Prominence and consumer search

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This article examines the implications of “prominence” in search markets. We model prominence by supposing that the prominent firm will be sampled first by all consumers. If there are no systematic quality differences among firms, we find that the prominent firm will charge a lower price than its less prominent rivals. Making a firm prominent will typically lead to higher industry profit but lower consumer surplus and welfare. The model is extended by introducing heterogeneous product qualities, in which case the firm with the highest-quality product has the greatest incentive to become prominent, and making it prominent will boost industry profit, consumer surplus, and welfare.

1. Introduction

In many markets, consumers search among alternative options before making a purchase. The way that choices are presented to consumers can then have a substantial impact on their search behavior and hence competition and market performance. For example, if (as in standard search models) choices are viewed ex ante symmetrically by consumers, then they may search randomly among alternatives, and symmetric outcomes as between firms will tend to result. However, if one purchase option is somehow more prominent than others, consumers are likely to consider that offering first. For example, when using a search engine online, people might first click on links displayed at the top of the page; when deciding what to watch on television, viewers may be biased toward the channels listed at the top of an electronic program guide; and when people visit a supermarket or bookstore, those products displayed in the entrance or other prominent positions might catch their attention first. In these examples, a consumer’s search order is not random, but is influenced by the way alternatives are presented, and resulting market outcomes are asymmetric as between firms. The aim of this article is to explore how prominence affects competition in search markets, and the implications, relative to the familiar symmetric search case, for consumer surplus, profit, and welfare.

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There is abundant evidence that the way options are presented can significantly influence choice. For example, Madrian and Shea (2001) identify a significant default effect with employee savings plans. They find that participation in such schemes is significantly higher under automatic enrollment, and a substantial fraction of participants hired under automatic enrollment “choose” both the default contribution rate and the default fund allocation. Ho and Imai (2006) and Meredith and Salant (2007) observe that being listed first on a ballot paper can increase a candidate’s vote share. Einav and Yariv (2006) present evidence that economists with surname initials earlier in the alphabet have more successful careers, and discuss various reasons why such researchers may be more “prominent.” Lohse (1997) investigates the influence of yellow page advertisement characteristics on consumer information-processing behavior. By tracing subjects’ eye movements, he finds that adverts which are larger, colorful, with graphics, or near the beginning of a heading are more likely to catch a reader’s attention.

Sellers are willing to pay for their products to be displayed in a prominent position. For example, Internet search engines make money through selling sponsored links in response to search enquiries. Manufacturers pay supermarkets for access to prominent display positions (e.g., at eye level, or at the ends of aisles), publishers pay bookstores substantial fees for a book to be the “book of the week.” More prominent adverts are more expensive in yellow pages directories, and eBay offers sellers the option to list their products prominently for an extra fee. Moreover, when a product is made prominent—such as a book at the entrance to a bookshop—it is often sold at a discount. Indeed, the word “promote” can mean to make prominent and to offer at a discount.

This discussion suggests that prominence plays an important role in affecting consumer choices and product prices, and its impact on market performance deserves investigation. In this article, we examine the impact of prominence in a framework where consumers search sequentially through their available options. To model prominence, we suppose that the prominent firm is the first firm to be sampled by consumers. If consumers are not satisfied with this initial offer, they will go on to search randomly among the remaining firms. We explore the following questions. Will a prominent firm charge a higher or lower price than its rivals? How does profit, consumer surplus, and overall welfare change when a firm is made prominent?

In Section 2, we present a benchmark model in which there are no systematic differences between firms or between consumers. Initially, we consider the simplest setting where there is an infinite number of firms, where it turns out that prominence has no impact on prices and welfare, and merely redistributes demand and profit toward the favored firm. However, prominence does matter when there are finitely many suppliers. We find that the prominent firm will then charge a lower price than its non-prominent rivals, as it faces more elastic demand. In addition, relative to the situation with random consumer search, the prominent firm’s price falls while non-prominent firms’ prices rise. We find that, after introducing a prominent firm, industry profit will typically increase. This means that, if a platform can extract industry profit, it will choose to make a firm prominent. However, introducing a prominent firm will lead to lower consumer surplus and lower total welfare. This is because, when a firm is made prominent, market prices are no longer uniform. Because the prominent firm charges a lower price than non-prominent firms, too many consumers are induced to buy from the prominent firm than is efficient. On top of this, we find that making a firm prominent will exclude more consumers from the market—that is to say, the price increase by non-prominent firms is more significant than the prominent firm’s price reduction—and this is a second source of inefficiency.

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1 Journalist Libby Purves, writing in the London Times on May 30, 2006, says “that WH Smith’s ‘book of the week’ title has been bought and paid for. The publisher handed over £50,000. Waterstone’s Book of the Week accolade is £10,000. […] Smaller sums buy other levels of prominence.”

2 According to the Oxford English Dictionary, one definition of “promote” is “to advance the interests of, move to a stronger or more prominent position.” And “on promotion” is defined as “at a reduced price or on special offer as part of a campaign to promote sales.”
The remainder of the article deals with asymmetries, first on the supply side and then on the demand side. In Section 3, we explore an extension where firms differ in their average quality. If the cost difference is small compared to the quality difference, we find that the firm with the highest quality is willing to pay the most to become prominent, and making it prominent will boost industry profit as before, but also boost consumer surplus and welfare. In effect, prominence now acts to guide consumers toward better products. The high-quality firm will set a high price, but consumers still benefit from encountering this firm first. In Section 4, we briefly discuss the impact of prominence when consumers differ in their search costs. Here, we find that the prominent firm could offer a higher price than its rivals. The reason is that this firm may now face a less elastic demand than its rivals, because it has some monopoly power over those consumers with high search costs.

Our model assumes that all consumers sample the prominent option first. There are at least three ways to think about this assumption. First, consumers may be exposed to options in an exogenously restricted order, and they have no ability to avoid the prominent product. For instance, if a consumer goes to a travel agent to buy airline tickets or a financial advisor to buy a savings product, the advisor may reveal options one by one. Second, consumers could suffer from bounded rationality of some form and be susceptible to manipulation by marketing ploys. In the psychological literature, it is well documented that a salient stimulus can more effectively catch people’s attention, and this reaction, to some degree, is independent from the economic importance of the stimulus (see, for instance, Fiske and Taylor, 1991). Third, consumers could be fully rational: they choose to visit the prominent firm first because they expect this firm to make the best offer, and this expectation is correct in equilibrium. Although our approach is largely neutral with respect to these three possibilities, it is a bonus that most of our results admit the rational-consumer interpretation. In the models presented in Sections 2 and 3 (but not Section 4), consumers are indeed better off if they choose to go first to the prominent firm, even when they have the ability to avoid it.

Our article draws on the rich literature on consumer search. In particular, our model is related to the branch of the search literature concerned with product differentiation, where consumers must search both for price and product fitness. An early contribution to this literature is Weitzman (1979), and this was later developed and applied to a market context by Wolinsky (1986). We use Wolinsky’s model as the starting point for our article. Wolinsky’s model is developed further by Anderson and Renault (1999), who, among other results, discuss how equilibrium prices are affected by changes in the degree of product differentiation. Compared to the homogeneous product search model, models with product differentiation often better reflect consumer behavior in markets with nonstandardized products. Moreover, they avoid the well-known modelling difficulty suggested by Diamond (1971), who showed with homogeneous products and positive search costs that rivalry between firms had no impact on price. In search models with product differentiation, there are some consumers who are ill matched with their initial choice of supplier and then search further, so that the pro-competitive benefit of actual search is present.

Although there is much evidence concerning the impact of prominence (generally conceived) on choice, not much of this work has examined market situations in which prominence affects competition between firms. In particular, there is little analysis of how prominence might affect...
a firm’s pricing policy. Nevertheless, there is a small literature on this topic. For instance, Perry and Wigderson (1986) suppose consumers consider, in a known, predetermined order, a finite number of suppliers with uncertain costs. (For instance, a driver may be looking for a garage along a road.) There is no scope for going back to a previous offer (unlike in our model), and so the final supplier enjoys a monopoly position over those consumers who wait that long. Their model assumes that consumers differ in their willingness to pay for the product, however, which implies that the final suppliers could be left with only the low-value consumers. The article argues that in equilibrium the observed prices, on average, could be nonmonotonic in the search order of the supplier.

Arbatskaya (2007) also considers a completely ordered search model with a homogeneous product, but where firms have identical costs and consumers differ in their cost of search. Because consumers only care about price, in equilibrium the prices must decline with the order in which they are sampled, otherwise no rational consumer would have an incentive to sample products in unfavorable positions. That is to say, the more prominent firms set higher prices. This framework is briefly discussed in Section 4 below. Both Perry and Wigderson (1986) and Arbatskaya (2007) present a positive analysis of the impact of search order on equilibrium prices, and there is no discussion of how a nonrandom search order affects industry profit, consumer surplus or welfare compared with random searching.  

Another strand of the literature to which our article relates is advertising. Indeed, a major purpose of advertising is to make a product more prominent. For instance, Robert and Stahl (1993) analyze a rich model where consumers search for a low price for a homogeneous product, and firms can also advertise their price to a subset of consumers. They find that in equilibrium, firms randomize between setting a high, unadvertised price and lower, advertised prices. Thus, the more prominent firms set lower prices, as in our model. A similar effect is found in Bagwell and Ramey (1994), although for very different reasons. In their paper, firms are identical \textit{ex ante} and attract consumers by means of advertising (which is not directly informative). Firms have economies of scale, so that a firm facing greater demand has a lower marginal cost. Consumers follow the rule of thumb whereby they buy from the firm which advertises most heavily. Because of economies of scale, this firm will have a lower price than its rivals. Thus, the consumer response to advertising is indeed rational even though advertising messages are not directly informative, and the more prominent firm sets a lower price. More recently, and closer in spirit to our approach, Haan and Moraga Gonzalez (2007) propose a model of search and advertising where the search model involves product differentiation as in Wolinsky (1986). A consumer’s search order is potentially nonrandom, and a consumer’s likelihood of sampling a firm is proportional to that firm’s advertising intensity. (Adverts do not contain price information, and merely persuade consumers to sample that product first.) In symmetric equilibrium, all firms set the same price and advertise with the same intensity, and so no firm is more prominent than any other. So consumers end up searching randomly and advertising is pure waste.

