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COMPETITION AND DISCLOSURE*

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There are many laws that require sellers to disclose private information about the quality of their products. But the theoretical justification for these laws is not obvious: economic theory predicts that a seller will voluntarily disclose such quality information, however unfavorable, as long as it is costless to do so. Here we show that competitive pressures between firms can undermine this full disclosure result, and explain why it may be the case that only high-quality firms choose to disclose. In this setting, mandatory disclosure laws can promote competition and raise consumer surplus at the expense of firm profits, potentially increasing the efficiency of the market.

I. INTRODUCTION

IN 1990, THE NUTRITION LABELING AND EDUCATION ACT (NLEA) was enacted by the U.S. Congress, requiring that most food products display a standardized nutrition label. Similar legislation exists in the European Union[1] and elsewhere. Prior to the introduction of these laws, labeling was voluntary. There are many other rules and laws which require sellers to disclose information about the quality of their products prior to sale: sellers of gasoline must post its octane rating; publicly traded corporations must publish detailed financial data when they issue securities; and so on.

But the theoretical justification for such laws is not obvious. Consider a seller with private (but verifiable) information about the quality of his product. A key result in the literature on disclosure states that the seller will voluntarily reveal this information, however unfavorable, as long as it is costless to do so (see Grossman & Hart [1980]; Grossman [1981]; Milgrom [1981]). The intuition behind this result is as follows. Suppose the quality of the product is a random variable s, which also measures the value of the product to the consumers. If the seller does not disclose his private

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[1] European Council Directive 90/496/EEC ('On Labelling of Foodstuffs'), 24 September, 1990.

information about the value of s, the most he can charge is $E[s]$. Thus for all realizations of $s > E[s]$, the seller *would* choose to disclose. The consumers, in turn, revise downwards their estimate of quality in the event of no disclosure. This causes more types of seller to disclose, and the process repeats itself until *all* types (except perhaps the lowest) disclose.

Notwithstanding this unraveling result, it seems clear that full disclosure is not forthcoming in practice. Mathios [2000] examines the labeling of salad dressings prior to the implementation of the NLEA. Of those firms selling salad dressings with low fat content (6 grams per serving or lower), all voluntarily disclosed fat information on product labels; of those selling salad dressings with high fat content (13 grams per serving or more), only 9% chose to disclose. There can be little doubt that fat content is a quality characteristic in this market. Staff at the Food and Drug Administration and others predicted substantial changes in consumer behavior following the introduction of mandatory disclosure (Zarkin *et al*. [1993]), and Mathios shows that the sales of high-fat salad dressings did indeed decline after the NLEA was implemented. Other more anecdotal examples of non-disclosure are easy to find.

Several theoretical explanations have been offered for the failure of the unraveling result. Viscusi [1978] and Grossman & Hart [1980] show that if disclosure is costly, sellers will disclose only if their quality exceeds some threshold level; below this level, the potential gains from improved consumer expectations are outweighed by the costs of disclosure. But in this setting, the total amount of disclosure will be socially excessive (Jovanovic [1982]), even if information itself is socially valuable (e.g., because it facilitates trade); mandatory disclosure laws that further increase the amount of disclosure would only cause harm.

Alternatively, Matthews & Postlewaite [1985] and Shavell [1994] assume that sellers are not originally informed about the quality of their own products. They can decide to become informed by testing the product, possibly at some cost to themselves; and if they acquire the information, it is costless to pass it on to consumers. Paradoxically, the introduction of a law that requires firms to disclose any information they have acquired may actually reduce the amount of disclosure in equilibrium, since firms no longer have the option of keeping quiet if the news turns out to be bad.

A recent paper by Fishman & Hagerty [2003] tells a different story. They consider a situation in which some consumers cannot understand potential disclosures, but can observe whether or not a disclosure is made. In this case, quality disclosure may not be forthcoming in equilibrium. Mandatory disclosure laws may be beneficial, but only if information itself increases the value of consumption.

Here we consider another explanation for the failure of full disclosure. In a competitive environment, a firm may choose not to disclose information about product quality if doing so would result in fiercer competition with its

rivals. More specifically, if one high-quality firm has chosen to disclose, others must trade off the increase in competition and resulting fall in price if they also disclose with the reduction in perceived quality (from the point of view of the consumers) if they do not. If some high-quality firms choose not to disclose, this generates positive externalities for low-quality firms who may pool with them and take advantage of raised consumer expectations. The welfare effects of mandatory disclosure are complex. We can expect increased competition among high-quality products, and thus a fall in price. The market for low-quality products may actually become less competitive, as they are now clearly distinguished from high-quality products; but this is mitigated by a drop in demand, so price may go up or down. Consumer surplus will rise as long as firms are sufficiently close in quality that the overall effect is increased competition. In this case, profits of all firms will go down.

The presence of competition between firms differentiates the present work from the majority of the theoretical work on quality disclosure, and it is worth stressing the importance of this distinction. Many other papers consider a number of hypothetical *types* of firm, each offering a different quality product. But only one of these firms really exists, and the remainder are used to represent uncertainty in the mind of the consumers about the quality of the actual firm. Thus partial disclosure results such as those derived by Grossman & Hart [1980] and Jovanovic [1982], where the monopoly firm discloses if and only if its quality exceeds some threshold level, do not describe the situation observed by Mathios [2000] in the salad dressing industry, where there are a number of actual firms and those above the threshold disclose while those below it do not. The results of our paper, on the other hand, describe equilibria in which this is precisely what happens: two firms are in competition with each other, and only the higher quality firm chooses to disclose.

