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Transparency, Entry, and Productivity

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Transparency, Entry, and Productivity

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Abstract

This paper studies the relationship between transparency on the consumer side and productivity of firms. We show that more transparent markets are characterized by higher average productivity as firms with low productivity abstain from entering these markets.

Keywords: Market Transparency; Firm Productivity; Salop Model; Heterogeneous Firms
JEL-Classification: D24; L13; L15

1 Introduction

Consumer-side transparency is generally thought to be beneficial for the functioning of markets. If consumers are better informed about prices, product characteristics, etc., they can make better decisions and market power

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of firms may be reduced (e.g., Schultz, 2005). Thus, transparency can improve market outcomes in a static sense. The present paper is concerned with dynamic effects of consumer-side transparency. We show that in more transparent markets only the most productive firms choose to enter. Hence a beneficial effect of increasing transparency is that these markets are characterized by a higher average productivity.

To analyze the issue raised above we study an industry where firms are heterogeneous in their cost structure and decide whether to enter a market. We develop a Salop-style model where a share of consumers is uninformed about prices and where firms differ in their marginal costs of production. The share of informed consumers is our measure for consumer-side transparency. As in Aghion and Schankerman (2004) and Syverson (2004) the marginal cost of each firm is private information. Firms can enter the market after investments are made. In this context, we ask which types of firms decide to enter a market and how this decision is affected by the degree of consumer-side transparency. Our main result is that transparency induces a selection of firms. If transparency is high only sufficiently productive firms can profitably enter a market thereby raising overall productivity.

We show that an increase in consumer-side transparency affects high-cost and low-cost firms quite differently. First, more transparency reduces price mark-ups. This effect is negative for all firms. Second, increased transparency redistributes market share from high-cost to low-cost firms. This effect is positive for low-cost firms, but negative for high-cost firms. Due to increased transparency, for a given number of firms, profits of all firms are affected negatively. However, a low-cost firm is affected to a lower degree as the decrease in price is partly compensated by a larger market share. This differential effect of transparency is the driving force for our selection result.

Existing studies on consumer-side transparency focus on symmetric industries. Schultz (2009) and Gu and Wenzel (2011) study the impact of transparency on entry decisions in a symmetric Salop model. These papers analyze how many firms enter the market and find that market transparency is welfare improving despite of the resulting reduction in entry. In contrast, the present paper focuses on asymmetric firms that differ in productivity. We ask which firms enter the market and how transparency affects the composition of productivity. These questions have not been addressed before. The novel result is that increasing transparency weeds out the least productive firms.

The selection effect by market transparency identified in this paper complements other mechanisms of demand side induced productivity selection in the literature of heterogeneous firms. Melitz (2003) shows that the exposure to international trade will force the least productive firms to exit. In Syverson (2004) and Melitz and Ottaviano (2008), larger markets are associated with higher average productivities. Our paper, on the other hand, suggests that even differences in consumer information can lead to differences in productivity across markets.

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 (2005), consumers of a proportion $\phi \in (0, 1]$ are fully aware of prices charged by all firms. All other consumers $(1 - \phi)$, however, are unaware of prices and buy from the nearest store. Secondly, we introduce firms that differ in their marginal production costs (Aghion and Schankerman, 2004; Syverson, 2004).

There is a measure one of consumers uniformly located along a circle of circumference one. Each consumer demands one unit of the differentiated product. The utility from buying product i is

$$U = v - p_i - tx,$$

where v denotes the gross utility, p_i the price charged by firm i and x the distance between the consumer and the firm. We assume v is sufficiently large so that the market is covered. Transportation costs are linear at a rate $t > 0$.

Following Syverson (2004), entry on the supply side of the market is determined in two stages. In the first stage, a large number of ex ante identical potential entrants decide whether to pay a sunk cost $F > 0$ to receive an idiosyncratic draw of marginal production cost c from a common distribution

$g(c)$ with support $[0, c_u]$, where $c_u > 0$ is the upper bound. A lower marginal cost corresponds to a higher level of productivity. In the second stage, those who have invested F and learned their cost draws decide whether to enter the market by paying a fixed cost of entry $f > 0$. Entrants are then placed randomly at equidistant locations on the circle (as in Syverson, 2004). For a given number of entrants, the main difference to the standard Salop model is that these firms differ in their marginal costs. A firm's marginal cost is private information.