Finally, our work is related to the work on auctions for being listed prominently on online search engines. The two papers by Chen and He (2006) and Athey and Ellison (2007) are especially relevant because they include a model of the consumer side of the market, and consumers search sequentially through the suggested links to find a good match for their needs. Links differ in “quality” in the sense that a high-quality link is more likely to generate a good match with any consumer. There is equilibrium behavior on both sides: consumers optimally search for a good match by moving through the links in the order presented because they anticipate that high-quality links will be placed higher up the listing; higher-quality links have a greater incentive to be placed higher in the list than lower-quality links given the consumer search order, because a link’s payoff

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6 Hortaçsu and Syverson (2004) construct a related empirical search model, where investors sample different mutual funds with unequal probabilities, to explain the price dispersion in the market for mutual funds. But they did not explore theoretical predictions of their model, and there is also no empirical conclusion about the relationship between sampling probability and price.
is proportional to the number of good matches with consumers. In particular, the ordered search facilitated by position auctions is beneficial for overall efficiency. (We make a similar point in Section 3.) However, in other respects, our model is different. In particular, there is no price competition in Chen and He (2006) and Athey and Ellison (2007), and so no role for prominence to affect market prices.\footnote{Chen and He (2006) do have prices charged by advertisers, but the structure of consumer demand in their model means that the Diamond Paradox is present, and all firms set monopoly prices.}

2. A model of prominence

Our underlying model of consumer choice is based on the framework developed by Wolinsky (1986). There are \( n \geq 2 \) firms, each of which supplies a single product at constant common unit cost, which we normalize to zero. There is no systematic quality difference among firms. Our aim is to extend this established framework to allow one product to be displayed more prominently than the others.

The number of consumers is normalized to one, and each consumer wishes to purchase one unit of one product from the market. The value of a firm’s product is idiosyncratic to consumers. Specifically, \((u_1, u_2, \ldots, u_n)\) are the values attached by a consumer to each of the \( n \) products, and \( u_i \) is assumed to be independently drawn from a common distribution \( F(u) \) on \([u_{\text{min}}, u_{\text{max}}]\) which has a positive density \( f(u) \). We also assume that all match values are realized independently across consumers. The surplus from buying firm \( i \)'s product is \( u_i - p_i \), where \( p_i \) is this firm’s price. If all match values and prices are known ex ante, a consumer will choose the product with the highest positive surplus \( u_i - p_i \). (If \( u_i - p_i < 0 \) for all \( i \), she will leave the market without buying anything.) In such a setting, there is no way to make a firm more “prominent” than its rivals.

However, we assume consumers initially have imperfect information about all prices and match values, and they must gather information through a sequential search process. By incurring a search cost \( s > 0 \), a consumer can discover a particular product’s price and match value.\footnote{Note that we do not suppose that the prominent firm can be sampled at zero (or reduced) cost. In some situations—for instance, when a book is prominently displayed at the entrance to the store—it would be natural to assume that there was a reduced cost to evaluate this option. However, in other situations—such as when the suggested links from a search engine are merely reordered—it is less natural to suppose that the prominent option has a lower inspection cost. Our results concerning the impact of prominence on prices and profits would carry over to the case where the prominent firm has a smaller search cost. However, our results on consumer surplus and overall welfare would need to be adjusted, because when a firm is made prominent this causes search costs to fall relative to the random search case.} We assume that the search process is without replacement and there is costless recall (i.e., a consumer can return to any firm she has visited without extra cost).

If all firms are equally prominent, we have Wolinsky’s model where consumers randomly search among firms. When one firm is more prominent than its rivals, we assume that all consumers will sample this firm first and then, if unsatisfied with this prominent product, they will go on to search randomly among the other firms.\footnote{The assumption that all consumers sample the prominent firm first is for simplicity. Relaxing it by assuming that a fraction greater than \( 1/n \) of consumers does so will not change our results qualitatively.} All firms maximize their profit, and they simultaneously set their prices \( p_i \) (\( i = 1, 2, \ldots, n \)) conditional on whether they or their rivals (or neither) are prominent and their expectations of consumer behavior.

\[ \int_{a}^{u_{\text{max}}} (u - a) \; d F(u) = s , \]
so that the incremental benefit from one more search is equal to the search cost.\footnote{This optimal stopping rule is well known in the search literature—for instance, see Weitzman (1979). As usual in search models, there also exists an uninteresting equilibrium where consumers expect all firms to set very high prices which leave them with no surplus, consumers do not participate in the market at all, and so firms have no incentive to reduce their prices.} Therefore, in equilibrium a consumer will buy the first product which generates match utility of at least $a$. It is clear that $a$ in (1) is decreasing in $s$; that is, the higher the search cost, the sooner consumers will cease searching.

Now consider an individual firm’s pricing decision. If a firm chooses price $p$ instead of $p_\infty$, a consumer who samples it will buy its product if

$$u - p \geq a - p_\infty,$$

because she still expects that the other firms charge $p_\infty$. Thus, this firm will aim to maximize

$$p \left[ 1 - F(p + a - p_\infty) \right].$$

Under regularity conditions (e.g., if the hazard rate $f(u)/(1 - F(u))$ is increasing in $u$), the first-order condition determines the optimal price, so that

$$p_\infty = \frac{1 - F(a)}{f(a)}.$$

\footnote{(This is expression (18) in Wolinsky (1986).) Provided the hazard rate is increasing, $p_\infty$ in (2) decreases with $a$, and hence $p_\infty$ increases with the search cost $s$. When $s$ tends to zero (in which case $a$ tends to $u_{\text{max}}$), it follows that $p_\infty$ also tends to zero. In particular, as emphasized in Wolinsky (1986), we do not see the Diamond Paradox in this framework.}

In equilibrium, $a - p_\infty$ is a consumer’s expected surplus, including her search costs, from participating in the market.\footnote{From (1), if each firm’s price is $p_\infty$, and if a consumer has found a product with match utility exactly equal to $a$, she is indifferent between consuming this product and searching further, and so $a - p_\infty$ is her expected surplus from participating in the market. Her expected surplus from the match achieved exceeds $a - p_\infty$ by an amount that equals her expected search costs.} Thus, a consumer finds it worthwhile to engage in search whenever $a - p_\infty \geq 0$, which requires that the search cost $s$ not be too large. In equilibrium, industry profit is $p_\infty$ (although each individual firm makes negligible profit) while total welfare—industry profit plus consumer surplus—is $a$.

Consider next the case where firm 1, say, is made prominent and so is sampled first by all consumers. Because all the non-prominent firms are symmetrically placed, we focus on equilibria where the prominent firm charges $p_1$ and all non-prominent firms charge the same price $p_2$. We are interested in the situation where there is an active search market where some consumers search beyond firm 1.\footnote{Similarly to footnote 10, there is another, less interesting equilibrium in which buyers expect that the price charged by non-prominent firms is very high so they never search beyond firm 1, and firm 1 sets the monopoly price. Because they do not expect consumers to visit them, the non-prominent firms have no incentive to deviate from this weakly dominated strategy.} Once consumers have rejected the prominent firm’s offering, they will behave as in the random search case just described. Hence, each non-prominent firm faces the same decision problem as in the random search case, and $p_2 = p_\infty$. Therefore, when a consumer considers the offer from the prominent firm, her reservation surplus is just $a - p_\infty$. This implies that the prominent firm will also charge $p_1 = p_\infty$. In sum, introducing prominence has no impact on market prices when there are infinitely many firms, and it merely redistributes consumer demand and profit between firms. Specifically, in equilibrium, firm 1’s demand is $1 - F(a)$ and its profit is

$$p_\infty(1 - F(a)),$$

while each non-prominent firm again earns negligible profit. We observe that (given the increasing hazard rate condition) this profit (3) increases with the search cost, and so a firm is willing to pay
more to become prominent in a market where consumers incur higher search costs. Because market prices are not affected by prominence, we deduce that prominence has no impact on industry profit, consumer surplus, or total welfare. In the next section, we show that this "neutrality" fails when there is a finite number of suppliers.

To illustrate these results, consider the case where \( u_i \) is uniformly distributed on the interval \([0, 1]\). Then (1) and (2) imply

\[
a = 1 - \sqrt{2s}; \quad p_\infty = \sqrt{2s}
\]

and the value of prominence in (3) is \(2s\). The market is active provided that \(a - p_\infty\) is nonnegative, that is, if

\[
s \leq \frac{1}{8}, \quad \text{or} \quad a \geq \frac{1}{2}.
\]

\[\square\]

**A finite number of suppliers.** Having set out the benchmark case with an infinite number of firms, we now analyze the case where \(n\) is finite.\(^{13}\) First consider the random search case where no firm is prominent. We focus on symmetric equilibria where each firm sets some price \(p_0\). Given the finite options available, one might suppose that an optimal search strategy exhibits features such as (i) the consumer becomes less choosy as the number of remaining options shrinks, or (ii) when there are fewer suppliers, consumers are less choosy. However, Wolinsky (1986) shows that the optimal search rule is stationary when consumers can costlessly go back to an earlier sampled product and all firms are expected to offer the price \(p_0\), and reduces (using our notation) to:

(a) If \(p_0 > a\), where \(a\) is given in (1), a consumer should not participate in the market;

(b) If \(p_0 \leq a\), a consumer should stop searching when she finds a product with \(u_i \geq a\); if no such product is eventually found among the \(n\) options, she goes back to buy the product with the highest \(u_i\), provided \(u_i \geq p_0\). If all \(u_i\) are below \(p_0\), then the consumer buys nothing.

This search strategy can be understood by means of backward induction. Suppose that a consumer has already sampled \(n - 1\) products and only one unsampled firm remains. It is then clear that the consumer should sample this remaining product if and only if her maximum match utility so far is lower than \(a\) as defined in (1). Now make the inductive assumption and consider the situation with more than one unsampled firm remaining. If the maximum match utility so far is lower than \(a\), then sampling one more firm is always worthwhile no matter what the consumer’s strategy is subsequently. If the maximum utility so far is greater than \(a\), expecting that she will stop searching whatever utility she discovers at the next firm (because of the inductive assumption), a consumer should actually cease her search now.

