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## Price competition and limited attention

*Alexander Karpov*

### **Abstract**

The paper develops a model of price competition in presence of consumers with limited attention. Education and obfuscation marketing strategies are studied. It is shown that firms in highly competitive industries have incentives to obfuscate, but firms in low competitive industries have not.

**JEL** D03 D11 D43

**Keywords** Bounded rationality; hotelling linear city model; consideration set; limited attention; unawareness

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## 1. Introduction

Numerous experimental and empirical studies show that agents behavior violates classic rational choice models. Behavioral economics has applications in industrial organization studies (see Ellison 2006; Grubb 2015a surveys), but many papers in this field have no strict theoretical framework. Some of them are purely empirical, other papers provide only ad hoc models (Spiegler 2017). A set of papers show the possibility of exploitation of consumers' limited attention. Using various marketing strategies, firms could change consumers' consideration sets (Eliaz, Spiegler 2011a, 2011b), influence on consumer decisions by changing product set (Gerasimou, Papi 2015) or by shrouding add-on prices (Gabaix, Laibson 2006). Introducing different formats of prices or other product characteristics, firms understate comparability of products (Piccione, Spiegler 2012, Spiegler 2014, 2016).

Eliaz, Spiegler (2015) set a problem of designing a model of a market, on which consumers have preferences justified by decision theory, including theories of bounded rationality. Thus, more abstract decision theory models can be applied to a wide class of industrial organization problems. Because of stupendous development of decision theory in the last decade, Eliaz, Spiegler's problem is particularly topical for economic theory.

The two-stage rationalization is one of the basic concepts in decision theory (see Danilov 2015, Aizerman, Aleskerov 1995 surveys). On the first stage, the decision maker applies an attention filter and defines the consideration set, on the second stage the decision maker chooses the best alternative within the consideration set. Attention filters are either deterministic (Masatlioglu et al. 2012, Masatlioglu, Nakajima 2015), or stochastic (Manzini, Mariotti 2014). Attention filters arise from boundedness of human cognition. Because of an increasing variety of goods and services and complexity of choice, consideration sets become an intrinsic part of the consumer model.

Consumer's unawareness leads to allocative efficiency losses. Consumers occasionally do not choose the best alternative (due to attention filter), or product with the lowest price (more about this behavior in (Grubb 2015b)). Thus, imperfect attention creates efficiency problem.

The aim of this paper is to develop a basic theoretical model of a market on which consumers have preferences justified by decision theory. The modern deterministic limited attention model (Masatlioglu et al. 2012) is the basis of a new model of behavioral consumer. Well-designed decision theory gives rise to development of industrial organization theory and applications. New theoretical framework links individual decision theory with competition theory. Thus, the relationship between individual characteristics of consumers, properties of equilibrium and firms' strategies is investigated.

Behavioral industrial organization studies describe several impacts of limited attention on competition. In some cases, firms use obfuscation, limited comparability of products, restrictions in information distribution, etc. In other cases, firms educate consumers, attract their attention, simplify access to information. Obfuscation and education as optimal firms strategies in Bertrand competition model arises in models of Gu and Wenzel (2014), Basov and Danilkina (2015), Cosander, Garcia, Knauff (2017).

Heidhues, Kőszegi (2017) studies Hotelling type competition in presence of naïve agents, which do not take into account the hidden part of the total price. They focus on naivete-price discrimination assuming that firms can uncover consumers' type. Our approach does not assume any possibility of discrimination. Within the Hotelling linear city model we study reasons of obfuscation and education. The basic decision theory model is Masatlioglu et al. (2012) model of deterministic attention filters. There are two basic scenarios. In the first case attention and brand preferences are independent. The share of consumers who pay attention to the product does not correlate with brand preferences. In the second case attention correlates with brand preferences. Consumers who have higher utility from the product are more likely to know about this product. In each case we study the two marketing strategies ("obfuscation" and "education"). Success of these strategies depends on the heterogeneity of brand preferences. In the case of industries with

low intensity of competition, firms have intrinsic incentives to educate consumers and achieve efficiency. In the case of industries with high intensity of competition consumer protection policy should be strong to save consumers from obfuscation. Some recommendations to consumer protection policy are proposed.

The paper is organized as follows. Section 2 shows a savvy consumers benchmark. Section 3 analyzes competition with different structure of non-savvy consumers. Section 4 concludes.