Two papers which *do* examine the effects of competition on firms' incentives to disseminate information about product quality are Hotz & Xiao [2008] and Levin *et al*. [2007]. Both papers consider models which combine horizontal and vertical product differentiation. In Hotz and Xiao, the information structure is similar to this paper, in that each firm observes the other's quality (although of course the consumers do not)[2]; but quality is a binary variable and the non-disclosure result requires sufficient correlation between consumers' vertical and horizontal preferences. Levin *et al*., on the other hand, assume that firms do not know each other's quality levels. Comparing the duopoly case with a joint-ownership structure, they show that there is typically less disclosure under duopoly (although in both cases

[2] In many settings this seems to be a reasonable assumption: it should be fairly easy for firms producing a particular product to test products produced by other firms in the same industry.

the amount of disclosure is socially excessive). As long as disclosure is costly, in the duopoly equilibrium there is a disclosure threshold, i.e., a quality level below which firms will not disclose. This mirrors the results of Grossman & Hart [1980] for the monopoly case. In contrast to our results and those of Hotz and Xiao, firms will fully disclose if there are no costs of doing so.

To recap, our aim in this paper is to show how competitive pressures between firms can explain why some choose not to disclose their quality levels to consumers, and to analyze the effect of laws which mandate disclosure. The paper is organized as follows. Section 2 presents a basic duopoly model which formalizes the intuition behind the partial disclosure result. In section 3 we consider the impact of a mandatory disclosure law, in particular examining the effect it has on consumer surplus for a range of parameter values. Finally, in section 4 we provide some concluding remarks.

II. THE MODEL

In this section, we examine a duopoly model with vertical differentiation (see Gabszewicz & Thisse [1979]; Shaked & Sutton [1982]). The quality of each product is exogenously determined and known by both firms but not by the consumers: firm 1 and firm 2 produce products of quality s_1 and s_2 respectively, where s_1 and s_2 are drawn independently from the uniform distribution on [0, 1] There are no costs of production. A consumer who purchases one unit from firm i and pays price p_i receives utility of $\theta s_i - p_i$, where θ is a parameter measuring taste for quality. θ is uniformly distributed on [0, 1]. Consumers purchase at most one unit, and have reservation utility of 0. Firms decide simultaneously whether or not to disclose quality, and then compete in prices. Disclosure is costless, credible and verifiable.[3]

II(i). *A Partial-Disclosure Result*

We now show that there is an equilibrium in which the higher-quality firm always discloses but its rival usually does not.[4] Consider first what happens in the second stage of the game, when the firms compete in prices having made their disclosure decisions. There are three scenarios to consider, corresponding to the different first-stage outcomes: (i) both firms disclose; (ii) only one firm discloses; and (iii) neither firm discloses. We examine each case in turn, assuming without loss of generality that $s_2 > s_1$.[5]

[3] We assume that firms do not have the option of disclosing the quality of their rivals' products. This assumption is reasonable if the disclosure mechanism takes the form of certification by a third party, such as an industry group or government agency. Although comparative advertising is permitted by both U.S. and European Law, disclosures of this kind are less likely to be viewed as credible by consumers.

[4] It should be noted that the model has other equilibria — see footnote 10 below.

[5] In fact this assumption is not quite without loss of generality, since it is possible that $s_1 = s_2$ A number of assumptions could be made about this case: perhaps the simplest is to suppose that

(a) *Both firms disclose:* If both firms choose to disclose, consumers know the values of s_1 and s_2. To calculate equilibrium in prices, we need to know each firm's demand curve. A consumer θ is indifferent between purchasing from firm 1 and firm 2 if

$$\begin{aligned} & \theta s_1 - p_1 = \theta s_2 - p_2 \\ \Rightarrow \quad & \theta = \frac{p_2 - p_1}{s_2 - s_1}; \end{aligned}$$

and she is indifferent between purchasing from firm 1 or not purchasing at all if

$$\begin{aligned} & \theta s_1 - p_1 = 0 \\ \Rightarrow \quad & \theta = \frac{p_1}{s_1}. \end{aligned}$$

So assuming that $0 \leqslant \frac{p_1}{s_1} \leqslant \frac{p_2 - p_1}{s_2 - s_1} \leqslant 1$ (this assumption is confirmed by the equilibrium values given below), the demand functions of the two firms are given by

$$D_1 = \frac{p_2 - p_1}{s_2 - s_1} - \frac{p_1}{s_1} \quad \text{and} \quad D_2 = 1 - \frac{p_2 - p_1}{s_2 - s_1}.$$

Since there are no costs, profit of firm i is simply $p_i D_i$. Solving for the (unique) equilibrium of the pricing game, we obtain

$$\begin{aligned} p_1^* &= \frac{s_1(s_2 - s_1)}{4s_2 - s_1}, & p_2^* &= \frac{2s_2(s_2 - s_1)}{4s_2 - s_1}; \\ D_1^* &= \frac{s_2}{4s_2 - s_1}, & D_2^* &= \frac{2s_2}{4s_2 - s_1}; \\ \pi_1^* &= \frac{s_1 s_2 (s_2 - s_1)}{(4s_2 - s_1)^2}, & \pi_2^* &= \frac{4s_2^2(s_2 - s_1)}{(4s_2 - s_1)^2}. \end{aligned}$$

The profits of firm 2, the higher-quality firm, are increasing in s_2, as we would expect. The profits of firm 1, on the other hand, are non-monotonic in s_1: profits are zero when $s_2 = 0$, are strictly positive for $s_1 \in (0, s_2)$, and tend to zero again as s_1 tends to s_2.