For simplicity, from now on suppose that \(u\) is uniformly distributed on the unit interval \([0, 1]\). To guarantee an active search market, assume condition (5) holds. Given the stopping rule, we claim that if a firm deviates to a price \(p\) while other firms offer the equilibrium price \(p_0\) its demand is

\[
q_0(p) = h_0(1 - a + p_0 - p) + r_0,
\]

where

\[
h_0 = \frac{1}{n} \sum_{k=0}^{n-1} a^k = \frac{1}{n} \cdot \frac{1 - a^n}{1 - a}
\]

\(^{13}\) Note that the finite \(n\) case is also relevant when there are many suppliers but consumers are willing or able to investigate only up to \(n\) options.
is the number of consumers who sample this firm’s product, and
\[ r_0 = \int_{p_0}^{a} u^{n-1} du \]  

(8) is the number of consumers who buy from this firm after sampling all firms.

To understand (6), consider the two sources of firm \( i \)'s demand. First, a consumer may come to firm \( i \) after sampling \( k < n \) other firms but without finding a satisfactory product (i.e., her previous match values were all less than \( a \)). The probability of this event is \( \frac{1}{n} a^{k} \) because a consumer will choose any search order with equal probability. (One in \( n \) consumers will have firm \( i \) as the \((k + 1)\)th firm in her random search order.) Summing up these probabilities over \( k = 0, \ldots, n - 1 \) leads to \( h_0 \). As usual in search models, a firm cannot affect the number of consumers who choose to sample its product—consumer search decisions are based on expectations of prices, not the actual prices—and so \( h_0 \) does not depend on the firm’s price \( p \). After sampling the firm, a consumer will buy firm \( i \)'s product immediately provided \( u_i - p \geq a - p_0 \), which occurs with probability \( 1 - a + p_0 - p \). This explains the first term in (6). We call this portion of a firm’s demand the “fresh demand.” Second, a consumer may find that the net surplus of all \( n \) products is less than \( a - p_0 \) (so she never stopped), and then returns to firm \( i \) if it provided the highest positive surplus. The probability of this event is

\[ \Pr \left( \max_{j \neq i} \{0, u_j - p_0\} < u_i - p < a - p_0 \right) = \int_{p}^{p+a-p_0} (u_i - p + p_0)^{n-1} du = r_0, \]

where the second equality follows from changing the integral variable from \( u_i \) to \( u = u_i + p_0 - p \). We call this portion of a firm’s demand the “returning demand.”

It is perhaps surprising that a firm’s returning demand in (8) is independent of its own price, \( p \). In general, reducing a firm’s price has two effects on its returning demand: (i) more consumers are satisfied with this firm’s offer at the first encounter and so fewer consumers go on to sample all firms, and (ii) the firm’s share of those consumers who sample all firms is increased. With a uniform distribution, these two effects exactly cancel out and the returning demand is price independent. (This can be seen in Figure 1 below, where a decrease in firm 1’s price simply shifts the set of consumers who buy its product after sampling all firms’ offers to the left.) In particular, a firm’s returning demand is less price elastic than its fresh demand.

When it charges price \( p \), a firm’s profit is \( pq_0(p) \). In symmetric equilibrium, each firm should have no incentive to deviate from \( p_0 \), which yields the first-order condition for \( p_0 \):

\[ h_0 (1 - a - p_0) + r_0 = 0. \]

The first term is the marginal profit from fresh buyers, and the second term is the marginal profit from returning buyers. We rewrite this as

\[ p_0 = 1 - a + \frac{r_0}{h_0}. \]  

(9) Notice that, in equilibrium, each firm’s fresh demand is \( h_0(1 - a) \), so \( r_0/h_0 \) is proportional to the ratio of returning demand to fresh demand. When the number of suppliers \( n \) becomes large, one can verify that \( r_0/h_0 \) tends to zero. As a result, when \( n \) tends to infinity, \( p_0 \) converges to \( p_\infty = 1 - a \) as in (4). (A firm’s fresh demand and returning demand both tend to zero, but the latter converges to zero faster so that \( r_0/h_0 \) becomes negligible when \( n \) is large.)

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14 Our demand function is legitimate only when the deviation price \( p \) is not too high. If \( p > 1 - a + p_0 \) then the fresh demand vanishes and the returning demand becomes \( \int_{0}^{1-a} u^{n-1} du = \int_{1-a}^{a} u^{n-1} du, \) which is no longer independent of \( p \). Therefore, a firm’s profit function has a kink at \( p = 1 - a + p_0 \) and may fail to be globally concave. A similar issue exists in the prominence case. However, as we argue in footnote 17, this issue does not affect the equilibrium prices derived below.

15 For other distributions, the net impact is not zero. Nevertheless, many of our main insights based on the uniform distribution will still apply, provided that the returning demand is less price elastic than the fresh demand. One can check that this happens when the density function increases, or does not decrease too fast.
In equilibrium, each firm’s demand is
\[ q_0 = h_0(1 - a) + r_0 = h_0 p_0, \]
where the second equality follows from the first-order condition (9). Thus, total demand in the market with random search is \( nh_0 p_0 \). On the other hand, total demand must also equal \( 1 - p_0 \), because \( p_0 \) is the fraction of consumers who find each product’s utility is lower than its price and who eventually leave the market without purchase. Hence, we have the following implicit formula for the equilibrium price \( p_0 \):
\[ 1 - a n = 1 - p_0. \]
(One can check that (11) and (9) are indeed equivalent.) One can see there is a unique solution to (11), and this satisfies \( p_0 \in [1 - a, 1/2] \) given assumption (5).

We now turn to the case where firm 1 is prominent. Because all the non-prominent firms are symmetric, suppose the prominent firm charges \( p_1 \) and all non-prominent firms charge the same price \( p_2 \). Define \( \Delta = p_2 - p_1 \) to be the price difference (if any) between the two kinds of supplier. Once a consumer has seen firm 1’s offer, her optimal stopping rule is similar to that in the random search case because she expects all non-prominent firms to charge the same price \( p_2 \).

The right-hand side of (11) is a decreasing function of \( p_0 \) when \( p_0 \) is positive. If \( p_0 = 1 - a \), the right-hand side is greater than the left-hand side given that \( a > 1/2 \). If \( p_0 = 1/2 \), the right-hand side is \((1 + \cdots + (1/2)^{n-1})\), which is less than the left-hand side \((1 + a + \cdots + a^{n-1})\).

For \( p_0 \) to be the equilibrium price, we need to ensure that a firm has no profitable deviation. The difficult issue is that, as mentioned in footnote 14, the demand function needs to be modified if a firm deviates to too high price, and the profit function may no longer be globally concave. Nevertheless, the price defined in the first-order condition is the equilibrium price even if we take this issue into account. In the random search case, a firm’s profit function is \( \pi(p) = p \int_{p_0}^{1 + p_0} u^{n-1} du \) for a high deviation price \( p \in [1 - a + p_0, 1] \). If we can show that profit is decreasing on this price interval, then we are done. First, because \( u^{n-1} \) is logconcave, the integration term is logconcave in \( p \). So \( \pi(p) \) is logconcave (so quasiconcave). Second, we claim \( \pi'(p_0) = \int_{p_0}^{1} u^{n-1} du - p_0 < 0 \) (i.e., \( (1 - p_0)/(p_0 < n) \)). This is true because, from (11), \( (1 - p_0)/(p_0 = (1 - a^n)/(1 - a) < n \). Finally, because \( \pi(p) \) is quasiconcave and \( \pi'(p_0) < 0 \), \( \pi(p) < 0 \) for any \( p \geq p_0 \). Thus, \( \pi(p) \) decreases with \( p \) on \([1 - a + p_0, 1] \). The prominence case, though more complicated, can be treated similarly.
That is to say, a consumer will stop searching when she finds a product which yields net surplus greater than \(a - p_2\).

The pattern of consumer demand when there are two firms is depicted in Figure 1. Here, consumers accurately predict that the second firm charges price \(p_2\). If the net surplus from the first product, \(u_1 - p_1\), is greater than \(a - p_2\), the consumer buys this product immediately. (This is firm 1’s “fresh demand.”) If the net surplus is below this threshold, the consumer samples the second firm and picks the option from the two with the greater net surplus (if one is positive). This generates firm 1’s “returning demand.” If neither option yields a positive surplus, the consumer does not buy at all (the shaded region in the figure).

The prominent firm’s demand when it charges \(p\) and all non-prominent firms charge \(p_2\) is

\[
q_1(p) = (1 - a + p_2 - p) + r_1, \tag{12}
\]

where

\[
r_1 = \int_p^a u^{n-1} du
\]

is its returning demand. A non-prominent firm’s demand when it charges \(p\), while all other non-prominent firms choose \(p_2\) and the prominent firm chooses \(p_1\), is

\[
q_2(p) = h_2 (1 - a + p_2 - p) + r_2, \tag{13}
\]

where

\[
h_2 = \frac{\Delta}{n-1} \sum_{k=0}^{n-2} a^k = \frac{a - \Delta}{n-1} \cdot \frac{1 - a^{n-1}}{1 - a}
\]

is the number of consumers who sample this firm and

\[
r_2 = \int_p^a u^{n-2}(u - \Delta) du
\]

is its returning demand. Note that each firm’s returning demand is independent of its own price \(p\), as is the number of consumers who choose to sample its product. In addition, we see that \(r_1 \geq r_2\) if and only if \(\Delta = p_2 - p_1 \geq 0\).

