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Voluntary disclosure of product quality in competitive markets[☆]

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Abstract

This note examines the incentives to communicate private information about product quality in markets in which sellers can voluntarily disclose this information before competing on prices. We provide sufficient conditions for the existence of two types of symmetric equilibria, one in which every type of seller fully discloses the quality of its product and one in which no such disclosures are made. We then show that if the disclosure cost is not too high the full disclosure equilibrium Pareto-dominates the full non-disclosure one, suggesting that competition may increase rather than reduce incentives to reveal information through disclosure.

Keywords: Disclosure, Quality, Signaling, Competition
JEL: L15, D43, D83

1. Introduction

This note is concerned with the choice between price signaling and voluntary disclosure of product quality in markets in which sellers can voluntarily disclose this information before competing on prices. Previous literature on this topic has assumed either that products are both vertically and horizontally differentiated (Levin, Peck, and Ye, 2009; Caldieraro, Shin, and Stivers, 2011; Hotz and Xiao, 2013) or that there is a single seller in the market (Fishman and Hagerty, 2003; Daughety and Reinganum, 2008a,b). Janssen and Roy (2015) are the first authors to study the choice between signaling and voluntary disclosure in a duopoly in which products are only vertically differentiated. Their main conclusion is that competition between sellers generates strong incentives in favor of signaling as the sellers' preferred mechanism to communicate product quality because non-disclosure softens price competition.

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In Janssen and Roy's (2015) model, sellers cannot contract with buyers based on the information revealed through disclosure even though the authors assume that this information is both credible and verifiable. This is important because competing sellers may use this information to commit to policies such as meet-the-competition clauses (henceforth, MCCs) (Salop, 1986) in order to sustain high price equilibria in the states of nature in which the quality of the products is the same. In this note, we extend Janssen and Roy's (2015) model by including the possibility that sellers adopt this type of policy at the disclosure stage of the game. We show that when disclosure is not too costly, the adoption of MCCs suffices for full disclosure to be a symmetric equilibrium outcome of the game. Furthermore, the full disclosure equilibrium may Pareto-dominate the (symmetric) equilibrium in which sellers signal product quality through prices, suggesting that disclosing information in competitive environments involves strategic opportunities that may lead sellers to prefer it over signaling for communicating the quality of their products.

We also examine a version of the model in which information is only partially verifiable. We show that the full disclosure equilibrium is not robust to the introduction of misreporting when the probability that the regulator checks the sellers' reports is low. We interpret this result as a suggestion that competition between sellers alone may not suffice to explain the observed reluctance of firms to voluntarily disclose the quality of their products (Jin, 2005; Dranove and Jin, 2010).

2. Model

The model is similar to that in Janssen and Roy (2015) with the exception that sellers can adopt MMCs in the disclosure stage of the game. There are two risk-neutral sellers, sellers A and B, and a unit mass of identical risk-neutral buyers. Each seller owns a unit of an indivisible good whose quality can be low (L) or high (H). The common knowledge cost of producing a unit of a product of quality τ is constant and equal to c_τ, $\tau \in \{L, H\}$. Buyers have unit demands and identical valuation θ_τ for a unit of a product of quality τ, with $\theta_\tau > c_\tau$.

In the first stage of the game, Nature independently draws the quality of seller j's product, $j = A, B$, from a common probability distribution that assigns probability $\alpha \in (0, 1)$ to quality H, and probability $1 - \alpha$ to quality L, a move that is observed only by seller j. In the second stage, sellers simultaneously decide whether to disclose the quality of their products. Disclosure is truthful, verifiable, and costly, with $\delta \geq 0$ as the disclosure cost. In addition to their disclosure decisions, the sellers also decide on the adoption of MCCs, which are commitments to matching any other price that a competitor charges for a product of identical quality. Sellers that do not disclose the quality of their products are banned from committing to this or any other policy that depends upon the

quality revealed through disclosure[1]. The sellers' decisions about disclosure, the outcome of these decisions, and whether they adopt MCCs are observed by every agent in this economy. In the third stage, sellers simultaneously compete on prices. Finally, buyers decide to buy from seller A or seller B or not to buy at all.

