

Information Disclosure in a Duopoly¹

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Abstract

This paper studies firms' disclosure decisions of product information in a duopoly setting, as well as the welfare implication of compulsory disclosure policy. I show that there is a problem of externality between the two firms: even if disclosure weakens price competition in the market and increases total industry profits, a firm could have incentive not to disclose product information because it decreases his market share. As a result, regulatory policy could increase total industry profits as it could rectify the problem of externality. Therefore, despite more information allows consumers to make a better choice between different alternatives, it might backfire as it could increase the average price in the market. I also present simple conditions on when providing more information could harm consumers, and when it will improve consumer welfare.

Keywords: Information disclosure, horizontal differentiation

JEL codes: M31, M37, L15

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1 Introduction

Firms often conceal product information³. Given the lack of information, consumers may not fully understand the product characteristics of different alternatives when they make their purchasing decisions. As a result, they may end up with a misfit product and regret that they have forgone the alternatives. On the other hand, although more information allows consumers to make a better choice between alternatives, there could be a downside because it also affects firms' pricing strategies. This paper aims to shed light on this trade-off by analyzing firms' incentive (not) to disclose product information in a competitive setting, and the equilibrium effects of regulatory policies.

In this paper, I analyze a simple duopoly model where two competing firms sell a horizontally differentiated product to a large number of consumers. The two firms decide whether to disclose product information before competing à la Bertrand. If a firm discloses his product information, consumers learn their consumption value with the corresponding product. Some might find it more appealing than expected while some might find it less appealing. On the other hand, if a firm does not disclose its product information, consumers evaluate the product using their prior knowledge.

The disclosure decisions affect how consumers evaluate the two products, thus affect the nature of the competition between the two firms. I show that the effects are best described in two channels, which is the *relative market power* and *competitiveness of the market*. The former refers to how the two firms share the total industry profit. Analogous to the concept of bargaining power, a firm gets a larger share of the “pie” if he has a larger relative market power over his rival. The latter refers to the intensity of price competition between the two firms, i.e., the more intense the price competition is, the more incentive the two firms have to cut price which leads to lower prices in the market.

The competitiveness of the market is a collective channel which affects

³See [Abernethy and Franke \(1996\)](#) and [Anderson and Renault \(2013\)](#) for empirical evidence. Both studies analyze the advertising content of firms, using different methods to categorize information content.

the two firms in the same way. That is, both firms' profit decreases (by the same proportion) with the competitiveness of the market. In contrast, by definition, the relative market power affects the two firms differently. It therefore induces a problem of externality between the two firms: even when disclosing product information weakens competition and increases the total profits, a firm may choose to not disclose because it decreases his relative market power and his share of the "pie" (total industry profit). As a result, if the regulator implements a compulsory disclosure policy with the objective of providing more information to consumers, it could rectify the externality problem and increases the total industry profit. Although more information allows consumers to make a better purchasing decision, it could increase the expected payment and decrease consumer welfare.

This paper is in contrast with the majority of information disclosure literature, which focus on monopoly settings. For instance, [Johnson and Myatt \(2006\)](#), [Anderson and Renault \(2006\)](#) and [Koessler and Renault \(2012\)](#) analyze the disclosure of product information of a monopoly firm, with different assumptions of disclosure technologies or structures of consumption values. [Anderson and Renault \(2013\)](#) analyzes the disclosure decision of a monopoly firm for both pricing and product information while [Wang \(2013\)](#) studies how consumers' search of product information affects firms' disclosure decisions.

To the best of my knowledge, the only paper which analyzes the disclosure of consumption value in a competition setting is [Anderson and Renault \(2009\)](#). Different from this paper, they focus on the case where the consumption values are symmetrically distributed, which is a restrictive assumption. This paper aims to complete the picture by analyzing distributions with more general shape. In particular, I show that the welfare implications of regulatory policies are different when the consumption values are asymmetrically distributed, in comparison to the case when they are symmetrically distributed.

This paper is organized as follows. In section 2 and 3, I present the model setting and analyze the pricing strategies of the two firms. In section 4, I look into firms' incentive (not) to disclose product information and characterize the equilibrium disclosure strategies. Section 5 presents the policy analysis.

Lastly, I conclude.

