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Worried about adverse product effects? Information disclosure and consumer awareness*

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Abstract

Whether consumers are aware of potentially adverse product effects, is key for private and social incentives to disclose information. To obtain a better understanding of this issue we propose a simple monopoly model that highlights the conceptual difference between consumer unawareness and consumer uncertainty. We show that total surplus may be larger in an environment in which consumers are unaware of the potentially adverse effect. We also show that disclosing information whether a particular ingredient is harmful or not increases consumer surplus, but mandatory disclosure of the level of this ingredient may make consumers worse off.

Keywords: Information disclosure, informative advertising, consumer awareness, behavioral bias, non-common prior, adverse effects, side effects, consumer protection, behavioral industrial organization

JEL Classification: D8, L5, M3

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1 Introduction

Adverse product effects are a serious economic problem. As a result of information disadvantages, consumers may be unaware of some low-quality aspects of products, for example, harmful radiation from computer monitors or cell-phones, health risks due to nanoparticles or artificial sweeteners in food, and side effects of medicines. A profit-seeking firm may use many ingredients in different degrees for the production of products. Such ingredients are supposed to improve the performance of the product or reduce the cost of production. However, these substances may have adverse effects on consumer well-being. Not only may such adverse effects be uncertain and of unknown degree but the consumer may initially be unaware that, by consuming, they expose them to such a risk. More examples are asbestos, nicotine, transgenic fats, and flavor enhancers, whose health risks are or were largely unknown by the consumers. The recent debate on genetically modified agricultural products has a similar flavor: Firms use products with certain genetic modifications; consumers are imperfectly informed about the degree of such modifications and whether such modifications are harmful.

In this paper, we consider two classes of information problems on the consumer side: uncertainty and unawareness. To model uncertainty on the consumer side, we develop a simple fully Bayesian model. To model unawareness, we develop a simple model in which consumers suffer from a biased prior. The main contribution of the paper is that we provide a simple model that allows us to highlight the conceptual differences between consumer unawareness and consumer uncertainty.

Formally, with some probability, some characteristic of a product by a firm creates health problems for consumers. Otherwise, this characteristic does not affect the well-being of consumers. In the "uncertainty" model, consumers are aware of the substance but uncertain of the level of the substance and whether the substance is harmful. In the unawareness model consumers are not aware of the existence of the substance at all. The monopolist firm knows whether the substance is harmful or not and the level of it. He then decides about his disclosure policy: He may fully, partially, or not at all disclose information through advertising.

The main results are as follows. First, social welfare may be higher with unaware consumers than that with aware consumers. Intuitively, a monopolist always sets a price higher than the social optimal level. This leads to too little consumption in the market with complete information. Hiding information, however, leads to too much consumption. The distortions created by monopoly and hiding information go in the opposite directions. Hence, in the presence of monopoly power, hiding information is not necessarily detri-

mental to welfare. However, the conclusion with respect to consumer surplus is unambiguous: Consumers are always better off if they are aware.

Second, from a policy perspective, mandatory information disclosure makes unaware consumers better off. In a market with unaware consumers we distinguish between full and partial mandatory disclosure. Partial disclosure refers to informing consumers that a particular substance is harmful, full disclosure refers to also disclosing which amount of the harmful substance the product contains. Partial disclosure makes consumers better off if they are initially unaware of the potentially adverse effect, while it is neutral if they are initially aware. We show that *consumers are not necessarily better off if full instead of partial disclosure is mandated*. The reason is that imposing full disclosure may lead to non-participation of the monopolist that may be consumer surplus reducing.

In an extension, we consider the situation of a mix of aware and unaware consumers. In this extension it is interesting to study what happens if initially a larger share of consumers becomes aware of adverse effects—such a change in the composition of the population may come from public awareness campaigns that increase the share of aware consumers. If there is a sufficiently large share of aware consumers, the firm has a stronger incentive to advertise if it has a moderate level of the potentially harmful ingredient.[1] Such advertising further increases the share of aware consumers because advertising is only imperfectly targeted.