3 Analysis

We first study a firm's entry decision in the second stage after it has received a cost draw. It enters if its expected profit from operating in the market exceeds the fixed cost of entry f. In the first stage, a potential entrant weighs its expect profit (net entry cost f) in the event when it does enter the market in the second stage against the cost of receiving a productivity draw, F. In a long-run free entry equilibrium, the expected benefit of a cost draw is equal to its cost. This condition ultimately determines the number of potential entrants who choose to make a productivity draw and their entry decision rule in the second stage.

3.1 Pricing equilibrium

In this part we derive an entrant's expected profit by analyzing firms' pricing strategies after they have entered.

Suppose that active firms serve both informed and uninformed consumers.[1] As uninformed consumers buy from the nearest firm, each firm expects to receive a demand of $(1-\phi)\frac{1}{n}$ from those consumers when there are n active firms.

[1]By comparing the expected equilibrium profit from serving both types of consumers (see Eq. (6)) to that of serving uninformed consumers only, this supposition holds if the transportation cost t is sufficiently high:

$$t \geq \frac{\phi(1-\phi)(v-c_i)}{n\left[\frac{1}{n}+\frac{\phi}{2t}(E(c)-c_i)\right]^2+\frac{\phi(1-\phi)}{2n}}.$$

Informed consumers know all prices and buy from the firm that offers the best combination of price and location. We assume that each active firm sells a positive quantity to informed consumers.[2] It follows that between any two adjacent firms there exists an informed consumer who is indifferent between buying from either of these two:

$$p_i + t\bar{x} = p_j + t\left(\frac{1}{n} - \bar{x}\right).$$

As costs are private information to each firm, the expected location of the marginal consumer for firm i is

$$E(\bar{x}) = \frac{1}{2n} + \frac{E(p) - p_i}{2t}.$$

With two immediate neighbors on each side, the expected share of informed consumers buying from firm i is $2E(\bar{x})$.

Adding up informed and uninformed consumers, the total expected demand of firm i is

$$E(D_i) = \phi\left(\frac{1}{n} + \frac{E(p) - p_i}{t}\right) + (1 - \phi)\frac{1}{n}.$$

The expected profit of firm i characterized by price p_i and cost c_i is then given by

$$E(\Pi_i) = (p_i - c_i)E(D_i) = (p_i - c_i)\left(\frac{1}{n} + \phi\frac{E(p) - p_i}{t}\right). \quad (1)$$

Maximizing (1) with respect to p_i, the first order condition gives us

$$p_i = \frac{t}{2n\phi} + \frac{1}{2}E(p) + \frac{1}{2}c_i. \quad (2)$$

Focusing on a symmetric pricing equilibrium, we have

$$E(p) = E(c) + \frac{t}{n\phi}. \quad (3)$$

[2] As in Syverson (2004), this assumption holds if $\hat{c} < \frac{2t}{n}$, where $\hat{c}$ is the highest marginal cost in the market. This inequality in turn holds under free entry when the fixed cost of entry f is sufficiently large. A copy of the formal proof is available from the authors upon request.

Substituting (3) back into (2), equilibrium prices, sales and profits are then characterized by

$$p_i^* = \frac{t}{n\phi} + \frac{1}{2}E(c) + \frac{1}{2}c_i, \tag{4}$$

$$E(D_i^*) = \frac{1}{n} + \frac{\phi}{2t}\left(E(c) - c_i\right), \tag{5}$$

and

$$E(\Pi_i^*) = \frac{t}{\phi}\left[\frac{1}{n} + \frac{\phi}{2t}\left(E(c) - c_i\right)\right]^2. \tag{6}$$

Lemma 1. The lower an active firm's marginal cost is, the higher is its expected profit.