(b) *Only one firm discloses:* We are trying to demonstrate the existence of an equilibrium in which the higher-quality firm always discloses; so if $s_2 > s_1$, it is firm 2 that decides to disclose and therefore consumers know the value of s_2. If firm 1 does not disclose, consumers must form beliefs about its quality level; on the equilibrium path, these beliefs are uniquely determined by the firms' disclosure and pricing strategies according to Bayes' rule, but we must also specify what the consumers believe if out-of-equilibrium prices

one of the firms takes on the dominant role and discloses, while the other does not disclose; prices and consumer beliefs are as specified in case (b) below.

are chosen. These beliefs generate consumer demand, and thus determine the profit-maximizing price level for firm 1. The simplest assumption to make is that consumer beliefs are the same *whatever* prices are chosen.[6] Let $E[s_1]$ denote the expected value of s_1 according to these beliefs. This expectation determines demand, since the expected utility of a consumer who purchases from firm 1 is given by $E[\theta s_1 - p_1] = \theta E[s_1] - p_1$. Because $E[s_1]$ is fixed whatever prices are charged, equilibrium prices are the same as under perfect information with $E[s_1]$ substituted for s_1, and profits are given by

$$\pi_1^* = \frac{E[s_1]s_2(s_2 - E[s_1])}{(4s_2 - E[s_1])^2}, \quad \pi_2^* = \frac{4s_2^2(s_2 - E[s_1])}{(4s_2 - E[s_1])^2}.$$

(c) *Neither firm discloses:* In equilibrium, at least one firm will disclose, so consumer expectations in the event of no disclosure are not pinned down by Bayes' rule. A reasonable assumption is that consumers do not update their prior beliefs about s_1 and s_2, whatever prices the two firms charge; hence $E[s_1] = E[s_2]$, and the unique equilibrium prices will be $p_1, p_2 = 0$, with resulting profits $\pi_1 = \pi_2 = 0$.

Having described what happens once disclosure decisions have been made, we are now in a position to compute equilibrium disclosure strategies. Suppose that the higher-quality firm (firm 2) always chooses to disclose, and the lower-quality firm (firm 1) obeys the following strategy: disclose if and only if $\underline{s} < \frac{s_1}{s_2} < \overline{s}$.[7] We show that this is part of an equilibrium strategy profile for some values of $\underline{s}$ and $\overline{s}$. Intuitively, when s_1 is close to s_2, firm 1 chooses not to disclose because the potential loss of profit from increased competition more than offsets the gain due to improved consumer expectations of quality; when s_1 is close to zero, firm 1 again chooses not disclose, but for the opposite reason: if it did disclose, the loss of profit due to lower consumer expectations of quality would outweigh the gains from reduced competition. Only when s_1 takes on an intermediate value will firm 1 choose to disclose: here, disclosure improves consumer expectations and the resulting increase in competition is not sufficiently large to offset this increase.

[6] In a setting where credible disclosure is not possible, Milgrom & Roberts [1986] have shown that price can be used as a signal of product quality. But in the Milgrom and Roberts model, pricing decisions can separate high from low quality products: firms producing high quality products stand to gain more from increased first-period sales, which are more likely to generate repeat purchases, and hence they are willing to sacrifice more in the first period to improve consumer expectations. In the present setting, profits depend *only* on consumer expectations and prices, not on actual quality. There is therefore no scope for the use of price as a tool for (positively) influencing consumers' beliefs, and conversely, no reason why consumers should think of price as correlated with quality. A firm chooses not to disclose precisely to hide the quality of its product: consumer expectations in the absence of disclosure generate a more favorable outcome for the firm than if its true quality were revealed.

[7] Note that in this equilibrium, we either have both firms disclosing or the higher-quality firm only disclosing (depending on the realized values of s_1 and s_2).

Figure 1 shows the profit of firm 1 as a function of s_1 in the perfect information case, with $s_2 = 1$. It is the non-monotonicity of this function that prevents unraveling: both high-quality types and low-quality types of firm 1 would prefer to be thought of as average-quality types, albeit for very different reasons. A small amount of unraveling does occur for intermediate values of s_1, but this process is halted when the actual value of s_1 catches up with its expected value, at $\underline{s}$.

To derive the values of $\underline{s}$ and $\overline{s}$ that give us an equilibrium, we must consider what happens at the pricing stage of the game. If firm 1 chooses to disclose, we are back to the perfect information case and equilibrium prices and profits are as calculated in case (a) above. If firm 1 does not disclose, then case (b) applies and profits depend on consumer expectations of s_1. These expectations (in equilibrium) depend on firm 1's type-contingent disclosure strategy. Given the strategy specified above, the consumers know that s_1 must lie either in the interval $[0, \underline{s}s_2]$ or the interval $[\overline{s}s_2, s_2)$. Since the prior distribution of s_1 is uniform, the posterior distribution is also uniform over this range with density $\frac{1}{s_2(\underline{s}+1-\overline{s})}$. Thus

$$
\begin{aligned}
E[s_1] &= \int_0^{\underline{s}s_2} s_1 \frac{1}{s_2(\underline{s}+1-\overline{s})}\,ds_1 + \int_{\overline{s}s_2}^{s_2} s_1 \frac{1}{s_2(\underline{s}+1-\overline{s})}\,ds_1 \\
&= \left[\frac{s_1^2}{2s_2(\underline{s}+1-\overline{s})}\right]_0^{\underline{s}s_2} + \left[\frac{s_1^2}{2s_2(\underline{s}+1-\overline{s})}\right]_{\overline{s}s_2}^{s_2} \\
&= \frac{s_2(\underline{s}^2+1-\overline{s}^2)}{2(\underline{s}+1-\overline{s})}.
\end{aligned}
$$