## 2. Savvy consumers benchmark

Two firms are located at the extremes of a  $[0,1]$  linear city. Firm 1 is located at point 0 and produces good 1; firm 2 is located at point 1 and produces good 2. Consumers of unit mass are uniformly distributed on the interval  $[0,1]$ . Each consumer consumes at most one unit of goods from one of the firms. Unit transportation costs are  $t > 0$ .

The consumer with location  $x$  has the following utility function

$$u(x) = \begin{cases} 0, & \text{if does not buy,} \\ 1 - p_1 - tx, & \text{if buys good 1,} \\ 1 - p_2 - t(1 - x), & \text{if buys good 2,} \end{cases} \quad (1)$$

where  $p_1, p_2$  are prices chosen by firms 1 and 2 respectively. For notational simplicity we will use  $u_i(x)$ , for utilities from buying goods  $i$ . Index  $i \in \{1,2\}$  always refers to the corresponding good or firm. Letter S in the superscript refers to savvy consumers.

Because consumers' reservation price is equal to 1, we do not consider prices above 1. Firms have no costs and maximize profit choosing own price. Firm  $i$ 's profit is the following

$$\pi_i^S(p_i, p_j) = \begin{cases} p_i, & \text{if } 0 \leq p_i \leq p_j - t; \\ \left(\frac{1}{2} + \frac{p_j - p_i}{2t}\right) p_i, & \text{if } p_j - t \leq p_i \leq \min(p_j + t, 2 - t - p_j); \\ \frac{(1 - p_i)p_i}{t}, & \text{if } 2 - t - p_j \leq p_i \leq 1; \\ 0, & \text{if } p_j + t \leq p_i \leq 1. \end{cases} \quad (2)$$

There are two situations with monopoly pricing. Firstly, it is the first line, where firm  $i$ 's price is significantly lower than firm  $j$ 's price. Secondly, it is the third line, where the both firms have relatively high prices and some consumers in the middle of  $[0,1]$  linear city prefer not to buy any goods. Between these two situations the firms compete on price. Solving profit maximization problem, we obtain the best response function:

$$p_i(p_j) = \begin{cases} \frac{t}{2} + \frac{p_j}{2}, & \text{if } p_j \leq \frac{4}{3} - t \text{ and } p_j \leq 3t; \\ 2 - t - p_j, & \text{if } \frac{4}{3} - t \leq p_j \leq 1.5 - t \text{ and } p_j \leq 3t; \\ \frac{1}{2}, & \text{if } 1.5 - t \leq p_j \leq 3t; \\ p_j - t, & \text{if } 3t \leq p_j. \end{cases} \quad (3)$$

Crossing the best response functions, we find equilibrium prices  $(p_1^S, p_2^S)$ :

$$p_i^S = \begin{cases} t, & \text{if } 0 \leq t \leq \frac{2}{3}; \\ 2 - t - p_j^S, & \text{if } \frac{2}{3} \leq t \leq 1 \text{ and } \frac{4}{3} - t \leq p_{1,2}^S \leq 1.5 - t; \\ \frac{1}{2}, & \text{if } 1 \leq t. \end{cases} \quad (4)$$

The first line corresponds with competitive behavior. Increase in  $t$  leads to intensity of competition weakening and increase in price. In this case all consumers are covered and have

positive utility levels. The third line corresponds with monopoly behavior. Only a fraction of consumers is served by the firms. In the second line equilibrium firms are constrained by consumers' reservation price. The consumer, who separates firm 1 area from firm 2 area, has zero utility. In different equilibria we have various indifferent consumers. In symmetric equilibrium the second line prices are equal to  $p_1^S = p_2^S = 1 - \frac{t}{2}$ .

The subsequent section applies (Masatlioglu et al. 2012) limited attention model. We design two models distinguished by interconnection between attention and brand preferences.

### 3. Consumers with deterministic limited attention (Masatlioglu et al. 2012)

According to (Masatlioglu et al. 2012) consumers do not compare all feasible goods (set  $\{1,2\}$ ). They make decisions based on their own consideration set. The consideration set is a nonempty subset of alternatives to which an agent pays attention. Within this model there are three possible consideration sets  $\{1\}$ ,  $\{2\}$ ,  $\{1,2\}$ . All consumers always have option not to buy.

Let us consider the polymorphic population of consumers. In each location there are several types of consumer. Let  $\alpha$  be the share of fully rational (savvy) consumers. Their consideration set is equal to  $\{1,2\}$ . The remainder of population (non-savvy consumers) pays attention only to good 1 or 2. There is no price discrimination. Firms set one price for all consumers.