By definition, all consumers sample the prominent product (if they participate at all). They will buy this product immediately if \(u_1 - p \geq a - p_2\), which has probability \(1 - a + p_2 - p\), and this explains the first term in (12). Its returning buyers are those who find that the net surplus of all products is lower than \(a - p_2\), but firm 1 provides the highest positive net surplus. The number of these consumers is

\[
Pr(\max_{j \geq 2} \{0, u_j - p_2\} < u_1 - p < a - p_2) = \int_p^{p+a-p_2} (u_1 - p + p_2)^{n-1} du_1 = r_1.
\]

For a non-prominent firm \(i\) charging \(p\), a consumer will sample it if she initially rejects the prominent firm, which has probability \(Pr(u_1 - p_1 < a - p) = a - \Delta\), and has visited other \(k \leq n - 2\) unsatisfactory firms, which has probability \(\frac{1}{n-1} a^k\). Summing these probabilities over \(k = 0, \ldots, n - 2\) yields \(h_2\). She will buy immediately at this firm if its net surplus is greater than \(a - p_2\). This explains the first term in (13). Its returning buyers number

\[
Pr(\max_{j \neq i} \{0, u_j - p_1, u_j - p_2\} < u_i - p < a - p_2) = \int_p^{p+a-p_2} (u_i - p + p_2)^{n-2}(u_i - p + p_1) du_i = r_2.
\]

The prominent firm’s profit when it deviates to \(p\) is \(pq_1(p)\), and each non-prominent firm’s profit when it deviates to \(p\) is \(pq_2(p)\). In equilibrium, no firm should want to deviate from the
equilibrium price, so we obtain two first-order conditions for \( p_1 \) and \( p_2 \):
\[
1 - a + p_2 - 2p_1 + r_1 = 0; \quad h_2(1 - a - p_2) + r_2 = 0. \tag{14}
\]
We can rearrange this pair of simultaneous equations to obtain
\[
p_1 = 1 - a + \frac{1}{2} \left( r_1 + \frac{r_2}{h_2} \right) \tag{15}
\]
\[
p_2 = 1 - a + \frac{r_2}{h_2}. \tag{16}
\]
Given assumption (5), within the square \([0, a]^2\), the pair of equations (15) and (16) has a unique solution and this solution lies in the region \((p_1, p_2) \in [1 - a, 1/2]^2\). One can also show that both \( p_1 \) and \( p_2 \) decrease with \( a \), that is, they increase with the search cost \( s \). (More details are provided in the first section of the Appendix). Because both \( p_1 \) and \( p_2 \) are smaller than \( a \) given (5), consumers have an incentive to participate in the market, as well as to search beyond the prominent firm if this firm does not provide a satisfactory product. When \( n \) becomes large, (15) and (16) imply that both \( p_1 \) and \( p_2 \) converge to \( p_\infty = 1 - a \).

Using the first-order conditions, the prominent firm’s equilibrium demand is
\[
q_1 = 1 - a + \Delta + r_1 = p_1, \tag{17}
\]
whereas each non-prominent firm’s demand is
\[
q_2 = h_2(1 - a) + r_2 = h_2 p_2. \tag{18}
\]
On the other hand, total demand must equal \( 1 - p_1 p_2^{n-1} \), because \( p_1 p_2^{n-1} \) is the fraction of consumers excluded from the market (see Figure 1 for an illustration of the two-firm case). Therefore, we have the following equation relating \( p_1 \) and \( p_2 \) to \( a \):
\[
p_1 + \frac{1 - a^{n-1}}{1 - a} (a - \Delta) p_2 = 1 - p_1 p_2^{n-1}. \tag{19}
\]

\[\square\] The impact of prominence. Here we present results describing the impact of making a firm prominent on market outcomes. (Proofs of each result are presented in the Appendix.) The first question is how making a firm prominent influences the equilibrium prices:

Proposition 1. (i) When a firm is made prominent, the prominent firm charges a lower price than non-prominent firms. (ii) The prominent firm’s price is lower than with random search while the prices of non-prominent firms are higher. In sum
\[
p_1 \leq p_0 \leq p_2, \tag{20}
\]
where the inequalities are strict if \( 1/2 < a < 1 \).

The intuition for this result is as follows. If \( p_0, p_1 \), and \( p_2 \) are not too far apart from each other, then, compared to the random search case, the prominent firm’s demand consists of proportionally more fresh demand while each non-prominent firm’s demand consists of proportionally more returning demand.\(^{18}\) Because fresh demand is more price sensitive than returning demand, a prominent firm faces more elastic demand than a firm in the random-search environment, which in turn faces more elastic demand than a non-prominent firm.

It is useful to consider two polar cases. When \( a \approx 1 \) (i.e., \( s \approx 0 \)), consumers sample all firms before they purchase, and so prominence has no impact and all prices converge to the full-information price \( \bar{p} \), say, which satisfies \( n \bar{p} = 1 - \bar{p}^n \). (This formula for \( \bar{p} \) is obtained from (11),

\(^{18}\) In equilibrium, the prominent firm’s ratio of fresh to returning demand is \( (1 - a + \Delta)/r_1 \), a non-prominent firm’s ratio of fresh to returning demand is \( (1 - a)h_2/r_2 \), whereas each firm’s ratio of fresh to returning demand when no firm is prominent is \( (1 - a)h_0/r_0 \). When all prices \( p_0, p_1 \), and \( p_2 \) are similar, then \( r_0, r_1 \), and \( r_2 \) are also similar and \( \Delta \approx 0 \). Therefore, because 
\[
1 > h_0 = \frac{1}{s}(1 + \cdots + a^{n-1}) > \frac{1}{s}(a + \cdots + a^{n-1}) \approx h_2 ,
\]
the claim in the text is valid.
or from (15) and (16), by letting $a$ approach $1.$ At the other extreme, when $a \approx 1/2$, all prices converge to the same price $1/2$, the monopoly price. Here, the high search cost makes a consumer willing to buy whenever she finds a product which yields her positive surplus, and so each firm (prominent or not) acts as a monopolist. Thus, the price difference $\Delta$ caused by prominence becomes negligible when the search cost is too high or too low, and it is most pronounced when the search cost is at an intermediate level. Figure 2 describes the relationship between the three equilibrium prices when $n = 2$ and $a$ varies from $1/2$ to $1$. (The higher line represents $p_2$, the lower line is $p_1$, and the middle line is $p_0$.)

Because making a firm prominent has no impact on equilibrium prices—and hence on consumer surplus, industry profit, or welfare—in the polar cases when $a = 1/2$ or $a = 1$, from now on assume that $1/2 < a < 1$. A corollary to the fact that a prominent firm offers a lower price than its rivals is that consumer search intensity is reduced when a firm is made prominent:

**Corollary 1.** The average number of searches made by consumers is smaller when a firm is made prominent.

The reason is intuitive: because the prominent firm has a lower price than firms subsequently visited, a consumer will buy from the first firm more often than she would with random search. Although this has benefits in terms of reducing search costs, it also implies that the average match utility is reduced.

The next result describes the impact of prominence on output:

**Proposition 2.** Total output is lower when a firm is made prominent.

Proposition 1 showed that the impact of making a firm prominent was to make that firm’s price fall and to raise the price offered by non-prominent firms. As such, the impact on overall demand is not clear *a priori*. However, Proposition 2 shows that the effect of the higher prices from the non-prominent firms is more marked than the impact of the price reduction by the prominent
firm, and overall output falls with prominence. (This is illustrated in Figure 2 above.) A corollary of this result is that welfare—consumer surplus plus industry profit—falls with prominence:

**Proposition 3.** Welfare is reduced when a firm is made prominent.

For a given level of total output, welfare is maximized if each product has the same price. If the market has a uniform price, the consumer’s stopping rule is independent of the price, and this is socially efficient because the consumer and the social planner face the same tradeoff between search costs and match utility. However, when a firm is made prominent, this induces nonuniform prices in the market. Therefore, keeping total output constant, prominence induces suboptimal search behavior. To be precise, when \( \Delta > 0 \), those consumers with \( u_1 \in [a - \Delta, a] \) will not search beyond firm 1 even though it would be socially efficient for them to do so. Moreover, when \( \Delta > 0 \), too many of the returning buyers end up buying from firm 1. A second, reinforcing reason why welfare falls with prominence is that total output falls (Proposition 2). Making a firm prominent means that output is reduced and that this output is poorly distributed across consumers.

This argument is analogous to the welfare effects of price discrimination. If a firm sets different prices for units which cost the same to produce, then total output is suboptimally distributed across consumers. Therefore, price discrimination can only improve welfare if it induces output to rise. (See Varian, 1985, for instance, whose argument is used in our proof of Proposition 3.) One difference with the (monopoly) price discrimination setting, however, is that monopoly profit is sure to rise with nonuniform pricing allowed (because the firm could set uniform prices if it wishes), whereas in the prominence model, prices are determined at equilibrium, and it is not obvious that industry profit rises with prominence. Indeed, as we show in Proposition 4, the impact of prominence on industry profit is ambiguous, although it “usually” increases industry profit:

**Proposition 4.** (i) When a firm is made prominent the prominent firm earns more than a non-prominent firm, and it also earns more than it would with random search, and (ii) industry profit is higher when a firm is made prominent except when \( n = 2 \) and \( a \) is relatively small.

Part (i) of this result is not surprising. For instance, the prominent firm could choose to set the non-prominent firms’ equilibrium price, in which case it still makes more profit than its rivals because it has greater demand. But it can do still better than this by choosing a lower price than its rivals. Part (ii) requires a more delicate analysis, because the impact of the price cut by the prominent firm must be weighed against the price rise by the non-prominent firms. In effect, part (ii) shows that the price cut usually has less of an impact on industry profit than the price rise. This is not surprising in the light of our earlier result that total demand falls when a firm is made prominent.

Proposition 4 is silent about the impact of prominence on the non-prominent firms’ profit. In fact, this impact is ambiguous due to three effects: (i) a non-prominent firm suffers from being pushed further back in each consumer’s search order and (ii) from the lower price offered by the prominent firm, but (iii) it benefits from the fact that its other non-prominent rivals raise their price. Let \( \pi_2 \) denote a non-prominent firm’s profit when one firm has been made prominent and let \( \pi_0 \) denote a firm’s profit in the case of random search. First, when \( n = 2 \), it is clear that \( \pi_2 < \pi_0 \) because there is no countervailing benefit (iii). Moreover, for fixed \( a < 1 \), \( \pi_2 < \pi_0 \) always holds for sufficiently large \( n \) because \( \lim_{n \to \infty} \frac{a}{n} = \lim_{n \to \infty} \frac{b_1}{n} = a < 1 \). Thus, with either two firms or with many firms, a non-prominent firm earns less than it would in a random-search environment. By contrast, though, for fixed \( n \geq 3 \), one can show that \( \pi_2 > \pi_0 \) whenever \( a \) is sufficiently close to 1. Therefore, when the search cost is very low all firms are better off when one of them is made prominent.

