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Advertising for Attention and Consumer Search in a Multiproduct Market

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Abstract

This study investigates two favored strategies, advertising and product line manipulation. We consider multiproduct market when the consumers search order is biased. The consumers sequentially search firms offering substitutable products. Firms employ advertising to create saliency in consumer memories. The consumers receive adverting and then choose their search order. The firm that has lower advertising costs advertises intensively and induces more consumers at the first search. This salient firm maintains higher profits, charges lower prices and has broader assortments. With harder searching, more advertising, more salient products, fewer less-salient products, and higher prices are revealed. With changes in advertising technology, we find that the progress enhances social welfare only if it increases the technology gap between firms. Symmetrical development does not affect welfare. It culminates with more intense levels of advertising.

Keywords: Advertising; Assortment; Consumer Search; Game Theory
JEL Classifications: C72; D43; D83; L13

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1. Introduction

Advertising competition among firms is becoming ever more intense. According to eMarketer, the global market research company, advertising spending worldwide stood at $513 billion in 2015, with average annual growth at 5.5%, faster than the rate of world output. The early literature studies highlighted advertising as a tool helping consumers realize the utility of products (Butters; 1979, and Grossman and Shapiro; 1984). Such works focused on Informative Advertising, which provides information to eliminate search costs, while not influencing consumers' search order. Advertising exists because consumers lack sufficient information. This information could entail either values or prices. Therefore, firms advertise in order to inform their clients. Consumers exposed to a particular advertisement receive information concerning the originating firm. Other consumers could gain such information by paying search costs. If these search costs are prohibitively high, they are likely to soon stop searching or, when the degree of product differentiation is very low (homogenous good), they are unlikely to search at all (Diamond, 1971).

Without guidance, all consumers would search randomly and sellers equally share the market. Nowadays advanced internet technologies help consumers become better informed. Numerous free internet based product review sites result in search costs being negligible. However, Rhodes (2011) claims that, even when the cost of searching websites and comparing products is essentially zero, prominent retailers earn significant profits. This paper emphasizes the importance of the relative position a product occupies in consumer search orders. Being first in a search listing favors firms since their products have a greater chance of being purchased. The ways products are presented can influence consumer search orders. In this sense, firms are willing to pay for their products to have prominence in search listings. Advertising could potentially be a tool to convince consumers to search shops first. Without such a message, firms have an equal chance to be sampled. In this framework, advertising cannot be substituted with the search costs, but could guide consumers in choosing their search orders. More consumers would visit a firm that advertises intensively.

Alongside advertising, product line extension has become one of the most favorite strategies adopted by firms in recent years (Draganska and Jain, 2006). A firm can sell various products which are different in favors, colors, or other attributes. Many studies try to explain why firms want to produce many products. Conventional wisdom informs that a firm extends products in a horizontal direction (products have the same price and quality, but vary in other attributes.) to improve their ability to capture consumers' match values. This is particularly important when consumers have high heterogeneity in tastes. It is generally accepted in marketing research that product extension strategies allow firms to charge higher prices (Draganska and Jain, 2006) and increase their market share and profitability (Kekre and Srinivasan, 1990), as well as softening price competition and achieving higher margins (Kadiyali et al., 1999). Despite the many benefits associated

with offering a larger assortment of products, the production processes become increasingly complicated and generate commensurately higher costs.

Most studies on product line extension assume that consumers know the prices and characteristics of all products available in the marketplace. Consumers become acquainted with products through a costless search. Whereas some of the literature (Wolinsky, 1984; Wolinsky, 1986; Rhodes, 2011) suggests that the consumer searching can play a significant role in the market, the consumer search model could explain why consumers shop around before buying. There are many industries in which buyer-related searching is an important feature in the market. For example, women frequently visit several shoe outlets before making a final purchase, or a couple will look at a variety of houses before eventually settling for only one.

Some studies in the relevant literature incorporate the concept of assortment within the consumer search model. Cachon et al. (2005) and Cachon et al. (2008) researched into consumers randomly searching. However, there are no studies examining the role of advertising within consumer search ordering. In addition, there is a dearth of studies incorporating advertising with the roles of saliency and assortment in the consumer search model. This study aims to fill the gap in the existing literature in such a way that more clarity will be revealed into the nature of the relationship between advertising and assortment strategies.

This study aims to analyze the impact of prominence on assortment and pricing. It also investigates the decision-making process when two firms are engaged in a battle for consumer attention. In addition, details of how each firm responds to changes in search costs are verified. Finally, we draw inferences on how the market should intervene in order to achieve optimal social welfare.

We focus on duopoly competition, principally concerning both pricing and non-pricing strategies. In particular, we seek to examine the advertising, assortment and pricing decision-making processes. The role of advertising is to create firm saliency, that is, the prominence of brands in consumers' memories. The order in which firms are visited is influenced by their advertising efforts. The assortment includes only decisions made in a horizontal direction within which all brands in the market have the same quality, but differ in terms of other attributes. Specifically, a firm's assortment guarantees a minimum utility to its consumers.

This article draws on the rich body of literature focusing on consumer search. In particular, our model is related to the branch within the search literature concerned with product differentiation, where consumers search considering both relative price and matching values. Weitzman (1979) proposes a sequential search strategy wherein an agent will terminate a search whenever the sampled reward exceeds the reservation price. This reservation price depends on three properties of option i. These are the cost to open it, the time lag to learn about the payoff, and the distribution of the payoff. Such a model was later developed by Wolinsky (1986) in order to study the behaviors of firms under consumer search, claiming that, with free entry and a large number of firms, search costs

allow firms to maintain significant market power. Wolinsky's model was developed further by Anderson and Renault (1999) who discuss how equilibrium prices are affected by changes in the degree of product differentiation. They claim that the Diamond Paradox is limited in the market with homogeneous product. In search models with product differentiation, there are some consumers who are ill-matched with their initial choice of supplier and then search further, so that the pro-competitive benefit of actual search is present. Generally, a model with product differentiation potentially reflects consumer behavior in markets with non-standardized products.

More recent consumer search models focus on biasing consumer search order. Armstrong et al. (2009) were motivated by the fact that consumer search order is not random, but is influenced by the way the options are presented. We use Armstrong et al. (2009) as the starting point for our study. As a result of high price elasticity, prominent firm sets lower prices and maintain higher profits.[1] Such a prominent firm solely gain from its advantages in terms of search ordering, while other non-prominent firms and consumers suffer from this condition. This study explains why firms need to attain prominence.

