Economies of Search

(with implications for horizontal mergers)*

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P R E L I M I N A R Y

Comments welcome!

Abstract

Often firms that merge choose to, in the medium- to long-run, shut down shops and crowd products together. When consumer search costs are significant, this process generates sizable *demand-side economies*. This paper studies the impact of these economies on the incentives to merge, and on the welfare consequences of mergers. We show that firms that merge may gain a prominent position in the market, even if they increase their prices more than what the non-merging firms do. In that case, consumers visit first the merged entity and the firms outside the merger lose out. Search cost economies may render a merger beneficial for consumers and so overall welfare may increase.

Keywords: mergers, consumer search, demand-side economies, insiders, outsiders

JEL Classification: D40, D83, L13

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1 Introduction

Often firms that merge, after a more or less complex process of business reorganization, choose to shut down shops and crowd products together. Even though this process may a priori be driven by a desire to achieve cost savings, we put forward a different, possibly complementary, rationale: when consumer search costs are significant, crowding products together generates *demand-side economies.* This paper studies, on the one hand, how firms can benefit from the consumer search economies generated by horizontal mergers and, on the other hand, the aggregate implications of merging activity.

We study a consumer search market where a few firms sell differentiated products. Firms compete in prices and consumers search for satisfactory deals sequentially. In the pre-merger symmetric market, all firms look alike and when consumers pick a first shop to visit, they do it in a random way. Those consumers who fail to find a satisfactory deal continue searching and once again they pick the next shop to visit randomly; and so on. This model was introduced by Wolinsky (1986) and was further studied by Anderson and Renault (1999).

When firms merge and crowd products together the following trade-off for a consumer arises: relative to the deal offered by a non-merging firm, at the merged entity, the consumer encounters more variety though likely offered at a higher price. We show that this trade-off ends up being favorable for the merging firms when search costs are relatively high. In the unique equilibrium of the post-merger market consumers find it optimal to search first at the merged entity and then, if unsatisfied with the deals available there, continue searching among the non-merging stores.

Search costs, even if small, are known to have important implications for the functioning of markets. In our model, merging is individually rational and, in contrast to most papers on mergers, the outsiders' profits decrease after a merger takes place. Moreover, consumers may benefit from consolidation in the market: we show that the economies from lower search costs may outweigh the price-rising effects of the merger.

The literature on the incentives to merge and the aggregate implications of mergers is quite extensive. For a recent survey of the main theoretical and empirical insights see Whinston (2006). A seminal paper in the literature is Salant *et al.* (1983), who demonstrated that merging is not very attractive in environments where firms compete in quantities and offer similar products. This result is so surprising that is referred to as the *merger paradox*. Deneckere and Davidson (1985) showed that price-setting firms selling horizontally differentiated products, other things equal, always have an incentive to merge. In contrast to the Cournot case analyzed by Salant *et al.*, this result arises because price increases of the merging firms, which favor the coalition partners, are accompanied by price increases of the non-merging firms, which also favors them.

In our model firms also compete in prices and sell differentiated products. When search costs converge to zero, our model gives the equilibrium in Perloff and Salop (1985), which is, in essence, similar to Deneckere and Davidson (1985). The interesting results arise when search costs are significant. In that case, by clustering all products together, mergers serve to effectively lower the costs of searching the products of the potentially merging firms. This, everything else equal, gives the merged entity a *prominent* position in the market, which implies that the merged entity attracts all consumer first-visits. In some cases, despite having to internalize the pricing externalities among all its goods, we show that the prominence effect may be so strong that the merged entity may charge lower prices than the non-merging firms (as it actually occurs in Armstrong, Vickers and Zhou's (2009) paper on the effects of prominence). In contrast to Deneckere and Davidson's (1985) analysis, in our paper insiders obtain larger gains than outsiders if a merger occurs. This is because consumers postpone visiting the outsiders until they have visited the merged entity. When search costs are high, consumer traffic from the merged entity to the non-merging firms is so small that the outsiders lose out. On the consumer welfare side, mergers have the potential to generate sufficiently large search economies so as to benefit consumers too.

Since the seminal paper of Williamson (1968), the role of mergers at generating supply-side economies, or cost-synergies, that can more than offset the market power effects of consolidation has been the focus of a considerable amount of research. Perry and Porter (1985), Farrell and Shapiro (1990) and McAfee and Williams (1992) explicitly modelled the cost efficiencies that arise from economies of sharing assets in product markets and stated conditions for an *efficiency defense* of mergers. Our paper also brings out an efficiency defence argument of mergers, but based on demand- rather than on supply-side economies.

Section 5.7 of the 2010 Merger Assessment Guidelines of the U.K. Competition Commission and the Office of Fair Trading acknowledges the importance of demand-side efficiencies in merger control. However, the guidelines focus mainly on cases where complementarities are significant: "*Demand-side efficiencies arise if the attractiveness to customers of the merged firm's products increases as a result of the merger. Common examples of demand-side efficiencies include: network effects, pricing effects and 'one-stop shopping'.*[1] Our paper shows that demand-side economies can also

[1]With *network effects*, users place a higher value for a product the more it is used by other consumers. A

arise even if products are substitutes. The reason is that shops that carry more variety can, in spite of the potential negative price effects, be more attractive for consumers.

Our paper is related to a strand of the consumer search literature dealing with firm's choice of location, entry and choice of product-lines in the presence of search costs. Our paper and those papers have in common that consumer search economies play a central role. In Stahl (1982) and Wolinsky (1983) savings in search costs can explain the observed geographical concentration of stores selling differentiated products. Fischer and Harrington (1996) go one step further and investigate the role of product heterogeneity in explaining interindustry variation in firm agglomeration. Dudey (1990) studies the case of homogeneous products and finds conditions under which firms cluster at a single location. Wilson (2010), by contrast, shows that homogeneous product firms may have an incentive to "obfuscate" the market by locating in less-easy-to-reach locations. Like in Fischer and Harrington (1996), Non (2010) reconciles these two ideas by showing that clustered and peripheral homogeneous product firms can coexist in the market. Ellison and Wolitzky (2009) also study obfuscation strategies in the market. They argue that consumer search dis-economies can very well explain the obfuscation strategies observed in Ellison and Ellison (2008). Economies of scope in search costs also play a central role in explaining entry patters and the choice of product-lines. Schulz and Stahl (1996) show that economies of scope in search costs can lead to excessive (price-increasing) entry. Economies of scope in shopping costs also arise when consumers buy many products and prefer to concentrate their purchases with a single supplier. Klemperer (1992) shows that in these situations firms may prefer head-to-head competition over product-line differentiation. In a subsequent paper, Klemperer and Padilla (1997) show that search cost economies can lead to excessive product-line variety.

Our paper is also related to a recent literature on ordered search. Arbatskaya (2007) studies a market for homogeneous products where the order in which firms are visited is exogenously given. In equilibrium prices must fall as the consumer walks away from the firms visited first. Zhou (forthcoming) considers the case of differentiated products and finds the opposite result. As mentioned above, Armstrong, Vickers and Zhou (2009) study the implications of "prominence" in search markets. In their model, there is a firm that is always visited first and this firm charges lower prices and derives greater profits than the rest of the firms, which are visited randomly after

merger may make networks compatible and so enhance the welfare of consumers. *Pricing effects* arise when bringing complement products under common ownership, which may results in lower prices for all products. Gains from *one-stop shopping* arise when consumers have a strong preference for buying a range of products at a single supplier.

consumers have visited the prominent firm. Zhou (2009) extends the ideas in Armstrong, Vickers and Zhou (2009) to the case in which a set of firms, rather than just one, is prominent. His analysis shares some features with our model because the merging firms, by crowding products together, become "prominent". Haan and Moraga-González (2011) study a model where firms compete in advertising to raise consumer attention. The firms whose advertising is more salient gain market prominence. Consumers visit them earlier along the search process and charge lower prices. They show that firms need not benefit from higher search costs.

The remainder of the paper is organized as follows. Section 2 describes the consumer search model. Section 3 presents the benchmark equilibrium of the pre-merger market. Section 4 discusses our main results. Section 5 briefly concludes the paper. To ease the reading of the paper, long proofs are placed in an appendix.

2 The model

We study the search model for differentiated products first proposed by Wolinsky (1986) and further studied by Anderson and Renault (1999).[2] On the supply side of the market there are n firms selling horizontally differentiated products. All firms employ the same constant returns to scale technology of production and we normalize unit production costs to zero. On the demand side of the market, there is a unit mass of consumers. A consumer m has tastes described by an indirect utility function

$$u^{mi}(p_i) = \varepsilon_{mi} - p_i,$$

if she buys product i at price p_i. The parameter ε_{mi} can be thought of as a match value between consumer m and product i. We assume that the value ε_{mi} is the realization of a random variable uniformly distributed on $[0, 1]$. Match values are independently distributed across consumers and products. No firm can observe ε_{mi} so personalised pricing is not possible. In what follows we will denote $z_k \equiv \max\{\varepsilon_1, \varepsilon_2, ..., \varepsilon_k\}$. For later reference, it is useful to calculate the optimal price of a multi-product monopolist selling k varieties, which we denote p_k^m. This price maximizes $p(\Pr[z_k \geq p])$, which gives $p_k^m = (1+k)^{-\frac{1}{k}}$. Setting $k = 1$, we have the single-product monopolist, whose price is simply denoted by p^m and is equal to $1/2$.

[2] More recently, this model has been used to explain incentives to invest in quality (Wolinsky, 2005), product-designs (Bar-Isaac et al., 2010) and the emergence and the effects of market prominence (Armstrong et al., 2009; Haan and Moraga-González, 2010; Zhou, 2009).

Consumers search sequentially with costless recall. Each time a consumer searches, she must pay a search cost denoted s. To avoid that a market equilibrium fails to exist (Diamond, 1971), we assume that search cost s is relatively small. In particular:

Assumption SC. *We assume that* $s \in [0, 1/8]$*; moreover, we assume that the number of firms* $n \leq 10$.[3]

This assumption ensures that the first search is always worthwhile for any number of varieties, k, sold by the first-visited shop, that is:

$$\begin{aligned}&\Pr[z_k \geq p_k^m]E[z_k - p_k^m \mid z_k \geq p_k^m] - s \\ &= \int_{p_k^m}^{1} (z_k - p_k^m)k\varepsilon^{k-1}d\varepsilon - s \geq 0 \text{ for all } k = 1, 2, ..., n\end{aligned}$$

For $k = 1$, this inequality holds strictly if $s = 1/8$. For larger k values, the expected utility a consumer derives from her first search always covers the search cost.

3 Pre-merger market

As a benchmark case, in this Section we characterize the pre-merger market symmetric equilibrium.

Let $p^* \in [0, p^m]$ denote the prices of firms other than firm i. Consider the (expected) payoff to a firm i that deviates by charging a price p_i. Assume $p_i \geq p^*$ without loss of generality. We start by computing the probability that a consumer accepts the offer of firm i, conditional on visiting firm i first. For this, we need to characterize the optimal consumer stopping rule. Suppose that a buyer has arrived at certain firm and her current most favorable purchase option gives her utility $\varepsilon_i - p_i$. If $\varepsilon_i - p_i < 0$, the consumer will search again given our assumption $s < 1/8$. Suppose $\varepsilon_i - p_i \geq 0$. In the Nash equilibrium, a visit to a new firm will yield utility $\varepsilon - p^*$. Kohn and Shavell (1974) show that the consumer should continue to search if her best previously discovered match value ε_i is lower than $\overline{x}$, where $\overline{x}$ is the solution to the equation

$$\int_{x}^{1} (\varepsilon - x)d\varepsilon = s, \tag{1}$$

[3] The restriction $n \leq 10$ is mainly technical and serves to avoid situations in which a post-merger equilibrium fails to exist. The reason is as follows. Fix the search cost s and suppose n is sufficiently large. Then an arbitrarily large k-firm merger has an incentive to charge such a high price that the buyer will find it unprofitable to enter the market. This produces a Diamond-paradox type of result and the equilibrium collapses. In practice, and for the purpose of this paper, since mergers are relevant in relatively concentrated markets, the restriction $n \leq 10$ implies little loss of generality.

that is, $\overline{x} = 1-\sqrt{2s}$. To see this, notice that searching one more time yields gains only if the consumer prefers the new option, say j, over option i, i.e., if $\varepsilon_j > \varepsilon_i - p_i + p^*$. Denoting $x \equiv \varepsilon_i - p_i + p^*$, the expected benefit from searching once more is $\int_x^1 (\varepsilon - x) d\varepsilon$, which is the LHS of (1). Searching one more time is worthwhile if and only if these incremental benefits exceed the cost of search s. Therefore, the buyer is exactly indifferent between searching once more and stopping and accepting the offer at hand if $x = \overline{x}$. Since $s \in [0, 1/8]$, we have that $\overline{x} \in [1/2, 1]$.