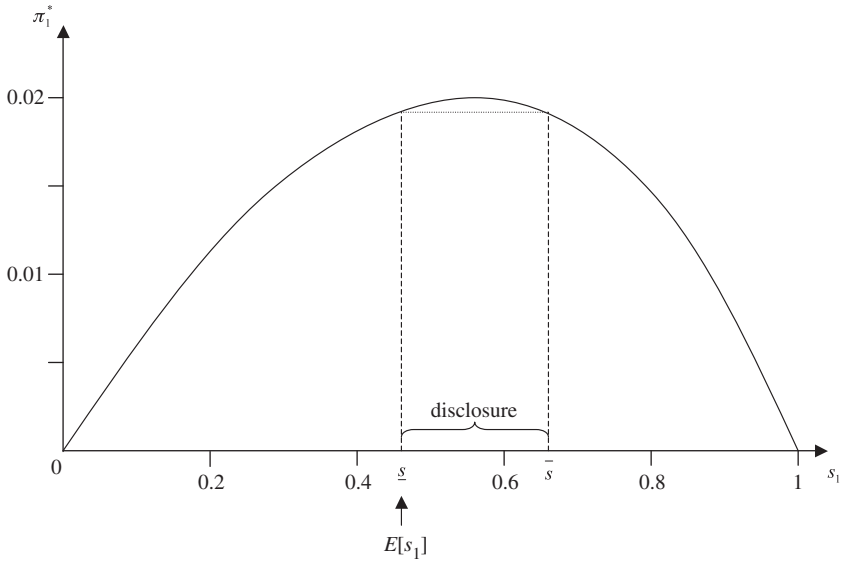

Figure 1
Profit of Firm 1 ($s_2 = 1$)

For given values of $\underline{s}$ and $\overline{s}$, there will be a range of values of s_1 for which firm 1 is better off disclosing than not. For instance, start by considering the case where $\underline{s} = \overline{s}$ (again with $s_2 = 1$) so firm 1 never chooses to disclose; then $E[s_1] = \frac{1}{2}$. But this cannot be an equilibrium, since firm 1 would prefer to disclose if $\pi_1^*(s_1) > \pi_1^*(\frac{1}{2})$, i.e., whenever $\frac{1}{2} < s_1 < \frac{4}{7}$. Next, setting $\underline{s} = \frac{1}{2}$ and $\overline{s} = \frac{4}{7}$, we obtain a new value for $E[s_1]$ and hence a new optimal disclosure range. Finally, when this range coincides with $(\underline{s}, \overline{s})$, we have an equilibrium (see Figure 1).

Some rather messy algebra (see Appendix) reveals that the unique values for which such an equilibrium occurs are

$$\underline{s} = 0.486 \quad \text{and} \quad \overline{s} = 0.653.$$

(Note that this gives us $E[s_1] = \underline{s}s_2$.[8]) Given these values of $\underline{s}$ and $\overline{s}$, $\pi_1^*(s_1) > \pi_1^{st}(E[s_1])$ for $s_1 \in (\underline{s}s_2, \overline{s}s_2)$; and $\pi_1^*(s_1) \leqslant \pi_1^*(E[s_1])$ for $s_1 \in [0, \underline{s}s_2]$ and $s_1 \in [\overline{s}s_2, s_2)$. This confirms the optimality of the proposed disclosure strategy for firm 1.

It remains to check that firm 2 is better off disclosing than not. Although π_2^* is strictly increasing in s_2, the standard unraveling argument does not apply: the calculation of π_2^* was based on the assumption that $s_2 > s_1$, and if firm 2 does not disclose, the consumers cannot be sure that this is the case. There are two possibilities. If firm 1 has chosen not to disclose, we reach a subgame with no disclosure. These subgames are examined in case (c) above, and it is shown that each firm receives profit of 0. But if firm 1 has chosen to disclose and firm 2 does not disclose, the consumers will assume that $s_1 > s_2$, since in equilibrium the higher-quality firm always discloses. More specifically, we have

$$E[s_2] = \frac{s_1(0.486^2 + 1 - 0.653^2)}{2(0.486 + 1 - 0.653)} = 0.486s_1,$$

yielding $\pi_2 = 0.0202s_1$. If firm 2 chooses to disclose, on the other hand, we have $\pi_2 = \frac{4s_2^2(s_2 - s_1)}{(4s_2 - s_1)^2}$. Letting $s_2 = xs_1$, this gives $\pi_2 = \frac{4(x-1)}{(4x-1)^2}x^2 s_1$. Since firm 1 chose to disclose, $s_1 \in (0.486s_2, 0.652s_2)$, i.e. $x \in (1.532,\ 2.057)$. Thus $\pi_2 \in (0.190s_1, 0.342s_1)$, and firm 2 is again better off disclosing.

