Quality Disclosure and Competition

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Overview

Motivation

- What determines firms' disclosure behavior?
- What is the motive for a firm to reveal its private information?
- How can a regulatory policy correct the inefficiency in a market with inefficient disclosure?

In this paper

- Hotelling model of price competition with differentiated products
- Comparison between duopoly and monopoly cartel
  - Expected level of disclosure
  - Welfare analysis
  - Socially optimal levels in each market structure

Overview

The model setup

- Two firms(Firm 0 and Firm 1) located at either endpoint of $[0, 1]$
  - Products differentiated by taste and quality
  - $\text{MC} = 0$

- The quality of the good produced by firm i is $\psi + q_i$
  - $\psi > \frac{3}{2}$ and exogenous
  - $q_i \sim U[0, 1]$
  - The cost of disclosing quality is δ
  - Certifying a false quality is impossible
  - $(\tilde{q}_0, \tilde{q}_1)$ denote the perceived qualities

- Consumers distributed along $\text{U}[0, 1]$
  - Consumer purchases either 0 or 1 unit of output
  - The utility from buying one unit of product 0 and 1 are $\psi + q_0 - p_0 - x$ and $\psi + q_1 - p_1 - (1 - x)$.

The time line

1. Each firm privately observes its quality q_i, and decides whether to disclose it or not.
2. The firms simultaneously choose prices.
3. Consumers observe the disclosure and pricing choices of the two firms, and make their purchasing decision.

Solving by backward induction

1. An indifferent consumer located at x^* will satisfy

$$\psi + \tilde{q}_0 - p_0 - x^* = \psi + \tilde{q}_1 - p_1 - (1 - x^*)$$

   Solving for x^*, $x^* = \frac{1}{2} + \frac{1}{2}(\tilde{q}_0 - \tilde{q}_1 + p_1 - p_0)$

2. Plugging x^* into the profit functions, firms maximize their profits by choosing p_0 and p_1. As a result, the prices are

$$p_0 = 1 + \frac{1}{3}(\tilde{q}_0 - \tilde{q}_1) \text{ and } p_1 = 1 + \frac{1}{3}(\tilde{q}_1 - \tilde{q}_0)$$

3. Market share x^* and profits can be expressed as a function $(\tilde{q}_0, \tilde{q}_1)$

$$x^{*D}(\tilde{q}_0, \tilde{q}_1) = \frac{1}{2} + \frac{1}{6}(\tilde{q}_0 - \tilde{q}_1)$$

$$\pi_0(\tilde{q}_0, \tilde{q}_1) = \frac{1}{18}(3 + \tilde{q}_0 - \tilde{q}_1)^2 \text{ and } \pi_1(\tilde{q}_0, \tilde{q}_1) = \frac{1}{18}(3 + \tilde{q}_1 - \tilde{q}_0)^2$$

The duopoly equilibrium

Proposition 1

The disclosure threshold q^* is given by

$$q^{*D} = \begin{cases} -\frac{5}{3} + \frac{1}{3}\sqrt{25 + 216\delta} & \text{if} \quad \delta \in [0, 13/72] \\ 1 & \text{if} \quad \delta > 13/72 \end{cases}$$

For $[0, q^{*D}]$, the consumer's perceived quality is $\tilde{q}_i = q^{*D}/2$.

Definition 1

A *duopoly equilibrium* is a symmetric PBE, in which there is a quality threshold, q^{*D}, such that (1) firm i discloses its quality q_i iff $q_i > q^{*D}$; and (2) if firm i does not disclose its quality, beliefs about q_i are independent of the firm's pricing choice.