There are two immediate effects of increasing transparency. First, competition for informed consumers becomes more intensive and prices decrease (see Eq. (4)). This effect is negative for all firms and in particular, the strength of this effect is independent of a firm's cost. This has already been shown in symmetric models (e.g. Schultz, 2009).

Second, expected demand shifts from high-cost to low-cost firms:

$$\frac{\partial E(D_i^*)}{\partial \phi} \begin{cases} > 0 & \text{if } c_i < E(c) \\ < 0 & \text{if } c_i > E(c) \end{cases}.$$

It follows that firms with lower than average cost can increase equilibrium market share while those with above average cost lose demand. As transparency in the market increases and more consumers become informed, these consumers realize better offers by low-cost firms. With more transparency low-cost firms find it easier to attract new consumers. This asymmetric effect on market share is novel and not present in symmetric models. In models with symmetric firms the market share of each firm is unaffected by transparency and remains constant.

As both effects are negative for high-cost firms, they unambiguously lose from increased transparency. For low-cost firms the effects oppose each other. However, the price effect dominates such that low-cost firms also lose by increased transparency, though to a lesser degree than their less productive competitors.[3]

[3] It can be shown that the condition for $E(\Pi_i^*)$ to decrease in ϕ is $E(c) - c_i < \frac{2t}{n\phi}$. Because

Summarizing,

Proposition 1. For a given number of active firms, an increase in transparency, i) decreases the equilibrium price for all firms, ii) shifts market demand from high-cost to low-cost firms, iii) decreases profits for all firms, and iv) the loss in profits is stronger for high-cost firms.

3.2 Market entry

Let N be the number of potential entrants that have invested in cost draws in the first stage. We focus on markets that are populated by many firms so N is assumed to be a large number. As we have seen in Lemma 1 that low-cost firms earn higher expected profits than high-cost firms, we aim to identify the cut-off level of marginal cost $\hat{c}$ such that a firm enters when its marginal cost is lower than $\hat{c}$ and stays out otherwise. Abstracting from integer problems, the number of entrants is $NG(\hat{c})$. Additionally, to an entrant, the expected marginal cost of rivals is

$$E(c) = \int_0^{\hat{c}} c\frac{g(c)}{G(\hat{c})}dc. \tag{7}$$

As a marginal cost draw of $\hat{c}$ makes a firm indifferent between entering and staying out, its expected profit from competing in the market is equal to the fixed cost of entry f. From Eq. (6),

$$E(\Pi^*|c = \hat{c}) = \frac{t}{\phi}\left[\frac{1}{n} + \frac{\phi}{2t}(E(c) - \hat{c})\right]^2 = f. \tag{8}$$

Rearranging (8), $\hat{c}$ is implicitly given by

$$\hat{c} = E(c) + \frac{2t}{n\phi} - 2\sqrt{\frac{tf}{\phi}}, \tag{9}$$

where $n = NG(\hat{c})$ and $E(c) = \int_0^{\hat{c}} c\frac{g(c)}{G(\hat{c})}dc$.

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to guarantee each firm sells a positive amount to informed consumers we need the highest marginal cost in the market $\hat{c}$ to be less than $\frac{2t}{n}$ (see footnote 2),

$$E(c) - c_i \leq E(c) < \hat{c} < \frac{2t}{n} \leq \frac{2t}{n\phi}.$$

Therefore, market transparency decreases profits for all active firms.

In the first stage, the benefit of investing F lies in the event when a below $\hat{c}$ marginal cost is drawn. In this case, the firm does enter the market and expects a profit higher than the entry cost f. In a free entry equilibrium, the expected benefit is equal to the cost F. This condition pins down the number of potential entrants (N) that invest in cost draws.