There are many ways to become prominent, for example both commission payments and advertising (Armstrong and Zhou, 2009). Advertising is generally considered as a tool for disseminating information. Grossman and Shapiro (1984) studies informative advertising which gives full information, thus eliminating search costs. In this case consumers are passive in search activity and only receive information via advertising. The improvements in advertising technology, including both reductions in advertising costs and an increased ability to target messages to specific groups of consumers, may potentially reduce profits by increasing price competition. Haan and Maranga-Gonzales (2011) generalize Armstrong et al. (2009) by introducing advertising as a tool to create prominence. Unlike Grossman and Shapiro's model, advertising does not reduce search costs, but rather affects a consumer's likelihood of sampling a firm's products. The firm that advertises more can attract more consumers. If all firms advertise equally, consumers will search randomly. In this case, the advertising will become a pure waste. In an asymmetric equilibrium, more efficient firm advertises more and charges a lower price. Industry profit can increase when the technology gap is large. Such an effect wherein more prominent firms set lower prices is found in Bagwell and Ramey (1994), although for very different reasons. Apart from high price elasticity, bigger firm still charge low price. Firms are identical ex ante and attract consumers by means of advertising. They have been able to acquire economies of scale, so that one facing greater demand has a lower marginal cost. Consumers follow the rule of thumb whereby they buy from firm which advertises most heavily. As a result of economies of scale, such firm will have a lower price than its rivals. Thus, the consumer response to advertising is indeed rational even though

[1] This condition does not hold in the case of an infinite number of firms. The prices of prominent and non-prominent firms are equal if n goes to infinity.

advertising messages are not directly informative, and again prominent firm sets a lower price.

The consumer search model also has some impact on the assortment strategies in which firms sell products encompassing a set of brands which differ across various attributes. Firms expect that having more distinct brands leads to a greater chance that potential consumers will purchase one of their products. An active searching consumer prefers firms that provide various products because she would expect higher benefits when visiting that firms' website. Cachon et al. (2008) observes that consumers randomly search among an infinite number of firms and find that easier search raises the number of brands and does not necessarily reduce profits. An easier search brings new consumers, so competition in the assortment leads to increased profitability. Draganska and Jain (2005) consider product assortment to be a competitive tool in the context of the U.S. yogurt industry. Research shows that firms extend assortments because they can then charge higher prices. Furthermore, firms prefer to commit to an assortment of brands if possible which means they are contribute to an excessive variety of competitors within their particular market. Such a conclusion may be drawn by implicitly assuming that consumers incur no searching cost. If consumers lack information about the characteristics and prices of brands in the market, research should investigate the impact of search costs and particular firms' saliency in the consumers' memory.

2. Model

This study focuses on advertising and assortment as competitive tools. The role of advertising is to create saliency, that is, the prominence of a firm in consumers' memories. Extended assortment occurs when a firm has various brands which can appear encompassing different color combinations, product sizes and different brand uses.

There are only two firms operating in the market. Each offers a set of differentiated products within the same category to consumers. Both firms simultaneously choose levels of advertising, assortments and prices.[2] While they have symmetric production technology, they have asymmetric advertising technology. Variable costs are normalized to zero, whereas the marginal costs incurred to extend the assortment are positive. The longer assortment, the higher production costs to be incurred at an increasing rate.

The consumers have both heterogeneity in taste and imperfect information about the match values of the available brands in the marketplace. To gain that information, consumers must sequentially search which imposes them to explicit search costs. Once they visit a firm, they must decide whether to terminate or continue their search.

[2] The assumption that each firm set the same price for its own brands is valid if consumers values in qualities more than products' attributes. Draganska and Jain (2006) confirm that setting the different prices according to products' qualities and the same price in the same product line (same quality) are the corrected pricing strategy.

2.1 Information

The main concern of this study lies in consumers' information. Here we assume that initially a consumer does not know the exact prices and her match values provided by both firms. However, she can gather such information by searching among firms. It should be noted that consumers could receive some information from advertisements, but still not have full information.

We make the following assumptions concerning consumers' search:

1) At a cost s per firm a consumer can sample firm's brands and find out about prices and her highest value in the shop.

2) The consumer's search is without replacement and with costless recall. That is, each time the consumer incurs costs, she will learn about a set of different brands, and can proceed to purchase any one of the brands she has already sampled without incurring additional search costs.

2.2 Consumer Search

The number of consumers in the market is normalized to 1. They are uniformly distributed along the characteristics line [0,1]. A consumer considers whether to purchase one unit from a set of products, or to purchase nothing, which we call the no-purchase option. The highest utility received from consuming her most favorite brand from firm *i* is Y_i. Consumers learn about Y_i only upon visiting firm *i*. A standard optimal stopping rule is employed with the form:

$$s = \int_{x_i}^{1} (y_i - x_i) dF(y_i, r_i) \tag{2.1}$$

The reservation price X_i is determined by search cost s and the assortment, r_i. It decreases with s , but increases with r_i. This implies consumers are more likely to terminate search sooner and may accept a payoff that is far from their preferences when search costs are high. On the contrary, as more brands are offered by firms, consumers will expect a better payoff in their next search, therefore they become more choosy. In this sense, a firm can extend its product line to substitute for search costs. If there is no search cost , $s \approx 0$, $x_i \approx 1$, the consumers will search until they meet a brand which gives the highest utility in the market. This can be perceived as a special case.

Given the finite options available, one might suppose that an optimal search strategy would exhibit (i) the consumer becoming less choosy as the number of remaining brands shrinks, or (ii) when there are fewer firms, a consumer is less choosy. However, Wolinsky (1986) shows that the optimal search rule is stationary when consumers can costless go back to the earlier sampled brands without incurring additional costs. It can be reduced to:

1) If $p_i > x_i$, a consumer should not participate in the market.

2) If $p_i \leq x_i$, a consumer should stop searching when she finds a brand with $y_i - p_i > x_j - p_j$; if no such brand is eventually found in both shops, she goes back buying the brand with the highest y_i, provided $y_i > p_i$. If all y_i are below p_i, then the consumer buys nothing.

2.3 Advertising

The purpose of firms engaging in an advertising battle is to lure consumers to their shops. In particular, a consumer is more likely to go to a firm *i* if she is more exposed to the advertising of that firm. Intuitively, the more advertising the more likely it is that consumers will remember the particular advertising content and messaging. The probability that the consumer will recall firm i from her first search is given by

$$\frac{a_i}{\sum_{i=1}^{2} a_i}. \tag{2.2}$$

This modeling of the recall probability captures the consumers' memory of competing firms. A firm that has zero advertising will be visited last. If no firm has positive advertising, the consumer visits firms randomly.[3]

The consumers receive all advertisements and they are able to derive some information, such as the prices and properties of products. One can think of the advertising of a firm as a ball this firm puts in an urn. Each firm can put in as many balls as it is able. Whenever the consumer needs a product, she draws one ball from the urn and visits the corresponding firm. In the first visit, if the consumer is not satisfied with the products she already sampled, she will search for another firm without drawing an additional ball.