Proof of proposition 1

- The expected profit when firm 0 discloses its quality q_0

$$q^* \left[\frac{1}{18}(3 + q_0 - q^*/2)^2\right] + \int_{q^*}^{1} \frac{1}{18}(3 + q_0 - q)^2 \, dq - \delta \qquad (1)$$

- The expected profit when firm 0 does not disclose its quality q_0

$$q^* \cdot \frac{1}{2} + \int_{q^*}^{1} \frac{1}{18}(3 + q^*/2 - q)^2 \, dq \qquad (2)$$

- A necessary and sufficient condition for q^* to characterize an equilibrium threshold is (1) = (2) being equal at $q_0 = q^*$

Overview

The model setup and Definition

- Two firms can perfectly coordinate on quality disclosure
  - The cartel can choose to disclose none, one, or both of the qualities
  - Assume $q_H = \max\{q_0, q_1\}$ and $q_L = \min\{q_0, q_1\}$

Definition 2

A *cartel equilibrium* is a PBE for which there is a threshold, q^{*C}, and a function, $G(\cdot)$, satisfying
(i) q_H is disclosed if and only if we have $q_H > q^{*C}$,
(ii) q_L is disclosed if and only if q_H is disclosed and we have $q_L > G(q_H)$,
(iii) beliefs are independent of prices,
(iv) if the cartel discloses a quality $q < q^{*C}$, then beliefs are that the undisclosed quality is uniformly distributed over $[0, q]$.

Again, solving by backward induction

- Given the perceived qualities $(\tilde{q}_0, \tilde{q}_1)$, the prices must satisfy

$$p_0 = \psi + \tilde{q}_0 - x^* \text{ and } p_1 = \psi + \tilde{q}_1 - (1 - x^*)$$

- x^* is determined such that
$x^* \in \text{argmax}\,(\psi + \tilde{q}_0 - x)\,x + (\psi + \tilde{q}_1 - (1 - x))\,(1 - x)$.
As a result, $x^{*C} = \frac{1}{2} + \frac{1}{4}(\tilde{q}_0 - \tilde{q}_1)$

- Plugging x^* into the pricing and profit functions, we have

$$\begin{aligned}
p_0 &= \psi - \frac{1}{2} + \frac{3}{4}\tilde{q}_0 + \frac{1}{4}\tilde{q}_1 \\
p_1 &= \psi - \frac{1}{2} + \frac{1}{4}\tilde{q}_0 + \frac{3}{4}\tilde{q}_1 \\
\pi^C(\tilde{q}_0, \tilde{q}_1) &= \psi - \frac{1}{2} + \frac{1}{2}(\tilde{q}_0 + \tilde{q}_1) + \frac{1}{8}(\tilde{q}_0 - \tilde{q}_1)^2
\end{aligned}$$

The cartel equilibrium

Proposition 2

1. If $\delta < \frac{7}{32}$, ${q^*}^C = 4\sqrt{1+2\delta} - 4$

$$G\left(q_H\right) = \begin{cases} \frac{2q_H - 4}{3} + \frac{2}{3}\sqrt{\left(q_H\right)^2 - 4q_H + 4 + 24\delta} & \text{for } \ q_H \in [\hat{q}, 1] \\ q_H & \text{for } \ q_H \in \left[{q^*}^C, \hat{q}\right] \end{cases}$$

where $\hat{q} = 4 - 4\sqrt{1-2\delta}$

2. If $\frac{7}{32} \leqslant \delta < \frac{9}{32}$, ${q^*}^C = 4\sqrt{1+2\delta} - 4$ and the lower quality is never disclosed, so (without loss of generality) let $G\left(q_H\right) = q_H$ hold.

3. If $\frac{9}{32} \leqslant \delta$, neither quality is disclosed.

Overview

The expected amount of disclosure

1. Duopoly case

$$\Delta^D = (q^{*D})^2 \times 0 + 2q^{*D}(1 - q^{*D}) \times 1 + (1 - q^{*D})^2 \times 2$$
$$= \frac{16}{3} - \frac{2}{3}\sqrt{25 + 216\delta} \quad \text{for } \delta \in [0, 13/72]$$
$$\Delta^D = 0 \quad \text{for } \delta \geq 13/72$$

