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On the evolution of monopoly pricing in Internet-assisted search markets☆

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ABSTRACT

This study examines the evolution of prices in markets with Internet price-comparison search engines. The empirical study analyzes laboratory data of prices available to informed consumers, for two industry sizes and two conditions on the sample (complete and incomplete). Distributions are typically bimodal. One of the two modes of distribution, corresponding to monopoly pricing, tends to attract such pricing strategies increasingly over time. The second one, corresponding to interior pricing, follows a decreasing trend. Monopoly pricing can serve as a means of insurance against more competitive (but riskier) behavior. In fact, experimental subjects who initially earn low profits due to interior pricing are more likely to switch to monopoly pricing than subjects who experience good returns from the start.

1. Introduction

Despite the competition-enhancing effect of price-comparison search engines on the Internet, price dispersion in virtual search markets is systematic and persistent. This study examines whether these prices converge towards some stable distribution. Specifically, two attractors of pricing strategies emerge: monopoly pricing and competitive pricing. In this context, results are informative on whether firms should expect competitive or monopolistic behavior to prevail in the long run. The main finding is that the frequency of monopoly pricing appears to have a systematically increasing trend, whereas, at the same time, competitive prices decline over time.

According to Diamond (1971), the existence of captive consumers may be sufficient for monopoly pricing to emerge in non-monopolistic homogeneous good markets. Burdett and Judd (1983), Rosenthal (1980), Stahl (1989), and Varian (1980) extend this theory. Mixed strategy equilibria render these models compatible with price dispersion in search markets. Along these lines, Baye and Morgan (2001), Brynjolfsson and Smith (2000), Iyer and Pazgal (2000), and Kocas and Kiyak (2006) focus specifically on the role of the Internet. Morgan, Orzen, and Sefton (2006) report experimental results confirming the basic comparative statics prediction of the Varian (1980) model. Also, Orzen (2005) offers some evidence for Janssen and Moraga-González's (2004) conjecture concerning the collusive-pricing attractor, which tends to reverse Varian's (1980) comparative statics prediction regarding the size of an industry.

Numerous scholars study the dynamic properties of price distributions in consumer search markets. Hopkins and Seymour (2002) show that a broad family of learning dynamics may be stable under sufficient ignorance. Benaïm, Hofbauer, and Hopkins (2009), referring to Shapley (1964) best-response cycles, show that price time averages may converge to Nash equilibria, even under unstable price dispersions.

Cason and Datta (2006), Cason and Friedman (2003), and Cason, Friedman, and Wagener (2005) focus on the dynamics of price dispersion. In particular, the Edgeworth cycles in Cason et al. (2005) provide evidence for the instability of price dispersion prediction (Hopkins & Seymour, 2002). Also, the serial correlation of individuals in Cason and Friedman (2003) may offer evidence against the hypothesis of mixed strategy play.

Finally, while Varian (1980) predicts agglomeration in monopoly pricing as a result of rational behavior, Baye and Morgan (2004) show a direct relation between the frequency of monopoly pricing and the

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level of bounded rationality in the market. Competitive pricing involves some probability of a higher profit but also the risk of a lower one.

Although Cason and Datta (2006) adopt a similar strategy to the one this study explores, the present experiment is innovative. Cason and Datta (2006) choose to simulate optimal consumer search behavior, whereas, in the experimental design in the present study, subjects face a simulator of rival behavior following equilibrium distributions. Thus, deviations from equilibria cannot be the result of learning among interacting agents. Two dynamic patterns occur in parallel. The two patterns form two alternative peaks of typically bimodal price distributions. The first peak is the *interior pricing* mode, and the second is the *monopoly pricing* mode. The dynamics affecting the two modes occur in opposite directions. Each one of the corresponding patterns remains invariant across different experimental conditions.

This paper contains the following sections. Section 2 outlines the theoretical framework. Section 3 describes the experimental design. Section 4 then reports the results, and Section 5 presents the conclusions of the study.

2. Theoretical framework

First, consider a homogeneous good that users search for in the Internet, and that opens for one period. Second, consider a price-comparison search engine operating in a market with $n \geq 3$ vendors (indexing vendors using $j = 1,\dots, n$) and a large consumer base. The price-comparison search engine lists the firms in its index, along with the prices they charge. Denote by k the number of vendors in the price-comparison search engine, so that k represents the size of the index. The search engine has complete coverage if the search engine indexes all vendors present in the market (i.e., $k = n$). The search engine has incomplete coverage if $k < n$, which gives a probability of k/n of indexing any one of the n vendors. This analysis corresponds to the case of unbiased incomplete coverage. García-Gallego, Georgantzís, Pereira, and Pernías (2004) discuss a version of the model accounting for biased incomplete coverage.

A unit measure continuum of risk-neutral consumers exists. Each consumer has a unit demand, and a reservation price of 1. Two types of consumers figure in the model: non-shoppers, which make up a proportion $\lambda \in (0, 1)$ of the consumer population, who do not use the price-comparison search engine; and shoppers, with a proportion of the population of $1 - \lambda$, who use the price-comparison search engine.