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19 The argument is lengthy, and the details are available from the authors.
Because welfare decreases when a firm is made prominent, in the usual case where prominence raises industry profit it follows that consumers in aggregate must be made worse off when a firm is made prominent. It turns out that even in those cases where profits fall with prominence (which necessarily entails $n = 2$), consumer surplus falls with prominence:

**Proposition 5.** Consumer surplus is reduced when a firm is made prominent.

One question we have not yet discussed is how the impact of prominence is affected by the search cost and the number of firms in the market. A complete investigation of this issue would be lengthy, and here we merely present some numerical examples. Figure 3 reports how the impact varies with $a$ when $n = 4$, where the upper (thin) line is the difference in industry profit, the bottom (thick) line is the difference in consumer surplus, and the central (medium) line is the difference in welfare, all calculated as we move from the random-search case to the case with prominence. All variables vary nonmonotonically with $a$. As we have pointed out, $p_1$ and $p_2$ coincide with $p_0$ when $a$ tends to $1/2$ or to 1, so the impact of prominence vanishes at the extremes of $a$. Figure 4 reports how the impact on profit, consumer surplus, and welfare varies with $n$ when $a = 0.7$ (i.e., when $s = 0.045$). The nonmonotonic pattern for industry profit and consumer surplus seen in Figure 4 appears to be quite widespread according to various numerical simulations we have performed. It is natural that the impact of prominence becomes less pronounced as the number of firms becomes large, because we are converging to the infinite-firm case where prominence has no impact on industry profit, consumer surplus, or welfare. However, it is less clear why it is common for industry profit to rise, and consumer surplus to fall, with $n$ when the number of suppliers is relatively small. In Figures 3 and 4, it appears that the impact of prominence on overall welfare is small relative to the distributional impact on profit and consumer surplus separately.

We end this section by pointing out the implications of these results in situations where there is a profit-maximizing platform through which firms sell their products to consumers. If the platform can extract the whole industry profit by, for example, charging each firm a fixed fee for access to its consumers, Proposition 4 tells us that it (usually) has an incentive to make one
supplier more prominent than the others. However, if the platform can extract total welfare by charging both firms and consumers, Proposition 3 tells us that it then has no incentive to make a firm prominent.

3. Asymmetric firms

Until now, our analysis suggests to a somewhat pessimistic view of the benefits of prominence, at least from the viewpoint of consumers and overall welfare. (However, with many firms, the welfare impact is negligible.) This assessment might change in a setting in which firms have differing product qualities, for then prominence could be used to guide consumer search toward better products. In this section we investigate this possibility, assuming that consumers cannot discern a firm’s average quality directly. Because this analysis is more involved than with the benchmark symmetric case, for simplicity we suppose there are infinitely many suppliers. As in the symmetric firm case, this assumption implies that prominence has no impact on equilibrium prices. However, in contrast to the symmetric case, there is nevertheless a significant impact of prominence on industry profit, consumer surplus, and welfare.

Suppose that firms are distinguished by the parameter $\alpha$, where a higher $\alpha$ represents a higher-quality firm (on average). Suppose that a consumer’s match utility $u$ from a type-$\alpha$ firm

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20 This point is emphasized in Chen and He (2006) and Athey and Ellison (2007). As in the model we present in this section, the highest-quality firm in their models (i.e., the firm with the highest probability of making a good match with each consumer) is willing to bid the most to be listed first, and so consumers have an incentive to click on the sponsored links in the order they appear.

21 The analysis in this section can simply be adapted to allow firms to offer symmetric products but to have different unit costs. In this case, the firm with the lowest cost will have the most to gain from becoming prominent.

22 This assumption contrasts with Weitzman (1979), who assumes that consumers know the distribution of payoffs for each option in advance.

23 With a finite number of firms a major complicating factor is that, when the highest-quality firm is made prominent (which we argue below will be the case), consumers will be able to infer something about the distribution of quality of the remaining firms after they sample the prominent product. This updating will cause consumers to revise their stopping rule, as analyzed in Athey and Ellison (2007).
is uniformly distributed on the interval \([0, \alpha]\). For simplicity, suppose that firms have the same marginal cost of supply even though they differ in quality.\(^{24}\) (This situation might apply to novels, say, where the marginal cost of production need not be strongly related to quality.) Suppose that \(\alpha\) is itself uniformly distributed, on the interval \([1 - \frac{\varepsilon}{2}, 1 + \frac{\varepsilon}{2}]\). Thus, \(\varepsilon\) measures the degree of firm heterogeneity present in the market, and the symmetric firm model in Section 2 corresponds to the degenerate case \(\varepsilon = 0\).

Let \(p_\alpha\) denote the equilibrium price of the type-\(\alpha\) firm. Consumers are assumed to know the distribution of \(\alpha\) in the population of firms, as well as the equilibrium (but not necessarily actual) prices \(p_\alpha\). If there is no prominent firm, they will search among firms randomly; if one firm is made prominent, consumers are assumed to consider its offer first. In either case, they will use a stationary stopping rule, and they will buy a product if and only if the net surplus, \(u - p\), is greater than some threshold \(y\). Given the equilibrium prices \(p_\alpha\), \(y\) satisfies the indifference condition

\[
\frac{1}{\varepsilon} \int_{1 - \frac{\varepsilon}{2}}^{1 + \frac{\varepsilon}{2}} \left( \frac{1}{\alpha} \int_{p_\alpha + y}^{\alpha} (u - p_\alpha - y) \, du \right) \, d\alpha = s. \tag{21}
\]

Here, the left-hand side of (21) is the expected benefit from one more search. For this expression to be valid, we must have all types of firm be active in equilibrium (i.e., \(\alpha - p_\alpha > y\) for all \(\alpha\)). This requires there not be too much quality variation, and we derive an explicit ceiling on \(\varepsilon\) below. In addition, we continue to assume (5), so that \(s \leq \frac{1}{8}\). As usual when there is an unlimited number of search options, \(y\) is each consumer’s expected net surplus from following the optimal stopping rule described above.

□  **Equilibrium prices and the value of being prominent.** We first characterize the equilibrium prices given a candidate stopping rule \(y\). Regardless of whether one firm is prominent or not, given the reservation surplus \(y\), a type-\(\alpha\) firm’s profit is proportional to \(p(1 - y + p_\alpha)\) when it sets price \(p\). The equilibrium price is chosen to maximize this profit, and so

\[
p_\alpha = \frac{1}{2}(\alpha - y). \tag{22}
\]

In particular, a higher-quality firm will set a higher price in equilibrium.

Substituting the prices (22) into (21) shows that \(y\) satisfies

\[
E_\alpha \left[ \frac{(\alpha - y)^2}{8\alpha} \right] = s, \tag{23}
\]

where \(E_\alpha\) is the expectation operator using the distribution for \(\alpha\). Given the uniform distribution for \(\alpha\), expression (23) becomes

\[
\eta_\varepsilon y^2 - 2y + 1 - 8s = 0,
\]

where \(\eta_\varepsilon = E_\alpha[\frac{1}{\alpha}] = \frac{1}{\varepsilon} \ln \frac{1 + \varepsilon/2}{1 - \varepsilon/2}\). Here, \(\eta_\varepsilon\) increases with \(\varepsilon\) and \(\eta_\varepsilon \to 1\) as \(\varepsilon \to 0\). The relevant root of the above quadratic is

\[
y = \frac{1 - \sqrt{1 - \eta_\varepsilon (1 - 8s)}}{\eta_\varepsilon}. \tag{24}
\]

When \(\varepsilon\) becomes small \(y\) tends to \(1 - \sqrt{8s}\), which is the reservation net surplus \((\alpha - p_\infty)\) in the case with symmetric firms in (4). The stopping rule in (24) has intuitive properties. First, as usual, \(y\) is decreasing in \(s\). In particular, as \(s \to \frac{1}{8}\), \(y \to 0\) and consumers will choose the first product which gives them a positive net surplus. Second, \(y\) is increasing in \(\eta_\varepsilon\) and therefore increasing in

\(^{24}\) This analysis can be adapted to situations where the cost depends on \(\alpha\). The results reported below remain valid provided that cost does not vary too much with \(\alpha\). In other cases, however, it might happen that prominence harms market efficiency by inducing inefficient search. That is because the firm having the greatest incentive to become prominent may not be the highest gross surplus provider.
That is, the greater the degree of firm heterogeneity, the more choosy consumers will be. From (22), these two properties imply that equilibrium prices will increase with $s$ but decrease with $\epsilon$.

We need to verify that all types of firm are active in the market, because these calculations were predicated on that being so. This requires $\alpha - p_\alpha > y$ for all $\alpha$, and from (22) this is equivalent to $y < 1 - \frac{\epsilon}{2}$. This requirement determines a maximum feasible level for $\epsilon$, say $\hat{\epsilon}$, where

$$\frac{\hat{\epsilon}}{2} + \frac{1 - \sqrt{1 - \eta_{\ell}(1 - 8s)}}{\eta_{\ell}} = 1.$$  

For example, when $\epsilon = \frac{1}{5}$, one can check that $\hat{\epsilon} \approx 0.95$. Therefore, as long as the quality variation among firms is not too great, so $\epsilon < \hat{\epsilon}$, all firms will be active in equilibrium and (21) is justified.

Within this framework, if a firm is not prominent its profit is zero; if it is prominent its profit is

$$p_\alpha \left( 1 - y + p_\alpha \right) = \frac{(\alpha - y)^2}{4\alpha},$$

which increases with $\alpha$. We deduce that the highest-quality firm has the most to gain from becoming prominent. If there is a procedure to endogenize prominence, the highest-quality firm is therefore likely to become the prominent seller. For example, if a platform auctions off the prominent position, the highest-quality firm is willing to pay the most. Prominence then becomes a signal of high quality (and high price).