A buyer that buys a product of quality τ at price p receives a payoff equal to $\theta_\tau - p$ whereas the seller receives a payoff equal to $p - c_\tau$. If indifferent, the buyer tosses a fair coin to choose a seller from which to buy.

The equilibrium concept is a perfect Bayesian equilibrium in which out-of-equilibrium beliefs satisfy Cho and Sobel (1990) D1 criterion, which means that for every possible disclosure outcome, we only consider price equilibria that satisfy the D1 refinement[2].

3. Analysis

Janssen and Roy (2015) showed that if sellers are not allowed to commit to any device that depends on the quality revealed through disclosure, then the condition

$$\theta_L - c_L > \theta_H - c_H \tag{1}$$

is sufficient for the existence of a unique symmetric equilibrium satisfying the D1 criterion in which sellers communicate the quality of their products through prices rather than voluntary disclosure[3].

Suppose that condition (1) holds and consider the following putative symmetric equilibrium in which low-quality and high-quality sellers voluntarily disclose the quality of their products and adopt MCCs. On the equilibrium path, the sellers compete on prices while knowing the quality of their competitors' products. In the continuation game in which products are of similar quality, each firm advertises a price equal to θ_τ, $\tau = L, H$. In the continuation game in which products are of different quality, the low-quality seller

[1]Two comments are in order. First, without disclosure a seller can simply refuse to match the competitor's price based on the lack of credible proof about the quality of its product. This could describe situations in which producing proof of quality is prohibitively expensive for anyone but the seller that produces the good. Second, under condition (1) below, there cannot be a separating equilibrium in which the sellers signal their quality through the adoption of MCCs without actual disclosure. The reasons are similar to those in Janssen and Roy (2015), i.e., a high-quality seller that signals its type in this manner is either undercut by a low-quality rival or lead to marginal cost pricing.

[2]See Janssen and Roy (2010, 2015) for details on how to apply this refinement to games with more than one sender.

[3]Intuitively, condition (1) implies that a high-quality seller that discloses its type is either undercut by a low-quality rival or led to marginal cost pricing. Moreover, charging a higher price against a rival that does not fully disclose its type is unprofitable because the D1 criterion selects beliefs in which buyers associate higher prices with low-quality. See Proposition 1 in Janssen and Roy (2015) for a formal proof of this claim.

charges a price equal to $\bar{p} := \theta_L - (\theta_H - c_H)$ and serves the entire market, and the high-quality seller randomizes uniformly in the interval $[c_H, c_H + \eta]$, where η is a positive and small constant[4]. Equilibrium profits are

$$\alpha \left(\frac{\theta_L - c_L}{2} \right) + (1 - \alpha)(\theta_L - (\theta_H - c_H) - c_L) - \delta \tag{2}$$

for the low-quality seller and

$$(1 - \alpha) \left(\frac{\theta_H - c_H}{2} \right) - \delta \tag{3}$$

for the high-quality seller. A necessary condition for this candidate to be an equilibrium is that the profits given by Eqs. (2) and (3) are non-negative. This is equivalent to the following condition on the disclosure cost:

$$\delta \leq \bar{\delta} := \min \left\{ (2 - \alpha) \left(\frac{\theta_L - c_L}{2} \right) - (1 - \alpha)(\theta_H - c_H); (1 - \alpha) \left(\frac{\theta_H - c_H}{2} \right) \right\} \tag{4}$$

In addition to condition (4), both low-quality and high-quality sellers must not have incentives to unilaterally deviate. Consider the continuation game that follows a deviation in which seller B does not disclose its type with positive probability, whereas seller A is revealed to be a low-quality seller. For seller A, setting a price higher than $\bar{p}$ cannot be optimal because any such price would imply being undercut with probability one by both types of seller B. Let $\hat{p}$ be the price charged by seller B. It is immediate that for seller B's deviation to be profitable, $\hat{p} < \bar{p}$ must hold. However, the D1 criterion suggests that any such price must come from a low-quality type because the high-quality type earns non-negative profits in equilibrium, and $\bar{p} < c_H$. It follows that the pricing subgame must be characterized by marginal cost pricing, making seller B's deviation unprofitable. Next, consider the continuation game that follows a deviation in which seller B does not disclose its type with positive positive probability, while seller A reveals itself to be a high-quality seller. It is fairly clear that the best seller A can do is to charge a price equal to c_H. Hence, seller B can undercut seller A by charging a price equal $\bar{p}$ and serve the entire market. However, this type of seller B is already serving the entire market at a price exactly equal to $\bar{p}$ in equilibrium, implying that seller B's deviation is unprofitable. Finally, a deviation in which the high-quality type of seller B does not disclose with positive probability cannot be profitable because the high-quality type seller loses its