The expected profit conditional on marginal cost when a firm does enter is given by (6). Using (9), we additionally have

$$\frac{1}{n} = \frac{\phi}{2t}(\hat{c} - E(c)) + \sqrt{\frac{f\phi}{t}}. \tag{10}$$

Substituting it back to (6),

$$E(\Pi(c)|c \leq \hat{c}) = \left[\frac{1}{2}(\hat{c} - c)\sqrt{\frac{\phi}{t}} + \sqrt{f}\right]^2. \tag{11}$$

Taking into account of the entry cost in the event of entry, the number of potential entrants that invest in cost draws is (implicitly through $\hat{c}$) given by

$$\int_0^{\hat{c}} (E(\Pi(c)|c \leq \hat{c}) - f)g(c)dc + \int_{\hat{c}}^{c_u} 0 \cdot g(c)dc = F,$$

or equivalently by

$$\int_0^{\hat{c}} \left[\left(\frac{1}{2}(\hat{c} - c)\sqrt{\frac{\phi}{t}} + \sqrt{f}\right)^2 - f\right] g(c)dc - F = 0. \tag{12}$$

Condition (12) implicitly determines the cut-off level of marginal cost $\hat{c}$. The corresponding number of active firms n is given by (10) and the number of potential entrants that invest in cost draws is given by $N = \frac{n}{G(\hat{c})}$.

4 Result

Proposition 2. In a long-run free entry equilibrium, an increase in market transparency ϕ reduces i) the highest marginal cost of active firms $\hat{c}$ and ii) the average marginal cost of active firms $E(c)$.

Proof. Let V be the left-hand side of Eq. (12). By the implicit function theorem,

$$\frac{d\hat{c}}{d\phi} = \frac{-(\partial V/\partial \phi)}{\partial V/\partial \hat{c}}.$$

Since

$$\frac{\partial V}{\partial \phi} = \int_0^{\hat{c}} \frac{1}{2}\left[\frac{1}{2}(\hat{c}-c)\sqrt{\frac{\phi}{t}} + \sqrt{f}\right]\sqrt{\frac{1}{t\phi}}(\hat{c}-c)g(c)dc > 0$$

and

$$\frac{\partial V}{\partial \hat{c}} = 0 + \int_0^{\hat{c}} \left[\frac{1}{2}(\hat{c}-c)\sqrt{\frac{\phi}{t}} + \sqrt{f}\right]\sqrt{\frac{\phi}{t}}g(c)dc > 0,$$

$\frac{d\hat{c}}{d\phi} < 0$. Therefore, the highest marginal cost of active firms $\hat{c}$ decreases in market transparency ϕ.

The second claim follows straightforwardly from the first one. □

The intuition for this result is the following. There are two opposing effects at work, a direct effect and an indirect one. The direct effect is the immediate effect of increased transparency. When a market becomes more transparent, price competition for the informed consumers is intensified. As a result, for a given number of active firms, profits are reduced. Therefore, firms with high marginal costs find it no longer worthwhile to pay the fixed cost of entry in the second stage .

This direct effect is somewhat mitigated by an indirect effect which works via the number of firms investing in the cost draw in the first stage of the entry. In more transparent markets, the expected value of entry is lower as profits of all firms are reduced (see Proposition 1) and, in consequence, less firms invest to find out their cost. A lower number of expected entry increases the scope for less efficient firms to earn positive profits, and hence, this indirect effect tends to increase the critical cut-off cost level. However, this indirect effect is small relative to the direct effect so that, overall, transparency reduces the highest marginal cost of active firms.

Proposition 2 identifies a novel positive welfare effect of increasing transparency.[4] More transparent markets are characterized by higher average

[4] A full welfare analysis, however, is analytically not possible. Yet, we strongly conjecture

productivity. While the existing literature has focused on the effects of consumer-side transparency in symmetric-firms setups, our contribution is that positive effects of transparency may be even larger in asymmetric industries as the least productive firms are precluded from entering.

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that the welfare effects are clearly positive. Existing studies with symmetric firms and free entry (Schultz, 2009; Gu and Wenzel, 2011) show that total welfare and consumer surplus increase if the number of informed consumers rises even though product variety may decrease. Our model comprises the same effects as their models and, in addition, the positive welfare effect of higher productivity.

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