2.4 Assortment

Each firm offers a unique set of products (i.e., each firm is the exclusive provider of its own assortment). This is appropriate in a market with both substantial variety and diffuse preferences, such as women's shoes, eyeglasses, furniture, antiques, bicycles, or paperback novels, among others. We assume that all firms' products are equally likely to be preferred, adjusting for any price differences. Let y_i be the consumer's highest utility provided by firm *i*. The CDF $F(y_i, r_i)$ is

$$F(y_i, r_i) = \frac{y_i - r_i}{1 - r_i} \qquad , r_i \in [0,1], \ and \ \ y_i \in [r_i, 1]$$

Firm *i* chooses level of assortment r_i (how much the minimum utility it guarantees to the consumers). For analytical simplicity, we treat r_i as a continuous variable. We assume that each firm purchases each product for the same marginal cost (normalized to zero), but variety is costly from an operational perspective. In particular, let $c(r_i)$ be a firm's operational costs when it carries r_i assortment, $c(0) = 0$, $c'(r_i) > 0$ and $c''(r_i) > 0$. Specifically, we assume

$$c(r_i) = \log\left(\frac{1}{1 - r_i}\right) - r_i \text{ and } c'(r_i) = \frac{r_i}{1 - r_i}.$$

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[3] In the symmetric case, the game in (2.2) can be considered as "Prisoners' dilemma". Firms equally advertise and also equally share a pool of consumers who sample their products first. However, in order to achieve this result, all firms would be better off not advertising at all.

2.5 Firms

Assume that, upon visiting a firm, a consumer learns its type and information about its products. Let $\Omega \in \{1,2,12,21\}$ which denotes the firms a particular consumer visits, and in what order. Thus $\Omega = 12$ implies that the consumer has first visited firm 1, and then firm 2. Let q_i^{Ω} denote the total demand for firm i from such consumers. Thus, q_1^{12} denotes the demand for firm 1 from consumers that visit firm 1 and 2 in that order, while q_1^{1} denotes the demand for firm 1 from consumers that only visit firm 1.

The probability that consumers sample firm i in their first search is $\lambda_i = \frac{a_i}{a_i + a_j}$. A consumer immediately discovers their utilities attached to each brand and realizes which brand give the highest utility y_i. She explores firm *i*'s single price *p* and accurately predicts another firm's price p_j.[4] Thus, a brand in firm i is chosen if $\Pr\left(y_i - p > x_j - p_j\right)$. Here, $x_j - p_j$ is the reservation surplus when a consumer deals with this firm. Then, firm *i*'s "fresh demand" is:

$$q_i^i(p) = \lambda_i \left[1 - \frac{x_j - p_j + p - r}{1 - r}\right]. \tag{2.3}$$

There is a situation wherein a consumer visits firm *j* first, but decides to continue her search to firm *i*. The probability is reflected by the term $h_i = \frac{x_i - p_i + p_j - r_j}{1 - r_j}$. Once she visits firm *i*, she will make a purchase if $\Pr(y_i - p_i > y_j - p_j)$ and $\Pr(y_i > p)$. Thus, firm *i*'s "experienced demand" is defined as:

$$q_i^{ji}(p) = \lambda_j \left[h_i \cdot \left(1 - \frac{x_i + p - p_i - r}{1 - r}\right) + \int_p^{x_i + p - p_i} \frac{y_i - p + p_j - r_j}{1 - r_j} \cdot \frac{1}{1 - r} dy_i \right] \tag{2.4}$$

When a consumer first visits firm *i* and then firm *j*, she will return to buy from firm *i* if it gives higher utility than firm *j*, $\Pr(y_j - p_j < y_i - p)$ and $\Pr(y_i > p)$. With costless recall, this consumer can choose a brand that she has already explored without any cost. This faction is "returning demand" and the probability of this event is:

$$q_i^{ji}(p) = \lambda_j \left[h_i \cdot \left(1 - \frac{x_i + p - p_i - r}{1 - r}\right) + \int_p^{x_i + p - p_i} \frac{y_i - p + p_j - r_j}{1 - r_j} \cdot \frac{1}{1 - r} dy_i \right].$$

$$q_i^{ij}(p) = \lambda_i \cdot \int_p^{p + x_j - p_j} \frac{y_i - p + p_j - r_j}{1 - r_j} \cdot \frac{1}{1 - r} dy_i \,. \tag{2.5}$$

The total demand of firm *i* comprises fresh demand q_i^i, experienced demand q_i^{ji}, and returning demand q_i^{ij}.

$$q_i = q_i^i + q_i^{ji} + q_i^{ij} \tag{2.6}$$

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[4] *p* and *r* denote the price and assortment firm *i* may choose, while p_i and r_i are those expected by consumers and the rival firm.

Firm i maximizes profit by simultaneously choosing a level of advertising a_i, assortment r_i, and a price p_i. This imposes the advertising cost $\phi_i(a_i)$ and production cost $c_i(r_i)$. When firm i charges p, the profit function is:

$$\pi_i(p) = pq_i - \phi_i(a) - c_i(r) \quad (2.7)$$

3. Results

The firm that invests more effort and resources into advertising is more likely to induce a greater number of consumers to make a first visit. The central question is whether firm which attract more consumers in the first visit charge higher or lower prices compared to other firms. Do such firm provide a broader assortment of products? More specifically, how does a greater volume of advertising correlate with price and assortment? How are firms' profits affected by firms' asymmetry?

We focus on a case where the asymmetry in equilibrium prices stems exclusively from differences in advertising levels, we assume that firms differ in the costs they have to incur in order to undertake a advertising campaign. Technically, we write the cost of firm i, $\phi_i(a_i)$, i = 1, 2.[5] One inherent complication in this context concerns consumer search behavior after out-of-equilibrium moves. Suppose that firms charge different prices in equilibrium. Let us assume consumers know the equilibrium prices, but do not know which firm has which particular price. Suppose now that a consumer observes an out-of-equilibrium price at her first visit. Her decision whether to continue searching will then be affected by whether she interprets this out-of-equilibrium price as coming from the low-price or high-price firm.

There are various ways to circumvent this complication. Haan and Moraga-Gonzalez (2011) simplifies considerations by assuming that, upon visiting a firm, a consumer can learn what type of company it represents.[6] This study computes the equilibrium under this assumption. Another possibility is to specify a set of beliefs after disequilibrium moves that sustain a given equilibrium.

As described in last section, the firm has three types of demand, fresh demand q_i^i, experienced demand q_i^{ji} and returning demand q_i^{ij}. When firm i charges p, its profit is:

$$\pi_i(p) = pq_i - c_i(r_i) - \phi_i(a_i) \quad (3.1)$$

Taking the FOCs with respect to own advertising intensity, assortment, and price, imposing $p = p_i$, $r = r_i$ and $a = a_i$, and doing so for $i = 1,2$ and $j \neq i$ yields six nonlinear

[5] In this case, if we choose marginal costs to be different, price variation due to marginal cost differences would be augmented by price variation due to different advertising.

