On the Effects of Consumer Search and Firm Entry in a Multiproduct Competitive Market

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This paper studies the effects of consumer search and firm entry on multiproduct firms’ pricing and product line breadth decisions in a competitive market. We consider three search models: costless search, costly parallel search and costly sequential search. Conventional economic intuition suggests that firm entry leads to more competition which leads to lower prices and narrower product lines. This indeed occurs in our models. Intuition also suggests that cheaper consumer search should intensify competition, thereby again leading to lower prices and narrower product lines. While the competition intensifying effect of search is present in our model, cheaper search also leads to more search, which gives each firm access to more consumers. A larger market encourages each firm to expand its product line. Because broader product lines are attractive to consumers, this market expansion effect mitigates the competitive pricing pressures associated with cheaper search. In fact, we find that the market expansion effect can dominate the competition intensifying effect, i.e., cheaper search in our model can lead to higher prices and higher firm profits. Hence, the impact of cheaper search is qualitatively quite different that the impact of firm entry: reduction in consumer search costs leads competitive firms to broaden their product lines, does not necessarily increase price competition and may even raise prices and firm profits.

1. Introduction

Existing research on effects of firm entry on product line/assortment offering and relationship between consumer search cost and pricing has suggested that both entry and lower consumer search cost reduce prices and assortment, since both of them create more competition in the market (e.g., Bakos 1997, BasuRoy and Nguyen 1998, Anderson and Renault 1999). Intuitively, one might still expect that lower consumer search cost affects prices and assortment offerings in the same way as firm entry in a multi-product oligopolistic market.

Surprisingly, we find that this is not necessarily the case. In our model of multi-product oligopolistic competition, in which firms have the flexibility to adjust both assortment and
prices, we show that a firm’s optimal response to firm entry is remarkably different from its optimal response to lower search costs. We define and study two search models: parallel search and sequential search. For both search models, while we can indeed show that firm entry leads to narrower assortment and lower prices, we show that lower search costs lead to deeper assortment and potentially higher prices. This sharp difference stems from the different effects of market entry and lower search costs on oligopolistic competition. With lower search costs, consumers are likely to search more firms, which in turn leads to more competition among firms. This competition intensifying effect of lower search costs appears similar to the effect of market entry and hence suggests narrower assortment and lower prices. However, with lower search costs, it is optimal for consumers to gather information from more firms, and thus the potential market of each firm increases. This market size expansion effect of lower search costs provides the firm with an incentive to expand their assortment and in turn possibly charge higher prices and earn higher profits.

2. Model

In our model there are \( n \) risk neutral multiproduct firms who sell to risk neutral consumers differentiated products in the same category. The firms simultaneously choose their prices and assortment. Consumers then shop among the firms and either buys one unit from one firm or purchases nothing. We study two consumer search models: parallel search and sequential search. Search is costly in the parallel search model, so consumers commit to visit a fixed number of firms and purchase their most preferred product among the firms searched. Search is also costly in the sequential search model but consumers do not \( a \ priori \) commit to the number of firms they will visit. Instead, they visit firms sequentially and decide after visit each firm whether to purchase an item at the current firm, continue their search or purchase nothing. In both models the firms choose their prices and assortment to maximize their expected profit given the consumers search behavior and consumers maximize their utility given the prices and assortment decisions of the firm.

Our consumer choice process is based on the multinomial logit (MNL) model (see Anderson, de Palma and Thisse 1992). The basic form of the model works as follows. A consumer considers whether to purchase one unit from a set of products, \( S \), or to purchase nothing, the no-purchase option, which we denote as product 0 (i.e., the consumer chooses not to purchase by choosing to “purchase” product 0). Let \( U_j \) be the consumer’s utility from
product $j$, $j \in S \cup 0$: $U_j = (u_j - p_j) + \zeta_j$, where $u_j$ is a constant, $p_j$ is the price of product $j$ ($p_0 = 0$), and $\zeta_j$ is a random variable with a zero-mean Gumbel distribution. A consumer chooses the product with the highest realized utility. Let $q_j (S \cup 0)$ be the probability a consumer chooses product $j$ given the choice set. It is well known that

$$q_j (S \cup 0) = \Pr(U_j = \max \{U_i, i \in S \cup 0\}) = \frac{\exp((u_j - p_j) / \mu)}{\sum_{i} \exp((u_i - p_i) / \mu) + \exp(u_0 / \mu)}.$$  