We have shown that there is an equilibrium in which the higher-quality firm always discloses, and the lower-quality firm discloses only if it its quality falls within an intermediate range of values. When s_1 falls outside this range, we observe partial disclosure.

[8] It is not a coincidence that $E[s_1]$ coincides with one of the bounds of the disclosure region. Since π_1^* is a continuous function of s_1 in the relevant range, a necessary condition for equilibrium is that $\pi_1^*(\underline{s}s_2) = \pi_1^*(E[s_1]) = \pi_1^*(\overline{s}s_2)$.

II(ii). *The Logic of Partial Disclosure*

The above result was obtained in the context of a model with very specific functional forms: firms operated with zero costs and consumer preferences resulted in linear demand functions. In addition, we assumed that firms competed in prices in the second stage of the game. The logic of the argument for partial-disclosure, however, is more general than this, and small relaxations of the assumptions preserve the result. First notice that the driving force behind the result was the non-monotonicity of the firm 1's profit as a function of s_1: this allowed us to construct an equilibrium in which neither high nor low quality types of firm 1 wished to disclose, both preferring consumers to think of them (in expectation) as average-quality types. So the possibility of a partial-disclosure equilibrium of this kind (in the duopoly model) requires that competition between the two firms drags down the profits of firm 1 as s_1 approaches s_2. If competition is less intense, for instance because firms compete in quantities rather than prices (as in Bonanno [1986]) or Gal-Or [1983]), or because the goods are differentiated horizontally as well as vertically, then firms known to produce the same quality level would no longer face zero profits in equilibrium. Nonetheless, a partial disclosure equilibrium may still exist, as long as the profit function is sufficiently symmetric in s_1: see Figure 2 below.

A necessary condition for the existence of such an equilibrium is that the profits obtained by firm 1 from disclosing $s_1 = \frac{s_2}{2}$ are greater than from head-to-head competition at $s_1 = s_2$ (assuming uniform distribution of s_1 and no costs of production, as before). Otherwise whatever the level of profits that

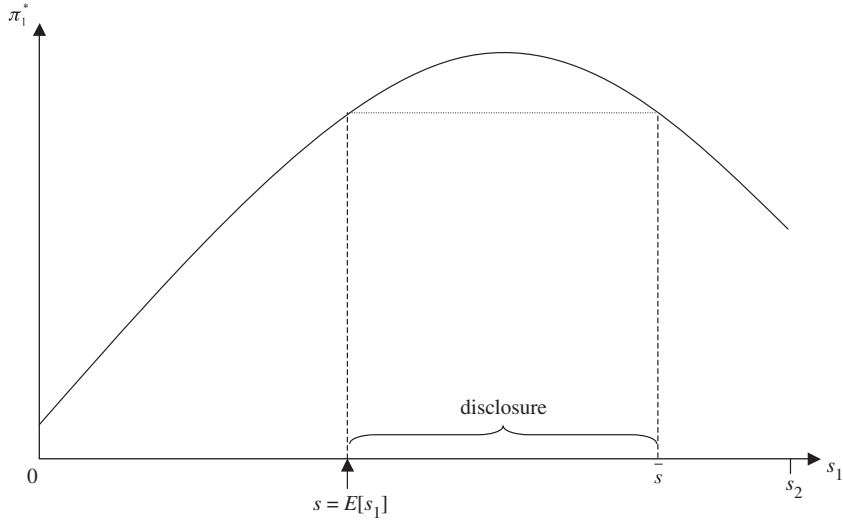

Figure 2
Partial Disclosure with Softer Competition

firm 1 can expect if it does not disclose, the interval of types $(\underline{s}, \overline{s})$ that prefer to disclose induces consumer expectations $E[s_1] < \underline{s}$ (unless $\underline{s} = 0$), and so full unraveling occurs.

III. MANDATORY DISCLOSURE LAWS

We have shown that when there is competition between firms, the unraveling result may fail: full disclosure of quality does not always occur. A rule imposing mandatory disclosure would therefore have some impact. We now consider the effects of such a rule.

For ease of exposition, we again assume that firm 2 produces the higher-quality product: $s_2 > s_1$. We use the equilibrium described in section 2.1 as the benchmark case, and relegate comparisons with the alternative equilibria to the end of the current section. In this equilibrium, if $s_1 \in (0.486s_2,\ 0.653s_2)$, both firms choose to disclose and the rule has no effect. But if $s_1 \in [0,0.486s_2]$ or $s_1 \in [0.653s_2,s_2)$, firm 1 would have chosen not to disclose. We consider each case in turn:

Case 1: $s_1 \in [0,0.486s_2]$. In this case, firm 1 chose not to disclose in order to hide the poor quality of its product. Clearly, mandatory disclosure will reduce the profits of firm 1 and increase the profits of firm 2. But the effects on consumer surplus are more ambiguous. Consider first the effect on prices. On the one hand, consumers are better informed and will now be less inclined to buy the poor quality product, putting downward pressure on its price; on the other, competition with firm 2 is weakened, reducing elasticity of demand and putting upward pressure on the prices charged by both firms. Overall, the first effect dominates for firm 1 and its price goes down, while the price charged by firm 2 rises. Consumers are made better off or worse off, therefore, depending on their taste for quality (θ).