In any symmetric equilibrium, it must be the case that $\overline{x} \geq p^*$ for otherwise no consumer would participate in the market. Given this, the probability that a buyer stops searching at firm i given that firm i is visited in first place is equal to

$$\Pr[x > \overline{x}] = 1 - (\overline{x} + p_i - p^*), \tag{2}$$

provided the deviating price is not too high, i.e., $p_i < 1-\overline{x}+p^*$, for otherwise every single consumer would walk away from firm i.[4]

Before visiting firm i, the consumer may have visited other firm(s). The probability that a consumer goes to firm i in her second search and decides to acquire the offering of firm i right away is $\overline{x}(1 - \overline{x} - p_i + p^*)$.[5] Similarly, the probability that a consumer goes to firm i in her h-th search and decides to acquire the offering of firm i right away is $\overline{x}^{h-1}(1 - \overline{x} - p_i + p^*)$.

To complete firm i's payoff calculation, we need to compute the joint probability that a consumer walks away from every single firm in the market and happens to return to firm i to conduct a transaction, that is

$$\Pr[\max\{0, z_{n-1} - p^*\} < \varepsilon_i - p_i < \overline{x} - p^*] \tag{3}$$

This probability is independent of the order in which firms are visited so we will denote it as $R(p_i; p^*)$. We then have:

$$R(p_i; p^*) = \int_{p_i}^{\overline{x}+p_i-p^*} (\varepsilon_i - p_i + p^*)^{n-1} d\varepsilon_i = \int_0^{\overline{x}-p^*} (\varepsilon_i + p^*)^{n-1} d\varepsilon_i = \frac{1}{n}(\overline{x}^n - p^{*n}).$$

We can now write the deviant firm's expected profits:

$$\Pi_i(p_i; p^*) = \frac{p_i}{n} \left[\frac{1-\overline{x}^n}{1-\overline{x}}(1 - \overline{x} - p_i + p^*) + (\overline{x}^n - p^{*n}) \right].$$

We look for a symmetric Nash equilibrium in prices. After applying symmetry ($p_i = p^*$), the first-order condition is:

$$1 - p^{*n} - p^* \frac{1-\overline{x}^n}{1-\overline{x}} = 0 \tag{4}$$

[4] In what follows we derive the payoff of a firm under the assumption that $p_i < 1 - \overline{x} + p^*$. When this does not hold, the payoff is slightly different. We deal with this case later (see footnote 6).

[5] Letting j denote the firm visited earlier, this probability is given by $\Pr[\varepsilon_i - p_i > \overline{x} - p^* > \varepsilon_j - p^*]$.

It is easy to check that (4) has a unique solution that satisfies $\overline{x} \geq p^* \geq 1-\overline{x} \geq 0$.[6] Since the LHS of (4) decreases in $\overline{x}$, the equilibrium price increases in the search cost s. In the limit when $s = 1/8$, $\overline{x} = p^* = 1/2$.

The profits of a typical firm in the pre-merger situation are

$$\pi^* = \frac{1}{n} p^* (1 - p^{*n}). \tag{5}$$

4 Mergers of k firms

In this section we study the price implications of mergers and the incentives to merge. Consider that k out of the n active firms merge, with $2 \leq k \leq n-1$. We take a long-term view of mergers and assume that the k merging stores shut down all their shops but one, where they crowd the k varieties stemming from the k original merging firms together. In what follows, a typical non-merging store will be denoted j.

Let $\tilde{p}^* \in [0, p^m]$ and $\hat{p}^* \in [0, p_k^m]$ denote the equilibrium prices charged by the non-merging firms and the merged entity, respectively. To characterize the post-merger equilibrium we need to write out the payoffs of the different types of firm. These payoffs in turn depend on the optimal consumer search behavior, which, of course, has to be consistent with equilibrium pricing.

We then proceed by first specifying the order in which consumers will visit the various types of firms, then calculating equilibrium prices and finally checking back the consistency of the search rule. The trade-off for a consumer is clear: relative to the deal offered by a non-merging firm, at the merged entity, the consumer encounters more variety but possibly at higher prices.[7] offered at

[6]The equilibrium price p^* is indeed an equilibrium if no firm has an incentive to deviate from it. So far we have checked that "small" deviations are not profitable. Suppose now that the deviant firm charges a price so high that consumers always walk away from it and therefore this firm only sells to those consumers who come back to it after having visited all other firms. In that case the deviant profits become $\Pi_i(p_i; p^*) = p_i \int_{p_i}^1 (\varepsilon_i - p_i + p^*)^{n-1} d\varepsilon_i$. Because of log-concavity of the uniform density function, this profits expression is quasi-concave in own price. Taking the derivative of the deviating profits with respect to p_i , and setting $p_i = p^*$, we get $d\Pi_i/dp_i|_{p_i=p^*} = (1-p^{*n}-np^*)/n < 0$, where the inequality follows from the fact that p^* solves (4). Since deviating profits are quasi-concave and they decrease at $p_i = p^*$, we conclude they are even lower at prices p_i such that $\overline{x} + p_i - p^* > 1$.

[7]Merging firms internalize pricing externalities so it is reasonable to expect lower prices at the non-merging stores. However, there is a recent literature on oligopolistic competition with search frictions showing that firms that are visited first charge lower prices than the rivals that are visited later (Armstrong et al., 2009; Haan and Moraga-González, 2011; Zhou, 2009). Therefore, if the merged entity were to be visited first by the consumers in an equilibrium, it may very well be the case that it ends up charging a lower price than the non-merging stores.

a higher price.

Let $\overline{\overline{x}}$ be the solution to

$$\int_{x}^{1} (\varepsilon - x) d\varepsilon^{k} - s = 0 \tag{6}$$

As in (1), $\overline{\overline{x}}$ represents a threshold value above which a consumer will decide not to continue searching the products of the merged entity.

Define the $\overline{x} - \tilde{p}^{*}$ as the reservation utility for searching a non-merging store. Note that in any equilibrium where the non-merging stores have positive market shares, it must be the case that $\overline{x} - \tilde{p}^{*} \geq 0$. Likewise, the number $\overline{\overline{x}} - \hat{p}^{*}$ is the corresponding reservation utility at the merged entity. Weitzman's (1979) paper on optimal search for the best alternative prescribes the consumer should search as follows: at every step in the search process a consumer should consider visiting next the (not-yet-visited) shop for which reservation utility is highest; moreover, at every step in the search process a consumer should terminate search whenever the maximum sampled reward so far is above the reservation utility at the shop to be visited next.

Momentarily, assume $\overline{\overline{x}} - \hat{p}^{*} > \overline{x} - \tilde{p}^{*}$ so that consumers visit first the merged entity. To calculate the post-merger equilibrium prices, we proceed by computing the payoffs the firms (merging and non-merging) would obtain when deviating from the equilibrium prices. Then we derive the first order conditions (FOCs), impose the symmetry of prices across firms of the same type, require consumer expectations to be correct, and solve for equilibrium prices. After this we look for conditions under which $\overline{\overline{x}} - \hat{p}^{*} > \overline{x} - \tilde{p}^{*}$ indeed holds. Later in Section 4.1.1 we prove that the equilibrium we derive here is unique provided that search costs are sufficiently large.

Payoff to a deviant merging store.

Since consumers expect the price set by the merged entity to be $\hat{p}^{*}$, given our assumption SC, they will make the first search. Upon arrival at the merged entity, they may be surprised by a deviation, denoted $\hat{p}$. Without loss of generality, suppose that the deviating price $\hat{p} < \hat{p}^{*}$.

Let $z_k - \hat{p}$ be the deal observed by the consumer at the merged entity. A consumer stops there and buys right away if the expected gains from further search are lower than the search cost. Applying the same logic as in equation (2), since consumers believe the non-merging firms to be charging $\tilde{p}^{*}$, the probability that a buyer stops searching at the merged entity is equal to

$$1 - (\overline{x} - \tilde{p}^{*} + \hat{p})^{k}, \tag{7}$$

provided, again, that the deviating price is not too high.

The merged entity also receives demand from consumers who decide to walk away from it and venture the non-merging firms only to find out that the deal offered by the merged entity is in the end the best in the market. This happens with probability:

$$\Pr\left[z_k - \hat{p} < \overline{x} - \tilde{p}^* \text{ and } z_{n-k} < \overline{x} \text{ and } z_k - \hat{p} > \max\{z_{n-k} - \tilde{p}^*, 0\}\right],$$

which is equivalent to

$$\begin{aligned}&\Pr\left[z_k - \hat{p} < \overline{x} - \tilde{p}^* \text{ and } z_k - \hat{p} > \max\{z_{n-k} - \tilde{p}^*, 0\}\right] \\ &= \int_{\hat{p}}^{\overline{x}-\tilde{p}^*+\hat{p}} (\varepsilon - \hat{p} + \tilde{p}^*)^{n-k} \, d\varepsilon^k = k \int_0^{\overline{x}-\tilde{p}^*} (\varepsilon + \tilde{p}^*)^{n-k} (\varepsilon + \hat{p})^{k-1} \, d\varepsilon \end{aligned} \quad (8)$$

The demand of the merged entity is therefore the sum of (7) and (8). Therefore, the total profit of the merged entity equals:

$$\hat{\pi}(\hat{p}) = \hat{p}\left[1 - (\overline{x} - \tilde{p}^* + \hat{p})^k + k \int_0^{\overline{x}-\tilde{p}^*} (\varepsilon + \tilde{p}^*)^{n-k} (\varepsilon + \hat{p})^{k-1} \, d\varepsilon\right] \quad (9)$$

Payoff to a deviant non-merging store.

We now compute the payoff of a non-merging store that deviates from $\tilde{p}^*$ by charging $\tilde{p}$. Without loss of generality assume $\tilde{p} < \tilde{p}^*$. Once consumers walk away from the merged entity, as all non-merging firms are supposed to charge the same price $\tilde{p}^*$, consumers are assumed to visit them randomly. Therefore the deviant firm may be visited in first place after the merged entity, in second place and so on till the $n - k^{th}$ place. Like any other non-merging store, the deviant has a probability $1/(n-k)$ of being visited in each of these places.

Consider that the deviant non-merging firm is visited by a consumer in her h-th search after walking away from the merged entity, with $h = 1, 2, ..., n-k$.[8] Suppose the deal the consumer observes upon entering the deviant's shop is $\varepsilon_j - \tilde{p}$. There are two situations in which the deviant sells to this consumer. First, the consumer may stop searching at this shop and buy there right away. Using the search logic described above, conditional on the consumer visiting the non-merging firm

[8]We note that when the consumer visits the deviant immediately after leaving the merged firm, $h = 1$, the consumer, even if surprised by a deviation, never wants to return to the merged entity without searching further. If fact, this event has probability

$$\Pr[z_k - \widehat{p}^* < \overline{x} - \widehat{p}^* \text{and } \varepsilon - \widetilde{p} > \overline{x} - \widetilde{p}^* \text{ and } z_k - \widehat{p}^* > \varepsilon - \widetilde{p}] = 0$$

j in her h-th search, this occurs when $\varepsilon_j \geq \overline{x} - \tilde{p}^* + \tilde{p}$. Therefore, the joint probability a consumer visits the deviant in h-th place and buys there directly is

$$\frac{1}{n-k} \Pr[z_k - \hat{p}^* < \overline{x} - \tilde{p}^* \text{ and } z_{h-1} < \overline{x} \text{ and } \varepsilon_j - \tilde{p} > \overline{x} - \tilde{p}^*] = \frac{1}{n-k}(\overline{x} - \tilde{p}^* + \hat{p}^*)^k \overline{x}^{h-1} (1 - \overline{x} + \tilde{p}^* - \tilde{p})$$

Second, the consumer may walk away from the deviant firm and come back to it after visiting all non-merging stores. This occurs when

$$\Pr\left[z_k - \hat{p}^* < \overline{x} - \tilde{p}^* \text{ and } z_{n-k-1} < \overline{x} \text{ and } \varepsilon_j - \tilde{p} < \overline{x} - \tilde{p}^* \text{ and } \varepsilon_j - \tilde{p} > \max\{z_k - \hat{p}^*, z_{n-k-1} - \tilde{p}^*, 0\}\right],$$

which after manipulation gives

$$\begin{aligned} &\Pr\left[\varepsilon_j - \tilde{p} < \overline{x} - \tilde{p}^* \text{ and } \varepsilon_j - \tilde{p} > \max\{z_k - \hat{p}^*, z_{n-k-1} - \tilde{p}^*, 0\}\right] \\ &= \Pr\left[\overline{x} - \tilde{p}^* + \tilde{p} > \varepsilon_j > \max\{z_k - \hat{p}^* + \tilde{p}, z_{n-k-1} - \tilde{p}^* + \tilde{p}, \tilde{p}\}\right] = \\ &= \int_{\tilde{p}}^{\overline{x} - \tilde{p}^* + \tilde{p}} (\varepsilon_j + \hat{p}^* - \tilde{p})^k (\varepsilon_j + \tilde{p}^* - \tilde{p})^{n-k-1} d\varepsilon_j = \int_0^{\overline{x} - \tilde{p}^*} (\varepsilon_j + \hat{p}^*)^k (\varepsilon_j + \tilde{p}^*)^{n-k-1} d\varepsilon_j \end{aligned}$$

Note that this probability does not depend on h.