Increase in  $\alpha$  corresponds to education marketing strategy, decrease in  $\alpha$  – obfuscation marketing strategy.

#### 3.1 Attention and brand preferences are independent

For the first approach we assume that non-savvy consumers are equally divided between the two firms. Letters NC in the superscript refer to no correlation.

Within non-savvy consumers market firms behave as monopolists and price  $p_i = 1 - t$  is the highest price, which the furthest consumer agrees to pay. Firm  $i$ 's profit is the following

$$\pi_i^{NC}(p_i, p_j) = \begin{cases} \frac{(1-\alpha)}{2} p_i + \alpha \pi_i^S(p_i) & \text{if } p_i \leq 1 - t; \\ \frac{(1-\alpha)}{2} \left(\frac{1-p_i}{t}\right) p_i + \alpha \pi_i^S(p_i) & \text{if } p_i \geq 1 - t. \end{cases} \quad (5)$$

Profit function is continuous, piecewise parabolic function. For each pair of  $t \geq 0$  and  $\alpha \in [0,1]$  except small area of  $(t, \alpha)$  space there exists unique symmetric equilibrium with the following prices

$$p_i^{NC} = \begin{cases} \text{no equilibrium, if } 0 \leq t \leq \frac{\alpha - \alpha^2}{1 + \alpha - \alpha^2}; \\ \frac{t}{\alpha}, \text{ if } \frac{\alpha - \alpha^2}{1 + \alpha - \alpha^2} \leq t \leq \frac{\alpha}{1 + \alpha}; \\ 1 - t, \text{ if } \frac{\alpha}{1 + \alpha} \leq t \leq \frac{1}{2}; \\ \frac{1 - \alpha + \alpha t}{2 - \alpha}, \text{ if } \frac{1}{2} \leq t \leq \frac{2}{2 + \alpha}; \\ 1 - \frac{t}{2}, \text{ if } \frac{2}{2 + \alpha} \leq t \leq 1; \\ \frac{1}{2} \text{ if } 1 \leq t. \end{cases} \quad (6)$$

There is no equilibrium for  $t$  close to zero. In this case optimal monopoly price  $p_i = 1 - t$  is the profitable deviation. The presence of non-savvy consumers changes incentives of the firms. There is an additional interval with  $p_i^{NC} = 1 - t$ . Firms choose this frontier price to serve all non-

savvy consumers. A simple comparison of equilibrium prices with savvy consumers' case leads to Proposition 1.

**Proposition 1.** *In symmetric equilibria we have,*

- (i) *if  $0 \leq t \leq \frac{1}{2}$ , then  $p_i^{NC}$  and  $\pi_i^{NC}(p_i^{NC}, p_j^{NC})$  weakly decrease with respect to  $\alpha$  and for any  $\alpha \in [0,1]$ ,  $p_i^{NC} \geq p_i^S$ ,  $\pi_i^{NC}(p_i^{NC}, p_j^{NC}) \geq \pi_i^S(p_i^S, p_j^S)$ ;*
- (ii) *if  $\frac{1}{2} \leq t$ , then  $p_i^{NC}$  and  $\pi_i^{NC}(p_i^{NC}, p_j^{NC})$  weakly increase with respect to  $\alpha$  and for any  $\alpha \in [0,1]$ ,  $p_i^{NC} \leq p_i^S$ ,  $\pi_i^{NC}(p_i^{NC}, p_j^{NC}) \leq \pi_i^S(p_i^S, p_j^S)$ .*
- (iii) *For any  $t$ , the total surplus weakly increases with respect to  $\alpha$ .*

The presence of non-savvy consumers creates two effects. On the one hand increase in  $\alpha$  (the higher share of savvy consumers) strengthening competition intensity, on the other hand increase in  $\alpha$  increases the number of potential buyers. The total effect on prices and profits is ambiguous. From Proposition 1 in the case of low transportation costs the first effect prevails. If firms have opportunity to influence the share of non-savvy consumers they would have incentives to obfuscate consumers and increase number of non-savvy consumers. High transportation costs (low intensity of competition) induce incentives to educate consumers.

### 3.2 Attention correlates with brand preferences

It is reasonable to assume that true brand preferences correlate with attention. For each location  $x$  let  $1 - x$  be the share of non-savvy consumers, who pay attention only to goods 1, and  $x$  be the share of non-savvy consumers, who pay attention only to goods 2. One half of non-savvy consumers pays attention to goods 1, another pays attention to goods 2.