Related Literature: In information disclosure problems, uncertainty problems have the feature that consumers are uncertain in the sense that they know the distribution of the relevant unknown attribute, although they do not know the exact value the attribute takes. The underlying adverse selection problem can be solved through voluntary information disclosure by the firm. It is well-known that, if such disclosure is costless, full unravelling results and the adverse selection problem is fully solved. See, e.g., Grossman and Hart (1980), Grossman (1981), Milgrom (1981), Milgrom and Roberts (1986), and the generalized model by Okuno-Fujiwara, Postlewaite, and Suzumura (1990). However, as also holds in our setting, if disclosure is costly no or only partial unravelling will occur (see, e.g., Shavell, 1994). After disclosure, consumers update their beliefs in a Bayesian fashion upon observing firms' disclosure actions. With respect to the contracting literature on information disclosure, we refer to the overview provided in chapter 5 in

[1] A similar effect is also present in the work by Gabaix and Laibson (2006) who consider a competitive market in which some consumer are unaware of add-ons. They show that firms are more likely to disclose the add-on if the fraction of aware consumers in the population is higher.

Bolton and Dewatripont (2005).

The law and economics literature has used the above approach to address consumer protection issues.[2] In the legal literature, Korobkin (2003) recommends ex ante intervention by legislatures; this corresponds to mandatory information disclosure rule. However, this ex ante mechanism sometimes inefficiently excludes firms from the market as information disclosure is costly as we show in this paper. Polinsky and Shavell (2006) compare mandatory to voluntary disclosure rules in a setting in which two firms decide whether to acquire information. They show that firms may have less incentive to acquire information under mandatory disclosure. We note that if the legislator can require the seller to disclose all the possibly harmful substances, it matters how the seller discloses the eye-opening information. If the seller puts the information only in fine print, the seller's action constitutes mis-selling if the information does not reach the consumers.

Other work has considered ex post judicial mechanisms. In the economics literature, Daughety and Reinganum (1995) and Daughety and Reinganum (2008) examine the firm's behavior when the firm is liable to make a payment in the event of harm. However, in our context, harm is often not contractible. Thus, this judicial mechanism has limited applicability.[3]

According to a different class of informational problems, unaware consumers do not know the attribute and do not know that they do not know it and so on so forth. To analyze this class of information problems, one has to give up common knowledge of the game (and rationality), and assume a non-common prior between firm and consumers. Epistemic foundations are provided by Board and Chung (2006), Galanis (2007), Heifetz, Meier and Schipper (2006), and Li (2009) in the unawareness literature. From a normative viewpoint, the consumers' prior is biased, unless they are made aware. This non-common prior approach has been used in a number of recent behavioral-IO models—see, e.g., present-biased consumers (Della Vigna and Malmendier, 2004) and the extension to diversely naive consumers (Eliaz and Spiegler, 2006), consumers who are unaware of some options (Eliaz and Spiegler, 2008), consumers who are unaware of some add-ons (Gabaix

[2] See, e.g., Shavell (2004) for extensive discussions of the law and economics literature on this issue. A different remedy with respect to adverse effects is to define minimum quality standards that refer to product safety or product quality (see, e.g., Leland, 1979, and Shapiro, 1983).

[3] It is worth mentioning that some legal scholars suggest another ex-post judicial mechanism (see Korobkin, 2003, and Becher, 2008): By using the unconsionability doctrine to interpret contracts, contracts with unconscionable terms (which, thus, put one party at the mercy of the other) are not enforced. Unfortunately, this mechanism appears to be of little help in our context because its implementation is difficult in the presence of adverse effects.

and Laibson, 2006), analogy-based-reasoning consumers (Mullainathan et al., 2008), limited-recall consumers (Shapiro, 2006), consumers who are susceptible to the law of small numbers (Spiegler, 2006).[4] Our paper adds to this literature by taking a closer look at information disclosure rules, highlighting the difference between a market inhabited by consumers that lack information but do not have biased beliefs and one in which consumers do have biased beliefs.

The remainder of the paper is organized as follows. Section 2 presents the model with aware consumers and unaware consumers, respectively. Section 3 examines the welfare consequence and discusses the information disclosure policies. Section 4 contains two extensions: a setting with moral hazard and a setting in which aware and unaware consumers coexist. The last section concludes.