We assume that all actual products are equally likely to be preferred, adjusting for any price differences. Furthermore, each firm offers a unique set of products (i.e., each firm is the exclusive provider of its assortment). Because all products are essentially identical in our model, it is optimal for a firm to set the same price across all of its products, and the firm’s assortment decision amounts to choosing the number of products to offer. We assume each firm purchases each product for the same marginal cost (normalized to zero) but variety is costly from an operational perspective. In particular, let $c(x)$ be a firm’s operational costs when it carries $x$ products, $c'(x) > 0$ for $x > 0$, $c(0) = 0$, $c'(0) = 0$ and $c''(x) > 0$. Firms choose their prices and assortments simultaneously and then consumers shop among the firms given their expectation of the firms’ prices and assortments. We focus on characterizing symmetric equilibrium.

3. Competition with Parallel Search

When consumers search firms in parallel, anticipating a symmetric equilibrium: each of the $n$ firms chooses price $p^*$ and assortment $x^*$, each consumer a priori commits to search $m$ firms. The consumer observes the product offerings of a randomly selected $m$ firms and then purchases the product that maximizes utility net price, which may be the no-purchase product. The consumer incurs a search cost of $\tau$ per firm included in the search, for a total search cost of $m\tau$. Consumers choose $m$ optimally given their expectations of $\{p^*, x^*\}$, and firms choose their prices and assortments optimally given their expectation of $m$. A symmetric equilibrium in this setting is a tuple, $\{p^*, x^*, m^*\}$, such that consumers have no incentive to deviate from their search strategy and no firm has an incentive to deviate from its price and assortment strategy. We show that in the parallel search model there exists a unique symmetric equilibrium, $\{p^*, x^*, m^*\}$. The following table summarizes how firm entry (increased $n$) and lower search costs (decreased $\tau$) influence equilibrium prices, assortment,
profits and the total number of products available in the market \((nx^*)\).

\[
\begin{array}{c|c|c}
\text{firm entry (increase } n\text{)} & \text{lower search costs (decrease } \tau\text{)} \\
\hline
p^* & +/− & − \\
x^* & + & + \\
\text{firm profit} & − & +/− \\
\text{total market variety, } nx^* & +/− & + \\
\end{array}
\]

where “+” indicates an increasing relationship, “−” indicates a decreasing relationship and “+/−” indicates an ambiguous relationship. Furthermore, lower search costs may increase price \(p^*\), and if it does so, then firm profit increases as well.

Although both entry and lower search cost intensify market competition, the contrast between the effect of firm entry on market equilibrium and the effect of lower search costs is striking. Consistent with commonly held view, firm entry always reduces equilibrium assortment, prices, and profits. However, lower search costs raises equilibrium assortment and may even increase equilibrium prices and profits. This sharp difference stems from the fact that in addition to the competition intensifying effect, lower search costs has one more effect on market dynamics: when consumers search more actively in the market with lower search costs, it allows a firm to access more potential consumers, i.e., lower search costs expands the potential market size for the firm. This market size expansion effect of lower search costs raises firms’ incentives to expand their assortment. With deeper assortment, firms are possibly able to charge higher prices and earn higher profits.

4. Competition with Sequential Search

When consumers search firms sequentially, consumers still incur a search cost of \(\tau\) to visit a firm. Suppose a consumer is visiting firm \(i\) with price \(p_i\) and her utility of the best product offered by firm \(i\) is \(y\). Anticipating a symmetric equilibrium, \(\{p^*, x^*\}\), it is worthwhile for the consumer to search another firm instead of purchasing the current best product if the expected value of search is greater than the search cost \(\tau\), i.e.,

\[
Z_{\infty} \int_{y-p_i+p^*} \phi \geq \tau,
\]

