpha^*\phi^*+\kappa^*\right)\right]/\Delta n$	$-$

Notes

[1]*Baye: Department of Business Economics and Public Policy, Kelley School of Business, Indiana University, Bloomington, IN 47405; Morgan: Department of Economics and Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, NJ 08544. We thank seminar participants at Florida, Georgetown, Indiana, Michigan, Missouri, Northwestern, Notre Dame, Princeton, Purdue, and VPI for comments on earlier versions of this paper. We are indebted to Dan Kovenock, Eric Rasmussen, three referees, and an associate editor for comments that greatly improved this paper. Morgan is also grateful to the NSF for support under grant SBR 9618648.

[1]Recently, the U.S. Justice Department raised concerns about the impact of Microsoft's attempts to integrate browsers and operating systems. The government's concern was that desktops and servers are the gateway to the Internet, and that it would be undesirable to have this information technology controlled by a monopoly gatekeeper. Similar concerns were raised against American Airlines and its control of the SABRE airline reservation system.

[2]Indeed, one of the authors availed himself of this opportunity by acquiring a mortgage for a property in Indiana from a lender in Maryland. In the traditional sense, there is no location advantage affecting Internet commerce.

[3]Equilibrium dispersion of advertised prices arises due to consumer heterogeneities,

which, in Varian and Salop-Stiglitz, stem from differences in consumers' costs of reading the paper. In Shilony, heterogeneities arise because some consumers have a preference for a particular firm's product (due to switching costs) and will pay more for it even if it does not offer the lowest price.

[4]A third approach assumes that there is no advertising, but that consumers can obtain price information through sequential or fixed-sample search search; see Jennifer F. Reinganum (1979); Avishay Braverman (1980); Kenneth Burdett and Kenneth L. Judd (1983); John Carlson and McAfee (1983); Raphael Rob (1985); Stahl (1989, 1996); James D. Dana (1994); and McAfee (1995).

[5]More generally, one can allow for positive delivery costs by interpreting prices and costs as being inclusive of delivery charges. The symmetric model examined here then obtains when delivery costs are independent of consumer and firm locations. Practical examples of this include mortages (where funds are wired) and settings where firms are retailers who fill orders by having goods shipped directly to consumers from a common wholesaler or manufacturer.

[6]An alternative interpretation is that each local market consists of firms who compete in a Cournot fashion, thus giving rise to a local equilibrium price of $r > c$. Under this interpretation, one firm in each local market has the potential for Internet presence and the creation of an Internet permits that firm to play a Bertrand game in the global market.

[7]While the assumption that $S(r) > \varepsilon$ rules out the case of rectangular demand, it does not rule out the case where demand is constant up to the monopoly price. In particular, suppose $q(p) = 1$ if $p \leq 1$ and $q(p) = 2 - p$ otherwise, and that marginal cost is zero. It is easy to verify that the monopoly price is $r = 1$, and furthermore, $S(r) = \frac{1}{2} > \varepsilon$ for small ε.

[8]In models where it is costly to visit a store that has market power and where firms can adopt nonlinear pricing, arguments along the lines of those first made by Peter Diamond (1971) imply that, in the absence of consumer resale, equilibrium entails an inactive product market. In the context of our model, once a consumer spends $\varepsilon > 0$ to visit the local store, the firm has an incentive to extract all surplus from the consumer by making a take-it-or leave-it offer to sell $q(c)$ units for $S(c) + cq(c)$. Anticipating this, no consumers will shop and the firm's profits are zero. Casual observation suggests that markets somehow overcome this problem. The traditional reason given is that the threat of consumer resale effectively constrains firms to charge linear prices. Alternatively, firms might establish a reputation for charging linear prices in order to avoid the zero-profit outcome that would prevail absent a credible commitment to not "hold-up" consumers. Our assumption that firms charge linear prices and $S(r) > \varepsilon$ guarantees an active product market.