2 Information Disclosure with Aware and Unaware Consumers

2.1 The Model

We present an adverse selection model in which a monopolist sells a single product to a unit mass of consumers. Consumers are aware of the existence of the product and know the utility from its intended use. However, the firm's product contains a potentially harmful substance (e.g., asbestos, nicotine, artificial sweeteners, genetically modified products etc.). The monopolist incurs constant marginal costs of production that are normalized to zero. He sets his price (or, equivalently, quantity) and his information disclosure policy, as will be specified below. We assume that the firm knows the exact quality of the product (i.e., whether or not the substance is harmful and which amount of it is used). Thus we rule out the problem of quality test (see, e.g., Matthews and Postlewaite, 1985).

We introduce the possibility of unawareness about adverse effects into a linear-quadratric representative-consumer model. In the context of information disclosure policies, this model has been used by Daughety and Rein-

[4] In psychology, the related concept of awareness is availability (see Kahneman and Tversky, 1973). For an alternative Bayesian approach of modeling contracting with unawareness, see Tirole (2009). Zhao (2009) extends Tirole (2009) to a model with asymmetric awareness between a seller and a buyer and focuses on the transaction cost of pre-contractual cognition of the buyer. By contrast, in this paper, unaware consumers are biased in the sense they are naive; thus there is no pre-contractual cognition involved.

ganum (2005).[5] We refer to the model with aware consumers if consumers are aware of the potentially adverse effect; however, absent information disclosure, they lack information about whether such adverse effects are present and about the magnitude of these effects. We refer to the model with unaware consumers if consumers are not aware that there are potentially adverse effects, unless such information is disclosed. In effect, they have a biased prior.

We aim at developing a simple framework to analyze the difference of market environments with aware vs unaware consumers. To do so, we need some notation: We denote

- θ as the amount of the substance, uniformly drawn from $[0, 1]$;
- I as an indicator which takes value $I = 1$ if the substance is harmful and $I = 0$ otherwise;
- p as the per-unit price of the product and q as the quantity sold by the monopolist.
- x as the probability that the substance is harmful;
- $a \equiv \alpha - I\theta$ as the true quality measure (net of any adverse effects) of the product, where α is a parameter that shifts the willingness-to-pay function and reflects the consumer's preference when abstracting from possible adverse effects;
- $\widetilde{a}$ as the expected quality according to consumer beliefs.

For simplicity, we assume that θ and I are independent. We postulate that the utility function of the representative consumer takes the standard linear-quadratic form

$$U = (\alpha - I\theta)q - \frac{1}{2}q^2 - pq.$$

The firm may disclose information through advertising at a fixed cost $c > 0$. Advertising is, thus, by definition, truthful.[6]

[5] We have checked that our results also hold in a heterogeneous consumer model with unit demand and a uniform distribution of the willingness-to-pay.

[6] This can be motivated by measures taken against misleading or false advertising. Such advertising about product characteristics is thus within the domain of informative advertising. However, since unaware consumers have biased beliefs advertising changes consumer preferences for the product at the moment of purchase—this is a feature of persuasive advertising. In contrast to work on persuasive advertising, in our setting advertising "corrects" consumer preferences—i.e., ex post preferences are the true preferences. For a monopoly model of persuasive advertising that allows for distorted preferences ex ante or ex post, see Dixit and Normann (1978); for a survey on the economics of advertising, see Bagwell (2007).

The timing of the game played by monopolist and consumers evolves as follows:

1. Nature chooses θ and I.

2. The monopolist observes θ and I—this is his *private* information. He then chooses if it partially or fully discloses information through advertising and sets its price p. If the firm advertises, it chooses to disclose θ and/or I.

3. Consumers observe the price and, if applicable, the advertisement and then make their purchasing decision.

Notice that the consumer's decisions only depend on the consumer's expected quality. It is straightforward to obtain the following lemma:

Lemma 1 *Independent of whether the representative consumer is aware or not, the market outcomes are characterized as follows:*

