Market Transparency and Product Differentiation

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Abstract

In a Hotelling market with endogenous choice of product characteristics increasing market transparency on the consumer side leads to less product differentiation, and lower prices and profits. This is welfare improving for all consumers and total surplus increases.

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1 Introduction

The effects of market transparency is an old issue in the competition policy debate. More transparency on the consumer side, so consumers are better informed about prices and product characteristics, are usually thought to promote competition, whereas more transparency on the producer side are thought to have opposite effects as it facilitates tacit collusion, see Kuhn and Vives (1995), Stigler (1964), or Tirole (1988).

This paper considers the effects on product differentiation and competition of increased transparency on the consumer side in a Hotelling market ala d'Aspremont et al (1979). Increasing consumers' information about prices *and* product characteristics makes the market more competitive so equilibrium prices decrease for given product characteristics. The business stealing effect becomes more important for the firms. However, as is well known, when firms locate endogenously, they have an incentive to move apart in order to mitigate competition. This raises the issue how increased market transparency affects product differentiation. If firms react by differentiating their products further, then the competitive effects may vanish.

Increasing market transparency leads to two opposite effects on the incentives to differentiate the products. Increasing transparency *about prices*, intensifies competition for given locations, and firms would like to mitigate this effect by differentiating their products further. On the other hand, since *more consumers learn product characteristics* before purchase, the business stealing effect is enhanced. In the Hotelling market, the second effect dominates: the equilibrium locations of the firms converge as a result of increased transparency. Increasing transparency on the consumer side is thus unambiguously beneficial for consumers and bad for firms even when the effects

on product differentiation are taken into account. The total welfare effects are positive.

We identify market transparency with the fraction of consumers who are informed about prices *and* product characteristics - following the lead of Varian (1980), who considers a homogeneous market where some consumers are unaware of prices. The model thus applies to markets where product characteristics as well as prices are not obvious to all consumers, for instance because the good is an experience good, or because the good's characteristic and the pricing are "complicated" as is the case with insurance policies, internet access or mobile phones. Uninformed consumers have rational expectations about prices and characteristics. They play an important role, since firms know that they rely on expectations and do not learn the firms' actual choices before purchase. The demand elasticity therefore depends on the fraction of uninformed consumers.

Transparency and product differentiation has been touched upon before. Dudey (1990) considers firms' geographic location choices in a model of homogeneous goods with a fixed number of locations, and consumers with limited price information. Consumers can visit one location only and seek locations with many firms where competition is tougher. Equilibrium therefore features clustering of firms. Stahl (1982), Wolinsky (1983) and Fischer and Harrington (1996) explain sellers geographical clustering by referring to scale economics in consumer search. Bester (1998) considers locational choice in a Hotelling model, where firms may also differentiate products vertically. Consumers are imperfectly informed about quality, and high prices signal quality. This mitigates horizontal product differentiation, since prices remain over marginal costs, even though firms locate together. In Wolinsky (1984) prices are fixed and consumers search to learn the available products.

In the present paper, transparency is an exogenous feature of the model, a literature has studied the case where information about prices and products are provided through advertising by the firms (Bester and Petrakis (1995), Butters (1977), and Grossman-Shapiro (1984)). Boone and Potters (2002) study a symmetric Cournot-Nash model of differentiated goods where transparency is interpreted as the fraction of consumers who are aware of all existing products in the market. Due to complementray goods effects an increase in this sort of transparency may lead to price increases. In their model the number of goods and the substitutability is exogeneous.

Schultz (2002) studies tacit collusion in a differentiated Hotelling market where firms locations are given. It is shown that increasing transparency makes tacit collusion harder to sustain in a differentiated market, while these effects vanish in an almost homogeneous market. Nilsson (1999), Møllgaard and Overgaard (2000) also consider aspects of tacit collusion and market transparency.

2 The model

We consider a Hotelling market with a continuum of consumers. Consumer x is located at $x \in [0,1]$. A consumer buys at most one unit of the good. There are 2 firms, A and B. First firms choose locations, a and b, on *the whole real line*, w.l.o.g. $a \leq b$. Some consumers are uninformed about the firms' locations, and only learn these when buying. A geographical interpretation of the line is therefore not reasonable.

If firms charge prices p_a and p_b, consumer x receives utility $u - p_a - t\left(x-a\right)^2$ from buying one unit from firm A and $u - p_b - t(1-b-x)^2$ from buying a unit from firm B. The parameter $t > 0$ measures the "intensity" of

product differentiation, we denote it the transportation cost. A consumer, who knows the prices and locations of the firms is indifferent between buying from A and B if she is located at

$$x = x(p_a, p_b, a, b) \equiv \frac{1 + a - b}{2} + \frac{p_b - p_a}{2t\,(1 - a - b)} \tag{1}$$

There are two different *information types* of consumers: a fraction ϕ are informed about both firms' prices and locations, while a fraction $(1 - \phi)$ are uninformed. The variable ϕ is our measure of market transparency, the higher is ϕ, the more transparent is the market. Both information types are uniformly distributed on locations.