Consumers with very low values of θ chose not to buy from either firm under the voluntary disclosure regime. These consumers don't buy under mandatory disclosure either, and are thus unaffected by the rule (region I in Figure 3). They are joined by a few consumers with slightly higher values of θ who were buying under voluntary disclosure and now drop out of the market as firm 1 is forced to reveal the poor quality of its product. These consumers were experiencing negative (*ex post*) consumer surplus before the rule was introduced, making their purchases on the basis of overly optimistic expectations about the quality of firm 1's product; they are made better off by the introduction of the rule (region II). All the consumers who continue to purchase from firm 1 are also made better off by the rule: their utility from consumption is unchanged but firm 1 lowers its price (region III). There are a few consumers, however, who switch from firm 2 to firm 1 as firm 2 increases its price. These consumers are made worse off (region IV). Finally, consumers with high values of θ continue to buy from firm 2, and are also adversely affected by the rule, again because the price charged by firm 2 goes up (region V).

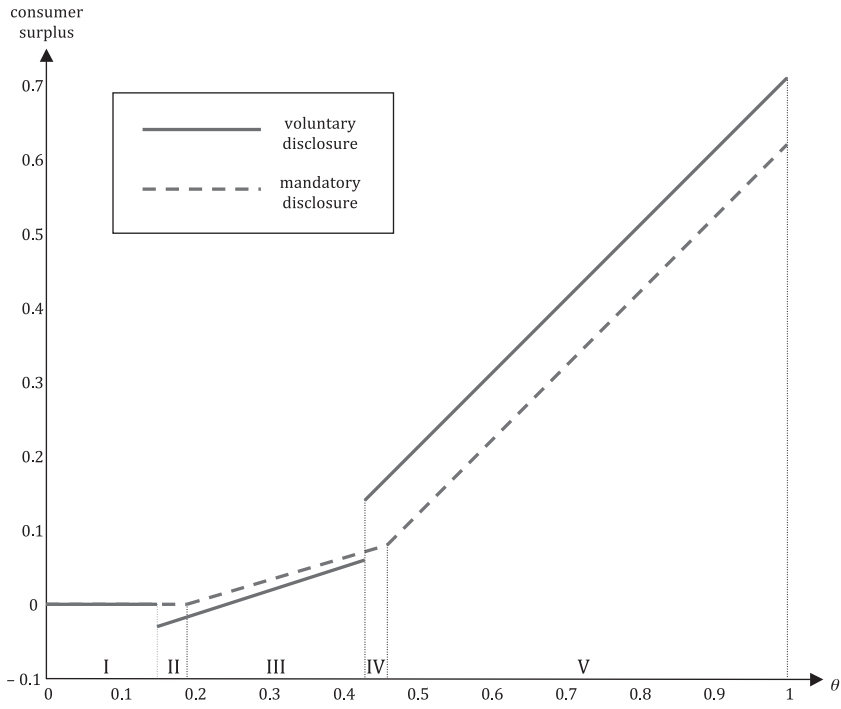

Figure 3
Consumer Surplus, $s_1 = 0.3$, $s_2 = 1$

Figure 3 shows consumer surplus as a function of θ when $s_1 = 0.3$, $s_2 = 1$, before and after the mandatory disclosure rule is introduced.

Case 2: $s_1 \in [0.653s_2, s_2]$. With the quality of firm 1's product close to that of firm 2's, firm 1 chose not to disclose in order to reduce competition with firm 2, accepting lower consumer expectations of quality in return for higher prices. In this case, mandatory disclosure is unambiguously bad for the firms and good for the consumers. Prices and profits of both firms go down. Of those consumers who were not buying from either firm before the rule was introduced, those with very low values of θ remain out of the market: they are unaffected by the rule (region I′ in Figure 4). But those with slightly higher values of θ enter the market and buy from firm 1, enjoying positive consumer surplus (region II′). Some of the consumers who were buying from firm 1 continue to buy from firm 1 (region III′), and others switch to firm 2 (region IV′): both groups are better off, since firm 1 has lower prices than before. All of those who were buying from firm 2 continue to buy from firm 2, and are also made better off as a result of lower prices (region V′).

Figure 4 shows consumer surplus as a function of θ when $s_1 = 0.8$, $s_2 = 1$ before and after the mandatory disclosure rule is introduced.