Taking into account that, once the consumer has walked away from the merged entity, the deviant may be visited by her in positions $h = 1, 2, ..., n-k$ we have a total demand for a non-merging firm equal to

$$\frac{1}{n-k} \sum_{h=1}^{n-k} (\overline{x} - \tilde{p}^* + \hat{p}^*)^k \overline{x}^{h-1} (1 - \overline{x} + \tilde{p}^* - \tilde{p}) + \int_0^{\overline{x} - \tilde{p}^*} (\varepsilon + \hat{p}^*)^k (\varepsilon + \tilde{p}^*)^{n-k-1} d\varepsilon$$

Using this expression, we obtain the profits of a non-merging firm:

$$\tilde{\pi}(\tilde{p}) = \tilde{p} \left(\frac{1}{n-k} \frac{1 - \overline{x}^{n-k}}{1 - \overline{x}} (\overline{x} - \tilde{p}^* + \hat{p}^*)^k (1 - \overline{x} + \tilde{p}^* - \tilde{p}) + \int_0^{\overline{x} - \tilde{p}^*} (\varepsilon + \hat{p}^*)^k (\varepsilon + \tilde{p}^*)^{n-k-1} d\varepsilon \right) \tag{10}$$

Taking the FOCs in (9) and (10), imposing symmetry among the prices of the non-merging firms, i.e. $\tilde{p} = \tilde{p}^*$, and requiring that consumer expectations are fulfilled, i.e. $\hat{p} = \hat{p}^*$, gives:

$$1 - (\overline{x} - \tilde{p}^* + \hat{p}^*)^{k-1} (\overline{x} - \tilde{p}^* + (k+1)\hat{p}^*) + k \int_0^{\overline{x} - \tilde{p}^*} (\varepsilon + \tilde{p}^*)^{n-k} (\varepsilon + \hat{p}^*)^{k-2} (\varepsilon + k\hat{p}^*) \, d\varepsilon = 0 \tag{11}$$

$$\frac{1}{n-k} (\overline{x} - \tilde{p}^* + \hat{p}^*)^k \frac{1 - \overline{x}^{n-k}}{1 - \overline{x}} (1 - \overline{x} - \tilde{p}^*) + \int_0^{\overline{x} - \tilde{p}^*} (\varepsilon + \tilde{p}^*)^{n-k-1} (\varepsilon + \hat{p}^*)^k \, d\varepsilon = 0 \tag{12}$$

4.1 Main results: high search costs

The main results of this article pertain to the case where search costs are significant. In this section we focus on such situations.[9]

Proposition 1 *Assume that $k \leq n-1$ firms merge. Then there exists a Nash equilibrium in the post-merger market where:*

- *Consumers prefer to search first the products of the merged entity and then, if they wish so, they proceed by searching the products of the non-merging firms.*
- *The merged entity charges a price $\hat{p}^*$ and the non-merging stores charge a price $\widetilde{p}^*$; these prices solve the system of first order conditions (11)-(12).*

This equilibrium exists if the search cost s is sufficiently large, in which case $\hat{p}^* \geq \widetilde{p}^*$.

The proof, which is presented in the Appendix, has three steps. We first prove that there exists at least one solution to the system of first order conditions (11)-(12). We then show that this solution is unique. Finally, we show that when the search cost is large, consumer putative search order (first the merged entity then the non-merging firms) is consistent with equilibrium pricing.

It is illustrative to look at the behavior of the reaction functions of the different types of firm once a merger takes place. We illustrate the main effects in Figure 1. In this figure, the crossing point between the two blue reaction functions gives the pre-merger equilibrium. The joint reaction function of the potentially merging firms is denoted by r_k^{pre}, while the joint reaction function of the non-merging firms is denoted by r_{n-k}^{pre}. In the pre-merger market, consumers expect all firms to charge the same price so they search them randomly. The joint reaction functions r_k^{pre} and r_{n-k}^{pre} cross on the 45 degrees line so both types of firms charge p^* and consumers' expectations are fulfilled.

When the potentially merging firms do indeed merge, two effects take place. On the one hand, there is *a search-order effect*: everything else equal, consumers prefer to visit first the merging

[9]When search costs are small, we obtain results similar to those in Deneckere and Davidson (1985). This is natural since our payoff functions are continuous in search costs. When search costs converge to zero, our model gives the equilibrium in Perloff and Salop (1985), which is, in essence, similar to Deneckere and Davidson (1985). In particular, we can show that there is a unique equilibrium where the merged entity is visited last. In such equilibrium, merging is individually rational but the outsider firms obtain greater profits than the insider firms. These results are available from the authors upon request.

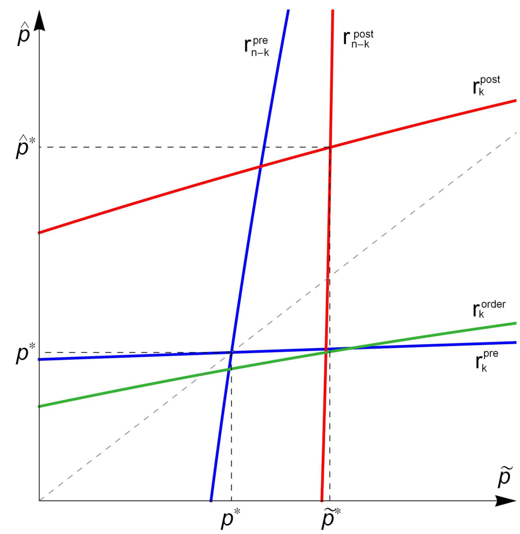


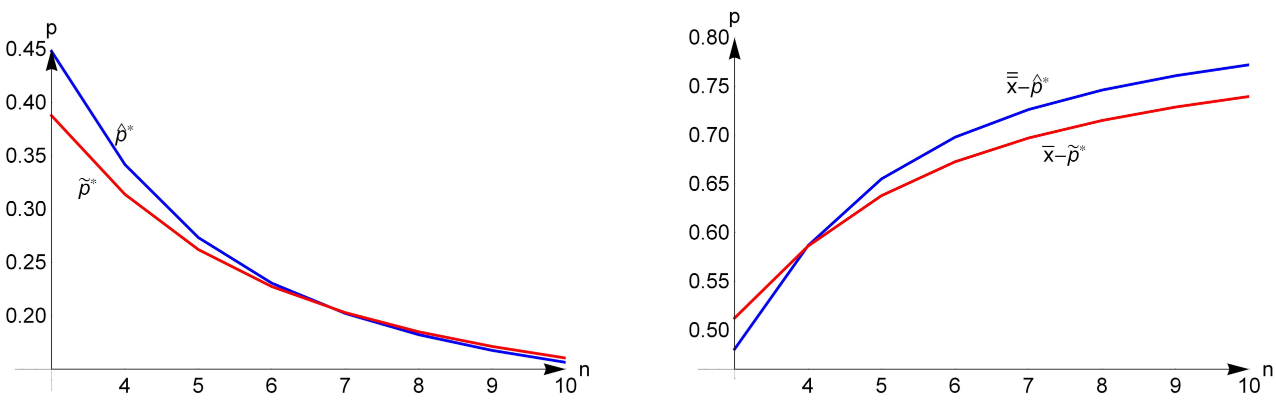
Figure 1: Reaction functions pre- and post-merger.

store since in this store they can compare k varieties upon a single visit. These search cost savings, which we refer to as *demand-side economies*, confer the merged entity market prominence, as in Armstrong et al. (2009), Haan and Moraga-González (2011) and Zhou (2009). On the other hand, there is an *internalization-of-pricing-externalities effect*, as usual when firms merge.

By the search-order effect, the joint reaction curve of the non-merging firms shifts rightward from r_{n-k}^{pre} (in blue) to r_{n-k}^{post} (in red). This move is driven by the fact that the demand of a non-merging firm becomes more inelastic after the search-order changes: only consumers who have been disappointed at the merged entity happen to reach the non-merging firms. Likewise, the joint reaction curve of the merging firms rotates counterclockwise from r_k^{pre} (in blue) to r_k^{order} (in green). This move captures the fact that a potentially merging firm demand becomes more elastic. The crossing point between r_{n-k}^{post} and r_k^{order} determines the price implications of a merger purely driven by the search-order effect: relative to the pre-merger situation, this search-order effect results in an decrease in the price of the merged, prominent, entity and in an increase in the price of the non-merging stores.

The change in the joint reaction curve of the merging stores due to the search-order effect is augmented by the usual internalization-of-pricing-externalities effect, which shifts the joint reaction function of the merging stores further from r_k^{order} (in green) to r_k^{post} (in red). At the post-merger equilibrium (the crossing point of the red curves), all prices, whether from outsiders or insiders, increase. Proposition 1 shows that when search costs are sufficiently large, in equilibrium the merged entity ends up charging a price higher than the price of the non-merging firms. In the jargon of this paper, this means that the internalization-of-pricing-externalities effect dominates the search-order effect. Still, the consumer trade-off is clear: she prefers to start searching the merged entity despite the fact that this firm has a higher price. Economies of search are at the heart of this result.

Before turning to a discussion of the aggregate implications of mergers, we make two remarks in connection with Proposition 1. The first observation is that, even though the proof of the proposition uses the case where the search cost is very high and converges to its maximum value, the result is true for much lower search costs. The second observation is that the ranking of merging and non-merging firm prices can be different than the one in Proposition 1. It is indeed possible that the search-order effect more than offsets the internalization-of-pricing-externalities effect, in which case the merged entity charges a price lower than the non-merging stores. This occurs when the search cost is relatively small and the number of merging firms relative to the total number of firms in the market is also small. These two remarks can be seen in the graphs of Figure 2. In these two graphs, the number of merging firms is set to 2 and the search cost is very small ($s = 0.005$). Figure 2(a) plots the post-merger equilibrium prices and shows that the merged entity charges a price lower than that of the non-merging when n is relatively large. Figure 2(b) plots consumer reservation utilities for searching the two types of firm, which shows that consumer search order is consistent with equilibrium pricing for all $n \geq 4$.



(a) Prices

(b) Reservation utilities

Figure 2: Post-merger prices and reservation utilities ($\overline{x} = 0.9, k = 2$).

We now turn to study the incentives to merge.

Proposition 2 *For the Nash equilibrium of Proposition 1 we have:*

- *Any k-firm merger is individually rational for the merging firms, that is,* $\hat{\pi}^*/k > \pi^*$.
- *If search cost is sufficiently large, in any k-firm merger the non-merging firms obtain lower profits than the merging firms, that is,* $\hat{\pi}^*/k > \tilde{\pi}^*$.

The proof is in the Appendix. As shown by Deneckere and Davidson (1985), in models of price competition with differentiated products merging is individually rational. Our first observation in Proposition 2 generalizes this insight to the case where there exist search frictions in the market. Our second result in Proposition 2 is that non-merging firms may obtain lower profits than the merging ones. This observation contrasts earlier work and deserves an explanation. Here, by merging, the potentially merging firms gain prominence in the market so that in the equilibrium of Proposition 1 the merged entity is visited first. This is to the detriment of the non-merging firms, which are relegated to the end of the optimal search order consumers follow when they search for satisfactory deals. When search costs are significant, the search-order effect is substantial: the non-merging firms receive too few visitors and lose out relative to the merging firms.