1. *If $\widetilde{a} > 0$—i.e., the representative consumer's expected quality is greater than zero— the consumer buys a strictly positive quantity of the product. The equilibrium price is $p = \frac{\widetilde{a}}{2}$ and quantity is $q = \frac{\widetilde{a}}{2}$; the gross profit of the firm is $\frac{\widetilde{a}^2}{4}$. In equilibrium, the representative consumer's utility level is*

$$CS^{\widetilde{a},a} = \frac{a}{2}\widetilde{a} - \frac{3}{8}\widetilde{a}^2,$$

and the total surplus is

$$TS^{\widetilde{a},a} = \frac{a}{2}\widetilde{a} - \frac{1}{8}\widetilde{a}^2.$$

2. *If $\widetilde{a} \leq 0$, the firm does not produce.*

Notice that in the case where consumers buy the product, adopting a consumer welfare standard, it is optimal to have $\widetilde{a} = 2a/3$. The consumers should have a downward bias in this belief about product quality, $\widetilde{a} < a$, due to asymmetric information between the firm and consumers. However, adopting a total welfare standard, it would be optimal for the consumer to have biased beliefs $\widetilde{a} = 2a$. The reason is that the consumer's upward bias in the belief about quality, $\widetilde{a} < a$, counteracts the social underproduction in monopoly that would result under unbiased beliefs.

2.2 Aware Consumers

As a benchmark model let us first analyze the model under the assumption that consumers are aware of the substance but *uncertain* of the level of θ and its presence in the product I. The main goal is to derive welfare measures—i.e., consumers surplus and total surplus, for further comparison.

Denote $\widetilde{a}_N$ the consumers' expected quality level in the absence of advertising. By the unravelling argument (see, e.g., Milgrom, 1981, and Milgrom and Roberts, 1986), if the firm advertises, the firm will disclose both I and θ; note that there would be full unravelling if $c = 0$. Thus, the firm with quality a will advertise if and only if

$$\frac{a^2}{4} - c \geq \max\{0, \frac{\widetilde{a}_N^2}{4}\}.$$

There are two cases to consider, depending on whether $\widetilde{a}_N$ is positive or not. Denote $\widehat{a}$ the cutoff value of the quality at which the firm is indifferent between advertising and no advertising.

Case 1: $\widetilde{a}_N \geq 0$. Then the firm with quality a advertises if

$$a \geq \widehat{a} = \sqrt{4c + \widetilde{a}_N^2}. \tag{1}$$

To make things interesting, we assume that α is not too small:

Assumption 1 $\alpha > \frac{16c+1}{4}$.

The assumption rules out the trivial case in which the cost of information disclosure c is too large such that the firm will never advertise.[7]

By Bayes' rule, the consumers' conditional expectation is (using the uniformity assumption)

$$\widetilde{a}_N = E[a|a \leq \widehat{a}] = \frac{\widehat{a} + \alpha - 1}{2}. \tag{2}$$

If c is not too large, the firm advertises with positive probability—i.e., with realizations of a above the critical value $\widehat{a}$ in the solution. Combining expressions (1) and (2), we obtain

$$\widetilde{a}_N = \frac{2}{3}\alpha + \frac{1}{3}\sqrt{12c - 2\alpha + \alpha^2 + 1} - \frac{2}{3}. \tag{3}$$

[7] When c is not too large advertising by some firm types takes place if and only if $\alpha > \sqrt{4c + \widetilde{a}_N^2}$. For the firm with $a = \alpha$ to have an strict incentive to advertise, $\widetilde{a}_N = \alpha - \frac{1}{2}$. Hence, we must have $\alpha > \sqrt{4c + \left(\alpha - \frac{1}{2}\right)^2}$ which is equivalent to $\alpha > (16c + 1)/4$.

In case 1, the consumer consumes a positive amount of the good at the profit-maximizing price. Equation (3) implies that $\widetilde{a}_N \geq 0$ if and only if

$$1 - 2\sqrt{c} \leq \alpha, \tag{4}$$

i.e., the cost of advertising is not too high compared to the highest quality of the product.

We now have that

$$\widehat{a} = \frac{1}{3}\alpha + \frac{2}{3}\sqrt{12c - 2\alpha + \alpha^2 + 1} - \frac{1}{3}.$$

Notice that $\widehat{a}$ is increasing in c. The advertising cost reduces the probability of information disclosure ex ante. Clearly, if c is equal to zero, there is full information disclosure due to unravelling. Note that in this case $\widehat{a}$ does not depend on x since the unraveling logic implies that the consumer knows for sure the substance is harmful if there is no advertising.

