E C O N O M I C S B U L L E T I N

Information externalities in a model of sales

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Abstract

We anlayze Varian's (1980) Model of Sales, and show that when the number of uninformed consumers increases, prices become less competitive for all consumers. Thus, the influx of uninformed consumers generates a negative externality increasing the prices paid by informed consumers.

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1 Introduction

In Varian's Model of Sales (1980, 1981) identical firms compete to sell some homogeneous product to "informed consumers", who obtain a complete list of firms' prices and buy from the firm with the lowest price, and "uninformed consumers" (or, equivalently, brand loyal consumers) who simply purchase from a firm selected at random. Equilibrium price dispersion arises as a result of the tension firms face between lowering price to attract informed consumers and the costs of doing so in terms of foregone rents from uninformed consumers. In this note we re-examine a key comparative static implication of the model: What happens to prices as the number of uninformed consumers increases? Varian (1981) states that uninformed consumers will pay higher prices, on average, but that the impact on prices paid by informed consumers is ambiguous. We demonstrate, however, that *all* consumers can expect to pay a higher price. That is, the influx of uninformed consumers exerts a negative externality on other consumers.

Varian's model represents an important approach toward rationalizing and understanding price dispersion as an equilibrium phenomenon, and it provides the basis for a number of recent theoretical and empirical papers. Some of these papers are motivated by the increasing importance of price comparison sites, such as mysimon.com, on purchasing decisions on the Internet. Consumers who choose to access these sites obtain a list of prices offered by competing sellers for an identical product and can readily buy from the firm offering the lowest price. However, only a small fraction of transactions occur through price comparison services. A substantial number of transactions on the Internet come from consumers who are presumably less informed about the list of available prices.

Among theoretical models that build on the Varian framework are Janssen and Moraga (2000), who endogenize search decisions by studying the case where informed consumers obtain access to a complete list of prices while uninformed consumers engage in optimal non-sequential search (along the lines of Burdett and Judd, 1983), and Baye and Morgan (2001), who study a model where an information gatekeeper controls access to the list of firm prices. Baye and Morgan show that price dispersion arises when consumers endogenously choose whether to become informed, firms endogenously choose whether to list their prices on the gatekeeper's site, and the gatekeeper sets access fees to the site to maximize profits.

Empirical examinations of these models include Villas-Boas (1995), who examines field data for the coffee and saltine cracker markets and finds some support for Varian's model, Baye, Morgan, and Scholten (2001), who study data from over 1000 consumer electronics products sold at an Internet price comparison site and find evidence consistent with theoretical models of price dispersion, and Morgan, Orzen, and Sefton (2001), who use laboratory experiments to examine two key comparative static predictions of Varian's model and find that the resultant empirical changes in price levels are strongly in accord with theoretical predictions. Kessner and Polbom (2000) investigate whether price dispersion in the German life insurance industry reflects differentiated products or equilibrium price dispersion for homogeneous products, and find that prices vary in response to changes in tax treatment as predicted by equilibrium price dispersion models.

2 Analysis

In Varian's model, he considers a market where consumer demand derives from two types of consumers: I informed and M uninformed consumers. All consumers have unit demand and a reservation price r. Informed consumers buy from the firm offering the lowest price, while uninformed consumers buy from a randomly selected firm, as long as the respective prices do not exceed r. Firms are identical and have declining average costs $AC(\cdot)$.

Then, a symmetric zero profit equilibrium in prices has the following properties:

1. n firms are active in the market where n solves

$$r = AC\left(\frac{M}{n}\right)$$

2. Each firm chooses prices according to the distribution

$$F(p) = 1 - g(p)^{\frac{1}{n-1}}$$

on the support $[p^*, r]$, where $p^* = AC\left(\frac{M}{n} + I\right)$ and

$$g(p) = \left(\frac{\frac{M}{n}(r-p)}{\frac{M}{n}(r-p) + \left(I + \frac{M}{n}\right)(p - p^*)}\right)$$

In an errata to the paper, Varian suggests that an unusual 'paradoxical' comparative static implication of the model sometimes obtains. Specifically, if the number of uninformed consumers increases, then it is possible that the average price paid by informed consumers could decrease. This is surprising in that intuition would suggest that with an increased number of uninformed consumers, it is increasingly costly to cut prices in order to attract informed consumers. Varian argues that the effect of increased firm entry may more than offset this effect. That is, increased numbers of uninformed consumers lead to an increased number of firms and the resulting competition benefits the informed consumers. As our main result shows, this is not the case:

Proposition *An increase in the number of uninformed consumers always raises the average price paid by informed customers.*

Proof. In any equilibrium $r = AC\left(\frac{M}{n}\right)$.Since the reservation price and cost schedule are exogenous, then in any equilibrium, the ratio of uninformed consumers to firms is constant. This implies that p^* and $g(p)$ are constant with respect to M.

Next, note that

$$(1 - F(p))^n = g(p)^{\frac{n}{n-1}}.$$

Taking logs and differentiating with respect to M we have

$$\frac{1}{(1 - F(p))^n} \frac{\partial (1 - F(p))^n}{\partial M} = - \ln(g(p)) \frac{1}{(n-1)^2} \frac{\partial n}{\partial M}.$$

Since $0 < g(p) < 1$, and $\frac{\partial n}{\partial M} > 0$, we have that for all $p \in (p^*, r)$,

$$\frac{\partial (1 - F(p))^n}{\partial M} > 0.$$

Following Varian, let $\bar{p}_{\min}$ denote the expected price paid by informed consumers. This is the expected value of the lowest of n independent draws from the distribution F. Or equivalently,

$$\bar{p}_{\min} = p^* + \int_{p^*}^{r} (1 - F(p))^n \, dp.$$

Differentiating with respect to M yields

$$\frac{\partial \bar{p}_{\min}}{\partial M} = \int_{p^*}^{r} \frac{\partial (1 - F(p))^n}{\partial M} dp$$

where we have used the fact that p^* is constant with respect to M. Finally, since for all $p \in (p^*, r)$, $\frac{\partial(1-F(p))^n}{\partial M} > 0$,then, $\frac{\partial \bar{p}_{\min}}{\partial M} > 0$. ■

The reason for this result can be seen from a careful examination of the equilibrium properties 1 and 2. From property 1, an increase in the number of uninformed consumers, M, induces entry of new firms, leaving the number of uninformed consumers per firm constant. In turn, property 2 implies that the distribution of prices shifts rightward (i.e., the new distribution first-order stochastically dominates the old distribution) and so prices tend to go *up*. Consequently, a given firm tends to charge a higher price (so that, for example, the expected price increases). On the other hand, an informed consumer has more firms from which to sample for the lowest price. The calculation above shows that the latter effect cannot fully offset the former, and so the expected minimum price increases.

3 Discussion

Conventional wisdom suggests that, by removing geographic barriers and increasing the ease and availability of information to consumers, pricing on the Internet will grow more competitive as more consumers shop online. In fact, this need not be the case. As we have shown, if new consumers coming to the Internet are mostly less knowledgeable about where to obtain the lowest price, then price dispersion will persist and price levels will rise for all consumers. That uninformed consumers will expect to pay higher prices is intuitive and is already known (Varian 1980). Our analysis shows that informed consumers are also adversely affected by the influx of uninformed consumers. This effect stems from the negative information externality new, but relatively uninformed, consumers impose on more informed consumers, and is not completely offset by an increase in the number of firms. If these new consumers become relatively more informed, then the information externality effect will ultimately reverse and prices will become more competitive.

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