[6] For example, from observing the lay-out and the colors in the store, she may realize that she has actually seen more advertisements from the other store and hence this store must be the one with the more costly technology.

equalities that can be solved to find equilibrium prices, assortments, and advertisings. From these FOCs:

$$p_i = q_i \frac{1 - r_i}{\lambda_i + h_i \lambda_j}, \tag{3.2}$$

$$r_i = p_i q_i \tag{3.3}$$

$$a_i = p_i \frac{\lambda_j}{\phi_i'} \left[\frac{q_i^i + q_i^{ij}}{\lambda_i} - \frac{q_i^{ji}}{\lambda_j} \right] - a_j \tag{3.4}$$

Proposition 1: There exists equilibrium of price, assortment, and advertising. Under the uniform distribution of matching values, within the ranges $\left(p_i^*, r_i^*, a_i^*\right) \in [0, x_i] \times [0, p_i] \times [0, \infty)$, the expressions *(3.2), (3.3),* and *(3.4)* have a unique solution.

Proof. See Appendix.

3.1 Analysis

We find the following results:

Proposition 2: With two firms, a uniform distribution of matching values and asymmetric advertising technologies, we reveal that the firm that advertises more, provides a broader assortment and sets a lower price: $a_i^* > a_j^*$ necessarily implies $r_i^* > r_j^*$ and $p_i^* < p_j^*$.

Proof. See Appendix.

This is not a surprising result. The previous literatures suggest that a firm with a higher degree of prominence will discount.[7] We contribute that the advertising does not give specific information regarding pricing power. We also find a positive relationship between advertising and assortment. A firm that conducts advertising more intensively attracts a broader range of consumers that on average are less interested in the products of this particular firm. Hence, this firm intends to charge lower price with a broader assortment in order to convince these consumers to terminate their search and buy immediately.

By continuing to search, consumers reveal that they do not particularly like the products the first firm offered. Therefore, such consumers are less price-sensitive than consumers who still have the option to visit another shop. The firm with less advertising has a higher share of these less price-sensitive consumers. Therefore, such a firm provides fewer brand and charges higher price.

To see which firm advertises more, we need to incorporate an additional structure into the model. Assume that advertising technologies are linear, so $\phi_i(a_i) = \gamma_i a_i$, with $\gamma_1 < \gamma_2$.[8] Then,

[7] See Armstrong et al. (2009), Leawsakul (2014), and Haan and Moraga-Gonzalez (2011).

[8] With linear advertising costs, it is not guaranteed that our profit functions are globally well-behaved (Proposition 3). To make sure that the solution to the FOCs in indeed a Nash equilibrium, we check numerically that any deviation from the solution to the FOCs yields a lower payoff.

Proposition 3: With two firms, a uniform distribution of matching values and linear asymmetric advertising technologies, in equilibrium, the more advertising-efficient firm will advertise more.

Proof. See Appendix.

To perform comparative statics, we have to resort to a numerical analysis. We again assume linear advertising technologies. Without loss of generality, we assume that firm 1 has more efficient technology, and normalize γ_2 to 1, so $\alpha = \frac{\gamma_1}{\gamma_2} \leq 1$. Proposition 2 implies that $r_1^* \geq r_2^*$ and $p_1^* \leq p_2^*$. The Figures 3.1, 3.2, and 3.3 depict an equilibrium in advertising, assortments and prices as a function of the firm asymmetry when $s = 0.08$. The horizontal axis α now reflects the extent of asymmetry between advertising technologies: as closer to 1, advertising technologies become more symmetric.

Figure 3.1: Advertising and Firm Asymmetry

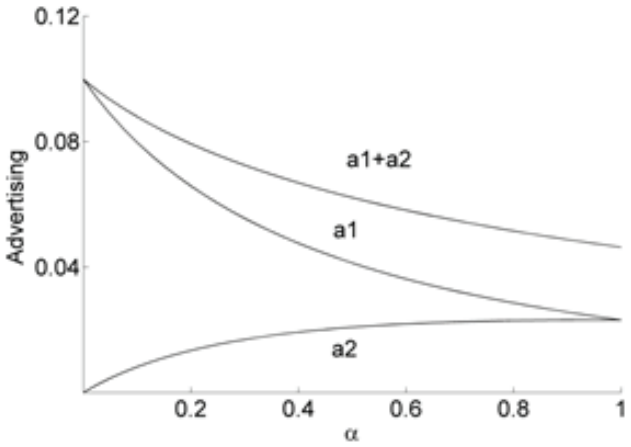


Figure 3.2: Assortment and Firm Asymmetry

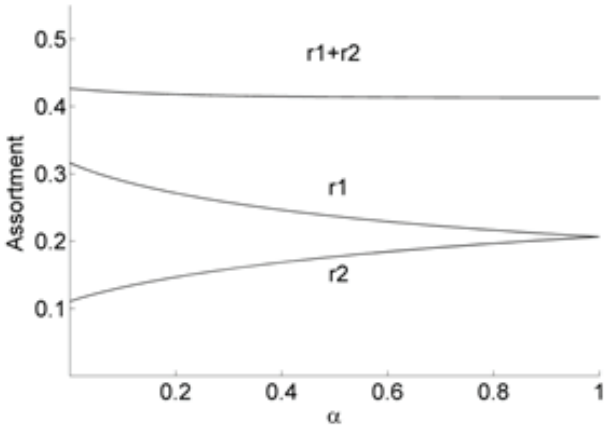
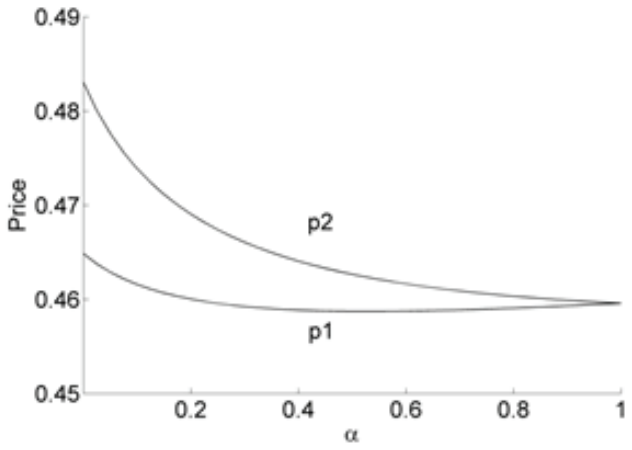


Figure 3.3: Price and Firm Asymmetry



Source: Author's calculations

Remark 4: With two firms, a uniform distribution of matching values, linear advertising technologies, and firm 1 being the more advertising-efficient firm, we maintain that an increase in the asymmetry in firm advertising efficiency has the following effects:

(1) The price gap increases, the price of the most expensive firm increases, while average prices also increase.

(2) The assortment level of the cheapest firm increases, that of the most expensive firm decreases, while average assortment levels are almost constant.

(3) The advertising level of the cheapest firm increases, that of the most expensive firm decreases, while average advertising levels also increase.

The cheaper firm could potentially charge both lower and higher price than it actually charges with equal advertising, while the more expensive firm charges a price that is higher than it charges with equal advertising. Remark 4(1) shows that the price gap becomes larger as the difference in equilibrium advertising levels increases. The cheaper firm provides a broader assortment than it provides with equal advertising, while the more expensive firm offers an assortment that is lower than in the case with equal advertising. Remark 4(2) states that the assortment gap increases with the advertising asymmetry. Remark 4(3) implies that, as the asymmetry in firm advertising costs increases, the difference in advertising efforts also increases.