[9]Clearly, firms have no incentive to price below marginal cost (c) or above the monopoly price (r). Technically, the assumption that the upper bound of the strategy space is r eliminates degenerate equilibria that can arise when consumers do not

visit their local firm because they believe the price at that store, p', is so high that $S(p') < \varepsilon$. These beliefs are self-confirming, as the local firm may as well price at $p' > r$ if no consumers visit the store. Note that even without the strategy space restriction, these equilibria vanish if the local firm ascribes even infinitesimal probability that consumers will visit his store (since prices $p > r$ are weakly dominated by the monopoly price, r).

[10]As in Salop-Stiglitz (1977) and Varian (1980), there is neither price discrimination nor information leakage between subscribers and non-subscribers.

[11]To be precise, let $\phi < \frac{n-1}{n}\mu\pi(r)$ and $\mu > 0$. By standard reasoning, one can show that in any symmetric equilibrium, $F(p)$ is atomless on $[p_0, r]$, with $F(r) = 1$. Notice that if all firms but i advertise,

$$\begin{aligned} E\pi_i(r, A) &= \frac{1-\mu}{n}\pi(r) - \phi \\ &< E\pi_i(N, r) = \frac{1-\mu}{n}\pi(r). \end{aligned}$$

Hence, firm i should not advertise. Similarly, if all firms but i do not advertise, $E\pi_i(r, A) > E\pi_i(r, N)$. Hence firm i should advertise. As a result, we may conclude that $\alpha \in (0, 1)$.

[12]Using equation (5), a firm that advertises a price $p' < p_0$ earns expected profits of $E\pi_i(p', A) = \mu\pi(p') + \frac{1-\mu}{n}\pi(p') - \phi < \mu\pi(p_0) + \frac{1-\mu}{n}\pi(p_0) - \phi = E\pi_i(p_0, A)$, so it is not profitable to advertise a price below p_0. We have assumed that the strategy space is $[c, r]$, so that it is not feasible for firms to price above r. Absent

the strategy space restriction (cf. footnote 9), a firm advertising a price $p' > r$ would also earn strictly less than it would by advertising a price of r. In particular, equation (5) implies that profits from advertising a price $p' > r$ are at most: $E\pi_i(p', A) = \mu\pi(p')(1-\alpha)^{n-1} + \frac{1-\mu}{n}\pi(p') - \phi < \mu\pi(r)(1-\alpha)^{n-1} + \frac{1-\mu}{n}\pi(r) - \phi = E\pi_i(r, A)$ since $\pi(p)$ is maximized at r. Obviously, a firm cannot gain by pricing below c.

[13]Similar to the model of Varian (1980), the symmetric equilibrium is the unique equilibrium when $n = 2$. When $n > 2$, asymmetric equilibria arise in addition to the symmetric equilibrium presented in Proposition 3. The reasoning is analogous to that given in Michael R. Baye, Dan Kovenock and Casper G. de Vries (1992).

[14]To be precise, when $\phi \geq \frac{n-1}{n}\pi(r)$ the unique equilibrium is $\alpha = \mu = 0$ and $p = r$. In this case there is no market for information and firms operate as local monopolies. When $\phi < \frac{n-1}{n}\pi(r)$ and $\kappa > \kappa^*(\phi)$, then one or more equilibria with an active market for information and partial consumer subscriptions (type (b) in Proposition 4) may also arise.

[15]If $K < \varepsilon$, the gatekeeping function could improve social welfare solely by permitting consumers to economize on transactions costs.

[16]While our analytic proof that $\mu = 1$ for arbitrary product demand functions relies on the fact that $\kappa \in [0, \kappa^*(\phi)]$, for common specifications of demand the result obtains for all κ, $\phi \in [0, \infty)$. With unit demand up to r or linear demand, numerical analysis reveals that the equilibrium that maximizes the gatekeeper's payoff entails

full consumer participation even when there is no restriction on subscription or advertising fees. The numerical analysis is based on unit demand (with $r = 1$) and linear demand (with $q(p) = 1 - p$) specifications, where for each specification the number of competing firms ranged from 2 to 50 and $c = \varepsilon = 0$. Henceforth, all discussion of unit and linear demand refers to these cases.

[17]We thank two referees for suggesting this argument.

[18]See Baye and John Morgan (1999).