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The informational divide ☆

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ABSTRACT

We propose a model of price competition where consumers exogenously differ in the number of prices they compare. Our model can be interpreted either as a non-sequential search model or as a network model of price competition. We show that (i) if consumers who previously just sampled one firm start to compare more prices all types of consumers will expect to pay a lower price and (ii) if consumers who already sampled more than one price sample (even) more prices then there exists a threshold – the informational divide – such that all consumers comparing fewer prices than this threshold will expect to pay a higher price whereas all consumers comparing more prices will expect to pay a lower price than before. Thus increased search can create a negative externality and it is not necessarily beneficial for all consumers.

1. Introduction

Is more information about prices always good for consumers? In this paper we analyze this question in a consumer search model à la Burdett and Judd (1983) where consumers exogenously differ in the number of prices they compare. In order to assess the welfare effects of increased information we consider the expected prices paid by the various consumers. It turns out that whether more information is indeed beneficial to *all* consumers will depend very much on *which* consumers get more information.

In line with the previous literature, we find that more information for previously uninformed consumers leads to lower expected prices for all types of consumers (Theorem 3.1) and increases consumer welfare unambiguously. But, surprisingly, increased search by those who already do some search actually harms the uninformed, while benefiting the well-informed, and merely re-distributes welfare from the former to the latter. More precisely, if some searchers search more, the endogenous equilibrium price distribution changes in such a peculiar way that – for a certain number $d > 1$ (the "informational divide") – all consumers who compare fewer than d prices face higher expected prices than before, whereas the others face

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lower expected prices (Theorem 3.2). In other words, more information for the informed creates a *negative externality* for the uninformed.

To gain an intuitive understanding of this "informational divide" we observe the following. Expected profits and hence the average selling price depend only on the share of uninformed consumers in the market. This is so because expected profits are equal to the profit a firm can make by selling only to uninformed consumers (at the monopoly price). Thus, if some searchers start to compare more prices, the average selling price remains the same and the resulting change in the equilibrium price distribution can only have a redistributive effect, benefiting some consumers and harming others. We show that the new price distribution "single-crosses" the old one, in such a way that the mean (= the expected price paid by the uninformed) increases and the lower bound decreases. This harms the uninformed and helps those who search a lot. More intuition is given after Theorem 3.2.

In addition to the results just described, we show by means of examples that "increased search" can have truly counter-intuitive effects: it can lead to higher expected prices for *all* consumer types that are actually present in the market (here a "type k" consumer is one who samples k prices), and it can even happen that those consumers who engage in more search harm themselves (see Example 3.3 and Example 3.4).

The rest of the paper is organized as follows: Section 2 spells out the model. Section 3 presents the results. In Section 4 we discuss some related issues, viz. (i) a *network interpretation* of our model, (ii) *endogenous search*, and (iii) *policy implications*. Proofs are relegated to Appendix A.

2. The model

We consider a market for a homogeneous good with N firms and M households (consumers), and write $\mu = M/N$ for the number of households per firm. Each firm can produce the good at constant marginal cost, without fixed cost, and sets the price at which it offers the good (all firms set their prices simultaneously). Each household demands one unit of the good, up to a given willingness to pay (assumed greater than the cost). Without loss of generality we normalize the cost to 0 and the willingness to pay to 1 (the same for all firms, respectively households).

Households differ in the *information* they have about the firms' prices. A household of *type* k observes the prices of k firms and buys from the cheapest (randomizing with equal probabilities in case of ties), provided the price does not exceed its willingness to pay. We denote by q_k the fraction of households of type k. The *information structure* (or consumer *search distribution*) is represented by the vector $q = (q_1, \dots, q_N)$, where of course $q_k \geqslant 0$ for all k and $\sum_{k=1}^{N} q_k = 1$. Equivalently, we can let q_k stand for the *number* of type k households. We usually do this in the examples. A household of type $k = 1$ is called *uninformed*, households of types $k \geqslant 2$ are called *informed* (also searchers or shoppers).

We thus obtain a strategic market game among the N firms, where we can take without loss of generality the strategy set of each firm to be the unit interval $[0, 1]$ (a price below 0 would generate losses, and at a price above 1 nobody would buy). Trivial cases apart, this game has equilibria only in mixed strategies, generating *price dispersion*. From now on, we assume always $0 < q_1 < 1$.

The following known result is stated here for easy reference. A more precise formulation is in Appendix A.

Proposition 2.1. *Consider a market game with information structure $q = (q_1, \dots, q_N)$ and assume $0 < q_1 < 1$. Then there exists a unique symmetric equilibrium in mixed strategies: each firm chooses its price at random according to a continuous distribution $F(p)$ with support $[p_{\min}, p_{\max}]$, where $0 < p_{\min} < p_{\max} = 1$. Moreover, the equilibrium profit per firm is $\pi = \mu q_1$, and the average selling price (average household expenditure) is $p_{av} = q_1$.*

The *expected price* p_k paid by a household of type k is given by

$$p_k = \int_{p_{\min}}^{1} p\, dF_k(p) \quad (k = 1, \dots, N),$$

where $F_k(p) = 1 - [1 - F(p)]^k$ is the distribution of the minimum of a sample of size k from the distribution F. The distribution F_k shifts more and more mass near $p_{\min}$, as k increases, so that $p_k \to p_{\min}$ for $k \to \infty$. It is easy to see[1] that the expected price p_k can also be written as

$$p_k = \int_{p_{\min}}^{1} \left[1 - F(p)\right]^k dp. \tag{1}$$

This implies the well-known fact that p_k is a strictly decreasing, convex function of k (cf. Burdett and Judd, 1983, p. 961). We write $p = (p_1, \dots, p_N)$ for the list of expected prices paid by the various types. Note that if $N > K$, we have expected prices p_k even for some types $k > K$, although there are actually no such consumers. Such a p_k is simply what a (hypothetical) consumer would expect to pay if she sampled k prices from the given distribution F.

[1] $p_k = \int p.F_k'(p)\,dp = \int pk[1 - F(p)]^{k-1} F'(p)\,dp = \int pk[1 - F(p)]^{k-1}\,dF(p) = \int [1 - F(p)]^k\,dp$, where the last equality follows by partial integration.