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Transparency, price-dependent demand and product variety ☆

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ABSTRACT

This paper revisits the relationship between transparency on the consumer side and product variety. We show that due to lower price–cost margins more transparency is welfare-improving. This result is achieved even though product variety may be reduced.

1. Introduction

This paper reconsiders the effects of consumer side transparency on product variety and social welfare in a differentiated product market. In a recent paper, Schultz (2009) demonstrates within the framework of the Salop model that more transparency leads to less product variety. As the Salop model exhibits excess entry, more transparency necessarily is welfare-improving. The present paper considers the robustness of this welfare result in a more general model where product variety can be excessive or insufficient. In such a framework the welfare impacts of transparency are a priori not obvious.

We extend the model of Schultz (2009) in the following way. Schultz uses a version of the Salop (1979) model with two consumer groups, informed and uninformed consumers. Only informed consumers are fully aware of prices charged by all firms while uninformed consumers always buy from the nearest one. The proportion of informed consumers is then taken as a measure for the transparency in the market. We follow this approach. One feature of the Salop model and of Schultz (2009) is that consumer demand for the differentiated product is inelastic. A consumer demands one single unit as long as the price is lower than the reservation value. In contrast, following Gu and Wenzel (2009a), we consider a version where demand is price-dependent. In this setup, product variety can be excessive or insufficient.

We identify two effects of increasing transparency on welfare. Firstly, it decreases the price–cost margin which affects welfare positively. Secondly, transparency reduces entry which is positive for welfare when variety is excessive but negative if there is insufficient variety. The total welfare effect of transparency is the sum of these two effects. In the case of excessive variety, both effects point in the same direction and the total effect is unambiguous. In the case of insufficient variety, the effects point in opposite directions. Surprisingly, however, the price effect dominates and increasing transparency is always welfare-improving. Thus, the present paper strengthens the robustness of the welfare results in Schultz (2009). Note, however, that the reasons for the results differ. While in the paper by Schultz (2009) welfare increases due to a reduction in (excessive) variety, in our paper the decrease of the price–cost margin is responsible for the overall result.

2. The model

Consider a variant of the Salop (1979) model. We depart in two aspects from the standard model. Firstly, as in Varian (1980) and Schultz (2009), consumers of proportion $\phi \in [0,1]$ are fully aware of prices charged by all firms. Other consumers $(1-\phi)$, however, are unaware of prices and buy from the nearest store. Secondly, we introduce price-dependent demand. Following the approach in Gu

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and Wenzel (2009a), we consider a demand function with a constant elasticity.[1]

Consumer utility depends on the quantity of the differentiated product and the quantity of a homogeneous numeraire good:

$$U = \begin{cases} \left(V - \frac{\epsilon}{1-\epsilon} q_d^{\frac{\epsilon-1}{\epsilon}} - td\right) + q_h & \text{if it consumes the differentiated product} \\ q_h & \text{otherwise,} \end{cases} \tag{1}$$

where q_d is the amount of the differentiated product and q_h the amount of the numeraire good. The parameter $0<\epsilon<1$ is the demand elasticity of the differentiated good.[2] Transportation costs are linear at a rate t and d is the distance between the consumer's location and the firm's.[3]

Each consumer has a fixed budget of Y to finance the consumption of the differentiated and the homogeneous product. Normalizing the price of the homogeneous product to one the budget constraint is $Y = p_d q_d + q_h$, where p_d is the price of the differentiated product. Maximization of the utility function under the budget constraint yields the following demand functions[4]:

$$\hat{q}_d = p_d^{-\epsilon}, \tag{2}$$

$$\hat{q}_h = Y - p_d^{1-\epsilon}. \tag{3}$$

Inserting into (1) gives the indirect utility when consuming the differentiated product from a certain firm:

$$\hat{U} = V + Y - \frac{1}{1-\epsilon} p_d^{1-\epsilon} - td. \tag{4}$$

There are $n \geq 2$ firms offering the differentiated product. These firms are located equidistantly around the circle. We seek for a symmetric equilibrium. Therefore, we derive the demand of a representative firm i. Firms attract consumers from both groups: informed and uninformed consumers. Uninformed consumers buy from the nearest firm. Therefore, each firm has a market share of $\frac{1}{n}$ of the uninformed consumers. Informed consumers are fully aware of all prices and choose to buy from the firm that offers the highest utility. The marginal consumer – given that firm i charges a price of p_i while all remaining firms charge a price of p – is given by:

$$x = \frac{1}{2n} + \frac{p^{1-\epsilon} - p_i^{1-\epsilon}}{2t(1-\epsilon)}. \tag{5}$$