Lemma 1 implies the following results:

If $I = 0$, the firm discloses I and θ and consumers learn that $a = \alpha$. The firm's net profit is $\frac{\alpha^2}{4} - c$, and the consumer's net utility level is $\frac{\alpha^2}{8}$.

If $I = 1$ and $a > \widehat{a}$, (i.e., θ sufficiently small) the firm discloses I and θ and consumers learn a. The firm's profit is $\frac{a^2}{4} - c$, and the consumers' utility level is $\frac{a^2}{8}$.

If $I = 1$ and $a < \widehat{a}$, the firm does not advertise. As follows from Lemma 1, the firm's profit is $\frac{\widetilde{a}_N^2}{4}$, and the consumers' utility level is $\frac{a\widetilde{a}_N}{2} - \frac{3\widetilde{a}_N^2}{8}$.

The expected consumer surplus is

$$CS_{A1} = x\left(\int_{\alpha-1}^{\widehat{a}}\left(\frac{a\widetilde{a}_N}{2} - \frac{3\widetilde{a}_N^2}{8}\right)da + \int_{\widehat{a}}^{\alpha}\frac{a^2}{8}da\right) + (1-x)\frac{\alpha^2}{8}. \tag{5}$$

The expected total surplus is

$$\begin{aligned} TS_{A1} = x\left(\int_{\alpha-1}^{\widehat{a}}\left(\frac{\widetilde{a}_N^2}{4} + \frac{a\widetilde{a}_N}{2} - \frac{3\widetilde{a}_N^2}{8}\right)da + \int_{\widehat{a}}^{\alpha}\left(\frac{a^2}{4} - c + \frac{a^2}{8}\right)da\right) \\ + (1-x)\left(\frac{\alpha^2}{4} - c + \frac{\alpha^2}{8}\right). \end{aligned} \tag{6}$$

Case 2: $\widetilde{a}_N < 0$. In this case, if the firm does not advertise, the consumers will buy zero quantity. The firm advertises if and only if its profit after advertising $\frac{a^2}{4} - c$ is positive, or equivalently, $a > \widehat{a}$ with $\widehat{a} = 2\sqrt{c}$. If there is a positive probability of advertising ex ante, it is necessary that $\widehat{a} < \alpha$. For this to be the case, we have to assume that $\alpha > 2\sqrt{c}$ which is implied by

Assumption 1. The reason is that if the firm will disclose information in case the consumers' expected quality is positive, the firm with the same quality will also disclose information if consumers' expected quality is negative. The expected consumer surplus is

$$CS_{A2} = x \int_{\widehat{a}}^{\alpha} \frac{a^2}{8} da + (1-x) \frac{\alpha^2}{8}. \tag{7}$$

The expected total surplus in this case is

$$TS_{A2} = x \int_{\widehat{a}}^{\alpha} \left(\frac{a^2}{4} - c + \frac{a^2}{8} \right) da + (1-x) \left(\frac{\alpha^2}{4} - c + \frac{\alpha^2}{8} \right). \tag{8}$$

Combining cases 1 and 2, we define the consumer surplus measure as

$$CS_A \equiv \begin{cases} CS_{A1} & \text{if } \widetilde{a}_N \geq 0, \\ CS_{A2} & \text{if } \widetilde{a}_N < 0. \end{cases}$$

We return to these surplus measures when comparing market environments in which consumers are aware to those in which they are unaware.

2.3 Unaware Consumers

The analysis with unaware consumers is straightforward and welfare measures are easily calculated. Absent information disclosure, consumers are unaware of the potential adverse effect—i.e., consumers naively believe that $\widetilde{a} = \alpha$ if there is no advertisement about the substance. Therefore, no advertisement leads to the firm's maximal net profit $\frac{\alpha^2}{4}$. Hence, the firm does not advertise in a market with unaware consumers. Thus in the second class of information problems there is zero advertising independent of the cost level. The firm does not have an incentive to solve the information problem consumers face because they are not aware of it. This result is in contrast to the case where the consumers are aware in which there is full information disclosure if the cost of advertising is zero.