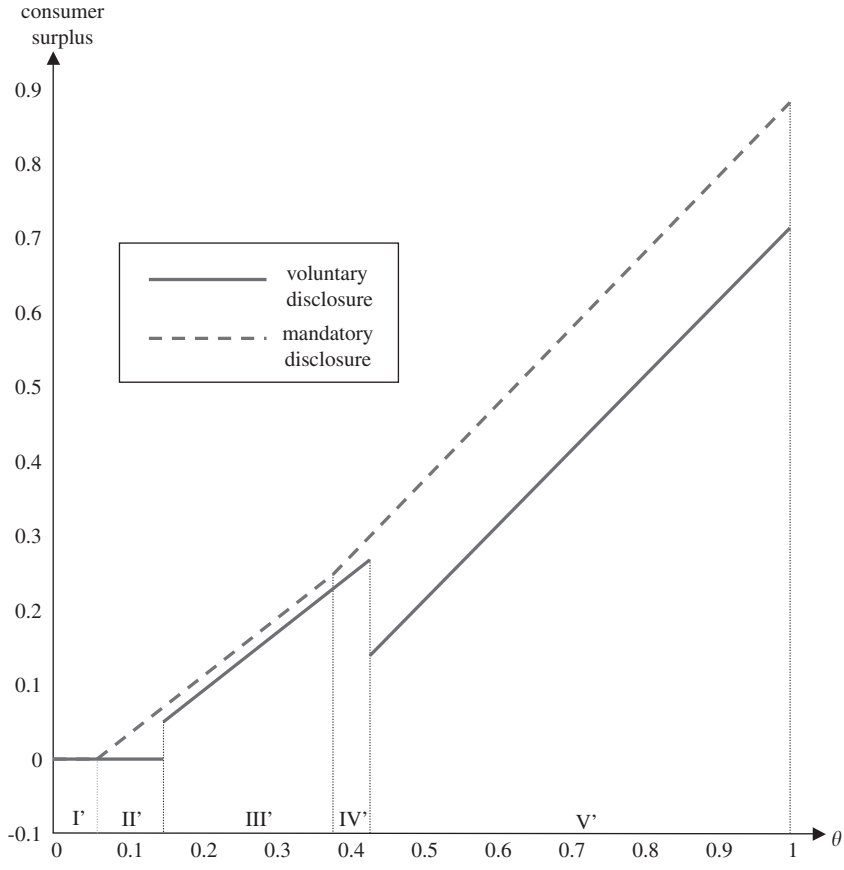

Figure 4
Consumer Surplus, $s_1 = 0.8$, $s_2 = 1$

We have shown the effect of the mandatory disclosure rule on consumer surplus as a function of θ It is also interesting to consider what happens to overall consumer surplus, which can be obtained by integrating across all values of θ. We first examine the case where disclosure is voluntary and firm 1 does not disclose:

$$CS^{PD} = \int_{\frac{p_1}{E[s_1]}}^{\frac{p_2-p_1}{s_2-E[s_1]}} (\theta s_1 - p_1)d\theta + \int_{\frac{p_2-p_1}{s_2-E[s_1]}}^{1} (\theta s_2 - p_2)d\theta$$
$$= \frac{s_2(s_1(2s_2 - 2E[s_1]) + 2E[s_1](E[s_1] - s_2))}{2(4s_2 - s_1)^2}$$
$$+ \frac{2s_2^2(E[s_1] + s_2)}{(4s_2 - E[s_1])^2}.$$

When firm 1 does disclose, voluntarily or not, we have:

$$CS^{FD} = \int_{\frac{p_1}{s_1}}^{\frac{p_2-p_1}{s_2-s_1}} (\theta s_1 - p_1)d\theta + \int_{\frac{p_2-p_1}{s_2-s_1}}^{1} (\theta s_2 - p_2)d\theta$$
$$= \frac{s_1 s_2^2}{2(4s_2 - s_1)^2} + \frac{2s_2^2(s_1 + s_2)}{(4s_2 - s_1)^2}.$$

(Note that *PD* and *FD* stand for *partial disclosure* and *full disclosure*, respectively.) Unsurprisingly, total consumer surplus is lowered by the introduction of the mandatory disclosure rule when s_1 is low: in this case the rule reduces competition; when s_1 is close to s_2, the rule increases competition and total consumer surplus rises. Figure 5 shows total consumer surplus as a function of s_1 when $s_2 = 1$.

The final step is to consider the change in *ex ante* total consumer surplus as we switch from voluntary to mandatory disclosure, integrating over all values of s_1 and s_2. First under voluntary disclosure:

$$TCS^V = 2\left(\int_0^1 \int_0^{\underline{s}} CS^{PD} ds_1 ds_2 + \int_{\underline{s}}^{\overline{s}} CS^{FD} ds_1 ds_2 + \int \int_{\overline{s}}^{s_2} CS^{PD} ds_1 ds_2\right)$$
$$= 0.177.$$

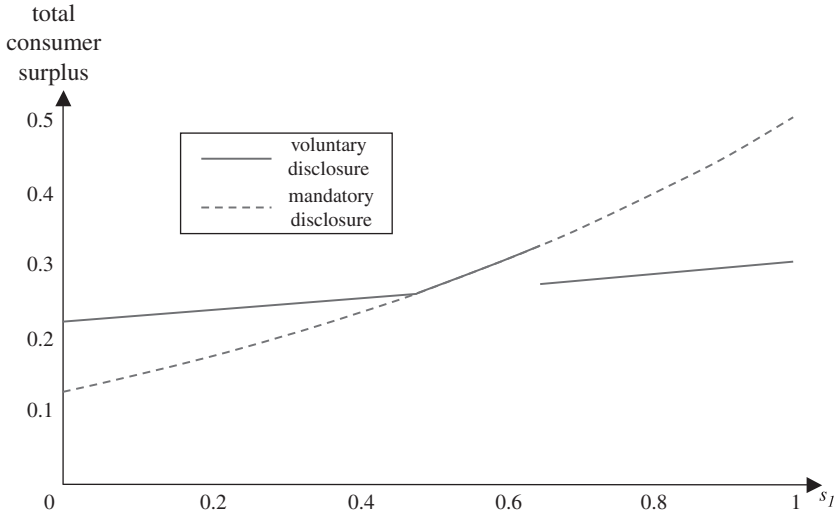

Figure 5
Total Consumer Surplus ($s_2 = 1$)

(The factor of 2 deals with the case where $s_1 > s_2$.) Under mandatory disclosure, on the other hand, we have:

$$TCS^M = 2\left(\int_0^1 \int_0^{s_2} CS^{FD} ds_1 ds_2\right)$$
$$= 0.187.$$

Thus consumers benefit from such laws. The analogous calculations for the firms, on the other hand, yield *ex ante* total profit of 0.122 under voluntary disclosure and 0.110 under mandatory disclosure: overall, profit is reduced. Note that the loss of profit slightly exceeds the increase in consumer surplus; this is because the loss of total surplus due to the consumers who drop out of the market when low quality firms ($s_1 \in [0, \underline{s}]$) are forced to disclose[9] exceeds the gain from consumers who enter the market when high quality firms ($s_1 \in [\overline{s}, s_2]$) are forced to do so.