2 Model Setting

Two firms, indexed by $k = 1, 2$, compete to sell their product to a continuum of consumers with mass normalized to 1. Firms' marginal cost of production is normalized to 0. I assume that the two products sold by the two firms have different product characteristics, while consumers are heterogeneous in their taste. In other words, different consumers evaluate a product differently because of their heterogeneous taste; and a consumer evaluates the two products differently because of their different product characteristics. Mathematically, denote v_{ki} as the consumption value of consumer i with product k . Following the literature of product information disclosure, I make the following assumption about the distribution of v_{ki} .

Assumption 1. v_{ki} are *i.i.d.* distributed (across k and i) according to a logconcave⁴ distribution with probability density function f .

The cumulative density function and the mean of the distribution are denoted by F and μ respectively. Note that assumption 1 implies the following intuitive property: without any information, different consumers evaluate the products in the same way, i.e., with expected consumption value μ . [Anderson and Renault \(2009\)](#) provides micro-foundations for this assumption⁵.

A priori, neither the two firms nor the consumers possess any information about the other parties, apart from the prior distribution f . However, the two firms can choose to disclose their product characteristics to consumers⁶. If firm k discloses his product information, consumers learn their consumption

⁴The assumption of logconcavity ensures the existence and uniqueness of the price equilibrium. It is fulfilled by a number of commonly used distributions, including the normal distribution.

⁵Roughly speaking, the assumption could be micro-founded using the Salop's circular model, where the two firms' position on the circle is uniform distributed while consumers are distributed according to some distribution g .

⁶As there is a continuum of consumers, each consumer (who has mass 0) has no incentive to disclose his taste to the two firms as it does not have any impact on the equilibrium outcome.

value with product k ; otherwise, they evaluate it with the expected value μ . The time-line of the game is as follows:

- at period 1, the two firms decide whether to disclose product information;
- at period 2, the two firms set their prices;
- at period 3, consumers purchase from one of the two firms.

Note that for simplicity, I assume that firms decide their disclosure strategies before competing in price. For instance, if instead firms choose their pricing and disclosure strategies simultaneously, it brings unnecessary complications as there may not exist any pure strategy equilibria. Moreover, this assumption is also more realistic as changing prices is (arguably) much easier than changing product information.

Moreover, I assume there is full market participation: consumers purchase from one and only one of the two firms. It implies an absence of outside options which is in contrast to the monopoly setting. It allows me to focus on how the competition between the two firms affect their disclosure strategy. Nonetheless, the qualitative insights hold when this assumption is relaxed, when the consumption value of the outside option is small enough.

The disclosure strategy of firm k is denoted by d_k . d_k could take value f or n which correspond to disclosure and no disclosure respectively, i.e., $d_k \in \{f, n\}$. I assume firms disclose when they are indifferent⁷. The equilibrium concept used is the sub-game perfect Nash equilibrium. I first solve the equilibrium of the price competition in different continuation games in period 2 and then proceed to analyze the equilibrium disclosure strategies of the two firms.

3 Price Competition

As the two firms are a priori homogeneous, without loss of generality I analyze three types of continuation games in period 2, where no firms, one firm

⁷This happens non-generically.

or both firms disclose product information. Moreover, firms' equilibrium prices, demands and profits depend only on their and their rival's disclosure strategies, but not their identities. Throughout the text, I index firms by their disclosure strategies. For example, firm 1 is also called firm n if it does not disclose product information, and is called firm f if it discloses. I denote the price, demand and profit of firm k as $p_{d_k|d_{-k}}$, $D_{d_k|d_{-k}}$ and $\pi_{d_k|d_{-k}}$ respectively, given the disclosure strategy d_{-k} of his rival. All equilibrium strategies and outcomes of the continuation games are superscripted with an asterisk.

3.1 No firms disclose information

When no firms disclose product information, consumers evaluate both products with the expected consumption value μ . The two products are thus perfect substitutes. Therefore in equilibrium, the prices and profits of both firms equal 0:

$$\begin{aligned} p_{n|n}^* &= 0; \\ \pi_{n|n}^* &= 0. \end{aligned}$$

3.2 Only one firm discloses information

When only one firm discloses product information, i.e., $(d_1, d_2) = (n, f)$ or (f, n) , consumers learn their consumption value with product f but not with product n . The two products become imperfect substitutes and consumer i buys from firm f if and only if⁸ $v_{fi} - p_{f|n} \geq \mu - p_{n|f}$. That is, firm f sells to the consumers who find product f sufficiently appealing while firm n sells to the others. The demand of the two firms are as follows:

$$\begin{aligned} D_{f|n}(p_{f|n}, p_{n|f}) &= 1 - F(\mu + p_{f|n} - p_{n|f}); \\ D_{n|f}(p_{f|n}, p_{n|f}) &= F(\mu + p_{f|n} - p_{n|f}). \end{aligned}$$

⁸I assume consumers buy from firm f if they are indifferent, which happens with probability 0.