If $I = 0$, the consumer's ex post utility level is $\frac{\alpha^2}{8}$. If $I = 1$, the consumers' ex post utility level is $\frac{a\alpha}{2} - \frac{3\alpha^2}{8}$, as follows from Lemma 1.

The expected consumer surplus is

$$CS_U = x \int_{\alpha-1}^{\alpha} \left(\frac{a\alpha}{2} - \frac{3\alpha^2}{8} \right) da + (1-x) \frac{\alpha^2}{8}. \tag{9}$$

The expected total surplus is

$$TS_U = x \int_{\alpha-1}^{\alpha} \left(\frac{a\alpha}{2} - \frac{\alpha^2}{8} \right) da + (1-x) \left(\frac{\alpha^2}{4} + \frac{\alpha^2}{8} \right). \tag{10}$$

3 Surplus Comparison and Mandatory Disclosure Rules

3.1 Surplus Comparison

In this section, we obtain an ambiguous result about the impact of consumer awareness on total surplus. However, consumers are always better off if they are aware.

Proposition 1 *Welfare may increase or decrease if all consumers become aware—i.e., $TS_U - TS_A$ is of ambiguous sign—while consumers are better off if they are aware—i.e., $CS_U < CS_A$.*

Proof. See Appendix 6.1. ■

The intuition that social welfare may be higher with unaware consumers than that with aware consumers is simple. We note that a monopoly seller always sets a price higher than the social optimal level. This leads to too little consumption in the market with complete information. If consumers are unaware of the potentially adverse effect they consume a larger quantity: if the firm hides information consumer demand is larger since the adverse effect shifts the consumers' willingness-to-pay downward. Thus, the distortions created by monopoly and unawareness go in opposite directions. Consequently, in the presence of market power, consumer unawareness is not necessarily detrimental to welfare measured as total surplus. Consequently, whether total surplus with aware consumers exceeds that with unaware consumers depends on the value the parameters take. If the bias of the consumer is small—i.e., x is small—or, relative to the scale of the harmful substance, the quality α is large, then the total surplus with unaware consumer is larger than with aware consumers. On the other hand, if the bias of the consumer is large and the quality is small relative to the scale of harmful substance, then the total surplus with aware consumer may be larger.

The conclusion with respect to consumer surplus is unambiguous: $CS_U < CS_A$. It does not depend on our specific assumption about the parameter values. We observe that aware consumers always obtain a higher surplus than unaware consumers: In comparison to aware consumers unaware consumers purchase too much and thereby obtain a lower surplus.

To summarize, while unawareness of adverse effects counteract monopoly distortions from a total welfare perspective, consumers are always worse off if they are unaware.

3.2 Mandatory Disclosure Rules

In this section we turn to consumer protection policies that may be introduced by the regulator or consumer protection authority. In particular, we explore the implications of two different information disclosure policies. The first policy is *mandatory full information disclosure*, according to which the firm must reveal all the information that it has—i.e., I and θ. The resulting situation is one of full information. Alternatively, the firm is only forced to reveal I (or, equivalently, the public authority performs its own analysis and reveals the realization of I to consumer.) With this *mandatory partial information disclosure* in place, consumers learn whether a substance is harmful but the firm is not required to reveal the amount of the substance that is contained in the product. In this case, if the firm is forced to reveal I we assume that revelation of I is not very costly, in contrast to the revelation of θ, since the message of I can be easily communicated in the content part of mass media—this information can be released by the firm or the public authority (to which the firm has reported). In particular, we assume that this cost is zero. However, if the firm reveals the exact amount of the substance θ and communicates the meaning of the amount to the consumers, it has to incur cost c. Note that the model with mandatory partial information disclosure is formally equivalent to our previous model with aware consumers.[8] Thus, to evaluate the impact of information disclosure on consumers, we have to compare consumer surplus of the three models analyzed above: the model with fully informed consumers, aware (but uninformed) consumers, and unaware consumers.

Assume first that there is a mandatory information disclosure rule such that the firm is required to disclose all its information. Mandatory information disclosure then leads to the full-information outcome. The firm's profit is $\frac{a^2}{4} - c$ for $a \geq \sqrt{4c}$ and zero otherwise, and the consumer's utility level is $\frac{a^2}{8}$.