The price gaps increase mainly because of larger differences in advertising. However, it also increases the assortment gap, and in turn reduces price gaps. The broader assortment strengthens firm 1's price, while lower assortment reduces firm 2's price. It explains why firm 1's prices increase when the firms become very asymmetrical.

The firm that advertises more is more likely to be visited first by a consumer. As she knows that this firm charges lower prices and has more varieties than the alternative company, she is also less likely to walk away from this particular firm. This suggests that the number of equilibrium searches will be lower when there is greater asymmetry between

the advertising levels of the two firms involved. The following result establishes that this is indeed the case.[9]

Proposition 5: With two firms, a uniform distribution of matching values and linear advertising technologies, we have that the number of searches and, hence, total search costs incurred by consumers, decrease as the asymmetry in advertising levels increases.

Proof. See Appendix.

Hence, advertising now has social value as it helps consumers to channel their first visits towards better deals.

3.2 The Impact of Search Costs

This section verifies how firms' equilibrium advertising, assortments, and prices react with search costs. We conduct a numerical analysis. The asymmetric technology parameter is restricted to 0.5. The findings are presented below:

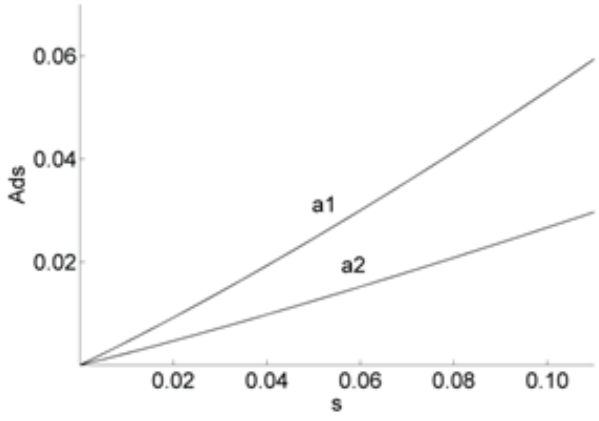
Remark 6: With two firms, a uniform distribution of matching values, linear advertising technologies, and firm 1 the more advertising-efficient firm, we have that an increase in search costs has the following effects:

(1) The advertising levels of both firms increase.

(2) The assortment level of the cheapest firm increases, that of the most expensive firm decreases, while average assortment levels also increase.

(3) The prices of both firms increase.

Figure 3.4: Advertising and Search Costs



[9] If we take the results in Remark 4 as given, we can also establish this formally. By construction, each consumer searches at least once for sure. If she visits i first, the probability of a second search is h^i .

Figure 3.5: Assortment and Search Costs

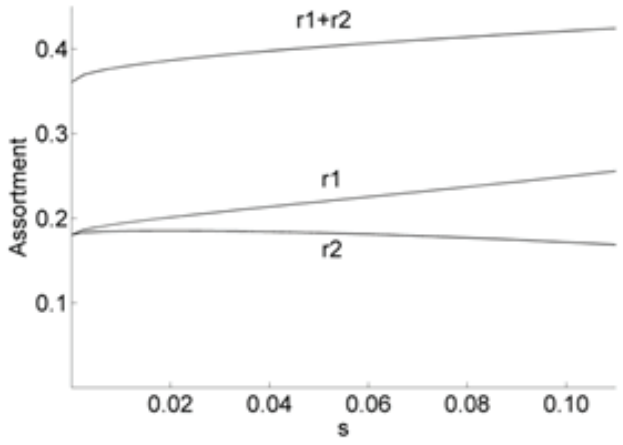
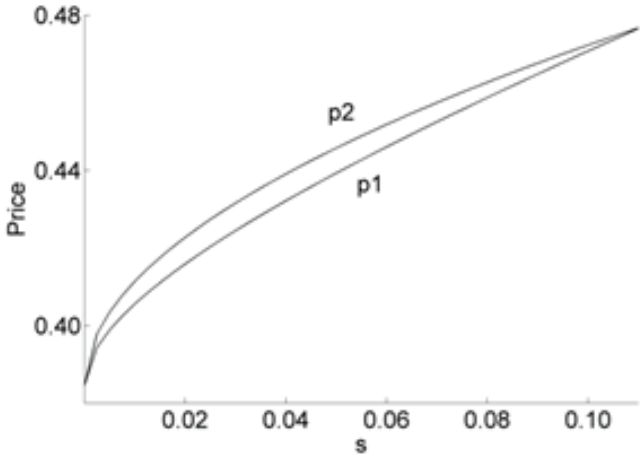


Figure 3.6: Price and Search Costs



Source: Author's calculations

Simulations show that the comparative statics with respect to search costs are qualitatively unaffected by the asymmetry of technologies. Since higher search costs induce consumers to terminate search in the first firm, all firms intensely need to raise consumer attention. Remark 6(1) shows that competition in advertising is more aggressive. Furthermore, there is more chance that consumers who first visit firm 1 will immediately buy because of the higher utility guarantee (broader assortment) and lower price. Therefore, firm 1 has more incentive to increase advertising.

Remark 6(2) illustrates how, with higher search costs, the cheaper firm provides a broader assortment, while the more expensive firm provides a lower one. Hence, the assortment gap increases with search costs. The reason is that visiting firm 1 is more attractive, so a broader assortment is more profitable. Since less consumers search for firm

2 and more for firm 1's brands, firm 2 reduces their assortment. An assortment strategy is important in creating fresh and experienced demand. As the search costs are greater, firm 1 has a greater share of the fresh and experienced demand, hence it extends its varieties. On the contrary, firm 2 relies more on returning demand and as such their assortment strategy is less important.

Remark 6(3) implies that, as the search costs increase, all prices also increase. This confirms the conventional wisdom that higher search costs give more pricing power. Greater search costs make consumers less choosy, and so the salient firm gains pricing power from a larger volume of first search consumers, while the less salient firm increases prices for its fewer consumers who have a lower price sensitivity.

3.3 Welfare

One question we have not yet answered is whether improvements in advertising technology can enhance social welfare. This section discusses the impact of both symmetric and asymmetric technological changes. We also investigate which parties gain from technological progress.