From this structure we obtain

$$\pi_1^{MNO}(p_1) = (1 - \alpha) \int_0^1 (1 - x) p_1 1_{u_1(x) \geq 0} dx + \alpha \pi_1^S(p_1), \quad (7)$$

$$\pi_2^{MNO}(p_2) = (1 - \alpha) \int_0^1 x p_2 1_{u_2(x) \geq 0} dx + \alpha \pi_2^S(p_2), \quad (8)$$

where  $1_{u_i(x) \geq 0} = 1$ , if  $u_i(x) \geq 0$  and non-savvy consumer buys good  $i$ , otherwise  $1_{u_i(x) \geq 0} = 0$ . Depending on price, firms serve all non-savvy consumers or not. Simplifying we have

$$\pi_i^{MNO}(p_i) = \begin{cases} (1 - \alpha) \frac{p_i}{2} + \alpha \pi_i^S(p_i) & \text{if } p_i \leq 1 - t; \\ (1 - \alpha) \left( \frac{2t - 1 + (2 - 2t)p_i - p_i^2}{2t^2} \right) p_i + \alpha \pi_i^S(p_i) & \text{if } p_i \geq 1 - t. \end{cases} \quad (9)$$

For each pair of  $t \geq 0$  and  $\alpha \in [0,1]$  except small area of  $(t, \alpha)$  space there exists a unique symmetric equilibrium with the following prices

$$p_i^C = \begin{cases} \text{no equilibrium, if } 0 \leq t \leq f(\alpha); \\ \frac{t}{\alpha}, \text{ if } f(\alpha) \leq t \leq \frac{\alpha}{1+\alpha}; \\ \frac{\alpha(\frac{3}{2}t-2)-2t+2+\sqrt{(1-\frac{3}{4}t^2)\alpha^2-\alpha(3t^2-2t+2)+4t^2-2t+1}}{3(1-\alpha)}, \text{ if } \frac{\alpha}{1+\alpha} \leq t \leq \frac{4}{\alpha+5}; \\ 1 - \frac{t}{2}, \text{ if } \frac{4}{\alpha+5} \leq t \leq \frac{8\alpha+4}{3\alpha+5}; \\ \frac{2(1-\alpha-t)+\sqrt{(1+3t)\alpha^2-\alpha(t+2)+4t^2-2t+1}}{3(1-\alpha)}, \text{ if } \frac{8\alpha+4}{3\alpha+5} \leq t. \end{cases} \quad (10)$$

**Proposition 2.** *In symmetric equilibria we have,*

- (i) *if  $0 \leq t \leq \frac{3+\sqrt{2}}{7}$  ( $\approx 0.63$ ), then  $p_i^C$  weakly decreases with respect to  $\alpha$  and for any  $\alpha \in [0,1]$ ,  $p_i^C \geq p_i^S$ ;*
- (ii) *if  $\frac{3+\sqrt{2}}{7} \leq t$ , then  $p_i^C$  weakly increases with respect to  $\alpha$  and for any  $\alpha \in [0,1]$ ,  $p_i^C \leq p_i^S$ .*
- (iii) *For any  $t, \alpha$ ,  $p_i^C \geq p_i^{NC}$*
- (iv) *For any  $t$ , total surplus weakly increases with respect to  $\alpha$ .*

The main distinction from the No correlation case is the difference between prices and profits behavior. For moderate transportation costs  $t$  (about 0.5-0.6) the profit function reaches the highest value at  $\alpha \in (0,1)$ . Firms have some optimal level of savvy consumers that equalize marginal effects of competition intensity and increase of the number of potential buyers.

Interconnection between attention and brand preferences weakens incentives to educate consumers.

## Conclusion

This paper develops the general model of price competition in the presence of consumers with limited attention. High competition intensity (low transportation costs) induces firms to use obfuscation strategy. Low competition intensity induces firms to use education strategy.

From a total welfare point of view, we can conclude that education is always beneficial. According consumer surplus comparison some obfuscation can optimal in case of high transportation costs, but for such case firms prefer full education. Consumer protection policy should be focused on highly competitive industries.

The model can be extended in asymmetric cases with arbitrary partition of consumers. It is particularly usable for an entry model, where an incumbent firm draw more attention than an entrant firm.

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