Under condition (4), the firm will sell under mandatory disclosure of I and θ independent of its type a. Then the consumer surplus CS_M under mandatory information disclosure rule is always greater than CS_A. To prove this, notice that CS_A only depends on the threshold value $\widehat{a}$, and $CS_M =$

[8] Recall that we call consumers aware if they are aware of the substance but uncertain of the value I and the level of θ. However, the regulator's disclosure of the harm I does not play any role for aware consumers because if $I = 0$, the firm will disclose this itself. Suppose $I = 1$, if the firm does not disclose θ, consumers know that the substance is harmful. The cutoff value is the same as before.

If consumers are unaware, disclosing I makes all consumers aware whether or not the substance is harmful. Hene, the regulator's disclosure of the harm is equivalent to the policy of making all consumers aware.

$CS_A \mid_{\widehat{a}=0}$. Hence, it is sufficient for us to show that CS_A is a decreasing function of $\widehat{a}$. Here, we indeed have

$$\begin{aligned}\frac{\partial CS_A}{\partial \widehat{a}} &= x\left(\frac{\widehat{a}\widetilde{a}_N}{2} - \frac{3\widetilde{a}_N^2}{8} + \int_{\alpha-1}^{\widehat{a}}\left(\frac{a}{4} - \frac{3\widetilde{a}_N}{8}\right)da - \frac{\widehat{a}^2}{8}da\right) \\ &= -\frac{x\left(\widetilde{a}_N - (\alpha-1)\right)^2}{8} < 0.\end{aligned}$$

However, when condition (4) is violated, the firm does not sell if it is of sufficiently low quality and expected consumer surplus is

$$\begin{aligned}CS_M &= x\int_{\sqrt{4c}}^{\alpha}\frac{a^2}{8}da + (1-x)\frac{\alpha^2}{8} \\ &= \frac{(1-x)\,3\alpha^2 + x\alpha^3 - 8c^{\frac{3}{2}}x}{24}.\end{aligned}$$

The question is which disclosure policy is better. Here, we obtain the surprising result that more mandated full information disclosure is not necessarily beneficial to consumers.

Proposition 2 *Mandatory information disclosure makes unaware consumers better off. However, consumers are potentially worse off if full instead of partial disclosure is mandated.*

Proof. See Appendix 6.2. ■

The intuition for the result that full disclosure can be worse than partial disclosure is that imposing a mandatory disclosure rule may lead to non-participation of the monopolist. If the monopolist was not allowed to quit the market (and, thus, his participation constraint could be ignored), we always would have $CS_A < CS_M$—this holds for the same reason as in the case that condition (4) holds.

Our result can be given a different interpretation: If $CS_U < CS_M < CS_A$, mandatory full information disclosure makes aware consumers worse off, while it makes unaware consumers better off. For the other two orderings the qualitative effect of mandatory full disclosure is the same for aware and unaware consumers alike.

4 Extensions

4.1 Moral hazard

Our analysis is easily modified to allow for unobservable effort in the reduction of the amount of the substance, θ.

Remark 1 *Suppose that the amount of the substance θ is determined by the firm, and reducing this amount is costly. Let the cost function be $K(\theta) \geq 0$ such that K is decreasing, convex, and $K(1) = K'(1) = 0$. We can then show that the firm reduces the amount of the substance if consumers are made aware of the potentially adverse product effects.*

To see this, let, for simplicity, the cost of advertising c be zero. If consumers are aware but uncertain, then, knowing that the realization of I is 1, the firm solves the following problem

$$\max_{\theta} pq - K(\theta).$$

By the unravelling arguments, the consumers always learn the amount of θ in equilibrium. Thus the firm with $I = 1$ solves the following problem

$$\max_{\theta} \frac{(\alpha - \theta)^2}{4} - K(\theta).$$

For the sake of the argument, suppose that $\alpha - 1 > 0$. Thus all firms will participate. (Otherwise, there would be zero pricing and zero quantity.) Under this assumption, $\theta = 1$ is never optimal (using the properties of K) and the firm takes a costly action to reduce the amount of the substance. Qualitatively, we obtain the same result if the firm has to invest in the reduction of θ even before knowing the realization of I.