Our final result pertains to the aggregate implications of mergers. As usual, we evaluate the effects of a merger on welfare grounds by comparing the pre- and post-merger un-weighted sum of consumer surplus and firms' profits. We now compute the expected surplus consumers derive in the post-merger market. Consider first those consumers who end up buying from the merged entity. As explained above, these consumers either buy directly, in which case they incur the search cost only one time, or they buy at the merged entity after having visited all the non-merging firms, in which case they incur a total search cost of $(n-k+1)\,s$. Denoting by $\widehat{CS}$ the expected surplus of the clientele of the merged entity we have:

$$\widehat{CS} = \int_{\overline{x}-\tilde{p}^*+\hat{p}^*}^{1} (\varepsilon - \hat{p}^* - s)\, d\varepsilon^k + \int_{\hat{p}^*}^{\overline{x}-\tilde{p}^*+\hat{p}^*} (\varepsilon - \hat{p}^* + \tilde{p}^*)^{n-k} (\varepsilon - \hat{p}^* - (n-k+1)\,s)\, d\varepsilon^k \qquad (13)$$

Consider now those consumers who end up buying from the non-merging firms. These consumers may buy directly at one of the non-merging firms after walking away from the merged entity, in which case they incur a total search cost of $2s$; or else they may leave some ℓ non-merging firms to finally buy at the $\ell+1$-th one, in which case the total search cost they incur is equal to $(\ell+2)s$; or finally, they may walk away from all merging and non-merging firms only to find out that the best deal is at one of the non-merging firms, in which case they incur a total search cost of $(n-k+1)\,s$. Denoting by $\widetilde{CS}$ the expected consumer surplus of the clientele of the non-merging firms we obtain

$$\begin{aligned}\widetilde{CS} &= (\overline{x}-\tilde{p}^*+\hat{p}^*)^k \sum_{\ell=1}^{n-k} \overline{x}^{\ell-1} \int_{\overline{x}}^{1} (\varepsilon-\tilde{p}^*-(\ell+1)s)d\varepsilon + \\ &+ (n-k)\int_{\tilde{p}^*}^{\overline{x}} \varepsilon^{n-k-1}\,(\varepsilon-\tilde{p}^*+\hat{p}^*)^k\,(\varepsilon-\tilde{p}^*-(n-k+1)\,s)\,d\varepsilon = \\ &= (\overline{x}-\tilde{p}^*+\hat{p}^*)^k\,\frac{1-\overline{x}^{n-k}}{1-\overline{x}}\int_{\overline{x}}^{1}(\varepsilon-\tilde{p}^*)\,d\varepsilon-(\overline{x}-\tilde{p}^*+\hat{p}^*)^k\,(1-\overline{x})\,s\sum_{\ell=1}^{n-k}(\ell+1)\overline{x}^{\ell-1}+ \\ &+ (n-k)\int_{\tilde{p}^*}^{\overline{x}} \varepsilon^{n-k-1}\,(\varepsilon-\tilde{p}^*+\hat{p}^*)^k\,(\varepsilon-\tilde{p}^*-(n-k+1)\,s)\,d\varepsilon. \end{aligned} \tag{14}$$

Some consumers do not buy at all. The mass of these consumers is $\hat{p}^{*k}\tilde{p}^{*n-k}$. By construction, they visit all the firms in the market. Hence, their consumer surplus is negative and equals

$$CS_{\varnothing} = -\hat{p}^{*k}\tilde{p}^{*n-k}\,(n-k+1)\,s \tag{15}$$

Aggregating the surplus over the different consumers and firms, we obtain a measure of expected social welfare

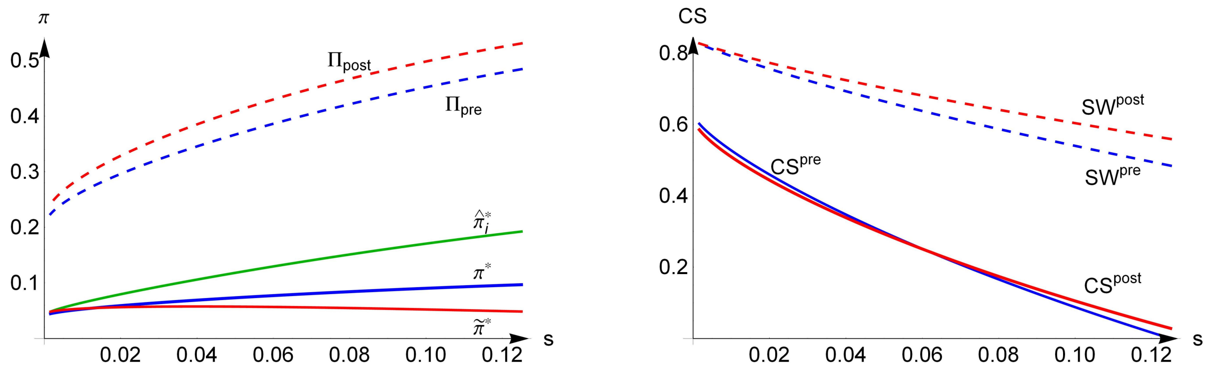
$$SW = \widehat{CS} + \widetilde{CS} + CS_{\varnothing} + \hat{\pi} + (n-k)\tilde{\pi}.$$

Proposition 3 *For the Nash equilibrium of Proposition 1, if search cost is sufficiently high we have that:*

- *Any k-firm merger results in an increase in industry profits.*
- *Consumer surplus increases after a k-firm merger.*

As a result, social welfare increases after a merger has taken place.

The proof is in the Appendix. The aggregate implications of a merger are illustrated in Figure 4. The first observation is that the results in Proposition 3 not only hold for very high search costs but more generally. In the first graph, Figure 3(a), we compare pre- and post-merger (individual and collective) profits. It can be seen that the merged entity's profits (green curve) are clearly above pre-merger levels (blue solid curve). As explained before, this is the outcome of two forces: one the one hand, the merged entity benefits from the market prominence it gains by clustering products together; on the other hand, the merged entity profits from increased market power. The figure also shows that when search costs are not extremely low, outsiders lose out (red solid curve). In any case, collectively firms obtain greater profits post-merger (red dashed curve) than pre-merger (blue dashed curve). Finally, it is also worth mentioning that the asymmetry in the way search costs affect the profits of the different firms after a merger. As search costs increase, the profits of the merged entity go up while the profits of the non-merging firms typically fall down. This is due to the fact that as search costs increase consumer traffic from the merged entity to the non-merging firms falls.



(a) Profits

(b) Consumer surplus

Figure 3: Pre- and post-merger profits and consumer surplus ($n = 5, k = 2$).

Figure 3(b) depicts pre- and post-merger consumer surplus and social welfare. The graph illustrates our result in Proposition 3 that when search cost is high, consumer search economies more than offset the negative price effects of consolidation. When search costs are low, consumers lose but overall welfare anyway increases. This is driven by the mitigating impact that consolidation has on the overall search frictions in the market.

4.1.1 Uniqueness of equilibrium

In the previous section we have characterized an equilibrium where the potentially merging firms gain market prominence if they indeed decide to merge. In the equilibrium or Proposition 1, consumers found it optimal to first search the products of the merged entity to continue later, if desired, searching the products of the non-merging firms. For this equilibrium to exist, search costs had to be sufficiently large. In this section we argue that the equilibrium in Proposition 1 is unique when search costs are indeed relatively high. We prove this by contradiction.

Suppose that consumers find it optimal to start searching for a satisfactory good among the products of the non-merged firms. If this is so, then the reservation utility at the merged entity, $\overline{\overline{x}} - \hat{p}^*$, must be lower than the reservation utility at a non-merging firm, $\bar{x} - \tilde{p}^*$ (where $\overline{x}$ and $\overline{\overline{x}}$, as before, solve (1) and (6), respectively). In what follows we derive the payoff functions of merged and non-merged firms under this assumption. We then compute the pair of equilibrium prices and show that, for those prices, when search costs are high, the reservation utility at the merged entity would be above the reservation utility at the non-merged firms, which constitutes a contradiction.

As before, let $\tilde{p}^*$ and $\hat{p}^*$ be the equilibrium prices and assume $\bar{x} - \tilde{p}^* > \overline{\overline{x}} - \hat{p}^*$. Invoking Weitzman (1979) again, given this inequality, consumers should start their search by visiting the non-merged firms. They will visit the merged entity only after having visited all non-merged shops.

We first derive the payoff of a (deviant) non-merging firm. Consider a non-merging firm, say firm i, that deviates by charging a price $\tilde{p} \neq \tilde{p}^*$. As all non-merging firms are supposed to charge the same price $\tilde{p}^*$, consumers are assumed to visit them randomly. The deviant firm may be visited by the consumer in first place, second place, etc. all the way till the $(n-k)$-th place. The probability that the deviating firm is visited in any of these positions is $1/(n-k)$. When the consumer visits the deviant firm in the 1st, 2nd, ..., $(n-k-1)$-th place, the decision whether to continue searching or not takes into account that the next visited shop is also a non-merging store. By contrast, when the deviant firm is the last non-merging store visited by the consumer, i.e. the $(n-k)$-th one, the decision of the consumer is slightly different because the next shop to be visited is a merging store and such a store charges a price different from the price of a non-merging store. Since the consumer stopping rule at any of the first $n-k-1$ non-merging stores is different from the one at the last non-merging store, it is convenient to distinguish among those two cases.

Consider a deviant firm i charging price $\tilde{p}$ and visited in positions $1, 2, ...n-k-1$. This type of firm receives demand from three types of consumers: one, from consumers who visit firm i and terminate their search there; two, from consumers who walk away from all non-merging firms including firm i and return to it after all; and three, from consumers who walk away from all (non-merging and merging) firms in the market and return to it in the end. We now compute the sizes of these groups of consumers. First, a consumer terminates her search immediately after visiting firm i if $\varepsilon_i > \bar{x} - \tilde{p}^* + \tilde{p}$. Therefore, conditional on reaching firm i, the probability that a consumer buys in shop i without searching further equals

$$1 - \bar{x} + \tilde{p}^* - \tilde{p}. \tag{16}$$

The consumer may have visited other non-merging firms before arriving at shop i. Since all other firms charge equilibrium prices, if a consumer has walked away from other shops this means that the match values there are lower than $\bar{x}$. Therefore, the demand received by the deviant firm from consumers who visit it in positions 1 to $n-k-1$ and terminate their search right away is

$$\frac{1}{n-k}\sum_{j=1}^{n-k-1}\bar{x}^{j-1}\left(1-\bar{x}+\tilde{p}^{*}-\tilde{p}\right)=\frac{1}{n-k}\frac{1-\bar{x}^{n-k-1}}{1-\bar{x}}\left(1-\bar{x}+\tilde{p}^{*}-\tilde{p}\right) \tag{17}$$

We now compute the demand received by this type of firm from consumers who walk away from all non-merging firms including firm i and return to it after all. Consider a consumer who is at the last non-merging firm and is therefore contemplating whether to continue searching for a satisfactory good among the products of the merged entity. The consumer will continue searching if the highest match value observed so far is lower than $\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}$. Therefore, the consumer will return to the deviant firm i without checking the products of the merged entity with probability:

$$\begin{aligned}\Pr\left[\bar{\bar{x}}-\hat{p}^{*}<\varepsilon_i-\tilde{p}<\bar{x}-\tilde{p}^{*} \text{ and } \varepsilon_i-\tilde{p}>z_{n-k-1}-\tilde{p}^{*} \text{ and } z_{n-k-1}\leq\bar{x}\right] &= \\ \int_{\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}}^{\bar{x}-\tilde{p}^{*}+\tilde{p}}\left(\varepsilon-\tilde{p}+\tilde{p}^{*}\right)^{n-k-1}d\varepsilon=\frac{1}{n-k}\left(\bar{x}^{n-k}-\left(\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}\right)^{n-k}\right)\end{aligned} \tag{18}$$

Finally, we calculate the demand received by firm i from consumers who visit all sellers in the market and return to firm i to buy there. The probability of this event equals

$$\begin{aligned}\Pr\left[0<\varepsilon_i-\tilde{p}<\bar{\bar{x}}-\hat{p}^{*} \text{ and } \varepsilon_i-\tilde{p}>\max\left\{z_{n-k-1}-\tilde{p}^{*},z_k-\hat{p}^{*}\right\} \text{ and } z_{n-k-1}-\tilde{p}^{*}\leq\bar{\bar{x}}-\hat{p}^{*}\right] &= \\ \int_{0}^{\bar{\bar{x}}-\hat{p}^{*}}\left(\varepsilon+\tilde{p}^{*}\right)^{n-k-1}\left(\varepsilon+\hat{p}^{*}\right)^{k}d\varepsilon\end{aligned} \tag{19}$$

Note that the number of these consumers does not depend on the position in which firm i has been visited.

As a result, we conclude that the total demand of firm i if it is sampled in position 1 to $n-k-1$ equals to the sum of (17), (18) and (19).

We now move to consider the demand of firm i when it is the last non-merging firm visited by the consumer. This type of firm receives demand from two types of consumers: one, consumers who stop searching at firm i right away: and two, consumers who visit all the shops in the market and return to firm i after all. The probability that a consumer terminates her search at firm i without visiting the merged entity equals:

$$\begin{aligned}\Pr\left[z_{n-k-1}<\bar{x} \text{ and } \varepsilon_i-\tilde{p}>\bar{\bar{x}}-\hat{p}^{*} \text{ and} \varepsilon_i-\tilde{p}>z_{n-k-1}-\tilde{p}^{*}\right] &= \\ \frac{1}{n-k}\bar{x}^{n-k-1}\left(1-\bar{x}+\tilde{p}^{*}-\tilde{p}\right)+\frac{1}{n-k}\left(\bar{x}^{n-k}-\left(\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}\right)^{n-k}\right)\end{aligned} \tag{20}$$

The returning demand of firm i does not depend on the order of sampling and is identical to (19).