Prices remain below 1, and shoppers buy a unit of the product from the cheapest seller in the engine. If prices are equal, buyers split equally among the sellers offering the lowest price. Non-shoppers distribute themselves evenly across all vendors.

Vendors are identical with marginal costs equal to zero. They know the probability with which they will be on the index, but are ignorant of the identity of the other vendors in the index before choosing prices.

Let $\Pi_j(p)$ be the expected profit of vendor j charging a price p in $\mathbb{R}_0^+$. A vendor's strategy is a cumulative distribution function over prices, $F_j(.)$. A standard result from the theory is that this game has no equilibrium in pure strategies. A Nash equilibrium is an n-tuple $\{F_1(.),\dots, F_n(.)\}$ of cumulative distribution functions over prices such that, for Π_j^* in $\mathbb{R}_0^+$, *and* $j = 1,\dots, n$, $\Pi_j(p) = \Pi_j^*$, *for all* p *in the support of* $F_j(.)$, *and* $\Pi_j(p) \leq \Pi_j^*$, *for all p. Denote by* τ *the type of search engine, and let C (I) be complete (incomplete) coverage. Then,* τ *belongs to {C, I}. Denote by* ϕ_j^τ *the probability that firm j is in the index, such that* $\phi_j^\tau = k/n$. *Ignoring ties (i.e., prices are equal), the expected profit of a vendor that charges* $p \leq 1$ *is:*

$$\Pi_j(p) = p\,\frac{\lambda}{n} + p(1-\lambda)\phi_j^\tau\left[1-F_j^\tau(p)\right]^{k-1} \quad (1)$$

Let l_j^τ be the lowest price vendor j is willing to charge to sell to both types of consumers when the search engine has type τ, that is: $l_j^\tau[\lambda/n + (1 - \lambda)\,\phi_j^\tau] - \lambda/n \equiv 0$.

According to Baye, Kovenock, and de Vries (1992), a continuum of asymmetric equilibria exists; however, in the symmetric equilibrium:

$$p\,\frac{\lambda}{n} + p(1-\lambda)\phi_j^\tau\left[1-F_j^\tau(p)\right]^{k-1} = \frac{\lambda}{n} \quad (2)$$

All vendors figure in the index with nonzero probability. Hence, they face the trade-off of charging the monopoly price to non-shoppers, or charging a low price to attract shoppers. This dilemma leads vendors to randomize their choice of prices. The price distribution when the market consists of n vendors and the search engine has an index of size $k \leq n$ is identical to the price distribution when the search engine has complete coverage (i.e., $k = n$) and the market consists of k vendors: $F^I(. ; n, k) = F^C(. ; k)$.

Following the discussion by García-Gallego et al. (2004), a decrease in the number of vendors in the index has two impacts. First, such a decrease reduces, from *k-1* to *k-2*, the number of rivals with which a vendor has to compete to sell to shoppers. Second, the decrease in the size of the index reduces the probability from k/n to $(k-1)/n$ that a certain vendor will feature in the index. Consequently, the price distribution rotates counterclockwise, as in Fig. 1.

3. Experimental design

Under the assumption of a market environment such as that which the discussion in Section 2 describes, the lab experiment runs with four experimental conditions. The four treatments (C3, I3, C6, I6) correspond to the combination of two different industry sizes, $n \in \{3, 6\}$, with two index sizes (complete, incomplete). The design is appropriate to test the model's comparative statics predictions concerning the size of the market under complete coverage by comparing four groups, from a complete coverage triopoly (C3) to a complete coverage hexopoly (C6). The comparison of C3 to I3 and C6 to I6 tests the hypotheses concerning the completeness of the index. In fact, both incomplete coverage treatments use a 2/3 probability of being in the index of the search engine. Thus, k = 2 in treatment I3, and k = 4 in treatment I6. In all treatments, λ is equal to 1/2.

Table 1 presents the details of the design and the statistics corresponding to the theoretical price distributions. This helps address the following testable hypotheses.

H1. An increase in the number of firms in the market leads to a higher average price.

H2. An increase in the size of the index leads to a higher average price.

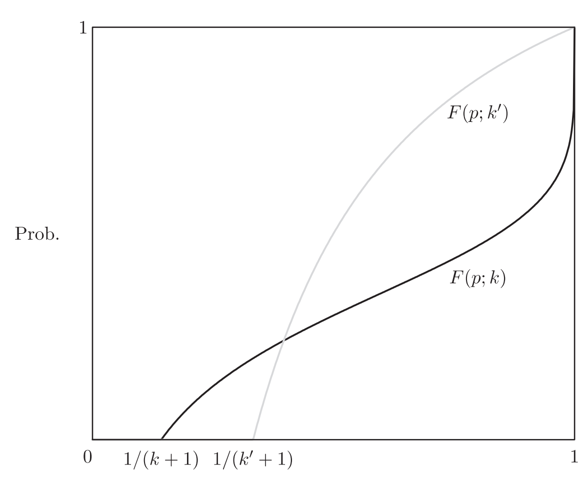

Fig. 1. Price rotation when k decreases to k'.