We first describe the formulation of consumer surplus which depends on where a consumer buys, and which firms she visits. The total consumer surplus equals:

$$V = \lambda_1\left(V_1^1 + V_1^{12} + V_2^{12}\right) + \lambda_2\left(V_2^2 + V_2^{21} + V_1^{21}\right) + V_0 \tag{3.5}$$

The surplus for consumers who first visit and immediately buy in firm *i* equals:

$$V_i^i = \int_{r_j}^1 \left(\int_{x_j - p_j + p_i}^1 (y_i - p_i - s) f(y_i) dy_i \right) f(y_j) dy_j \tag{3.6}$$

The surplus for consumers who first visit firm *i* and buy in firm *i* only after they visit both firms equals:

$$V_i^{ij} = \int_{p_i}^{x_j - p_j + p_i} \left(\int_{r_j}^{y_i + p_j - p_i} (y_i - p_i - 2s) f(y_j) dy_j \right) f(y_i) dy_i \tag{3.7}$$

The consumers who first visit firm *i* but continue to search and buy in firm *j* and have a consumer surplus equals:

$$\begin{aligned} V_j^{ij} = & \int_{x_j}^1 \left(\int_{r_i}^{x_j - p_j + p_i} (y_j - p_j - 2s) f(y_i) dy_i \right) f(y_j) dy_j \\ & + \int_{p_j}^{x_j} \left(\int_{r_i}^{y_j - p_j + p_i} (y_j - p_j - 2s) f(y_i) dy_i \right) f(y_j) dy_j \end{aligned} \tag{3.8}$$

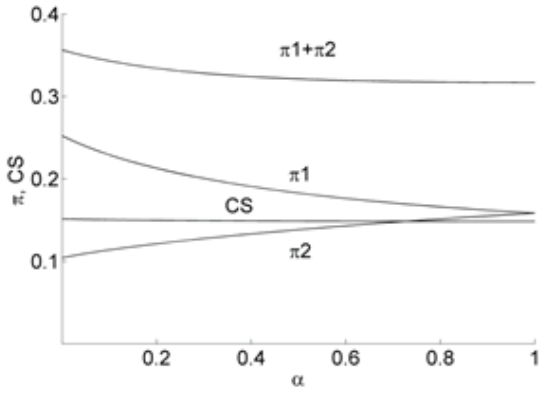
The consumer surplus for some consumers who do not buy at all equals:

$$V_0 = -\frac{2s(p_i - r_i)(p_j - r_j)}{(1 - r_i)(1 - r_j)} \tag{3.9}$$

and total welfare is $WF = \pi_1 + \pi_2 + V$ as usual.

Remark 7: With two firms, a uniform distribution of matching values, and linear advertising technologies, progress in advertising technology improves social welfare only if technology gaps increase.

Figure 3.7: Welfare and Firm Asymmetry



Source: Author's calculations

To fully appreciate the effect of a change in α on welfare, we have to resort to numerical analysis. In Figure 3.7, we depict the components of total welfare, the equilibrium profits of firms 1 and 2 and consumer surplus, as a function of α , for the case that $s = 0.08$. For different levels of s , the picture looks qualitatively the same. The profits of firm 1 decrease as firms become more symmetric, while the profits of firm 2 increase – but by a lesser degree. Total profits thus increase as firm 1's cost of advertising falls, adjusted to firm 2's cost. The Figure also shows that consumer welfare increases slightly after α goes down. Taking these effects together, it transpires that total welfare goes up as firms become more asymmetric. This is clearly driven by the decrease in advertising outlay.

The above result contrasts with Grossman and Shapiro (1984) claiming that better advertising technology reduces profits by increasing price competition. When consumers actively search and advertising does not eliminate search costs, asymmetric better technology (lower α) enhances industry profits and consumer surplus. Only less efficient firm is hurt by this progress. An asymmetric advance allows highly efficient firm to gain proportionately more consumers. A salient firm provides lower price and a broader variety, while more consumers transfer to this firm. On the contrary, the symmetric advance (constant α) increases advertising proportionately, and so prices and assortments remain unchanged. Thus, the profits, consumer surplus, and welfare remain the same.

Simulations show that the comparative statics with respect to search costs are qualitatively unaffected by the asymmetry of advertising technologies. For given advertising asymmetry α , total advertising is still increasing in search costs. The equilibrium advertising levels of both firms increase with s , as do prices. The profits of

firm 1, the most advertising efficient firm, increase with search costs. The opposite appears cogent for firm 2. Total profits are non-monotonic in s : initially they increase but for high enough s , they decrease. Total welfare decreases in search costs, as does consumer welfare.

4. Conclusions

This research examines the implications of biasing each consumer's search order with firms' competition in advertising and product lines. We model this idea in the framework of a search with differentiated products. Two firms engage in a battle for attention in an attempt to be visited early by consumers. Since consumers are more likely to be exposed to the firm that advertises intensely, more of them visits the shop for which they see more advertising and because search costs are non-negligible, they are also more likely to buy from such a shop. This difference has an implication on the relationship between prices, assortments and advertisings outlays. In this framework, advertising is not a winner-takes-all contest: after a consumer has visited a firm, she may still decide to go to a different outlet if she does not sufficiently like the brands offered by the initial firm.

Through spending in the advertising, a firm can achieve a salient place in consumer memories. Consumers will then visit this firm sooner than a rival firm. The firm with the better advertising technology becomes salient. The core finding is that salient firm has broader assortments, charge lower prices and obtain greater profits. Making firms more asymmetric increases the gaps in advertising, prices, assortments and profits. We still confirm that prices increase with search costs. The salient assortment increases, while the less salient assortment decreases with search costs. The impact of search costs is positive on the salient firm's profits, but negative on the less-salient firm's profits.

With better symmetric technology, or when firms' advertising costs are reduced proportionately, prices and assortments remain the same. This progress does not affect consumer search strategies. The only change is the higher levels of advertising of both firms. Therefore, such a development is not desirable for any of the parties concerned. The results also explain situations wherein there exist low search costs, but also high levels of advertising. Clearly, low search costs reduce advertising and prices. However, if advertising technology enormously advances, advertising competition can increase overwhelming the effects of low search costs. With growing e-commerce business influence, the scenario of consumers encountering online stores is almost costless. They have much lower search costs. However, firms still need to advertise intensely to raise the consumer attention.

Welfare improves only in the case of asymmetric progress. As technology gaps increase, salient firm advertises more, attracts more consumers, and so increases profits. Industry profit also increases due to lower total advertising costs. The consumer surplus is larger because they are led to channel their first visits towards better deal. This finding

relies on the main assumptions that all consumers can receive advertising from both firms, but they do not receive full information. In this event, advertising is not a winner-take-all contest. Therefore, in the equilibrium, all consumers do not search for the salient firm even though it provides higher expected payoffs. If advertising sends signals about prices and matching values, the salient firm will take all fresh demand. This scenario may also be found in Armstrong et al. (2009), but their findings do not discuss the effect of advertising. Under signaling advertising, welfare may increase in case of symmetric technological progress when enhanced advertising technology attracts new consumers to the market. I suggest that further studies should consider this.

References

Anderson, S. P., & Renault, R. (1999). Pricing, Product Diversity, and Search Costs: A Bertrand-Chamberlin-Diamond Model. RAND Journal of Economics, 30(4), 719-735.

Anderson, S. P., & Renault, R. (2009). Comparative Advertising: Disclosing Horizontal Match Information. RAND Journal of Economics, 40(3), 558-581.

Armstrong, M., Vickers, J., & Zhou, J. (2009). Prominence and Consumer Search. RAND Journal of Economics, 40(2), 209-233.

Armstrong, M., & Zhou, J. (2011). Paying for Prominence. The Economic Journal, 121(556), 368-395.