In equilibrium, the two firms set price to maximize their profit:

$$\begin{aligned} p_{f|n}^* &= \arg \max_{p_{f|n}} (1 - F(\mu + p_{f|n} - p_{n|f})) p_{f|n}; \\ p_{n|f}^* &= \arg \max_{p_{n|f}} F(\mu + p_{f|n} - p_{n|f}) p_{n|f}. \end{aligned}$$

As $f(v)$ is logconcave, the equilibrium prices are unique and solved by the first order approach. More specifically, they are the solution of the following system of equations:

$$\begin{aligned} p_{f|n}^* &= \frac{1 - F(\mu + \Delta p)}{f(\mu + \Delta p)}; \\ p_{n|f}^* &= \frac{F(\mu + \Delta p)}{f(\mu + \Delta p)}, \end{aligned} \tag{1}$$

where $\Delta p = p_{f|n}^* - p_{n|f}^*$. The profits of firm f and firm n follow:

$$\begin{aligned} \pi_{f|n}^* &= \frac{[1 - F(\mu + \Delta p)]^2}{f(\mu + \Delta p)}; \\ \pi_{n|f}^* &= \frac{F(\mu + \Delta p)^2}{f(\mu + \Delta p)}. \end{aligned} \tag{2}$$

As shown by equation (2), the profits of both firms are decreasing in the mass of marginal consumers $f(\mu + \Delta p)$, which measures the competitiveness of the market. The larger the mass of marginal consumers is, the more incentivize the firms are to decrease marginally their prices to capture that extra demand.

On the other hand, when $F(\mu + \Delta p)$ is not equal to $1/2$, the profits of the two firms are different, i.e., they get different share of the total industry profit. Analogous to the idea of bargaining power, I denote the ability of firms to earn a larger share of the “pie” (total industry profit) as their market power, which is formally defined as follows.

Definition 1 (Market Power). *Given disclosure strategies (d_k, d_{-k}) , I define the market power of the firm k , denoted by $MP_{d_k|d_{-k}}$, as his share of*

total industry profit, i.e.,

$$MP_{d_k|d_{-k}} = \frac{\pi_{d_k|d_{-k}}^*}{\pi_{d_k|d_{-k}}^* + \pi_{d_{-k}|d_k}^*}.$$

Similarly, the relative market power of firm k over firm $-k$, denoted by $RMP_{d_k|d_{-k}}$ is equal to the ratio of firm k 's share of the total industry profit over that of firm $-k$, i.e.,

$$RMP_{d_k|d_{-k}} = \frac{\pi_{d_k|d_{-k}}^*}{\pi_{d_{-k}|d_k}^*}.$$

As an example, when $F(\mu + \triangle p) > 1/2$, equation 2 implies that firm n has a larger market power than firm f as he gets a larger share of the total industry profit compared to firm f , i.e., $\pi_{n|f}^* > \pi_{f|n}^*$. The two factors aforementioned, i.e., the relative market power and the competitiveness of the market, have an important impact on firms' incentive to disclose product information and will be discussed in details in the next section.

3.3 Both firms disclose information

Lastly, when $(d_1, d_2) = (f, f)$, consumers learn their consumption value with both products. As a result, consumer i buys from firm 1 if and only if $v_{1i} - p_1 \geq v_{2i} - p_2$. The demand of the two firms are

$$\begin{aligned} D_1(p_1, p_2) &= \int F(v + p_2 - p_1) f(v) dv; \\ D_2(p_1, p_2) &= \int F(v + p_1 - p_2) f(v) dv. \end{aligned}$$

In appendix A, I show that the symmetric price equilibrium is the unique equilibrium of this continuation game. Thus both firms face the following maximization problem:

$$p_{f|f}^* = \arg \max_{p_{f|f}} \left[\int F(v + p_{f|f}^* - p_{f|f}) f(v) dv \right] p_{f|f}.$$

By simple differentiation, the equilibrium prices and profits of the two firms are given by the following equations:

$$\begin{aligned} p_{f|f}^* &= \frac{\int F(v)f(v)dv}{\int f(v)^2 dv} = \frac{1}{2E(f(v))}; \\ \pi_{f|f}^* &= \frac{1}{4E(f(v))}. \end{aligned} \tag{3}$$

By comparing equation (3) and (2), it becomes clear that the disclosure strategies of the two firms change the nature of the price competition, as they change the relative market power of the two firms and the competitiveness of the market. On one hand, when both firms disclose product information, they always enjoy the same level of market power, i.e., both of them get half of the total industry profit. On the other hand, the mass of marginal consumers is equal to $E(f(v))$, which is different from the case where only one firm discloses product information.