where \(H(\phi, x)\) is the CDF of the maximum utility of \(x^*\) products. It implies that the optimal consumer search strategy is a threshold strategy: there exists a threshold \(\tilde{U}(x^*, \tau)\) such that consumers will choose to search another firm if \(y \leq \tilde{U}(x^*, \tau) + (p_i - p^*)\). Consumers choose their search threshold \(\tilde{U}(x^*, \tau)\) optimally given their expectations of \(\{p^*, x^*\}\), and
firms choose their prices and assortment optimally given their expectation of consumer search threshold \( \tilde{U}(x^*, \tau) \). We assume that consumers observe their no-purchase utility \( U_0 = u_0 + \zeta_0 \) first. Thus, a consumer will search a firm if and only if \( U_0 \leq \tilde{U}(x^*, \tau) - p^* \). Therefore, only a fraction of consumers actually enter the market. A symmetric equilibrium in this model is a tuple, \( \{p^*, x^*, \tilde{U}(x^*, \tau)\} \), such that consumers have no incentive to deviate from their search strategy and no firm has an incentive to deviate from its price and assortment strategy. We establish the existence and uniqueness of the unique symmetric equilibrium \( \{p^*, x^*, \tilde{U}(x^*, \tau)\} \). The comparative statics of market equilibrium with respect to firm entry (increased \( n \)) and lower search costs (decreased \( \tau \)) are summarized in the following table.

<table>
<thead>
<tr>
<th></th>
<th>firm entry (increase ( n ))</th>
<th>lower search costs (decrease ( \tau ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p^* )</td>
<td>( \text{N} )</td>
<td>-</td>
</tr>
<tr>
<td>( x^* )</td>
<td>( \text{-} )</td>
<td>( \text{+} )</td>
</tr>
<tr>
<td>firm profit</td>
<td>( \text{-} )</td>
<td>( \text{+ / -} )</td>
</tr>
<tr>
<td>total market variety, ( nx^* )</td>
<td>( \text{+ / -} )</td>
<td>( \text{+} )</td>
</tr>
</tbody>
</table>

where “+” indicates an increasing relationship, “−” indicates a decreasing relationship, “+/−” indicates an ambiguous relationship, and “N” indicates no relationship.

Qualitatively, the above results are consistent with the main findings in the parallel search model: firm entry and lower search costs influence market equilibrium quite differently because of the market size expansion effect of lower search costs. It is interesting to note that in the sequential search model, the market size expansion effect of lower search cost has two forms: total market size expansion and individual firm market size expansion. The former one reflects that lower search cost induces more consumers to enter the market at the first place and the latter reflects that a firm is able to access more consumers as they search more actively with lower search cost.

It seems that lower search costs is less helpful to firm profitability than it is in the parallel search model, since the equilibrium assortment expansion driven by its individual firm market size expansion effect is not strong enough to elicit a price increase any more. Nevertheless, we find that lower search costs still can possibly increase the equilibrium profits, especially when consumers’ expected no-purchase utility \( u_0 \) is large. When \( u_0 \) is large, consumers are less likely to enter the market at all. In this case, the total market expansion effect of lower search cost becomes stronger and more important to firms’ profitabilities. Therefore, when \( u_0 \) is large enough, with lower search costs, this total market size expansion overwhelms the price decline and assortment cost increase to increase the equilibrium firm profit.
5. Conclusion

This paper explores the effects of firm entry and lower search costs on market equilibrium in a competitive multiproduct market. Conventional economic wisdom suggests that more competition leads to lower prices and narrower assortment. However, we show that lower search costs influences market equilibrium very differently as compared to firm entry, although both of them intensify competition in the market. Specifically, with parallel search model in which consumers commit to visit a fixed number of firms, we find that lower search costs actually raises the equilibrium assortment and does not necessarily cause a price war and profit decline in the market, while firm entry lowers equilibrium prices, assortment, and profits. With sequential search in which consumers search firms one by one in a sequence, we also find the similar significant differences between the effects of lower search costs and firm entry on the market price and assortment. This sharp difference relies on the unique market size expansion effect of lower search costs. We conclude that when facing increasing competitive pressure in the market, firms should pay close attention to identify the driving forces behind changing market dynamics. Failing to do so may lead firms to end up with fundamentally wrong strategic responses to the changing market conditions and potential disadvantages in competition.

References