Putting the above demands together, the total payoff of a deviating non-merging firm equals:

$$\begin{aligned}\tilde{\pi}(\tilde{p}) &= \tilde{p}\left[\frac{1}{n-k}\frac{1-\bar{x}^{n-k}}{1-\bar{x}}\left(1-\bar{x}+\tilde{p}^{*}-\tilde{p}\right)+\frac{1}{n-k}\left(\bar{x}^{n-k}-\left(\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}\right)^{n-k}\right)\right.\\ &+ \left.\int_{0}^{\bar{\bar{x}}-\hat{p}^{*}}\left(\varepsilon+\tilde{p}^{*}\right)^{n-k-1}\left(\varepsilon+\hat{p}^{*}\right)^{k}d\varepsilon\right]\end{aligned}$$

Taking the FOC, imposing the rational expectations requirement that $\tilde{p}=\tilde{p}^{*}$ and simplifying gives:

$$\frac{1}{n-k}\frac{1-\bar{x}^{n-k}}{1-\bar{x}}\left(1-\bar{x}-\tilde{p}^{*}\right)+\frac{1}{n-k}\left(\bar{x}^{n-k}-\left(\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}\right)^{n-k}\right)+\int_{0}^{\bar{\bar{x}}-\hat{p}^{*}}\left(\varepsilon+\tilde{p}^{*}\right)^{n-k-1}\left(\varepsilon+\hat{p}^{*}\right)^{k}d\varepsilon=0 \tag{21}$$

We now derive the payoff of the merged entity when it deviates to $\hat{p}\neq\hat{p}^{*}$. As discussed above, consumers will walk away from all non-merging stores and arrive to the merged entity if the best of the non-merging firms' deals is lower than $\bar{\bar{x}}-\hat{p}^{*}$. Therefore, the merged entity will only receive demand when its offer is the best of all offers in the market. The probability of this event equals

$$\begin{aligned}&\Pr\left[z_{n-k}-\tilde{p}^{*}<\bar{\bar{x}}-\hat{p}^{*}\text{ and }z_{k}-\hat{p}>\max\left\{0;\,z_{n-k}-\tilde{p}^{*}\right\}\right] =\\ &\left(\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}\right)^{n-k}\left(1-\left(\bar{\bar{x}}-\hat{p}^{*}+\hat{p}\right)^{k}\right)+k\int_{\hat{p}}^{\bar{\bar{x}}-\hat{p}^{*}-\hat{p}}\left(\varepsilon-\hat{p}+\tilde{p}^{*}\right)^{n-k}\varepsilon^{k-1}d\varepsilon\end{aligned}$$

Its payoff then equals:

$$\hat{\pi}(\hat{p})=\hat{p}\left[\left(\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}\right)^{n-k}\left(1-\left(\bar{\bar{x}}-\hat{p}^{*}+\hat{p}\right)^{k}\right)+k\int_{0}^{\bar{\bar{x}}-\hat{p}^{*}}\left(\varepsilon+\tilde{p}^{*}\right)^{n-k}\left(\varepsilon+\hat{p}\right)^{k-1}d\varepsilon\right] \tag{22}$$

Taking the FOC, imposing the rational expectations condition that $\hat{p}=\hat{p}^{*}$ and simplifying gives:

$$\left(\bar{\bar{x}}-\hat{p}^{*}+\tilde{p}^{*}\right)^{n-k}\left(1-\bar{\bar{x}}^{k}-k\bar{\bar{x}}^{k-1}\hat{p}^{*}\right)+k\int_{0}^{\bar{\bar{x}}-\hat{p}^{*}}\left(\varepsilon+\tilde{p}^{*}\right)^{n-k}\left(\varepsilon+\hat{p}^{*}\right)^{k-2}\left(\varepsilon+k\hat{p}^{*}\right)d\varepsilon=0 \tag{23}$$

Proposition 4 *Assume that a k-firm merger takes place in the market. Assume also that the search cost is sufficiently high. Then an equilibrium where consumers prefer to search first the products of the non-merging firms and then, if they wish so, the products of the merged entity does not exist. As a result, the equilibrium in Proposition 1 is unique.*

Proof. Assume that there is a pair of non-negative prices $\hat{p}^{*}$ and $\tilde{p}^{*}$ that satisfy the system of equations (21) and (23). For these prices to be consistent with equilibrium, first, they must be lower than or equal to the monopoly prices p_k^m and p^m, respectively; moreover, the reservation utility at the merged entity must be lower than the reservation utility at a non-merging firm.

Take the LHS of the FOC of a non-merging firm, equation (21). Note that the integral in this equation is positive. Observe now that the second summand, $\frac{1}{n-k}(\bar{x}^{n-k} - \left(\bar{\bar{x}} - \hat{p}^* + \tilde{p}^*\right)^{n-k})$, is also positive because the assumption $\bar{x} - \tilde{p}^* > \bar{\bar{x}} - \hat{p}^*$ implies that $\bar{x} > \bar{\bar{x}} - \hat{p}^* + \tilde{p}^*$. As a consequence, if an equilibrium exists, the first term of the FOC (21) must be negative. This implies that in equilibrium, it must be the case that $\tilde{p}^* > 1 - \bar{x}$.

Take now the limiting case where search cost is high so that $\bar{x} \to 1/2$. If this is so, for an equilibrium to exist, it must be the case that $\tilde{p}^* > 1/2$. But this is a contradiction because $\tilde{p}^* \leq p^m = 1/2$. ■

5 Conclusions

In the long-run firms that merge end up shutting down shops and clustering their products together. In this paper we have argued that when search costs are significant, this process generates substantial demand-side economies. What happens is that in the post-merger market, everything else equal, consumers do not need to search as intensively as in the pre-merger situation to find satisfactory products. This paper has emphasized the importance of these demand-side economies. We have shown that firms that merge may gain a prominent position in the market, even if they increase their prices more than what the non-merging firms do. In that case, consumers prefer to start searching for satisfactory products at the merged entity. In equilibrium, insider firms gain custom and increase their profits, while outsider firms lose out because they are pushed all the way back in the optimal search order consumers follow when they search for products. We have shown that consolidation may create sufficiently large search economies so as to generate rents for consumers too.

The difference between the short- and the long-run effects of mergers is important. In a companion paper (Moraga-González and Petrikaitė, 2009), we have studied the short-run implications of mergers. We have shown that firms that merge raise their prices more than what the non-merging firms do, so absent any other offsetting effect, merging firms are pushed all the way back in the optimal search order consumers follow when they search for satisfactory products. Merging thus gives the outsiders a free ride that is freer the greater the search costs. For sufficiently large search costs, it turns out that merging in a product differentiation environment lowers the short-run profits of the merging firms. To counter this effect, firms may cluster their products together. In this paper we have shown that by doing so search economies unfold, which makes mergers profitable for the merging firms and, sometimes, for the consumers too.

In a recent paper on mergers in the Italian banking sector, Foccarelli and Panetta (2003) forcefully make the point that mergers may generate efficiency gains (headquarter consolidation, shutting down of branches, etc.) that take a relatively long time to materialize. In fact, they show that consolidation leads to adverse price changes only temporarily, and that when sufficient time elapses efficiency gains kick-in and prices decrease. Seen against earlier empirical results by Kim and Singal (1993) and Prager and Hannan (1998), this is an interesting insight. Our theory points out that after-merger downsizing may lead to important search economies that in the long-run may result in price decreases. In this sense it yields implications consistent with Foccarelli and Panetta's empirical findings. Whether supply- or demand-side economies cause the results remains an empirical question. Developing methods to separate the relative importance of demand- versus cost-economies seems a fascinating area of research.

6 Appendix

Proof of Proposition 1. Let $G(\hat{p}^*, \tilde{p}^*)$ and $H(\hat{p}^*, \tilde{p}^*)$ denote the LHS of the FOCs (11) and (12), respectively. In what follows, we drop the "$*$" super-indexes to shorten the expressions. We organize the proof in a series of Claims, which are proven in turn.

Claim 1.1 *There is a unique pair of prices* $\hat{p}$ and $\tilde{p}$ *that satisfy the first-order conditions* $G(\hat{p}, \tilde{p}) = 0$ *and* $H(\hat{p}, \tilde{p}) = 0$.

Proof. Existence. We first prove the existence part of the claim. The function G is differentiable and takes on real values for all $(\hat{p}, \tilde{p}) \in [0, p_k^m] \times [0, p^m]$. Therefore, the FOC $G(\tilde{p}, \hat{p}) = 0$ defines an implicit relation between $\hat{p}$ and $\tilde{p}$. Let us denote such relationship by $\tilde{p} = \upsilon_1(\hat{p})$. We now argue that υ_1 is increasing. By the implicit function theorem

$$\frac{\partial \upsilon_1}{\partial \hat{p}} = \frac{-\partial G/\partial \hat{p}}{\partial G/\partial \tilde{p}} \tag{24}$$

We next note that G is decreasing in $\hat{p}$ and increasing in $\tilde{p}$. To see this, compute first

$$\begin{aligned}\frac{\partial G}{\partial \hat{p}} &= \Big[- (k-1)(\overline{x} - \tilde{p} + \hat{p})^{k-2} (\overline{x} - \tilde{p} + (k+1)\hat{p}) - (k+1)(\overline{x} - \tilde{p} + \hat{p})^{k-1} + \\ &\quad + k(k-1) \int_0^{\overline{x}-\tilde{p}} (\varepsilon + \tilde{p})^{n-k} (\varepsilon + \hat{p})^{k-3} (2\varepsilon + k\hat{p})\, d\varepsilon \Big] = \\ &= -k(\overline{x} - \tilde{p} + \hat{p})^{k-2} (2\overline{x} - 2\tilde{p} + (k+1)\hat{p}) + k(k-1) \int_0^{\overline{x}-\tilde{p}} (\varepsilon + \tilde{p})^{n-k} (\varepsilon + \hat{p})^{k-3} (2\varepsilon + k\hat{p})\, d\varepsilon\end{aligned}$$

Note next that $\partial G/\partial \hat{p}$ decreases in $\bar{x}$. This is because

$$\begin{aligned}\frac{1}{k} \frac{\partial^2 G}{\partial \overline{x} \partial \hat{p}} &= -(k-2)(\overline{x} - \tilde{p} + \hat{p})^{k-3} (2\overline{x} - 2\tilde{p} + (k+1)\hat{p}) - 2(\overline{x} - \tilde{p} + \hat{p})^{k-2} + \\ &\quad + (k-1)\overline{x}^{n-k} (\overline{x} - \tilde{p} + \hat{p})^{k-3} (2\overline{x} - 2\tilde{p} + k\hat{p}) = \\ &= -(k-1)(\overline{x} - \tilde{p} + \hat{p})^{k-3}(2\overline{x} - 2\tilde{p} + k\hat{p}) \left(1 - \overline{x}^{n-k}\right) < 0\end{aligned}$$

We know that $\overline{x} \geq \tilde{p}$. If we evaluate $\partial G/\partial \hat{p}$ at $\overline{x} = \tilde{p}$ we obtain $\partial G/\partial \hat{p} = -k(k+1)\hat{p}^{k-1} < 0$. Since $\partial G/\partial \hat{p}$ decreases in $\bar{x}$, then we conclude $\partial G/\partial \hat{p}$ is negative for all $\overline{x}$.

Compute now

$$\frac{\partial G}{\partial \tilde{p}} = (k-1)\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k-2}\left(\overline{x}-\tilde{p}+(k+1)\,\hat{p}\right)+\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k-1}+$$
$$+\,k\,(n-k)\int_0^{\overline{x}-\tilde{p}}(\varepsilon+\tilde{p})^{n-k-1}(\varepsilon+\hat{p})^{k-2}(\varepsilon+k\hat{p})\,d\varepsilon-$$
$$-\,k\overline{x}^{n-k}\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k-2}\left(\overline{x}-\tilde{p}+k\hat{p}\right)=$$
$$=k\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k-2}\left(\overline{x}-\tilde{p}+k\hat{p}\right)\left(1-\overline{x}^{n-k}\right)+$$
$$+\,k\,(n-k)\int_0^{\overline{x}-\tilde{p}}(\varepsilon+\tilde{p})^{n-k-1}(\varepsilon+\hat{p})^{k-2}(\varepsilon+k\hat{p})\,d\varepsilon>0$$

As a consequence, υ_1 is increasing in $\hat{p}$.

We now observe that the solution of the equation $G(\hat{p},\tilde{p})=0$ when $\hat{p}=0$ is negative. We establish this by contradiction. Suppose that the solution to $G(0,\tilde{p})=0$ is some non-negative number. If this is so, since we know G increases in $\tilde{p}$, it should be the case that $G(0,0)<0$. However,

$$G(0,0)=1-\overline{x}^k+k\int_0^{\overline{x}}\varepsilon^{n-1}>0,$$

which leads to a contradiction. Summarizing, we have shown that the implicit function υ_1, defined on $[0,p_k^m]$, starts taking negative values and is increasing.