4 Do firms disclose?

Now, I analyze the equilibrium disclosure strategies of the two firms. Given the equilibrium profits characterized in the last section, I represent the first stage of the game by the payoff matrix on table 1:

		d_2	
		n	f
d_1	n	$0, 0$	$\frac{F(\mu+\Delta p)^2}{f(\mu+\Delta p)}, \frac{(1-F(\mu+\Delta p))^2}{f(\mu+\Delta p)}$
	f	$\frac{(1-F(\mu+\Delta p))^2}{f(\mu+\Delta p)}, \frac{F(\mu+\Delta p)^2}{f(\mu+\Delta p)}$	$\frac{1}{4E(f(v))}, \frac{1}{4E(f(v))}$

Table 1: Payoff matrix of the two firms given their disclosure strategies. In each box, the first element represents the payoff of firm 1 while the second element represents the payoff of firm 2.

Note that when none of the two firms discloses product information, both of them get 0 profit. From the payoff matrix, it is clear that they have

incentive to deviate (to disclose product information) in order to avoid intense price competition. Therefore at least one firm discloses in equilibrium, i.e., $(d_1^*, d_2^*) \neq (n, n)$. On the other hand, suppose that firm 1 discloses product information, firm 2 will also disclose if and only if he gets a higher profit from disclosing. The equilibrium disclosure strategies are characterized as follow:

$$(d_1^*, d_2^*) \begin{cases} \in \{(n, f), (f, n)\} & \text{if } \frac{F(\mu + \Delta p)^2}{f(\mu + \Delta p)} > \frac{1}{4E(f(v))}; \\ = (f, f) & \text{if } \frac{F(\mu + \Delta p)^2}{f(\mu + \Delta p)} \leq \frac{1}{4E(f(v))}. \end{cases}$$

In the following, I discuss in more details the incentive of firms (not) to disclose product information through the two factors aforementioned: the relative market power and the competitiveness of the market.

4.1 Relative Market Power

First, disclosure of product information changes the relative market power of a firm over his rival. As mentioned before, given that firm 1 discloses product information, if $F(\mu + \Delta p) > \frac{1}{2}$, no disclosure gives firm 2 a larger market power compared to that of firm 1. That is, when $(d_1, d_2) = (f, n)$, firm 2 enjoys a larger share of total industry profit compared to firm 1, i.e., $\pi_{n|f}^* > \pi_{f|n}^*$. In contrast, if firm 2 also discloses product information, he has the same market power as firm 1, i.e., they share the total industry profit equally. Therefore, in comparison to disclosure, no disclosure gives firm 2 a larger relative market power over his rival, i.e., when $F(\mu + \Delta p) > \frac{1}{2}$,

$$\frac{\pi_{n|f}^*}{\pi_{f|n}^*} = RMP_{n|f} > RMP_{f|f} = \frac{\pi_{f|f}^*}{\pi_{f|f}^*}.$$

The opposite holds true if $F(\mu + \Delta p) < \frac{1}{2}$, i.e., no disclosure gives firm 2 a smaller relative market power over firm 1, in comparison to disclosure.

The following proposition shows that whether not disclosing product information gives the firm a larger or smaller relative market power over his rival boils down to a simple condition about the consumption value distribution.

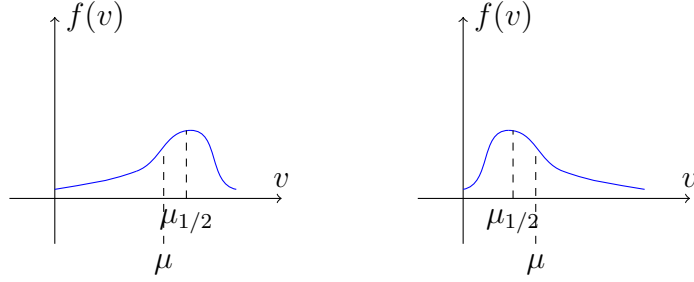


Figure 1: In the left figure, $F(\mu) < \frac{1}{2}$ while in the right figure, $F(\mu) > \frac{1}{2}$. $\mu_{1/2}$ denotes the median of the distribution.