We allow firms to locate outside the unit interval in order to avoid corner solutions so that their choice of location is influenced by marginal incentives. d'Aspremot et al (1978) show that if $\phi = 1$ and firms are restricted to locate in [0,1], they locate in 0 and 1, respectively. This would not be the case if the density of consumers were higher in the middle. The formulation chosen here avoids corner solutions and maintains the simplicity of the uniform distribution.

An uninformed consumer has an *expectation* p_i^e of firm $I's$ price and i^e of its location, consumer $x's$ *expected* utility from buying form firm A is $u - p_a^e - t\,(a^e - x)^2$. The uninformed consumer located at $y = x(p_a^e, p_b^e, a^e, b^e)$ is indifferent between buying from the two firms. In the sequel, we will concentrate on symmetric equilibria where $y = 1/2$. An uninformed consumer only learns the location of a firm by consuming the good (the good is an experience good) and the price is only learned by purchase. She cannot visit the firms sequentially and collect information before purchase.

The time line is as follows. First consumers form expectations about locations and prices. Then firms choose locations, learn each other's location

and finally choose prices. Some consumers learn the locations and prices. Based on knowledge or expectations, consumers decide which firm to visit. A consumer can only go to one firm. Then transactions take place.

The demand for firm $A's$ product is

$$D = \phi x(p_a, p_b, a, b) + \frac{(1-\phi)}{2} \tag{2}$$

where we have used symmetric expectations. We assume that the market is covered, so that firm B's demand is $1 - D$.

3 Prices

When choosing locations and prices, firms take the expectations as given. Expectations are rational, so in equilibrium there will be no consumers, who are surprised by a firm's location or price and would wish to go the other firm.

We assume marginal costs are constant and normalize them to zero, so firm $A's$ profit is

$$\pi_a = p_a \left(\phi x(p_a, p_b, a, b) + \frac{(1-\phi)}{2} \right)$$

We solve the game backwards. At the last stage the firms choose prices to maximize profit taking as given the expectations of the consumers, the locations, a, b, and the price of the other firm. The first order condition for firm A is $D + p_a \phi \frac{\partial x}{\partial p_a} = 0$, the price is chosen so that the elasticity of demand equals -$\frac{1}{\phi}$. The equilibrium prices are

$$p_a(a, b, \phi) = \frac{(1-a-b)(\phi(1+a-b)+2+(1-\phi))}{3\phi} t \tag{3}$$

$$p_b(a, b, \phi) = \frac{(1-a-b)(4+\phi(b-a-1)+(\phi-1))}{3\phi} t \tag{4}$$

The prices are decreasing in ϕ, increasing transparency makes price setting more competitive for given locations.

4 Locations

When choosing locations, the firms take into account that prices will affected, cf. (3) and (4). They each maximize profit taking as giving the expectations and the location of the other firm. The equilibrium locations are outside [0,1] in a and $1-\ b$ respectively, where

$$a = b = \frac{7\phi - 9}{8\phi} < 0$$

The firms are symmetrically located, confirming expectation of consumers. As a is increasing in ϕ, firms locate closer in a more transparent market. Since the locations are outside the interval [0,1] *all* consumers' transportation costs decrease. In itself this is welfare improving.

The equilibrium prices and profits are

$$p_a = p_b = \frac{3}{4}\frac{(3-\phi)}{\phi^2}t \text{ and } \pi_a = \pi_b = \pi = \frac{3}{8}\frac{3-\phi}{\phi^2}t \tag{5}$$

they both decrease in ϕ; firms dislike transparency. The decrease is a sum of two effects, as we saw above prices decrease for given locations, an additional decrease comes from the fact that firms locate closer. As utility is linear in prices, the welfare loss of the firms from an increase in transparency is mirrored by a similar welfare gain for consumers.

When t is very low, equilibrium prices are very low. A firm may then gain by raising the price to $\left(u - \left(\frac{1}{2} - a\right)t\right)$ and only serve the uninformed consumers arriving in equilibrium. This gives less profit than (5) if

$$\frac{t}{u} > \frac{2}{3}\frac{\phi^2}{6 + \phi - \phi^2}$$

If this condition is not fulfilled, a pure strategy equilibrium to the pricing game fails to exist and equilibria are mixed - as Varian (1980) showed is the case in a homogeneous market. We will not consider this case[1]. We have also assumed that the market is covered, this takes that the consumer in the middle is interested in buying, inserting the equilibrium values of prices and locations, it is easy to check that this is fulfilled.

Summarizing our results,

Theorem 1 *Increasing market transparency leads to less product differentiation, lower prices and lower profits, this is unambiguously better for consumers and worse for firms. The social surplus increase with the decrease in transportation costs.*

One may speculate what happens if consumers all are informed about prices but some are unsure about product characteristics. In the simple Hotelling market of this paper, the uninformed consumers would be able to learn the characteristics through the price. There is a one to one relation between price and the distance between the firms' locations. In a symmetric equilibrium, consumers are therefore able to infer the locations of the firms from the prices.

If on the other hand, consumers are informed about characteristics but some are uninformed about prices, similar results as those obtained above also holds. Increasing transparency lowers prices and makes the firms locate closer to each other.

[1]It is treated at some lenght in Schultz (2002) for the case of given locations, $a = b = 0$.

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