Bagwell, K., & Ramey, G. (1994). Coordination Economies, Advertising, and Search Behavior in Retail Markets. American Economics Review, 84(3), 498-517.

Butters, G. R. (1977). Equilibrium Distributions of Sales and Advertising Prices. The Review of Economic Studies, 44(3), 465-491.

Cachon, G. P., Terwiesch, C., & Xu, Y. (2005). Retail Assortment Planning in the Presence of Consumer Search. Manufacturing & Service Operations Management, 7(4), 330-346.

Cachon, G. P., Terwiesch, C., & Xu, Y. (2008). On the Effects of Consumer Search and Firm Entry in a Multiproduct Competitive Market. Marketing Science, 27(3), 461-473.

Casella, G., Berger, R. L. (2002). Statistical Inference. Pacific Grove, California: Duxbury/ Thomson Learning Inc.

Chamberlin, E. (1993). The Theory of Monopolistic Competition. Cambridge, Mass.: Harvard University Press.

Diamond, P. A. (1971). A Model of Price Adjustment. Journal of Economics Theory, 3, 156-168.

Draganska, M., & Jain, D. C. (2005). Product-Line Length as a Competitive Tool. Journal of Economics & Management Strategy, 14(1), 1-28.

Draganska, M., & Jain, D. C. (2006). Consumer Preferences and Product-Line Pricing Strategies: An Empirical Analysis. Marketing Science, 25(2), 164-174.

Grossman, G. M., & Shapiro, C. (1984). Informative Advertising with Differentiated Products. The Review of Economic Studies, 51(1), 63-81.

Haan, M. A., & Moraga-González, J. L. (2011). Advertising for Attention in a Consumer Search Model. The Economic Journal, 121(552), 552-579.

Kadiyali, V., Vilcassim, N., & Chintagunta, P. (1999). Product Line Extensions and Competitive Market Interactions: An Empirical Analysis. Journal of Econometrics, 89, 339–363.

Kekre, S., & Srinivasan, K. (1990). Broader Product Line: A Necessity to Achieve Success?. Management Science, 36, 1216–1231.

Leawsakul, K. (2014). Competitions from the Product Line in a Consumer Search Model, Thammasat Economics Journal, 32 (4).

Mas-Colell, A., Whinston, M. D., & Green, J. R. (1995). Microeconomics Theory. New York: Oxford University Press Inc.

Rhodes, A. (2011). Can Prominence Matter even in an Almost Frictionless Market?. The Economic Journal, 121(556), 297-308.

Varian, H. R. (1985). Price Discrimination and Social Welfare. American Economics Review, 75(4), 870-875.

Weitzman, M. L. (1979). Optimal Search for the Best Alternative. Econometrica, 47(3), 641-654.

Wolinsky, A. (1984). Product Differentiation with Imperfect Information. The Review of Economic Studies, 51(1), 53-61.

Wolinsky, A. (1986). True Monopolistic Competition as a Result of Imperfect Information. The Quarterly Journal of Economics, 101(3), 493-511.

APPENDIX

Proof of Proposition 1. To show the existence, consider equation (3.2). If $p_i = 0$, the RHS will be positive. Here $\frac{1-r_i}{\lambda_i + h_i\lambda_j}$ and q_i is a decreasing function of p_i. When the price increases, the RHS monotonically decreases. Therefore, p_i has a unique solution for $p_i \in [0, x_i]$.

Next, consider equation (3.3). If $r_i = 0$, the RHS will be positive. Here both p_i and q_i are increasing functions of r_i. However, if r_i is low, $p_i q_i$ increases by a relatively small amount. Because $q_i \leq 1$, it makes $r_i \leq p_i$. We can show that when $r_i = p_i$, the RHS is lower than LHS. Hence, r_i has a unique solution for $r_i \in [0, p_i]$.

Finally, rewriting the equilibrium of advertising exhibits in equation (3.4)

$$\phi_i' = p_i \frac{a_j}{(a_i + a_j)^2}\left[\frac{q_i^i + q_i^{ij}}{\lambda_i} - \frac{q_i^{ji}}{\lambda_j}\right] \tag{A.1}$$

The RHS of (A.1) increases with a_i. When $a_i = 0$ we assume the marginal cost of advertising ϕ_i' is sufficiently high so that the RHS will be lower than LHS. Therefore, a_i has a unique solution for $a_i \in [0, \infty]$. Q.E.D.

Proof of Proposition 2. Recall the FOCs of prices,

$$\begin{aligned}
\nu_1(\lambda_1, p_1, p_2) &= q_1 + p_1 q_{1,p} = 0 \\
&= \lambda_1\left[1 - \frac{x_2 - p_2 + 2p_1 - r_1}{1 - r_1} + \int_{p_2}^{x_2} \frac{y_1 - r_2}{1 - r_2}\frac{1}{1 - r_1}\,dy_1\right] \\
&\quad + (1 - \lambda_1)\left[\frac{x_1 + p_2 - p_1 - r_2}{1 - r_2}\left[1 - \frac{x_1 - r_1 + p_1}{1 - r_1}\right] + \int_{p_1}^{x_1} \frac{y_1 + p_2 - p_1 - r_2}{1 - r_2}\frac{1}{1 - r_1}\,dy_1\right]
\end{aligned}$$

$$
\begin{aligned}
v_2(1-\lambda_1, p_2, p_1) &= q_2 + p_2 q_{2,p} = 0 \\
&= (1-\lambda_1)\left[1 - \frac{x_1 - p_1 + 2p_2 - r_2}{1-r_2} + \int_{p_1}^{x_1} \frac{y_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2\right] \\
&\quad + \lambda_1\left[\frac{x_2 + p_1 - p_2 - r_1}{1-r_1}\left[1 - \frac{x_2 - r_2 + p_2}{1-r_2}\right] + \int_{p_2}^{x_2} \frac{y_2 + p_1 - p_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2\right]
\end{aligned}
$$