Proposition 1. *Suppose firm 1 discloses product information. Firm 2 enjoys a larger relative market power over firm 1 if firm 2 does not disclose product information, compared to that if he discloses, i.e., $RMP_{n|f} \geq RMP_{f|f}$, if and only if*

- *more than half of the consumers find the product less appealing than expected after they learn the product information, i.e., $F(\mu) \leq \frac{1}{2}$, or equivalently;*
- *the mean of the consumption value distribution is bigger than its median, i.e., $\mu \geq \mu_{1/2}$.*

The intuition of proposition 1 is as follows: Suppose firm 1 discloses his product characteristics and the majority of consumers find the product less appealing than expected. It implies those consumers' consumption value with product 1 are smaller than μ , and will prefer product 2 if firm 2 does not disclose. Thus when $(d_1, d_2) = (f, n)$, the majority of consumers prefer product 2 over product 1, and it gives firm 2 a better position compared to his rival to get a larger share of the total industry profit.

Moreover, whether $F(\mu)$ is bigger or smaller than $\frac{1}{2}$ boils down to a simple comparison of the mean and median of the distribution (See figure 1), i.e., $F(\mu) \geq \frac{1}{2}$ if and only if the mean of the distribution is bigger than the median. As will be shown later, this comparison has useful welfare implication on disclosure policy.

4.2 Competitiveness

Another factor which determines firms' incentive (not) to disclose product information is the competitiveness of the market. It is measured by the mass of marginal consumers, which equals $f(\mu + \Delta p)$ and $E(f(v))$ when only one firm or both firms disclose product information respectively. The larger the mass of marginal consumers is, the two firms have more incentive to cut price to capture the extra demand and thus the more competitive the market is.

It is in general complicated to compare $f(\mu + \Delta p)$ and $E(f(v))$ because Δp has no closed-form solution and changes with the characteristics of distribution. In the special case where the distribution $f(v)$ is symmetric, i.e., $F(\mu) = 1/2$, the following result is obtained in [Anderson and Renault \(2009\)](#).

Corollary 1 ([Anderson and Renault \(2009\)](#)). *Assume that $f(v)$ is symmetric. The market is less competitive when both firms disclose product information, compared to when only one firm discloses, i.e.,*

$$E(f(v)) < f(\mu + \Delta p) = f(\mu)$$

Moreover, both firms disclose product information in equilibrium, i.e., $(d_1^*, d_2^*) = (f, f)$.

When $f(v)$ is symmetric, the assumption of log-concavity implies that $f(v)$ peaks at the mean μ (See figure 2a). Suppose only firm 1 discloses product information, a large proportion of the consumers learn that their consumption value with product 1 (i.e., v_{1i}) is around μ and thus find the two products similarly appealing. There are big incentive for firms to cut price to capture the demand from those consumers. On the other hand, if both firms disclose product information, consumers' valuation for both products become more diverse and there are fewer consumers whose consumption values with the two products are similar. Put differently, the two products are more differentiated if both firms disclose. Disclosure weakens price competition and both firms disclose product information in equilibrium.