[4]This continuation equilibrium (whose proof follows almost verbatim from Blume (2003)) is consistent with the rationing rule in which both sellers split the market if prices are such that consumers are indifferent. It features the low-quality seller serving the entire market at a price equal to $\bar{p}$ and the high-quality seller charging a price such that it makes no sales.

ability to rely on the MCC to sustain a price strictly above c_H in the state of nature in which the rival is also a high-quality seller.

Proposition 3.1. *Suppose that conditions* (1) *and* (4) *hold. Then, there is a symmetric D1 equilibrium in which low-quality and high-quality sellers voluntarily disclose the true quality of their products.*

Because MCCs have no effect if sellers do not disclose the quality of their products, full disclosure and full non-disclosure equilibria coexist when the disclosure cost satisfies condition (4). From Janssen and Roy (2010, 2015), on the equilibrium path of the full non-disclosure equilibrium the high-quality seller charges a price $p_H = \max\{c_H; c_L + 2(\theta_H - \theta_L)\} < \theta_H$, and the low-quality seller follows a mixed price strategy with support $\underline{p}_L, \bar{p}_L]$, where $\bar{p}_L < p_H$. Equilibrium profits are

$$(1-\alpha)(p_H - (\theta_H - \theta_L) - c_L) \tag{5}$$

for the low-quality seller and

$$(1-\alpha)\left(\frac{p_H - c_H}{2}\right) \tag{6}$$

for the high-quality seller.

It is fairly clear that $p_H < \theta_H$ is sufficient for the existence of some $\underline{\delta}_H > 0$ such that $\forall \delta < \underline{\delta}_H$,

$$(1-\alpha)\left(\frac{\theta_H - c_H}{2}\right) - \delta > (1-\alpha)\left(\frac{p_H - c_H}{2}\right)$$

implying that the high-quality seller earns strictly higher profits in the full disclosure equilibrium as long as the disclosure cost is positive but small. For the low-quality seller, the existence of such a threshold requires a positive lower bound for α. To see this, note that the profit in Eq. (5) is fully determined by the high quality price p_H. If $p_H = c_L + 2(\theta_H - \theta_L)$ then this profit is strictly higher than the profit that the low-quality seller earns in the full disclosure equilibrium when facing a high-quality competitor. Therefore, for the low-quality seller to prefer the full disclosure equilibrium, the profit that this seller expects to earn in the state of nature in which both sellers offer low-quality products must be sufficiently high. Define $\bar{\alpha} < 1$ by

$$\bar{\alpha} = \max\left\{\frac{2(\theta_H - c_H)}{2(\theta_H - c_H) + (\theta_L - c_L)}; 0\right\} \tag{7}$$

Proposition 3.2. *If $\alpha > \bar{\alpha}$, where $\bar{\alpha}$ is given by* (7)*, then there exists a threshold cost $\underline{\delta} > 0$ such that $\forall \delta < \underline{\delta}$ the full disclosure equilibrium yields higher profits to both low- and high-quality sellers.*

Proof. For the low-quality seller, the difference between the full disclosure (net of the disclosure cost) and the full non-disclosure equilibrium profits must be greater than

$$\alpha\left(\frac{\theta_L - c_L}{2}\right) + (1-\alpha)\left(\theta_L - (\theta_H - c_H) - c_L\right) - (1-\alpha)(\theta_L - c_L)$$

because $p_H < \theta_H$ implies that profit in (5) must be (weakly) lower than $(1-\alpha)(\theta_L - c_L)$. Some algebraic manipulations yield:

$$\underline{\delta}_L := \alpha\left[\left(\frac{\theta_L - c_L}{2}\right) + (\theta_H - c_H)\right] - (\theta_H - c_H)$$

and $\underline{\delta}_L > 0$ if $\alpha > \bar{\alpha}$. Therefore, $\forall \delta < \max\{\underline{\delta}_H, \underline{\delta}_L\}$ both low- and high-quality sellers earn a higher profit in the full disclosure equilibrium. □