□  The impact of prominence. One issue is whether it is in a consumer’s interest to sample the prominent firm first in those situations in which consumers are not forced to do so. As just mentioned, the prominent firm is predicted to offer a high-quality product (on average), but also to set a high price. To understand a consumer’s incentives, suppose hypothetically a consumer can choose the type $\alpha$ of the first firm sampled, and denote by $v(\alpha)$ the payoff to her if she chooses to go first to a type-$\alpha$ firm. Then

$$v(\alpha) \equiv \frac{1}{\alpha} \int_{y + p_\alpha}^\alpha (u - p_\alpha) \, du + (1 - \varphi_\alpha)y - s,$$  \hspace{1cm} (25)

where

$$\varphi_\alpha \equiv 1 - \frac{y + p_\alpha}{\alpha}$$

denotes the probability that a consumer buys the type-$\alpha$ firm’s product when she samples it. To understand expression (25), note that the first term represents net surplus in the event the match value is above the threshold $y + p_\alpha$, whereas if the match value is below the threshold (which occurs with probability $1 - \varphi_\alpha$), the consumer starts from scratch with random search, which yields her the expected payoff $y$.

After substituting the price (22) into (25), this formula simplifies to

$$v(\alpha) = \frac{y^2 + \alpha^2 + 6\alpha y}{8\alpha} - s.$$  

(As required, one can verify using expression (23) that the expected value of $v(\alpha)$ over all $\alpha$ equals $y$.) Because $v(\alpha)$ increases with $\alpha$, it follows that if a consumer could choose the type of the firm first sampled, she would choose the highest-quality firm. Because the prominent firm is the highest-quality firm, we deduce that a consumer has a strict incentive to visit that firm first, even if she has the ability to bypass the prominent firm. This argument also shows that consumers are better off when there is a prominent firm compared to the case where search is random: the firm that is willing to pay most for the privilege of being prominent

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25 In addition, we require $\eta_{\ell} < 1/(1 - 8s)$ to guarantee that $y$ in (24) is a real solution. It turns out that the requirement that $y < 1 - \frac{\epsilon}{2}$ is the tighter constraint. If $\eta_{\ell} = 1/(1 - 8s)$ then $y = 1/\eta_{\ell}$ in (24), and $1/\eta_{\ell} > 1 - \frac{\epsilon}{2}$ for all $\epsilon > 0$.  

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is also the firm that consumers most want to visit first. That contrasts with the symmetric firm case, where we showed that consumers were worse off when there was a prominent firm (Proposition 5).

Consider next the impact on industry profit. Let $\Pi_0$ denote equilibrium industry profit when consumers search randomly. Using a similar argument to that for consumer surplus just above, if all consumers sample a type-$\alpha$ firm first, industry profit, denoted $\Pi(\alpha)$, is

$$
\Pi(\alpha) = \varphi_\alpha p_\alpha + (1 - \varphi_\alpha)\Pi_0.
$$

The value of $\Pi_0$ can be obtained by noting that $E_\alpha \Pi(\alpha) = \Pi_0$, so that

$$
\Pi_0 = \frac{E_\alpha[\varphi_\alpha p_\alpha]}{E_\alpha[\varphi_\alpha]},
$$

and industry profit with random search is just a weighted average of market prices. Incremental industry profit when the type-$\alpha$ firm is made prominent is $\Pi(\alpha) - \Pi_0 = \varphi_\alpha(p_\alpha - \Pi_0)$, which is positive whenever the type-$\alpha$ firm’s price is above the market average price. In particular, because $p_\alpha$ increases with $\alpha$, this is true if the highest-quality firm is made prominent. The intuition is simple: compared to random search, making a high-quality firm prominent distributes more demand to the firm with a high profit margin.

We summarize these results in the following:

**Proposition 6.** With an infinite number of firms and symmetric costs, a firm with a higher average quality charges a higher price (but on average offers a better deal to consumers), and the highest-quality firm has the greatest incentive to become prominent. Making this firm prominent boosts industry profit and consumer surplus, and hence total welfare, relative to the situation in which no firm is prominent.

### 4. Asymmetric consumers

In this section, we briefly discuss the impact of prominence when consumers differ in their cost of search. Here a new role for prominence emerges, which is that a prominent firm can exploit those consumers with a high search cost by setting a high price. We can understand this effect most easily in the context of a homogeneous product market. Arbatskaya (2007) analyzes this situation in a fairly general framework with $n$ completely ordered firms. However, for our purposes, the basic point can be illustrated very simply. A stark model in which consumers have different search costs is in Varian (1980), where $n$ identical firms compete to offer a homogeneous product to consumers. A fraction $\lambda$ of consumers do not have any search costs and know the prices of all firms, and so buy from the lowest-price supplier. The remaining consumers have an infinite cost of searching beyond the initial firm sampled, and they buy from the first firm they encounter (provided that that firm’s price is no higher than their reservation utility). In Varian’s model, the first firm sampled by a consumer is random and firms compete by offering random prices. (A firm must trade off the need to compete for the informed consumers with the profit obtained by exploiting the uninformed consumers.) If the reservation utility for a unit of the homogeneous product is $v$ and production is costless, Varian shows that in symmetric equilibrium the expected price paid is $p_0 = (1 - \lambda)v$, which is the weighted average of the competitive price ($p = 0$) and the monopoly price ($p = v$).

Suppose now that one firm is made prominent in this market, in the sense that all consumers see its price first, and that there are at least two other firms. The prominent firm therefore knows that it will serve the entire market of uninformed consumers, while the other firms know that

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26 Athey and Ellison (2007) also have heterogeneous search costs. However, because there is no product-market competition in their model, there is no scope for exploiting the high-search-cost consumers.

27 This simplified framework also avoids one awkward point in Arbatskaya (2007), which is that an inactive firm offering a particular price must be assumed in order to avoid the Diamond Paradox.
they will not meet any of these consumers. The non-prominent firms can compete only for the informed consumers, and so in Bertrand fashion they will offer the competitive price \( p_2 = 0 \). Thus, making a firm prominent exerts a competitive externality on the remaining firms, because they are left with only the fully informed consumers. It is more profitable for the prominent firm to supply only the uninformed consumers, in which case it should charge the monopoly price \( p_1 = v \). In sum, in this framework with heterogeneous search costs, making a firm prominent causes that firm to raise its price, while non-prominent firms are forced to reduce their price relative to the random search case, so that

\[
p_1 > p_0 > p_2.
\]  

(Under our assumption that each consumer has unit demand there is no impact on industry profit, aggregate consumer surplus, or welfare.) Here, prominence has the opposite impact on prices compared to our earlier model when all consumers had the same search cost (see expression (20) above).

In a less extreme model where consumers have intermediate search costs, we still expect to see the same relative prices as in (26). In particular, Arbatskaya (2007) shows that equilibrium prices fall monotonically as consumers move along the list of firms. Intuitively, those consumers who immediately stop at the prominent firm are more likely to have a high search cost than other consumers, and so we expect that the prominent firm faces less elastic demand than its rivals. Of course, because consumers here get a worse deal when they buy from the prominent firm (unlike in our other models), in many situations we expect that consumers will learn this feature of the market, and perhaps start to avoid the prominently displayed products if they can do so.

This argument relies on assuming a homogeneous product in the market. As we have said, in many markets it is more natural to assume a degree of product differentiation. Presumably, in a richer model where (i) consumers have different search costs and (ii) there is product differentiation as in Wolinsky (1986), the prominent firm’s price could be higher or lower than its rival’s prices, depending on the relative importance of (i) and (ii). In particular, we expect that our earlier prediction that the prominent firm will offer a lower price remains valid when search costs do not vary too much.

5. Conclusion

This article has examined the implications of biasing each consumer’s search order, so that consumers encounter a prominent product first. In an environment without systematic quality differences, we find that the prominent firm will charge a lower price than non-prominent firms. We also find that making a firm prominent will typically reduce average search intensity and increase industry profit, but lower consumer surplus and welfare. In a richer environment in which firms differ in quality, the firm with the highest average quality most wants to become prominent if the cost variation among firms is insignificant, and making it prominent can increase industry profit, consumer surplus, and welfare. In this situation, prominence guides consumers toward better—and better-value—products.

A feature of these models—with the exception of the model with heterogeneous search costs in Section 4—is that rational consumers will prefer to sample the prominent product first, even when they need not do so. In the benchmark model of Section 2 (with finite suppliers), rational consumers expect the prominent firm to charge a lower price than others and so they sample it first; predicting this consumer behavior, the prominent firm does indeed have an incentive to charge a lower price. In theory, even without exogenous prominence, this kind of asymmetric equilibrium might occur.\(^{28}\) However, there are many such equilibria, and without guidance it will be hard for consumers to coordinate their choice on one favored firm. In this sense, prominence

\(^{28}\)That is to say, there are also asymmetric equilibria in Wolinsky (1986) in which all consumers sample the same firm first and, as a result, that firm chooses a lower price than its rivals.
functions as a coordination device.\textsuperscript{29} In situations in which the prominent firm offers a worse deal to consumers (as in the heterogeneous search-cost model), by contrast, for the model to be convincing, consumers must either have some form of bounded rationality or they must be exogenously compelled to sample this firm first.

The topic of prominence deserves further research. In subsequent work, Zhou (2008) has analyzed the case where there is more than one prominent position, in the sense that consumers first randomly search through $k \leq n$ products, and then (if necessary) search randomly through the remaining, less prominent, products. He shows that our main results remain: the prominent products are cheaper, and making $k$ firms prominent ($1 < k < n$) tends to reduce welfare and increase profit relative to the situation in which no products are favored. The welfare loss due to making some firms prominent turns out to be nonmonotonic in the number of prominent positions, first increasing and then decreasing in $k$. A second extension considered in Zhou (2008) is a situation whereby the platform through which the various products are sold chooses the retail price for each product. (For instance, a supermarket may be able to determine the prices, as well as the relative prominence, of its products.) In this situation, when the platform chooses its price for a prominent product, it takes into account the impact of this price on its sales of less prominent products. Zhou shows that a prominent product may now have a higher price, all else equal, than less prominent products, in contrast to our analysis where each product has its price determined by an independent seller.