In contrast, when $f(v)$ is not symmetric, disclosing product information

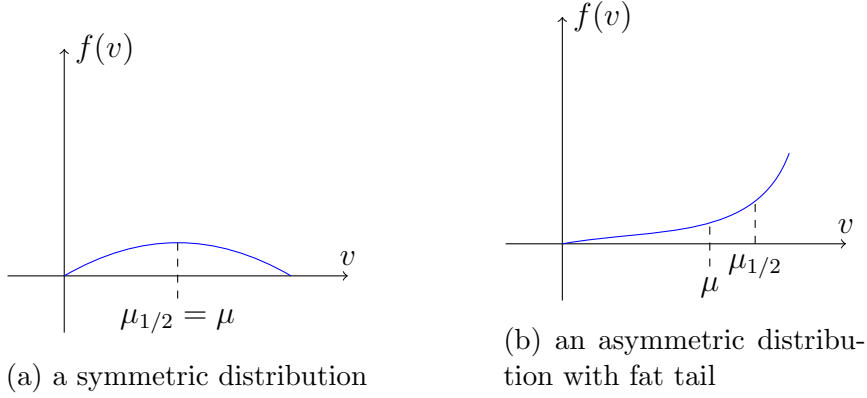


Figure 2: Two examples of consumption value distribution

does not necessarily weaken price competition. Consider the distribution shown in figure 2b. It has a thick right tail, which resembles situations where both products possess attributes which are appealing for the majority of the consumers. After learning the product characteristics, the majority of consumers adjust upwardly their evaluation of the products but some of them find the product distasteful and negatively adjust their evaluation to a large extent. In this case, when both firms disclose product information, many consumers will adjust upwardly their consumption values with both products and thus find the two products similarly appealing. In contrast, when only one firm discloses product information, consumers are effectively segmented, i.e., the firm which discloses product information serves consumers who find the attributes appealing while the other firm serves the rest. There is smaller incentive for firms to cut price. In this case, disclosing product information strengthens price competition. This is illustrated in the following proposition using an example of exponential distribution.

Proposition 2. *When $v \sim \exp(\lambda)$,*

1. *competition is weaker if only one firm discloses product information, compared to if both firms disclose, i.e., $f(\mu + \Delta p) < E(f(v))$;*
2. *only one firm discloses product information in equilibrium, i.e., $(d_1^*, d_2^*) = (f, n)$ or (n, f) .*

The proof is presented in the appendix. When the consumption values follow exponential distribution, disclosing product information strengthens price competition (point 1). Only one firm discloses product information in equilibrium (point 2). In general, when the consumption values are not symmetrically distributed, disclosure could strengthen price competition and the equilibrium could involve asymmetric disclosure strategies where only one firm discloses product information.

5 Disclosure Policy

Now suppose the government is considering whether to make disclosure compulsory, in order to provide more information to consumers. An example is to draft a list of relevant product attributes that firms are obliged to disclose. More information allows consumers to make a better choice between the two products, however there is an equilibrium effect as it affects the prices charged by the firms. In the following, I present simple conditions on when a compulsory disclosure policy could harm consumers, and when it will benefit consumers.

First, as shown in corollary 1, both firms disclose product information in equilibrium when $f(v)$ is symmetric. Therefore, compulsory disclosure policy plays no role when $f(v)$ is symmetric.

Corollary 2 (Anderson and Renault (2009)). *When $f(v)$ is symmetric, compulsory disclosure policy does not affect consumer welfare.*

Now consider any, symmetric or asymmetric, logconcave distribution $f(v)$. When only one firm discloses product information, average consumer welfare is equal to:

$$\left[\mu + \int_{\mu - p_{n|f}^* + p_{f|n}^*}^{\infty} (v - \mu) f(v) dv \right] - [\pi_{n|f}^* + \pi_{f|n}^*].$$

The terms in the first square bracket is the expected consumption value consumers get while the terms in the second bracket is the expected payment of consumers. On the other hand, when both firms disclose product

information, average consumer welfare is equal to:

$$2 \int vF(v)f(v) dv - 2\pi_{f|f}^*.$$

Note that the expected consumption value consumers get is higher when both firms, instead of one firm, disclose product information, i.e.,

$$2 \int vF(v)f(v) dv > \mu + \int_{\mu - p_{n|f}^* + p_{f|n}^*}^{\infty} (v - \mu)f(v) dv \quad (4)$$

because of the extra information consumers get and the absence of distortion driven by the price difference. That is, when only one firm discloses information, the difference in prices between the two products distorts the consumers' decisions on picking the product with higher expected consumption value. Equation (4) implies that compulsory disclosure decreases consumer welfare only if it increases the expected payment, or equivalently the total industry profit. The following proposition presents a simple condition on when it could happen.

Proposition 3. *A compulsory disclosure policy strictly increases the expected payment of consumers only if the majority of consumers find the product less appealing after learning its product information, i.e.,*

$$2\pi_{f|f}^* > \pi_{n|f}^* + \pi_{f|n}^* \text{ only if } F(\mu) > 1/2.$$

Note that the condition is necessary but not sufficient. The intuition of the proposition is as follows. When $F(\mu) > 1/2$, a firm gets a smaller share of total industry profit if he discloses product information, in comparison to if he does not disclose, i.e., $\frac{\pi_{f|f}^*}{2\pi_{f|f}^*} < \frac{\pi_{n|f}^*}{\pi_{n|f}^* + \pi_{f|n}^*}$. As a result, he might choose not to disclose product information even if full disclosure weakens competition and increases total industry profit. In other words, the factor of relative market power imposes an externality problem on the two firms. A compulsory disclosure policy may rectify the externality problem and increases total industry profit. As a result, it could increase consumers' expected payment and decrease consumer welfare.