Adding up the informed and uninformed consumers the market share of firm i is:

$$m_i = \phi\left[\frac{1}{n} + \frac{p^{1-\epsilon} - p_i^{1-\epsilon}}{t(1-\epsilon)}\right] + (1-\phi)\frac{1}{n}. \tag{6}$$

As each consumer demands a quantity $p_i^{-\epsilon}$ of the differentiated product, total demand for its product is $D_i = m_i p_i^{-\epsilon}$.

[1] Using a demand function with constant elasticity has the advantage of yielding closed-form solutions. However, our results do also hold for other demand functions. In light of Gu and Wenzel (2009b), we have checked the robustness of our result when using linear demand function. We had to rely on numerical solutions but the welfare results do not change compared to the specification used in this paper.

[2] When ε approaches zero, demand tends to be completely inelastic and the model converges to the one in Schultz (2009).

[3] Examples of markets that fit these preferences would be the supermarket and restaurant markets: One can only enter one supermarket (restaurant), but one may buy more or less depending on the price. We thank a referee for the example.

[4] We assume that all consumers decide to buy a positive amount of the differentiated good, i.e., the market is covered.

3. Equilibrium analysis

We focus on cases where firms serve both informed and uninformed consumers (first condition in (7)) and at least two firms enter (second condition in (7)). This is guaranteed by assuming that transportation costs are sufficiently high:

$$t \geq max\left[(1-\epsilon)\frac{4(1-\phi)^2\phi}{(2+\phi-\phi^2)^2}\frac{V^2}{f}, \frac{4\phi f}{1-\epsilon}\right]. \tag{7}$$

We start by considering the price equilibrium for a given number of firms in the market. Assuming zero production costs, the profit function of firm i is:

$$\Pi_i = D_i p_i = m_i p_i^{1-\epsilon}. \tag{8}$$

Equilibrium price and profits are then:

$$p^c = \left[\frac{t(1-\epsilon)}{\phi n}\right]^{\frac{1}{1-\epsilon}}, \tag{9}$$

$$\Pi^c = \frac{t(1-\epsilon)}{\phi n^2}. \tag{10}$$

Both prices and profits decrease in the share of informed consumers.

In the next step we determine equilibrium product variety. To enter the market an investment of f is needed. The number of entering firms is determined by setting (10) equal to f:

$$n^* = \sqrt{\frac{t(1-\epsilon)}{\phi f}}. \tag{11}$$

The number of entrants decreases with the share of informed consumers. Thus, transparency has an adverse impact on product variety in the market. Inserting n^* into (9) gives the free-entry equilibrium price:

$$p^* = \left[\sqrt{\frac{tf(1-\epsilon)}{\phi}}\right]^{\frac{1}{1-\epsilon}}. \tag{12}$$

The price decreases when the market is more transparent. As we have assumed zero production costs, the price is moving closer to marginal cost.

The number of entrants is at least two if the second part of (7) is fulfilled. When a firm wants to serve the uninformed consumers only, it charges the price $\left[(1-\epsilon)\left(V-\frac{t}{2n}\right)\right]^{\frac{1}{1-\epsilon}}$ to make a profit of $\frac{1-\phi}{n}(1-\epsilon)\left(V-\frac{t}{2n}\right)$. This profit is lower than the equilibrium profit of serving both informed and uninformed consumers if the first condition in (7) is satisfied.

4. Welfare impact of transparency

Our main concern in this paper is to determine the impact of transparency on the welfare properties of the free-entry equilibrium. We study the impact of increased transparency on total welfare which is defined by the sum of consumer surplus and industry profits. For given prices and neglecting constants, welfare is

$$W = -\frac{1}{1-\epsilon}p^{1-\epsilon} - 2n\int_0^{\frac{1}{2n}} txdx + p^{1-\epsilon} - fn. \tag{13}$$