The above analysis shows that there may be a rationale for mandatory disclosure rules even when information about quality has no value *per se*. The potential benefit of such rules comes from their effect on competition between firms. In (Fishman & Hagerty [2003]), on the other hand, the positive welfare effects of mandatory disclosure laws arise because information about the quality of a good allows some consumers to make better choices about the use of that good: information is directly valuable. Including this feature in our framework would strengthen the case for mandatory disclosure.

We end this section with a *caveat*. There are other equilibria of the model[10] which would yield different welfare comparisons. One approach to the problem of multiple equilibria is to appeal to some equilibrium selection device to choose among the alternatives. We do not take this path here. The aim of this paper is not to provide unique predictions about how much disclosure we can expect to observe in particular markets. Rather the goal (as in much of the theoretical industrial organization literature) is to untangle the various elements of strategic interaction and thereby achieve a better understanding of the forces at work. Specifically, the model described here provides a new explanation for the failure of firms fully to disclose private information about the quality of their products, and suggests that

[9] These consumers actually get negative consumer surplus under voluntary disclosure (see figure 3), but they generate profit for the low-quality firm.

[10] For instance, (i) there is an equilibrium where neither firm discloses, regardless of their quality levels; if consumers believe (out-of-equilibrium) that if one of the firms does disclose, the other has exactly the same quality level, then Bertrand competition will drive profits of both firms down to zero and nothing can be gained by the disclosure; and (ii) there is an equilibrium where both firms always disclose, where consumers believe (out-of-equilibrium) that a non-disclosing firm has quality of zero.

mandatory disclosure laws may have a (potentially valuable) effect on the competitiveness of an industry.

IV. CONCLUSION

In this paper we have shown that in a competitive environment, firms with private information about the quality of their products may choose not to disclose this information to consumers. If a high-quality firm decides to disclose, this may raise consumer expectations of the quality of its product, but at the same time it may toughen competition with rivals of similar quality who also choose to disclose. If the second effect outweighs the first, the firm will prefer not to disclose. Low-quality firms may also choose not to disclose, taking advantage of the raised consumer expectations created by non-disclosing high-quality firms. This theory of disclosure suggests that mandatory disclosure laws have an important role to play. By increasing the competitiveness of the market, they can increase consumer surplus at the expense of firm profits, reducing monopoly distortions and improving overall efficiency.

There may be further benefits of mandatory disclosure laws not analyzed in this paper. Information itself may have positive value, if better information about the quality of a product allows the consumers to use it more effectively and thereby derive greater utility. For example, information about the nutritional content of food may allow one to eat a more balanced diet, with beneficial health implications. This effect is strengthened by the fact that mandatory disclosure laws typically require information be presented in a standard format, designed to help consumers understand and use it. Food labels list nutrients in a set order, with per cent daily value figures giving advice about how much of each one should eat.

Although we have examined only a specific duopoly model, we believe our key finding that competition works as a force against disclosure is worthy of further investigation, both theoretically and empirically. In particular, should we expect to find less disclosure as the number of firms in a market increases? A recent study by Jin [2005] suggests that this is indeed the case in the HMO industry: she found that the fraction of HMOs seeking accreditation from the National Committee of Quality Assurance was negatively related to number of firms serving the market.

APPENDIX DERIVATION OF $\underline{s}$ AND $\overline{s}$

Necessary and sufficient conditions for the existence of an equilibrium of the kind described in section 2.1 are:

$$\pi_1^*(\underline{s}s_2) = \pi_1^*(E[s_1]) \tag{1}$$

$$\pi_1^*(\overline{s}s_2) = \pi_1^*(E[s_1]) \tag{2}$$

(3) $\underline{s} < \overline{s}$

where

$$E[s_1] = \frac{s_2(\underline{s}^2 + 1 - \overline{s}^2)}{2(\underline{s} + 1 - \overline{s})}.$$

(1) and (2) yield $\pi_1^*(\underline{s}s_2) = \pi_1^*(\overline{s}s_2)$. Recalling that $\pi_1^*(s_1) = \frac{s_1 s_2(s_2 - s_1)}{(4s_2 - s_1)^2}$ and using (3), we obtain

(4) $$\overline{s} = \frac{16(1 - \underline{s})}{16 - 7\underline{s}}.$$

Additionally, since $\pi^*(\cdot)$ is strictly convex on $[0, s_2]$, either $E[s_1] = \underline{s}s_2$ or $E[s_1] = \overline{s}s_2$; the latter yields no solutions in the relevant range, while the former generates a cubic with a unique real root:

$$\underline{s} = \frac{1}{21}\left(50 - \frac{247}{(16759 - 27\sqrt{364602})^{\frac{1}{3}}} - (16759 - 27\sqrt{364602})^{\frac{1}{3}}\right)$$
$$\approx 0.48613.$$

Substituting this value into (4), we find $\overline{s} = 0.65268$.

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