On the other hand, when $F(\mu) < 1/2$, disclosing product information increases the share of total industry profit a firm gets, i.e., $\frac{\pi_{f|f}^*}{2\pi_{f|f}^*} > \frac{\pi_{n|f}^*}{\pi_{n|f}^* + \pi_{f|n}^*}$. Therefore, the only reason that the firm does not disclose product information is that full disclosure strengthens the competitiveness of the market. In this case, a compulsory disclosure policy always improves consumer welfare, as it decreases their expected payment.

Corollary 3. *A compulsory disclosure policy (weakly) improves consumer welfare when:*

1. *it increases the competitiveness of the market, i.e., $f(\mu + \Delta p) \leq E(f(v))$ or;*
2. *the majority of consumers find a product more appealing after learning its product characteristics, i.e., $F(\mu) < 1/2$.*

For example, it improves consumer welfare when $v \sim \exp(\lambda)$.

The intuition of the corollary holds true in more general settings, for instance when there are multiple product attributes. It suggests a simple reasoning for regulators to assess the effects of informational policy. If disclosing a product attribute increases the demand of the corresponding firm in equilibrium, then providing that information improves consumer welfare as it strengthens the competitiveness in the market. In other case, making disclosure compulsory may backfire and decrease consumers welfare as it could increase the expected payment of consumers.

6 Conclusion

To conclude, this paper analyzes the incentive of firms (not) to disclose product information in a competitive setting. There are two factors which determine the disclosure level in the equilibrium, which is how disclosure affects the relative market power of firms and the competitiveness of the market. The latter is a collective factor which affects the two firms in the same way, while the former is an individual factor which affects them in opposite direction. Thus there exists a problem of externality between the two firms. A

compulsory disclosure policy could then rectify the externality and increases the total industry profit. Despite the fact that it could provides more information to consumers, it may backfire and decrease consumers welfare as it increases the average price in the market.

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A Uniqueness of the Price Equilibrium when

$$(d_1, d_2) = (f, f)$$

The Maximization problems of the two firms are

$$\begin{cases} \text{Max}_{p_1} [\int F(v + p_2 - p_1) f(v) dv] p_1; \\ \text{Max}_{p_2} [1 - \int F(v + p_2 - p_1) f(v) dv] p_2. \end{cases}$$

The prices in equilibrium, obtained by the first order conditions, are

$$\begin{aligned} p_1^* &= \frac{\int F(v + p_2^* - p_1^*) f(v) dv}{\int f(v + p_2^* - p_1^*) f(v) dv} = \frac{E(F(v + p_2^* - p_1^*))}{E(f(v + p_2^* - p_1^*))}; \\ p_2^* &= \frac{1 - \int F(v + p_2^* - p_1^*) f(v) dv}{\int f(v + p_2^* - p_1^*) f(v) dv} = \frac{1 - E(F(v + p_2^* - p_1^*))}{E(f(v + p_2^* - p_1^*))}. \end{aligned}$$

The equation of price difference is thus

$$p_1^* - p_2^* = \frac{E(1 - 2F(v + p_1^* - p_2^*))}{E(f(v + p_1^* - p_2^*))}.$$

$p_1^* - p_2^* = 0$ is a solution of the problem as $E(F(v)) = 1/2$. Moreover, $E(F(v))$ is bigger (resp. smaller) than $1/2$ when $p_1^* - p_2^*$ is smaller (resp. bigger) than 0. As a result, there does not exist a solution where $p_1^* - p_2^* \neq 0$. When $(d_1, d_2) = (f, f)$, the unique price equilibrium is a symmetric equilibrium where both firms charge the same price.

B Omitted Proofs

B.1 Proof of Proposition 1

Proof. Using equation (1), I derive the following equation which characterizes Δp :

$$\Delta p = \frac{1 - 2F(\mu + \Delta p)}{f(\mu + \Delta p)}. \quad (\text{B.1})$$