Consider now the second FOC $H(\hat{p},\tilde{p})=0$ and rewrite it as

$$\frac{1-\overline{x}^{n-k}}{(n-k)\,(1-\overline{x})}\left(1-\overline{x}-\tilde{p}\right)+\frac{1}{\left(\overline{x}-\tilde{p}+\hat{p}\right)^k}\int_0^{\overline{x}-\tilde{p}}(\varepsilon+\hat{p})^k(\varepsilon+\tilde{p})^{n-k-1}\,d\varepsilon=0$$

Let us denote the LHS of this expression by $L(\hat{p},\tilde{p})$. The equation $L(\hat{p},\tilde{p})=0$ defines an implicit relationship between $\hat{p}$ and $\tilde{p}$, which we denote $\tilde{p}=\upsilon_2(\hat{p})$. We show next υ_2 is also increasing. By the implicit function theorem we have

$$\frac{\partial \upsilon_2}{\partial \hat{p}}=\frac{-\partial L/\partial \hat{p}}{\partial L/\partial \tilde{p}},$$

We note that L is increasing in $\hat{p}$ and decreasing in $\tilde{p}$. The first observation comes from

$$\frac{\partial L}{\partial \hat{p}}=\frac{k}{\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k+1}}\int_0^{\overline{x}-\tilde{p}}(\varepsilon+\hat{p})^{k-1}(\varepsilon+\tilde{p})^{n-k-1}\left(\overline{x}-\tilde{p}-\varepsilon\right)d\varepsilon>0.$$

For the second, we compute

$$\frac{\partial L}{\partial \tilde{p}}=-\frac{1-\overline{x}^{n-k}}{(n-k)\,(1-\overline{x})}+\frac{k}{\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k+1}}\int_0^{\overline{x}-\tilde{p}}(\varepsilon+\hat{p})^k(\varepsilon+\tilde{p})^{n-k-1}\,d\varepsilon$$
$$+\,\frac{n-k-1}{\left(\overline{x}-\tilde{p}+\hat{p}\right)^k}\int_0^{\overline{x}-\tilde{p}}(\varepsilon+\hat{p})^k(\varepsilon+\tilde{p})^{n-k-2}\,d\varepsilon-\overline{x}^{n-k-1} \qquad (25)$$

It is difficult to evaluate the sign of this derivative on inspection. To ease the evaluation, consider first the term in the second line of this derivative. We note that

$$\begin{aligned}&\frac{n-k-1}{\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k}}\int_{0}^{\overline{x}-\tilde{p}}\left(\varepsilon+\hat{p}\right)^{k}\left(\varepsilon+\tilde{p}\right)^{n-k-2}d\varepsilon-\overline{x}^{n-k-1}\\&<\left(n-k-1\right)\int_{0}^{\overline{x}-\tilde{p}}\left(\varepsilon+\tilde{p}\right)^{n-k-2}d\varepsilon-\overline{x}^{n-k-1}=-\tilde{p}^{n-k-1}<0\end{aligned}\tag{26}$$

Consider next the first term of (25) and note that

$$\begin{aligned}&\frac{k}{\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k+1}}\int_{0}^{\overline{x}-\tilde{p}}\left(\varepsilon+\hat{p}\right)^{k}\left(\varepsilon+\tilde{p}\right)^{n-k-1}d\varepsilon-\frac{1-\overline{x}^{n-k}}{\left(n-k\right)\left(1-\overline{x}\right)}\\&<\frac{k\overline{x}^{n-k-1}}{\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k+1}}\int_{0}^{\overline{x}-\tilde{p}}\left(\varepsilon+\hat{p}\right)^{k}d\varepsilon-\frac{1-\overline{x}^{n-k}}{\left(n-k\right)\left(1-\overline{x}\right)}\\&=\frac{k\bar{x}^{n-k-1}}{k+1}-\frac{k\overline{x}^{n-k-1}\hat{p}^{k+1}}{\left(k+1\right)\left(\overline{x}-\tilde{p}+\hat{p}\right)^{k+1}}-\frac{1-\overline{x}^{n-k}}{\left(n-k\right)\left(1-\overline{x}\right)}\\&<\frac{k\bar{x}^{n-k-1}}{k+1}-\frac{1-\overline{x}^{n-k}}{\left(n-k\right)\left(1-\overline{x}\right)}=\frac{1}{1-\bar{x}}\left[\frac{k\bar{x}^{n-k-1}\left(1-\bar{x}\right)}{k+1}-\frac{1-\bar{x}^{n-k}}{n-k}\right]\end{aligned}\tag{27}$$

We now argue that the term in square brackets in the last line of (27) is negative for all $\bar{x}$. To see this, we first observe that it increases in $\bar{x}$. In fact, taking the derivative w.r.t. $\bar{x}$ we get

$$\begin{aligned}\frac{k+1}{\bar{x}^{n-k-2}}\frac{\partial}{\partial\bar{x}}\left[\frac{k\bar{x}^{n-k-1}\left(1-\bar{x}\right)}{k+1}-\frac{1-\bar{x}^{n-k}}{n-k}\right]&=k\left(n-k-1\right)-k\left(n-k\right)\bar{x}+(k+1)\bar{x}\\&=-k\left(k+1\right)+\left(k+1\right)\bar{x}+k^{2}\bar{x}+nk\left(1-\bar{x}\right)\\&\geq-k\left(k+1\right)+\left(k+1\right)\bar{x}+k^{2}\bar{x}+\left(k+1\right)k\left(1-\bar{x}\right)\\&=\bar{x}>0\end{aligned}$$

Since for the highest possible $\bar{x}$ we have

$$\lim_{\bar{x}\to1}\frac{k\bar{x}^{n-k-1}\left(1-\bar{x}\right)}{k+1}-\frac{1-\bar{x}^{n-k}}{n-k}=0$$

we conclude that (27) is negative. This in turn implies that L decreases in $\tilde{p}$. Since L is increasing in $\hat{p}$ and decreasing in $\tilde{p}$, the function υ_2, defined implicitly by the first order condition $H(\hat{p},\tilde{p})=0$, is also increasing in $\hat{p}$.

We finally observe that the solution to $L(\hat{p},\tilde{p})=0$ when $\hat{p}=0$ must be a positive number. By contradiction, suppose that the solution to $L(0,\tilde{p})=0$ is some negative number. If this is so, since we know L decreases in $\tilde{p}$, it should be the case that $L(0,0)<0$. However,

$$L(0,0)=\frac{1-\overline{x}^{n-k}}{n-k}+\frac{1}{\overline{x}^{k}}\int_{0}^{\overline{x}-\tilde{p}}\varepsilon^{n-1}d\varepsilon>0,$$

which constitutes a contradiction. Summarizing, we have now shown that the implicit function υ_2 defined on $[0, p_k^m]$ starts taking positive values and is increasing.

To show that υ_1 and υ_2 cross at least once, we now prove that $\upsilon_1(p_k^m) = \overline{x} > \upsilon_2(p_k^m)$ (since both are increasing in $\tilde{p}$ and we know that $\upsilon_1(0) < 0 < \upsilon_2(0)$). Setting $\hat{p} = p_k^m$ in the FOC for the merged entity gives

$$G(p_k^m, \tilde{p}) = 1 - (\overline{x} - \tilde{p} + p_k^m)^{k-1}(\overline{x} - \tilde{p} + (k+1)p_k^m) + k\int_0^{\overline{x}-\tilde{p}} (\varepsilon + \tilde{p})^{n-k}(\varepsilon + p_k^m)^{k-2}(\varepsilon + kp_k^m)\, d\varepsilon = 0,$$

whose solution is $\tilde{p} = \overline{x}$ since $G(p_k^m, \overline{x}) = 1 - (k+1)(p_k^m)^k = 0$ by definition of p_k^m.

Likewise setting $\hat{p} = p_k^m$ in the FOC for the non-merging firm gives

$$L(p_k^m, \tilde{p}) = \frac{1 - \overline{x}^{n-k}}{(n-k)(1-\overline{x})}(1 - \overline{x} - \tilde{p}) + \frac{1}{(\overline{x} - \tilde{p} + p_k^m)^k}\int_0^{\overline{x}-\tilde{p}} (\varepsilon + p_k^m)^k (\varepsilon + \tilde{p})^{n-k-1}\, d\varepsilon = 0$$

Since $L(p_k^m, \overline{x}) = (1 - \overline{x}^{n-k})(1 - 2\overline{x}) / (n-k)(1-\overline{x}) \leq 0$ and we know that L decreases in $\tilde{p}$, it is clear that the solution to $L(p_k^m, \tilde{p}) = 0$ must be some $\tilde{p} < \overline{x}$.

To complete the proof of existence, it remains to be shown that at the point(s) at which υ_1 and υ_2 cross we have $\tilde{p} \leq p^m = 1/2$. For this, it suffices to show that $L(p_k^m, 1/2) < 0$ because since L decreases in $\tilde{p}$, this means that the solution to $L(p_k^m, \tilde{p}) = 0$ must be some $\tilde{p} < 1/2$. In fact, setting $\tilde{p} = 1/2$, we get

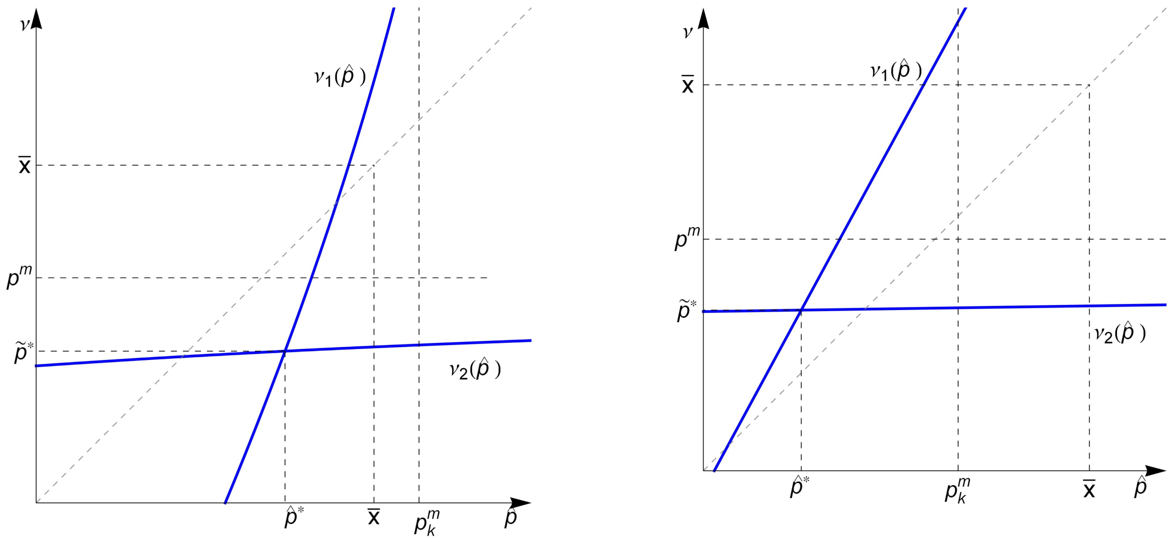
$$L(p_k^m, 1/2) = \frac{1 - \overline{x}^{n-k}}{(n-k)(1-\overline{x})}\left(\frac{1}{2} - \overline{x}\right) + \frac{1}{(\overline{x} - \frac{1}{2} + p_k^m)^k}\int_0^{\overline{x}-\frac{1}{2}} (\varepsilon + p_k^m)^k \left(\varepsilon + \frac{1}{2}\right)^{n-k-1} d\varepsilon. \quad (28)$$

We now note that $L(p_k^m, 1/2)$ decreases in $\overline{x}$. To see this, compute

$$\begin{aligned}\frac{\partial L\left(p_k^m, \frac{1}{2}\right)}{\partial \bar{x}} &= -\frac{1 + (n-k-1)\overline{x}^{n-k} - (n-k)\overline{x}^{n-k-1}}{2(n-k)(1-\overline{x})^2} \\ &\quad - \frac{k}{(\overline{x} - \frac{1}{2} + p_k^m)^{k+1}}\int_0^{\overline{x}-1/2} (\varepsilon + p_k^m)^k \left(\varepsilon + \frac{1}{2}\right)^{n-k-1} d\varepsilon \qquad (29)\end{aligned}$$

and notice that $1 + (n-k-1)\overline{x}^{n-k} - (n-k)\overline{x}^{n-k-1} > 0$ for all $\overline{x}$ (since it decreases in $\overline{x}$ and equals zero when $\overline{x} = 1$). Therefore, if $L(p_k^m, 1/2) \leq 0$ for the lowest value of $\overline{x}$, then it is negative everywhere. In fact, setting $\overline{x} = 1/2$ in (28) yields $L(p_k^m, 1/2) = 0$. To summarize, we have now shown that υ_1 and υ_2 cross at least once on $[0, p_k^m] \times [0, p^m]$ so a candidate equilibrium exists.