Another interesting avenue to explore would be to modify our framework so that products were ordered according to their price, as is often the case with a price-comparison website, for instance. Thus, in this alternative framework, a product is prominent because of its low price (whereas in our framework a product has a low price because it is prominent). Our framework assumes that consumers know neither a product’s match utility nor its price until they sample the product. An alternative would be to suppose that consumers can observe prices (or the ranking of prices) in advance, and they incur a search cost merely to judge the match utility. In the price-comparison website example, firms choose their prices, and the lowest-price firm automatically becomes the prominent firm. It is clear there could be no symmetric pure strategy pricing equilibrium in this situation, because by undercutting its rivals a little a firm obtains a discrete jump in its demand. Moreover, pricing at marginal cost cannot be an equilibrium (with a finite number of firms) because a firm can always attract some demand at a price slightly above marginal cost from those consumers who are dissatisfied by all the rival products. It is possible in such a setting that higher search costs might act to reduce prices, in contrast to more standard search markets. The reason is that higher search costs increase the benefit to becoming prominent (see the discussion in Section 2), and thus intensify the incentive to choose a low price.

Making a firm prominent will have an impact on product variety in a free-entry market. In situations where non-prominent firms obtain lower profit compared to the random-search case, we expect that prominence will reduce the free-entry number of firms. But this might increase efficiency because free entry may result in excess entry in the random-search case (see Anderson and Renault, 1999).

The fact that prominence as well as pricing can affect consumer behavior is important for business strategy and public policy in situations such as the presentation of choices about savings plans, healthy eating, advertising and its regulation, or the operation of commission schemes for sales agents. (See Thaler and Sunstein, 2008, for an overview of these issues.) Our analysis has used a consumer search framework with product differentiation and imperfect competition to examine interactions between prominence and pricing, and to derive some implications for profits and welfare. With suitable adaptation, such a framework might have application to a variety of circumstances where market participants or public authorities seek to influence consumer choice by framing the ways that choices are presented.

\textsuperscript{29} A similar feature is seen in Bagwell and Ramey (1994). However, in that paper, coordination is good for consumers, because they obtain a lower price. In our model, making a firm prominent is often bad for consumers.
Appendix

Claim 1. Under assumption (5), within the square \([0, a]^2\) expressions (15) and (16) have a unique solution, which satisfies \((p_1, p_2) \in (1 - a, 1/2)^2\). Both prices decrease with \(a\).

Proof. By assumption, \(a \geq 1/2\). Fix \(p_1 \in [0, a]\), and consider (16). Then \(p_2 = 1 - a + t_2\), where

\[
t_2 = \frac{r_2}{h_2} = \frac{(n-1)(1-a)}{1-a^{n-1}} \int_{p_2}^{a} \frac{\alpha}{\alpha - \Delta} u^{-2} du.
\]

Here, \(t_2\) is a decreasing function of \(p_2\) for \(p_2 \in [0, a]\) because the integrand \(\frac{\alpha}{\alpha - \Delta} u^{-2}\) is positive and decreases with \(p_2\) when \(u < a\). Moreover, because \(\frac{\alpha}{\alpha - \Delta} \sum_{k=0}^{n-1} a^k \geq u^{-2}\) when \(p_2 \leq u \leq a\), we have \(t_2 < a - p_2\). We then have: (i) if \(p_2 = 1 - a\), then \(t_2 < a - t_2\). This is because \(t_2 > 0\) given that \(p_2 < a\). (ii) If \(p_2 = 1/2\), then \(p_2 > 1 - a + t_2\). This is because \(t_2 < a - p_2\). Therefore, for \(p_1 \in [0, a]\), (16) has a unique solution for \(p_2 \in [0, a]\), say \(p_2 = b_2(p_1)\), and \(b_2(p_1) \in [1 - a, 1/2]\).

Next, from (14) we have

\[
p_1 = \frac{1}{2} \left[ 1 - a + p_2 + \frac{a^r - p_2^n}{n} \right] = b_1(p_2).
\]

One can check that \(b_1(p_2) \in [0, \frac{1}{2}]\). One can also check that \(b_1(p_2) \in [1 - a, 1/2]\) when \(p_2 \in [1 - a, 1/2]\). A solution to the pair of equations (15) and (16) involves \(p_1 = b_1(b_2(p_1))\), and by a fixed-point argument there exists such a \(p_1 \in [1 - a, 1/2]\). Because \(p_2 = b_2(p_1) \in [1 - a, 1/2]\), the pair of first-order conditions has at least one solution \((p_1, p_2) \in [1 - a, 1/2]^2\).

Next consider uniqueness. Substituting \(b_1(p_2)\) into (16), we have

\[
p_2 = 1 - a + \frac{(n-1)(1-a)}{1-a^{n-1}} \int_{p_2}^{a} \frac{\alpha}{\alpha - \Delta} u^{-2} du.
\]

(A1)

Because \(b_1(p_2) \in [0, \frac{1}{2}]\), \(b_1(p_2) - p_2\) decreases with \(p_2\). This implies that the right-hand side of (A1) decreases with \(p_2\). Therefore, the solution is unique.

Finally, consider how \((p_1, p_2)\) vary with \(a\). One can show, using the observation that \(b_1(p_2)\) decreases with \(a\), that the right-hand side of (A1) decreases with \(a\). Therefore, because the right-hand side also decreases with \(p_2\), it follows that \(p_2\) is a decreasing function of \(a\). Therefore, \(p_1 = b_1(p_2)\) decreases with \(a\) as well.

Proof of Proposition 1. (i) Because \(h_2 < 1\), (15) and (16) imply that

\[
p_2 - p_1 = \frac{1}{2} \left( \frac{p_2}{h_2^2} - r_1 \right) > \frac{1}{2} (r_2 - r_1).
\]

However, because \(r_2 - r_1\) has the same sign as \(p_1 - p_2\), the latter must be negative.

(ii) Define

\[
A = \frac{1 - a^n}{1 - a}, \quad B = \frac{1 - a^{n-1}}{1 - a}.
\]

(A2)

Because \(p_1 < p_2\), the left-hand side of (19), which is \(p_1 + B(a - \Delta)p_2\), satisfies

\[
p_1 + B(a - \Delta)p_2 < p_2 + aBp_2 = Ap_2.
\]

But the right-hand side is greater than \(1 - p_2^n\), so we have

\[
A > \frac{1 - p_2^n}{p_2}.
\]

Comparing this to (11), we deduce \(p_2 > p_0\).

Finally, because \(\Delta > 0\) and \(a > p_2\), it follows that \((a - \Delta)p_2 > a p_1\). Then the left-hand side of (19) is greater than \(Ap_1\), but the right-hand side of (19) is less than \(1 - p_2^n\), and so

\[
A < \frac{1 - p_2^n}{p_1}.
\]

Comparing this with (11) implies \(p_1 < p_0\).

Proof of Corollary 1. With random search, the probability that a consumer searches exactly \(k\) times, for \(1 \leq k \leq a - 1\), is \(a^{k-1} (1 - a)\). The probability that a consumer samples all products \((k = n)\) is \(a^{n-1}\). This implies that the expected number of searches with random search is \(A\) as given in (A2). On the other hand, with one firm prominent, the probability that a consumer searches just once is \(1 - (a - \Delta)\), the probability that a consumer searches \(k\) times, where \(2 \leq k \leq a - 1\), is \((a - \Delta) a^{k-2} (1 - a)\), whereas the probability that a consumer samples all products is \((a - \Delta) a^{n-2}\). The expected number of searches in this case is therefore \(A - \Delta B < A\).

Proof of Proposition 2. It is useful first to establish two preliminary results:

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Claim 2. $p_0 > a p_2 + (1 - a)^2$

Proof. Because $p_2 > p_6$, we have

$$r_2 = \int_{p_2}^{a} \left(1 - \frac{\Delta}{u}\right) du < \left(1 - \frac{\Delta}{a}\right) r_0.$$ 

Then,

$$p_0 = 1 - a + \frac{r_0}{h_0} > 1 - a + \frac{r_2}{(1 - \Delta/a)h_0} > 1 - a + \frac{r_2}{h_0} = a p_2 + (1 - a)^2.$$ 

The second inequality holds because $(a - \Delta) h_0 < h_1$, whereas the final equality follows from (16). This completes the proof of the claim.

Claim 3. $\Delta < A(p_2 - p_0)$, where $A$ is given in (A2)

Proof. From (11) and (19), we obtain

$$p_1 p_2^{s-1} - p_0^s = p_0 - p_1 + B \{\Delta p_2 - a(p_2 - p_0)\}.$$ 

On the other hand, we can write the left-hand side of the above expression as

$$p_1 p_2^{s-1} - p_0^s = p_2^{s-1} [(p_2 - p_0) L - \Delta],$$

where $L = [1 - (p_0/p_2)^2] / [1 - (p_0/p_2)]$. These two equations imply

$$\frac{\Delta}{p_2 - p_0} = \frac{A + p_2^{s-1} L}{1 + B p_2 + p_2^{s+1}}.$$ 

(A4)

Therefore, from (A4), $A - \Delta / p_2 - p_0$ has the same sign as

$$ABp_2 - (L - A) p_2^{s-1} > p_2 - (L - A) p_2^{s-1} > p_2 - (n - 1) p_2^{s-1} > p_2 \left(1 - \frac{n - 1}{2n - 2}\right) \geq 0.$$ 

The first inequality follows because $AB > 1$. The second inequality follows because $p_2 / p_2 < 1$ implies that $L < n$, and so $L - A < n - A < n - 1$. The third inequality follows because $p_2 < 1 / 2$. This completes the proof of the claim.

Proof of the Proposition. From Section 2, we know that total output with random search, say $Q_r$, is equal to $1 - p_0$, whereas total output when a firm is prominent, say $Q_p$, is equal to $1 - p_1 p_2^{s-1}$. Therefore, expression (A3) implies that

$$Q_r - Q_p = p_1 p_2^{s-1} - p_0^s = p_2^{s-1} [(p_2 - p_0) L - \Delta] > p_2^{s-1} (p_2 - p_0) (L - A) > 0.$$ 

Here, the first inequality uses Claim 3. The second inequality follows from the implication of Claim 2 that $p_0 > a p_2$, which implies $L > A$.