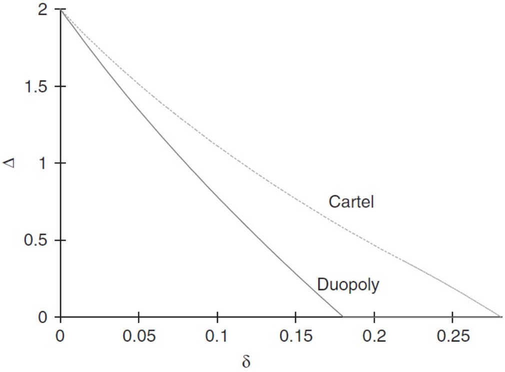
2. Cartel case

$$\Delta^C = (q^{*C})^2 \times 0 + 2\int_{q^*c}^{1}\int_{0}^{G(q_H)} dq_L dq_H \times 1$$
$$+ \; 2\int_{q^*C}^{1}\int_{G(q_H)}^{q_H} dq_L dq_H \times 2 \quad \text{for } \delta \in [0, 7/32]$$
$$\Delta^C = 1 - (-4 + 4\sqrt{1 + 2\delta})^2 \quad \text{for } \delta \in [7/32, 9/32]$$
$$\Delta^C = 0 \quad \text{for } \delta > 9/32$$

The expected amount of disclosure

Proposition 3

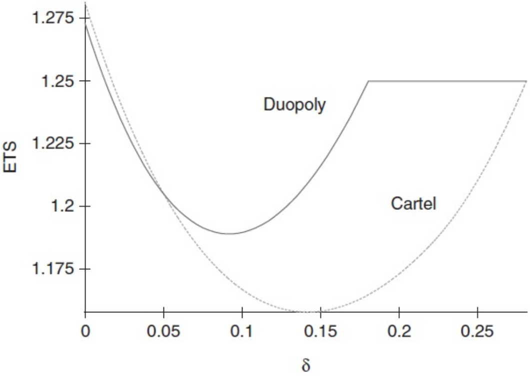
In equilibrium, we have ${q^*}^C < {q^*}^D$, and the expected number of disclosed products under duopoly is strictly lower than under a cartel, for $\delta \in (0, 9/32)$. Outside this range, either both products are disclosed ($\delta = 0$) or neither product is disclosed ($\delta \geq 9/32$) under both market structures.



Comparison of welfare

Proposition 4

There exists $\delta^* \in (0, 13/72)$, such that for $\delta \in [0, \delta^*)$, the expected total surplus is higher under a cartel, and for $\delta \in (\delta^*, 9/32)$, the expected total surplus is higher under duopoly. For $\delta \geq 9/32$, welfare is the same under the two market structures.



Overview

The time line

1. Given the market structure, the social planner picks the disclosure policy.
2. The firms disclose according to the policy chosen by the social planner.
3. After the quality disclosure, the firms choose prices.
4. The consumers make their purchase decisions.

Socially optimal disclosure

Proposition 5

1. Duopoly case

$$q^{**D} = \begin{cases} 12\sqrt{\delta/5} & \text{if} \quad \delta \in [0, 5/144] \\ 1 & \text{if} \quad \delta > 5/144 \end{cases}$$

2. Cartel case

$$q^{**C} = G^{**}(q_H) = \begin{cases} 8\sqrt{\delta/3} & \text{if} \quad \delta \in [0, 3/64] \\ 1 & \text{if} \quad \delta > 3/64 \end{cases}$$

3. In either market structure, equilibrium disclosure is excessive, as compared to its socially optimal disclosure benchmark.

Socially optimal disclosure

Proposition 6

Given the planner's threshold, q^D or q^C, the resulting expected consumer surplus is decreasing in q^D or q^C. In other words, more mandated disclosure increases expected consumer surplus.

Dicussion: the issue of commitment

- What happens if the firms could commit to their disclosure policies before they observe their qualities?

$$q^{**C} \leqslant q^{**D} \leqslant q_c^{*C} \leqslant q_c^{*D}$$

- With commitment, the equilibrium disclosure is insufficient rather than excessive.

Overview

Summary

- The expected amount of disclosure is always higher under a cartel than under duopoly.
- For small values of δ, welfare is higher under a cartel. For large values of δ, welfare is higher under duopoly.
- Compared to the socially optimal threshold, the equilibrium levels of disclosure are excessive in both models.