The arguments in the proof can be seen in Figure 4. As explained in the main text, the equilibrium candidate may entail prices for the non-merging firms above or below the price of the merged entity. In Figure 4(a), we set $n = 3$, $k = 2$ and $\overline{x} = 0.54$ so that the internalization-of-pricing-externalities effect dominates the search-order effect. In Figure 4(b) we depict a case with many firms ($n = 10$, $k = 2$ and $\overline{x} = 0.9$) where the search-order effect has a dominating influence over the internalization-of-pricing-externalities effect.



(a) Case $\hat{p}^* > \tilde{p}^*$

(b) Case $\hat{p}^* < \tilde{p}^*$

Figure 4: Existence of equilibrium

Uniqueness. We now move to prove the uniqueness of a candidate equilibrium. For this, we start by noting that υ_1 is increasing in $\hat{p}$ at a rate greater than 1. Using the derivations above, this follows from the following remarks. First, note that

$$\frac{1}{k}\left(-\frac{\partial G}{\partial \hat{p}} - \frac{\partial G}{\partial \tilde{p}}\right) = (\overline{x} - \tilde{p} + \hat{p})^{k-2}\left((\overline{x} - \tilde{p} + \hat{p}) + \overline{x}^{n-k}(\overline{x} - \tilde{p} + k\hat{p})\right) - \\ - (k-1)\int_0^{\overline{x}-\tilde{p}} (\varepsilon + \tilde{p})^{n-k}(\varepsilon + \hat{p})^{k-3}(2\varepsilon + k\hat{p})d\varepsilon + \\ - (n-k)\int_0^{\overline{x}-\tilde{p}} (\varepsilon + \tilde{p})^{n-k-1}(\varepsilon + \hat{p})^{k-2}(\varepsilon + k\hat{p})d\varepsilon. \qquad (30)$$

Observe now that this expression is increasing in $\overline{x}$, as its derivative with respect to $\overline{x}$ equals $(k-1)(\overline{x} - \tilde{p} + \hat{p})^{k-2}\left(1 - \overline{x}^{n-1}\right) \geq 0$. Therefore, if (30) is positive when $\overline{x}$ takes on its lowest value, then it is positive everywhere. Setting $\overline{x} = \tilde{p}$ in the RHS of (30) gives $\hat{p}^{k-2}\left(\hat{p} + k\tilde{p}^{n-k}\hat{p}\right) > 0$, which proves that υ_1 increases with slope greater than 1.

We continue by noting that the rate at which υ_2 increases is lower than 1. Using the derivations above, since $\partial L/\partial \tilde{p} < 0$, we need to show that

$$\frac{\partial L}{\partial \hat{p}} + \frac{\partial L}{\partial \tilde{p}} = -\frac{1-\overline{x}^{n-k}}{(n-k)(1-\overline{x})} + \frac{k}{(\overline{x}-\tilde{p}+\hat{p})^k}\int_0^{\overline{x}-\tilde{p}} (\varepsilon+\hat{p})^{k-1}(\varepsilon+\tilde{p})^{n-k-1}\,d\varepsilon$$
$$+\frac{n-k-1}{(\overline{x}-\tilde{p}+\hat{p})^k}\int_0^{\overline{x}-\tilde{p}} (\varepsilon+\hat{p})^{k}(\varepsilon+\tilde{p})^{n-k-2}\,d\varepsilon - \overline{x}^{n-k-1} \tag{31}$$

is negative. Now notice that the last line of this expression is negative (from (26)). Moreover, regarding the first line of (31) we have

$$\begin{aligned}
&-\frac{1-\overline{x}^{n-k}}{(n-k)(1-\overline{x})} + \frac{k}{(\overline{x}-\tilde{p}+\hat{p})^k}\int_0^{\overline{x}-\tilde{p}} (\varepsilon+\hat{p})^{k-1}(\varepsilon+\tilde{p})^{n-k-1}\,d\varepsilon \\
&< -\frac{1-\overline{x}^{n-k}}{(n-k)(1-\overline{x})} + \frac{k\overline{x}^{n-k-1}}{(\overline{x}-\tilde{p}+\hat{p})^k}\int_0^{\overline{x}-\tilde{p}} (\varepsilon+\hat{p})^{k-1}\,d\varepsilon \\
&= -\frac{1-\overline{x}^{n-k}}{(n-k)(1-\overline{x})} + \frac{\overline{x}^{n-k-1}}{(\overline{x}-\tilde{p}+\hat{p})^k}\left[(\overline{x}-\tilde{p}+\hat{p})^k - \hat{p}^k\right] \\
&< -\frac{1-\overline{x}^{n-k}}{(n-k)(1-\overline{x})} + \overline{x}^{n-k-1} = -\frac{1+(n-k-1)\,\bar{x}^{n-k}-(n-k)\,\bar{x}^{n-k-1}}{(n-k)(1-\bar{x})} < 0,
\end{aligned}$$

where the last inequality follows from the remarks after equation (29). This implies that υ_2 increases at a rate less than 1. This, together with the arguments before shows that there exists a unique candidate equilibrium. ■

Claim 1.2 *The candidate equilibrium where consumers start searching by the merged entity, which charges a price $\hat{p}^*$, and then continue by the non-merging stores, which charge a price $\widetilde{p}^*$ exists if the search cost s is sufficiently large, in which case $\hat{p}^* \geq \widetilde{p}^*$.*

Proof. Basically, we need to prove that the putative search order which prescribes consumers to go first to the merged entity and then continue searching the non-merging stores is indeed optimal. For this, as described in the main text of the paper, we need to show that $\overline{\overline{x}} - \widehat{p}^* > \overline{x} - \tilde{p}^*$.

(i) Consider the case in which s is sufficiently large, so $s \to 1/8$ and $\bar{x} \to 1/2$. It takes a few derivations to check that the solution to the first order conditions

$$1-\left(\frac{1}{2}-\tilde{p}^*+\hat{p}^*\right)^{k-1}\left(\frac{1}{2}-\tilde{p}^*+(k+1)\,\hat{p}^*\right)+k\int_0^{\frac{1}{2}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k}(\varepsilon+\hat{p}^*)^{k-2}(\varepsilon+k\hat{p}^*)\,d\varepsilon = 0$$
$$\frac{1}{n-k}\left(\frac{1}{2}-\tilde{p}^*+\hat{p}^*\right)^{k}2\left(1-\frac{1}{2^{n-k}}\right)\left(\frac{1}{2}-\tilde{p}^*\right)+\int_0^{\frac{1}{2}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k-1}(\varepsilon+\hat{p}^*)^{k}\,d\varepsilon = 0$$

is

$$\begin{aligned}\tilde{p}^* &= p^m = 1/2 = \bar{x}\\ \hat{p}^* &= p_m^k = 1/(1+k)^{\frac{1}{k}}\end{aligned} \tag{32}$$

Inspection of (32) reveals that when $s \to 1/8$, $\hat{p}^* > \tilde{p}^*$. Moreover, to prove the claim it suffices to show that when $s \to 1/8$

$$\overline{\overline{x}} - \hat{p}^* > 0.$$

From equation (6) we know $\overline{\overline{x}}$ satisfies $\int_x^1 (\varepsilon - x) d\varepsilon^k - s = 0$, or

$$\frac{k(1-\overline{\overline{x}}) - \overline{\overline{x}}(1-\overline{\overline{x}}^k)}{k+1} - s = 0. \tag{33}$$

We note now $\overline{\overline{x}}$ increases in k. This is because the derivative of the LHS of (33) is

$$\frac{1+\overline{\overline{x}}^{k+1}((k+1)\ln[\overline{\overline{x}}]-1)}{(k+1)^2} > 0$$

(the positive sign follows from noting that this derivative decreases in $\overline{\overline{x}}$ and that at $\overline{\overline{x}} = 1$ it takes value zero). Equation (33) can be rewritten as

$$\overline{\overline{x}} = \frac{k+\overline{\overline{x}}^{k+1}}{k+1} - s$$

Deducting $\hat{p}^*$ on both sides of this equality gives

$$\overline{\overline{x}} - \hat{p}^* = \frac{k+\overline{\overline{x}}^{k+1}}{k+1} - \hat{p}^* - s. \tag{34}$$

From the solution in (32) we know that when $s \to 1/8$, then $\hat{p}^* \to 1/(1+k)^{\frac{1}{k}}$. As a result, when $s \to 1/8$, equation (34) gives

$$\overline{\overline{x}} - p_m^k = \frac{k+\overline{\overline{x}}^{k+1}}{k+1} - \frac{1}{(1+k)^{\frac{1}{k}}} - \frac{1}{8} \tag{35}$$

Note now that the RHS of (35) increases in $\overline{\overline{x}}$. Setting the lowest admissible value for $\overline{\overline{x}}$, we have

$$\overline{\overline{x}} - p_m^k = \frac{k+(\frac{1}{2})^{k+1}}{k+1} - \frac{1}{(1+k)^{\frac{1}{k}}} - \frac{1}{8} > 0$$

for all $k \leq n-1$. ■

The proof of the Proposition is now complete. ■

Proof of Proposition 2. (i) We first show that the merging stores increase their profits after the merger. The difference between the profit per product of the merged entity, $\hat{\pi}_i/k$, and the typical pre-merger profit of a firm, π^*, equals:

$$\frac{\hat{\pi}_i}{k} - \pi^* = \frac{\hat{p}^*}{k}\left(1-(\overline{x}-\tilde{p}^*+\hat{p}^*)^k + k\int_0^{\overline{x}-\tilde{p}^*}(\varepsilon+\hat{p}^*)^{k-1}(\varepsilon+\tilde{p}^*)^{n-k}d\varepsilon\right)$$
$$-\frac{p^*}{n}\left(1-p^{*n}\right)$$

Since $\hat{p}^*$ is an equilibrium price, then, given the non-merging firm's price, $\hat{\pi}_i(\hat{p}^*)$ is greater than $\hat{\pi}_i(\hat{p})$ for any $\hat{p} \neq \hat{p}^*$. Therefore, replacing $\hat{p}^*$ by $\tilde{p}^*$ gives

$$\frac{\hat{\pi}_i}{k} - \pi^* > \tilde{p}^* \left(\frac{1-\overline{x}^k}{k} + \frac{1}{n} \left(\overline{x}^n - \tilde{p}^{*n} \right) \right) - \frac{p^*}{n} \left(1 - p^{*n} \right)$$

We now note that $\frac{1-\overline{x}^k}{k} = \int_{\overline{x}}^{1} \varepsilon^{k-1} d\varepsilon$ and is decreasing in k. Therefore,

$$\begin{aligned} \tilde{p}^* \left(\frac{1-\overline{x}^k}{k} + \frac{1}{n} \left(\overline{x}^n - \tilde{p}^{*n} \right) \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) > \\ \tilde{p}^* \left(\frac{1-\overline{x}^{n-1}}{n-1} + \frac{1}{n} \left(\overline{x}^n - \tilde{p}^{*n} \right) \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) = \\ \frac{\tilde{p}^*}{n(n-1)} \left(n - n\bar{x}^{n-1} + (n-1)\bar{x}^n - (n-1)\tilde{p}^{*n} \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) \end{aligned}$$

where the inequality follows from setting $k = n-1$. Observe next that this expression is decreasing in $\overline{x}$ since its derivative with respect to $\overline{x}$ is equal to $-\overline{x}^{n-2}(n(n-1)(1-\overline{x})) < 0$. Therefore we have

$$\begin{aligned} \frac{\tilde{p}^*}{n(n-1)} \left(n - n\bar{x}^{n-1} + (n-1)\bar{x}^n - (n-1)\tilde{p}^{*n} \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) > \\ \frac{\tilde{p}^*}{n(n-1)} \left(n - 1 - (n-1)\tilde{p}^{*n} \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) = \\ \frac{\tilde{p}^*}{n} \left(1 - \tilde{p}^{*n} \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) \end{aligned}$$

where the inequality follows from setting $\overline{x} = 1$.

Finally, note that the expression $\frac{\tilde{p}^*}{n}\left(1 - \tilde{p}^{*n}\right)$ is increasing in $\tilde{p}^*$ because its derivative with respect to $\tilde{p}^*$ is equal to $\frac{1}{n}\left(1 - (n+1)\tilde{p}^{*n}\right) > 0$. Therefore, if it is the case that $\tilde{p}^* > p^*$, we can write

$$\begin{aligned} \frac{\tilde{p}^*}{n} \left(1 - \tilde{p}^{*n} \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) > \\ \frac{p^*}{n} \left(1 - p^{*n} \right) - \frac{p^*}{n} \left(1 - p^{*n} \right) = 0 \end{aligned}$$

where the inequality follows from replacing $\tilde{p}^*$ with p^*. We then conclude that $\frac{\hat{\pi}_i}{k} - \pi^* > 0$ if $\tilde{p}^* > p^*$.