Finally, we present some analysis of the effects of partially verifiable information about product quality. Consider a variation of the previous model in which high-quality sellers can misreport the quality of their products (i.e., they may claim that heir products are of low quality). Low-quality sellers cannot forge proofs about quality, and hence, they either disclose their true type or remain silent about it. There is a regulator that inspects the sellers' products with some exogenous and positive probability $\phi \in (0,1)$. Conditional on inspecting, the regulator publicly announces the true quality of the sellers' product before price competition takes place. We assume that because of laws on misleading advertising, MCCs depend on the reports made by the sellers whenever these reports are not checked and depend on the true quality whenever the reports are checked.

Suppose that there is an equilibrium in which both sellers truthfully report the quality of their products while adopting MCCs. Consider a deviation in which the high-quality type of seller B reports being a low-quality seller while adopting a MCC. With probability ϕ, this seller's product is inspected, and the regulator publicly reveals the true quality of it. However, with complementary probability $1-\phi$, seller B's product is not inspected, and hence, seller A treats seller B as if it were a low-quality seller when setting its price. Consequently, seller A charges a price equal to θ_L if its own product is a low-quality one and uniformly randomizes between and $[c_H, c_H + \eta]$ if its product is a high-quality one. As seller B has adopted a MCC, its best strategy is to charge a price equal to θ_L when seller A is revealed to be a low-quality seller and c_H when seller A is revealed to be a high-quality seller[5]. Thus, seller A's payoff when deviating is

$$(1-\phi)\alpha\left(\frac{\theta_L - c_H}{2}\right) - \delta \tag{8}$$

[5]Observe that the best strategy for seller B when facing a high-quality seller A is to set a price equal to c_H regardless of the beliefs that buyers may hold after observing this price.

and hence, deviating is profitable if, and only if,

$$(1-\phi)\alpha\left(\frac{\theta_L - c_H}{2}\right) > (1-\alpha)\left(\frac{\theta_H - c_H}{2}\right) \tag{9}$$

It is immediate that condition (9) holds whenever ϕ satisfies

$$\phi < \bar{\phi} := \max\left\{1 - \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\theta_H - c_H}{\theta_L - c_H}\right); 0\right\} \tag{10}$$

Note that $\bar{\phi} = 0$ if $\alpha \leq 1/2$ because $\theta_H > \theta_L$. This is consistent with the intuition that misreporting its true quality is profitable for the high-quality seller insofar as it can appropriate more surplus from buyers in those states of nature in which both sellers offer low-quality products. Thus, the more likely the high-quality sellers is to face a low-quality seller, the more attractive it is for the former to misreport its quality. The following result is based on this discussion and Proposition 1 in Janssen and Roy (2015).

Proposition 3.3. *Suppose that high-quality sellers can misreport the quality of their products. If $\alpha < \bar{\alpha}$, where*

$$\bar{\alpha} := \max\left\{\frac{1}{(\theta_H + \theta_L) - 2c_H}; 0\right\}$$

then there exists a strictly positive inspection probability $\bar{\phi}$ given by (10)*, such that for all $\phi < \bar{\phi}$ the unique symmetric equilibrium outcome is one in which both sellers communicate the quality of their products through price signaling rather than voluntary disclosure.*

4. Conclusions

This note investigates incentives to communicate private information about product quality in a market in which sellers can voluntarily disclose the quality of their products before competing on prices. It shows that competing sellers may prefer disclosure to price signaling if they can communicate the quality of their products in a credible and verifiable manner and the disclosure cost is not too high. This result is in contrast with previous findings reported in the literature showing that competition may reduce incentives to reveal information through disclosure. To reconcile this finding with the observed reticence of firms to voluntarily disclose quality attributes, we explore the effects of introducing partially verifiable information into the model. We show that full disclosure equilibrium is not robust to the introduction of partially verifiable information if the probability that the regulator inspects the sellers' product is low. This finding suggests that competition alone may not be sufficient to explain this reticence to communicate private information through disclosure.

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