The equilibrium requires $v_1(\lambda_1, p_1^*, p_2^*) = v_2(1-\lambda_1, p_2^*, p_1^*)$. Rewriting to move the term λ_1 to the LHS, we have:

$$
\begin{aligned}
&\lambda_1\left\{\begin{array}{l}
2 - \dfrac{x_2 - p_2 + 2p_1 - r_1}{1-r_1} - \dfrac{x_1 - p_1 + 2p_2 - r_2}{1-r_2} + \displaystyle\int_{p_2}^{x_2} \frac{y_1 - r_2}{1-r_2}\frac{1}{1-r_1}\,dy_1 + \int_{p_1}^{x_1} \frac{y_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2 \\
\quad - \dfrac{x_2 + p_1 - p_2 - r_1}{1-r_1}\left[1 - \dfrac{x_2 - r_2 + p_2}{1-r_2}\right] - \displaystyle\int_{p_2}^{x_2} \frac{y_2 + p_1 - p_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2 \\
\quad - \dfrac{x_1 + p_2 - p_1 - r_2}{1-r_2}\left[1 - \dfrac{x_1 - r_1 + p_1}{1-r_1}\right] - \displaystyle\int_{p_1}^{x_1} \frac{y_1 + p_2 - p_1 - r_2}{1-r_2}\frac{1}{1-r_1}\,dy_1
\end{array}\right\} \\
&= \left\{\begin{array}{l}
1 - \dfrac{x_1 - p_1 + 2p_2 - r_2}{1-r_2} + \displaystyle\int_{p_1}^{x_1} \frac{y_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2 \\
\quad - \dfrac{x_1 + p_2 - p_1 - r_2}{1-r_2}\left[1 - \dfrac{x_1 - r_1 + p_1}{1-r_1}\right] - \displaystyle\int_{p_1}^{x_1} \frac{y_1 + p_2 - p_1 - r_2}{1-r_2}\frac{1}{1-r_1}\,dy_1
\end{array}\right\}
\end{aligned}
$$

$$
\begin{aligned}
&2\lambda_1\left\{\begin{array}{l}
2 - \dfrac{x_2 - p_2 + 2p_1 - r_1}{1-r_1} - \dfrac{x_1 - p_1 + 2p_2 - r_2}{1-r_2} + \displaystyle\int_{p_2}^{x_2} \frac{y_1 - r_2}{1-r_2}\frac{1}{1-r_1}\,dy_1 + \int_{p_1}^{x_1} \frac{y_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2 \\
\quad - \dfrac{x_2 + p_1 - p_2 - r_1}{1-r_1}\left[1 - \dfrac{x_2 - r_2 + p_2}{1-r_2}\right] - \displaystyle\int_{p_2}^{x_2} \frac{y_2 + p_1 - p_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2 \\
\quad - \dfrac{x_1 + p_2 - p_1 - r_2}{1-r_2}\left[1 - \dfrac{x_1 - r_1 + p_1}{1-r_1}\right] - \displaystyle\int_{p_1}^{x_1} \frac{y_1 + p_2 - p_1 - r_2}{1-r_2}\frac{1}{1-r_1}\,dy_1
\end{array}\right\} \\
&= 2\left\{\begin{array}{l}
1 - \dfrac{x_1 - p_1 + 2p_2 - r_2}{1-r_2} + \displaystyle\int_{p_1}^{x_1} \frac{y_2 - r_1}{1-r_1}\frac{1}{1-r_2}\,dy_2 \\
\quad - \dfrac{x_1 + p_2 - p_1 - r_2}{1-r_2}\left[1 - \dfrac{x_1 - r_1 + p_1}{1-r_1}\right] - \displaystyle\int_{p_1}^{x_1} \frac{y_1 + p_2 - p_1 - r_2}{1-r_2}\frac{1}{1-r_1}\,dy_1
\end{array}\right\}
\end{aligned}
$$

Let us simply denote B for RHS and A for the curly term in LHS and we will get $2\lambda_1 = \frac{B}{A}$. Because $a_1 > a_2$ means $2\lambda_1 > 1$, the term $\frac{B}{A} > 1$ is also hold. Next, we show that, with $p_1 = p_2$ and $p_1 > p_2$, the following inequality cannot be satisfied (A and B are negative definite).

$$B < A \tag{A.2}$$

(i) When $p_1 = p_2$, the expression (A.2) cannot be satisfied.

Define $p_1 = p_2 = p_0$. From (A.10) substituting p_0 into A and B and rearranging the terms, we have $B < A$ in the following expression

$$p_0(r_1 - r_2) < x_1(2 - x_1 - 3p_0) - x_2(2 - x_2 - 3p_0) - r_1(2x_2) + r_2(2x_1)$$

$$0 < x_1(2 - x_1 - 3p_0) - x_2(2 - x_2 - 3p_0) + r_1(-p_0 + 2x_2) - r_2(-p_0 + 2x_1)$$

Because of $\frac{x_1}{x_2} < \frac{(2 - x_2 - 3p_0)}{(2 - x_1 - 3p_0)} < 1$ and $\frac{r_1}{r_2} > 1 > \frac{(-p_0 + 2x_1)}{(-p_0 + 2x_2)}$, the RHS is definite negative.

(ii) When $p_1 > p_2$ the expression (A.2) cannot be satisfied. Rearranging to get $LHS = 0$. Then,

$$C = -p_1(3 + x_1 - 2x_2 - 2p_1) + p_2(3 + x_2 - 2x_1 - 2p_2) + x_1(2 - x_1) - x_2(2 - x_2) - r_1(2x_2) + r_2(2x_1) > 0$$

Because of $\frac{p_2}{p_1} < \frac{(3 + x_1 - 2x_2 - 2p_1)}{(3 + x_2 - 2x_1 - 2p_2)} < 1$, $\frac{x_1}{x_2} < \frac{(2 - x_2)}{(2 - x_1)} < 1$ and $\frac{r_1}{r_2} > \frac{x_1}{x_2}$, the inequality $0 < C$ cannot be satisfied. Q.E.D.

Proof of Proposition 3. The best response function in the advertising level is:

$$\gamma_i = p_i \frac{a_j}{(a_i + a_j)^2} \left[\frac{q_i^i + q_i^{ij}}{\lambda_i} - \frac{q_i^{ji}}{\lambda_j} \right] \tag{A.3}$$

Firm 1 is created to be a more efficient firm, so $\gamma_1 < \gamma_2 = 1$. We then require that the RHS of (A.3) for firm 1 to be smaller than that for firm 2. It can be shown that the inequality simplifies to:

$$\frac{p_1}{a_1} < \frac{p_2}{a_2} \tag{A.4}$$

Suppose that $a_1 < a_2$. This, by Proposition 2, necessary implies $p_1 < p_2$, hence $p_1 a_2 > p_2 a_1$. But this contradicts (A.4), thus Proposition 3 is established. Q.E.D.

Proof of Proposition 5. If we take the results in Remark 4 as given, we can also establish this formally. By construction, each consumer searches at least once for sure. If she visits i first, the probability of a second search is $F(x_j - p_j + p_i)$. If she visits j first, the probability of a second search is $F(x_i - p_i + p_j)$. We can write the expected number of searches as:

$$E(searches) = 1 + \lambda_i F(x_j - p_j + p_i) + \lambda_j F(x_i - p_i + p_j) \tag{A.5}$$

The results in Remark 4 imply that, if firm i is more efficient, $\frac{\partial a_i}{\partial \alpha} > 0$, $\frac{\partial a_j}{\partial \alpha} < 0$, $\frac{\partial r_i}{\partial \alpha} > 0$, $\frac{\partial r_j}{\partial \alpha} < 0$, $\frac{\partial p_i}{\partial \alpha} < \frac{\partial p_j}{\partial \alpha}$ so $F(x_j - p_j + p_i)$ is smaller, while $F(x_i - p_i + p_j)$ is larger.

Hence the number of searches decreases as α increases, that is, if the asymmetry between equilibrium advertising levels increases. Q.E.D.