Logconcavity of f ensures the existence and uniqueness of the fixed point of equation B.1. First, when $F(\mu) = 1/2$, it is obvious $\Delta p = 0$ and $D_{n|f}^* = 1/2$. On the other hand, when $F(\mu) > 1/2$, $\frac{1-2F(\mu)}{f(\mu)} < 0$. By logconcavity, $\frac{1-2F(x)}{f(x)}$ is decreasing in x , therefore

$$\Delta p < 0 \quad \text{and} \quad D_{n|f}^* = F(\mu + \Delta p) > 1/2$$

Similarly, when $F(\mu) < 1/2$, $\Delta p > 0$ and $D_{n|f}^* < 1/2$. □

B.2 Proof of Proposition 2

Proof. When $v \sim \exp(\lambda)$, its p.d.f. and c.d.f. are:

$$\begin{aligned} f(v) &= \lambda e^{-\lambda v} \\ F(v) &= 1 - e^{-\lambda v} \end{aligned}$$

and its mean is equal to λ^{-1} . By equation (B.1), Δp is the solution of the following equation:

$$\Delta p = \frac{1 - 2(1 - e^{-\lambda(\lambda^{-1} + \Delta p)})}{\lambda e^{-\lambda(\lambda^{-1} + \Delta p)}}$$

After some simple manipulations:

$$\begin{aligned} e^3 &= e^{2-\lambda\Delta p}(2 - \lambda \Delta p) \\ 2 - \lambda \Delta p &= W(e^3) \\ \Delta p &= \frac{2 - W(e^3)}{\lambda} \end{aligned}$$

where $W(\cdot)$ is the Lambert W function. The prices and profits when only one firm discloses product information are:

$$\begin{aligned} p_{f|n}^* &= \frac{1}{\lambda}; \\ p_{n|f}^* &= \frac{W(e^3) - 1}{\lambda}; \\ \pi_{f|n}^* &= \frac{1}{\lambda W(e^3)}; \\ \pi_{n|f}^* &= \frac{1}{\lambda} (W(e^3) + e^{W(e^3)-3} - 2). \end{aligned}$$

The mass of marginal consumers when only one firm discloses and when both firms disclose product information are:

$$\begin{aligned} f(\mu + \Delta p) &= \frac{\lambda}{W(e^3)}; \\ E(f(v)) &= \frac{\lambda}{2} > f(\mu + \Delta p). \end{aligned}$$

which proves the first point of proposition 2. Firms' profits when both firms disclose product information equal:

$$\pi_{f|f}^* = \frac{1}{2\lambda} < \pi_{n|f}^*.$$

Therefore, $(d_1^*, d_2^*) = (f, n)$ or (n, f) which proves the second point of proposition 2. $\square$

B.3 Proof of Proposition 3

Proof. A compulsory disclosure policy (strictly) increases the expected payment of consumers when

$$\begin{aligned} \pi_{n|f}^* &> \pi_{f|f}^* \text{ and } ; \\ 2\pi_{f|f}^* &> \pi_{n|f}^* + \pi_{f|f}^*. \end{aligned}$$

The first inequality implies that in equilibrium only one firm discloses product information while the second inequality implies that the expected payment

of consumers when only one firm discloses is smaller than when both firms disclose. The two inequalities are rewritten and combined as

$$\frac{2F(\mu + \Delta p)^2}{f(\mu + \Delta p)} > \frac{1}{2E(f(v))} > \frac{F(\mu + \Delta p)^2 + (1 - F(\mu + \Delta p))^2}{f(\mu + \Delta p)}$$

in which a necessary condition is

$$\begin{aligned} 2F(\mu + \Delta p)^2 &> F(\mu + \Delta p)^2 + (1 - F(\mu + \Delta p))^2 \\ F(\mu + \Delta p)^2 &> (1 - F(\mu + \Delta p))^2 \\ F(\mu + \Delta p) &> 1 - F(\mu + \Delta p) \\ F(\mu + \Delta p) &> 1/2 \\ F(\mu) &> 1/2 \end{aligned}$$

where the last inequality is implied by Proposition 1.

□

B.4 Proof of Corollary 3

Proof. The second point of the corollary is directly implied by proposition 3.

I now prove the first point. When $E(f(v)) > f(\mu + \Delta p)$,

$$\begin{aligned} 2\pi_{f|f}^* &= \frac{1}{2E(f(v))} \leq \frac{1}{2f(\mu + \Delta p)} \\ &\leq \frac{F(\mu + \Delta p)^2 + (1 - F(\mu + \Delta p))^2}{f(\mu + \Delta p)} = \pi_{n|f}^* + \pi_{f|f}^* \end{aligned}$$

where the second inequality is implied by the fact that $x^2 + (1 - x)^2$ is convex and minimized at $x = \frac{1}{2}$. The result follows. □