To complete the argument, we now show $\tilde{p}^* > p^*$ is indeed true. For this, we build on a result of Zhou (2009b). Consider the following modification of our model. Suppose that (i) the merging stores did not internalize the price-effects they impose on one another (ii) the merged entity continued to keep all its stores and (iii) consumers visited the merging stores first. If this were so, this modified model would be exactly identical to the market situation studied in Zhou's

(2009b) article on the effects of market prominence with multiple prominent firms. In his article, in fact, a number of "prominent" firms are searched first by the consumers, who, in case they do not find a satisfactory product, continue searching among the non-prominent firms.

In such a modified model, the payoff of a deviant (potentially) merging firm (or prominent firm in Zhou's terminology) would then be given by

$$\hat{\pi}_j = \hat{p}_j \left[\frac{1}{k} \frac{1-\bar{x}^k}{1-\bar{x}} \left(1 - \bar{x} + \hat{p}^* - \hat{p}_j\right) + \frac{1}{k} \left(\bar{x}^k - \left(\bar{x} - \tilde{p}^* + \hat{p}^*\right)^k \right) + \int_0^{\bar{x}-\tilde{p}^*} \left(\varepsilon + \tilde{p}^*\right)^{n-k} \left(\varepsilon + \hat{p}^*\right)^{k-1} d\varepsilon \right] \tag{36}$$

where $\hat{p}_j$ is indexed by j to indicate that it is the deviation price of a single potentially merging firm j. In the modified model, however, the payoff to a non-merging firm (or non-prominent firm) is exactly the same as the payoff in our model given in (10). This signifies that the reaction function of a non-merging firm is identical to $\nu_2(\hat{p})$, which was derived in the proof of claim 1.1.

Taking the FOC in (36) gives:

$$\frac{1}{k} \frac{1-\bar{x}^k}{1-\bar{x}} \left(1 - \bar{x} - \hat{p}^*\right) + \frac{1}{k} \left(\bar{x}^k - \left(\bar{x} - \tilde{p}^* + \hat{p}^*\right)^k \right) + \int_0^{\bar{x}-\tilde{p}^*} \left(\varepsilon + \tilde{p}^*\right)^{n-k} \left(\varepsilon + \hat{p}^*\right)^{k-1} d\varepsilon = 0 \tag{37}$$

This equation defines implicitly a relation $\tilde{p} = \nu_0(\hat{p})$. The crossing point between $\nu_0(\hat{p})$ and $\nu_2(\hat{p})$ gives the equilibrium prices $\hat{p}^*$ and $\tilde{p}^*$ in the modified model. As in our original model, note that the functions $\nu_0(\hat{p})$ and $\nu_2(\hat{p})$ can be interpreted as the joint reaction functions of the potentially merging and non-merging firms, respectively.

Zhou's (2009) Proposition 3 shows that non-prominent firms charge a price above the price the firms would charge if no firm were prominent. In the jargon of this paper, this implies that the non-merging firms in this modified model will charge a price above the pre-merger price, which is the result we want to prove.

To complete the proof, we now argue that moving from the modified model to the original model can only enhance the difference between the price of a non-merging firm and the pre-merger price. Consider first the effect of price coordination among the potentially merging firms, as it occurs after a merger has taken place. Under joint profit maximization, we need to add to the FOC in (37) the effect of a change in $\hat{p}_j$ on the profits of the other potentially merging firms. This effect is given by the following expression:[10]

$$\sum_{i\neq j}\frac{\partial\hat{\pi}_i}{\partial\hat{p}_j}\Big|_{\hat{p}_j=\hat{p}^*}=\hat{p}^*\left[\frac{1}{k}\frac{1-\bar{x}^k}{1-\bar{x}}-(\bar{x}-\tilde{p}^*+\hat{p}^*)^{k-1}+(k-1)\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\hat{p})^{k-2}(\varepsilon+\tilde{p}^*)^{n-k}d\varepsilon\right]>0 \tag{38}$$

We note now that the LHS of (37) decreases in $\hat{p}^*$. This is because its derivative is equal to

$$-(\bar{x}-\tilde{p}^*+\hat{p}^*)^{k-1}+(k-1)\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k}(\varepsilon+\hat{p}^*)^{k-2}d\varepsilon<$$
$$-(\bar{x}-\tilde{p}^*+\hat{p}^*)^{k-1}+(k-1)\bar{x}^{n-k}\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\hat{p}^*)^{k-2}d\varepsilon=$$
$$-(\bar{x}-\tilde{p}^*+\hat{p}^*)^{k-1}\left(1-\bar{x}^{n-k}\right)-\bar{x}^{n-k}\hat{p}^{*k-1}<0$$

Since (38) is positive, this implies that the internalization-of-pricing-externalities effect shift upwards the joint reaction function $\nu_0(\hat{p})$ of the potentially merging stores. Consequently, since the reaction function of the non-merging stores is upward sloping (due to strategic complementarity of the price-strategies) the internalization-of-pricing-externalities effect can only increase further the price of the non-merging stores, as expected.

To conclude, we show that in this modified model once the merging firms coordinate their prices their payoff is independent of whether the keep the k stores or shut down all but one.[11] To see this, multiply the sum of (37) and (38) by k to obtain:

$$\frac{1-\bar{x}^k}{1-\bar{x}}(1-\bar{x}-\hat{p}^*)+\left(\bar{x}^k-(\bar{x}-\tilde{p}^*+\hat{p}^*)^k\right)+k\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k}(\varepsilon+\hat{p}^*)^{k-1}d\varepsilon+$$
$$\hat{p}^*\left[\frac{1-\bar{x}^k}{1-\bar{x}}-k(\bar{x}-\tilde{p}^*+\hat{p}^*)^{k-1}+k(k-1)\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\hat{p})^{k-2}(\varepsilon+\tilde{p}^*)^{n-k}d\varepsilon\right]$$
$$=1-(\bar{x}-\tilde{p}^*+\hat{p}^*)^{k-1}(\bar{x}-\tilde{p}^*+(k+1)\hat{p}^*)+k\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k}(\varepsilon+\hat{p}^*)^{k-2}(\varepsilon+k\hat{p}^*)d\varepsilon$$

This last equation is exactly identical to the LHS of our FOC (11). These arguments together imply that $\tilde{p}^*>p^*$; hence, $\frac{\hat{\pi}_i}{k}-\pi^*>0$.

(ii) We now prove the second statement. For this we need to show that $\hat{\pi}^*/k-\tilde{\pi}^*>0$. It has been shown in the proof of Proposition 1 that when search cost is large $\hat{p}^*\to p_k^m$ and $\tilde{p}^*\to\frac{1}{2}$. Therefore, for the difference between the post-merger payoff of a merging firm $\hat{\pi}_i^*/k$ and the post-merger payoff

[10] Details on how to obtain this formula, which are available from the authors upon request, are omitted to save space.

[11] Of course, in our model, consumer search behavior is only consistent with equilibrium pricing if the merged entity sell all products at a single point-of-sale.

of a non-merging firm, $\tilde{\pi}^*$, we have:

$$\lim_{\bar{x}\to 1/2}\frac{\hat{\pi}_i^*}{k}-\tilde{\pi}^*=\lim_{\bar{x}\to 1/2}\left[\frac{\hat{p}^*}{k}\left(1-(\bar{x}-\tilde{p}^*+\hat{p}^*)^k+k\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k}(\varepsilon+\hat{p}^*)^{k-1}d\varepsilon\right)\right.$$
$$\left.-\tilde{p}^*\left(\frac{(\bar{x}-\tilde{p}^*+\hat{p}^*)^k}{n-k}\left(1-\bar{x}^{n-k}\right)+\int_0^{\bar{x}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k-1}(\varepsilon+\hat{p}^*)^k d\varepsilon\right)\right]$$
$$=\frac{p_k^m}{k}\left(1-(p_k^m)^k\right)-\frac{1}{2}\frac{(p_k^m)^k}{n-k}\left(1-2^{k-n}\right)$$
$$=\frac{1}{k}p_k^m\left(1-(p_k^m)^k\right)-\frac{1}{2\,(n-k)}(p_k^m)^k\left(1-\frac{1}{2^{n-k}}\right)$$
$$=\frac{1}{k}p_k^m\left(1-(p_k^m)^k\right)-\frac{(p_k^m)^k}{2}\int_{1/2}^1\varepsilon^{n-k-1}d\varepsilon$$

This expression is increasing in n because its derivative with respect to n equals

$$-\frac{(p_k^m)^k}{2}\int_{1/2}^1\varepsilon^{n-k-1}\ln\varepsilon d\varepsilon>0$$

Then

$$\lim_{\bar{x}\to 1/2}\frac{\hat{\pi}_i^*}{k}-\tilde{\pi}^*\geq\frac{p_k^m}{k}\left(1-(p_k^m)^k\right)-\frac{1}{2}\frac{(p_k^m)^k}{k+1-k}\left(1-2^{k-k-1}\right)=$$
$$\frac{p_k^m}{k+1}-\frac{(p_k^m)^k}{2}\left(1-\frac{1}{2}\right)=\frac{p_k^m}{k+1}-\frac{1}{4\,(k+1)}=\frac{1}{4\,(k+1)}\left[4p_k^m-1\right]>0$$

where the first inequality follows form replacing n by $k+1$. ■

Proof of Proposition 3. (i) We first note that the equilibrium of Proposition 1 has $\hat{p}^*>\tilde{p}^*$ when the search cost is sufficiently high. The difference between post- and pre-merger total industry profits, denoted as $\Delta\Pi$, is:

$$\Delta\Pi=\hat{\pi}+(n-k)\tilde{\pi}-n\pi^*$$

Using the expressions for profits above, we have

$$\Delta\Pi=\hat{p}^*\left(1-(\overline{x}-\tilde{p}^*+\hat{p}^*)^k+k\int_0^{\overline{x}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k}(\varepsilon+\hat{p}^*)^{k-1}d\varepsilon\right)+$$
$$\tilde{p}^*\left((\overline{x}-\tilde{p}^*+\hat{p}^*)^k\left(1-\overline{x}^{n-k}\right)+(n-k)\int_0^{\overline{x}-\tilde{p}^*}(\varepsilon+\tilde{p}^*)^{n-k-1}(\varepsilon+\hat{p}^*)^k d\varepsilon\right)-p^*\left(1-p^{*n}\right)$$

Note now that this expression is clearly increasing in $\hat{p}^*$ (the derivative of the first line, by the FOC, is zero and that of the second line is positive). Hence,

$$\Delta\Pi>\left.\Delta\Pi\right|_{\hat{p}^*=\tilde{p}^*}=\tilde{p}^*\left(1-\tilde{p}^{*n}\right)-p^*\left(1-p^{*n}\right)$$

Observe next that (**??**) increases in $\tilde{p}^*$ because its derivative with respect to $\tilde{p}^*$ equals $1-(n+1)\,\tilde{p}^{*n}$. Therefore,

$$\tilde{p}^*\left(1-\tilde{p}^{*n}\right)-p^*\left(1-p^{*n}\right)>p^*\left(1-p^{*n}\right)-p^*\left(1-p^{*n}\right)=0$$

where the inequality follows from using the result in the proof of Proposition 2 that $\tilde{p}^*>p^*$ and replacing $\tilde{p}^*$ by p^*.

(ii) In the pre-merger market, consumer surplus is given by

$$CS^{pre-merger}=\frac{1-\overline{x}^n}{1-\overline{x}}\int_{\overline{x}}^{1}\left(\varepsilon-p^*\right)d\varepsilon-s\frac{1-(n+1)\,\overline{x}^n+n\overline{x}^{n+1}}{1-\overline{x}}+n\int_{p^*}^{\overline{x}}\varepsilon^{n-1}\left(\varepsilon-p^*-ns\right)d\varepsilon-nsp^{*n}$$

In the post-merger market, consumer surplus is given by $CS^{post-merger}=\widehat{CS}+\widetilde{CS}+CS_{\varnothing}$, where the expressions for $\widehat{CS}$, $\widetilde{CS}$ and $CS_{\varnothing}$ are given in (13), (14) and (15).

When $s\to 1/8$, $\overline{x}\to 1/2$, $p^*\to 1/2$ and $\hat{p}^*\to p_k^m$. Then, we can establish the comparison

$$lim_{s\to 1/8}\left[CS^{post-merger}-CS^{pre-merger}\right]=\int_{p_k^m}^{1}\left(\varepsilon-p_k^m\right)d\varepsilon^k-\frac{1}{8}>0$$

The proof is now complete. ■

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