Proof of Proposition 3. Let $V(p_1, p_2)$ denote aggregate consumer surplus when the prominent firm sets price $p_1$ and all the non-prominent firms are known by consumers to choose price $p_2$. Consumer surplus when there is no prominent firm and all firms are known to set price $p_0$ is just $V(p_0, p_0)$. Then, just as in standard consumer theory with perfect information, Roy’s Identity holds in this search context, and $V$ differentiates to give (minus) the demand for the prominent and non-prominent products. That is to say,

$$\frac{\partial V(p_1, p_2)}{\partial p_1} = -Q_1(p_1, p_2); \quad \frac{\partial V(p_1, p_2)}{\partial p_2} = -Q_2(p_1, p_2).$$

(A5)

where $Q_1$ and $Q_2$ are demands for the prominent product and for all the non-prominent products, respectively. Here, expressions (12) and (13) imply that

$$Q_1(p_1, p_2) = 1 - a + p_2 - p_1 + r_1; \quad Q_2(p_1, p_2) = (a - \Delta) (1 - a^{s-1}) + (n - 1) r_2.$$ 

By evaluating the determinant of its Hessian matrix, one can check that $V$ is a convex function over the relevant range $0 \leq p_1, p_2 \leq 1$.

The reason that Roy’s Identity holds in this context is the usual envelope reasoning. A small increase in $p_1$, say, has two effects on consumers. First, it causes direct harm to those consumers who are already buying the prominent product. Second, it contracts the set of consumers who choose to buy the prominent product, and it does this along three boundaries: (i) the set of consumers who buy nothing expands (i.e., the right-hand boundary of the dotted non-participation region in Figure 1 shifts to the right); (ii) among those consumers who sample all products, the prominent firm’s (returning) demand shrinks (this margin is the diagonal line on the figure); and finally (iii) it induces more consumers to search beyond the first firm. However, in each of these three cases, consumers on these margins are indifferent between their initial choice and the choice induced by the price rise, and so the price rise has no (first-order) impact on these consumers. Thus, only the direct harm matters, as described in (A5).
Let

\[ W(p_1, p_2) = V(p_1, p_2) + p_1 Q_1(p_1, p_2) + p_2 Q_2(p_1, p_2) \]

denote welfare—the sum of consumer surplus and industry profit—when the prominent firm charges price \( p_1 \) and non-prominent firms charge \( p_2 \). Let \( (p_1, p_2) \) be the equilibrium prices when a firm is made prominent, and let \( p_0 \) be the equilibrium price with random search. We wish to evaluate the sign of \( W(p_1, p_2) - W(p_0, p_0) \). (The following argument is exactly that used by Varian, 1985, in the context of price discrimination.)

Because \( V \) is a convex function it lies above its tangent plane, and so in particular

\[ V(p_0, p_0) \geq V(p_1, p_2) - (p_0 - p_1) Q_1(p_1, p_2) - (p_0 - p_2) Q_2(p_1, p_2). \]

Therefore, \( W(p_1, p_2) - W(p_0, p_0) \) no greater than

\[
(p_0 - p_1) Q_1(p_1, p_2) + (p_0 - p_2) Q_2(p_1, p_2) + p_1 Q_1(p_1, p_2) + p_2 Q_2(p_1, p_2) - p_0 [Q_1(p_0, p_0) + Q_2(p_0, p_0)]
\]

\[ = p_0 (Q_1(p_1, p_2) + Q_2(p_1, p_2) - Q_1(p_0, p_0) - Q_2(p_0, p_0)) = p_0 (Q_r - Q_s) < 0, \]

where the final inequality follows from Proposition 2. (Recall that \( Q_r \) is total demand when a firm is prominent and \( Q_s \) is total demand when no firm is prominent.)

**Proof of Proposition 4.** (i) Write \( \pi_o, \pi_1, \) and \( \pi_2 \) for the respective equilibrium profit of each firm in the random-search case, of the prominent firm in the prominence case, and of each non-prominent firm in the prominence case. Then

\[ \pi_1 > p_1(1 - a + r_1) > p_2(h_2(1 - a) + r_2) = \pi_2. \]

The first inequality holds because the prominent firm makes less profit if it deviates from \( p_1 \) to \( p_2 \). (Recall that its demand is given by (12).) The second inequality holds because \( h_2 < 1 \) and \( r_2 < r_1 \). Similarly,

\[ \pi_1 > p_0 (1 - a + p_2 - p_0 + r_0) > p_0(h_0(1 - a) + r_0) = \pi_0. \]

Here, the second inequality holds because \( h_0 < 1 \) and \( p_2 - p_0 > (p_2^* - p_0^*)/n = r_0 - r_1 \).

(ii) Industry profit when one firm is prominent is

\[ p_2 [q_1 + (n - 1)q_2] - \Delta q_1 = p_2 [p_2 - \Delta + B(a - \Delta)p_2] - \Delta p_1, \]

\[ = p_2 [A p_2 - \Delta(1 + B p_2)] - \Delta p_1. \]

(Recall the definition of \( A \) and \( B \) in (A2).) The first equality follows from (17) and (18), whereas the second follows after noting that \( A + a B = 1 \). From (10), industry profit in the random-search case is

\[ n p_0 q_0 = A p_0^2. \]

Therefore, prominence increases industry profit if and only if

\[ A \left( p_2^* - p_0^* \right) > \Delta \left[ (1 + B p_2) p_2 + p_1 \right]. \]

From (A4), this condition is equivalent to

\[
\frac{A + p_2^{n-1} L}{1 + B p_2 + p_2^{n-1}} \leq \frac{A(p_2 + p_0)}{(1 + B p_2)p_2 + p_1}. \]

(A6)

For \( n = 2 \) and \( a \approx 1/2 \) (so that \( A \approx 3/2, B \approx 1, L \approx 2 \), and all prices are approximately 1/2), one can check that the left-hand side of (A6) is about 5/4 but the right-hand side is about 6/5, so that (A6) fails to hold. Therefore, prominence causes industry profit to fall in a duopoly when the search cost approaches its maximum limit.

We next show that (A6) holds when \( n \geq 3 \) or when \( n = 2 \) and \( a \) is relatively large. Inequality (A6) is equivalent to

\[ L p_2^{n-1} [(1 + B p_2) p_2 + p_1] < A \left[ B p_0 p_2 + p_0 - p_1 + p_2^{n-1}(p_2 + p_0) \right]. \]

After dividing both sides of the above by \( p_2 \) and using \( p_2 > p_0 > p_1 \), a sufficient condition for this inequality is

\[ L p_2^{n-1} (2 + B p_2) \leq A \left[ B p_0 + p_2^{n-2}(p_2 + p_0) \right], \]

which in turn is true if

\[ \frac{L p_2^{n-1}}{p_0} (2 + B p_2) \leq A \left( B + 2 p_2^{n-2} \right). \]

Note that

\[ \frac{L p_2^{n-1}}{p_0} = \frac{p_2^{n-1} + p_2^{n-2} + \cdots + p_2^{1-1}}{p_0} < (n - 1) p_2^{n-2} + \frac{p_2}{p_0} p_2^{n-2} < k p_2^{n-2}, \]

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where \( k = n - 1 + (1 - 2(1 - a^2))/a \). The last inequality follows from Claim 2, which implies that \( p_2/p_0 < (1 - 2(1 - a^2))/a \) by noting \( p_0 < 1/2 \). Therefore, a sufficient condition for industry profit to rise with prominence is

\[
\frac{k}{2 + B/p_0^2} < \frac{A}{2 + Bp_2}.
\]

Because \( p_2 < 1/2 \), the above inequality is true if

\[
\frac{k}{4 + 2^{n-1}B} < \frac{A}{B + 4}.
\]

When \( n = 2 \), we have \( A = 1 + a \) and \( B = 1 \), and one can check that this inequality holds for about \( a > 0.794 \). For \( n = 3 \), it holds for all \( 1/2 \leq a \leq 1 \). For \( n > 3 \), it holds because the left-hand side decreases with \( n \) when \( n \geq 3 \) and the right-hand side increases with \( n \) (which can be seen by noting that \( A = 1 + aB \) and \( B \) increases with \( n \)).

**Proof of Proposition 5.** We wish to evaluate the sign of \( V(p_1, p_2) - V(p_0, p_0) \). Because \( V \) is convex and total output when both prices are \( p_2 \) is \( 1 - p_2^2 \), Roy’s Identity implies that

\[
V(p_2, p_2) - V(p_0, p_0) \leq -(p_2 - p_0) \left( 1 - p_2^2 \right).
\]

Similarly, from (A5),

\[
V(p_1, p_2) - V(p_2, p_2) = \int_{p_1}^{p_2} (1 - a + p_2 - p + r_i) dp
\]

\[
= \Delta \left( 1 - a + r_i + \frac{1}{2} \Delta \right)
\]

\[
= \Delta \left( p_1 - \frac{1}{2} \Delta \right),
\]

where the final equality follows from (14). Therefore, we can deduce

\[
V(p_1, p_2) - V(p_0, p_0) = [V(p_1, p_2) - V(p_2, p_2)] + [V(p_2, p_2) - V(p_0, p_0)]
\]

\[
\leq \Delta \left( p_1 - \frac{\Delta}{2} \right) - (p_2 - p_0) \left( 1 - p_2^2 \right).
\]

If \( p_1 < \Delta/2 \), the above expression is negative and we are done. Otherwise, Claim 3 tells us that \( \Delta < A(p_2 - p_0) \), so if we can show

\[
1 - p_2^2 > A \left( p_1 - \frac{\Delta}{2} \right),
\]

we are done. First, it can be verified that

\[
\frac{p_1 - \frac{\Delta}{2}}{1 - p_2^2} < \frac{p_1}{1 - p_1 p_2^{-1}} \iff 1 > 3 p_1 p_2^{-1}.
\]

The latter inequality must be true because both prices are less than 1/2. Therefore, a sufficient condition for the result to hold is that

\[
\frac{1 - p_1 p_2^{-1}}{p_1} > A.
\]

However, using (19) and the observation that \( (a - \Delta)p_2 > a p_1 \), we have

\[
\frac{1 - p_1 p_2^{-1}}{p_1} = \frac{1}{p_1} \left[ p_1 + B(a - \Delta)p_2 \right] > 1 + aB = A.
\]

**References**