If, on the other hand, the consumers are unaware, the optimal θ is always 1: The firm does not engage in efforts to reduce the amount of θ because consumers are not aware about the possibility of adverse effects.

Therefore, when the amount of the substance is chosen by the firm, we have an interior solution (or a corner solution with $\theta = 0$) of the optimal amount of the substance when the consumers are aware. In contrast, we have a corner solution with $\theta = 1$ when the consumers are unaware. Hence, the result as stated in the remark holds.

4.2 Mixed Population

So far we only considered the extreme cases in which consumers are either fully aware or fully unaware. In this section, we study the more general situation with a mixed population. Suppose that initially a share $\rho_0 > 0$ of consumers is aware. We assume that advertising cannot be perfectly targeted to aware consumers, and advertising thus increases the share of aware consumers to $\rho_1 = \rho_0 + \Delta\rho$ with $\Delta\rho > 0$. A special case is non-targeted advertising in which case $\rho_1 = 1$.

We first determine the firm's profit-maximizing price given the share of aware consumers ρ. A share $1 - \rho$ of consumers are unaware and their expected product quality is α. The expected quality of the aware consumers is equal to $\widetilde{a}_N$ if there is no advertising and a otherwise. Given the quadratic utility of the consumers, we derive the demand function as $q(p) = \widetilde{a} - p$, where $\widetilde{a}$ is the aware consumers' expected quality.

The firm's expected demand function is therefore

$$Q(p) = \begin{cases} (1-\rho)(\alpha - p) + \rho(\widetilde{a} - p) & \text{if } p < \widetilde{a}, \\ (1-\rho)(\alpha - p) & \text{if } p \geq \widetilde{a}. \end{cases}$$

The expected demand function has a kink at the point $p = \widetilde{a}$. The firm's problem is $\max_p pQ(p)$. The profit-maximizing price is

$$p = \begin{cases} \frac{(1-\rho)\alpha + \rho\widetilde{a}}{2} & \text{if } \widetilde{a} \geq \overline{a}, \\ \frac{\alpha}{2} & \text{if } \widetilde{a} < \overline{a}, \end{cases}$$

where $\overline{a} = \frac{\sqrt{1-\rho}\left(1-\sqrt{1-\rho}\right)}{\rho}\alpha$. The corresponding profit is

$$\pi = \begin{cases} \frac{[(1-\rho)\alpha + \rho\widetilde{a}]^2}{4} & \text{if } \widetilde{a} \geq \overline{a}, \\ \frac{(1-\rho)\alpha^2}{4} & \text{if } \widetilde{a} < \overline{a}. \end{cases} \tag{11}$$

In words, if $\widetilde{a}$ is large enough, then the firm will sell its product to aware and unaware consumers, and it determines the profit-maximizing price as if it was facing only consumers with expected quality that is equal to the average quality $(1-\rho)\alpha + \rho\widetilde{a}$. On the other hand, if $\widetilde{a}$ is small the firm will only sell its product to unaware consumers and the firm sets its price as if it was facing $1 - \rho$ of consumers with expected quality α.[9]

The threshold value $\overline{a}$ here is decreasing in ρ. Hence, if the firm chooses to serve both types of consumers in the case of no advertising, so does it in the

[9] Note that, for $\widetilde{a} = \overline{a}$, there are two solutions to the maximization problem; for convenience, we selected one of them.

case of advertising. It is worth mentioning that the firm will lower its price for a larger share of aware consumers since it prefers to serve both types of consumers. This benefits all consumers including those who remain unaware.

For the ease of exposition, we assume zero (exogenous) disclosure cost and suppose that $x = 1$—i.e., the substance is harmful with probability one. Then the firm advertises if and only if his profit with advertising is higher than that without advertising, which gives a cutoff value $\widehat{a}$ such that the firm advertises if and only if $a \geq \widehat{a}$. Note that in the extreme case with only aware consumers there would be full unravelling, since we consider the special case of zero exogenous disclosure costs. But this does not hold with mixed population, as information disclosure takes place only for a low level of the harmful substance.

We distinguish two cases: In case 1, the firm sells to both types of consumers if it chooses not to advertise. In case 2, the firm sells only to unaware consumers if it chooses not to advertise. Notice that the firm will serve both types of consumers if it chooses to advertise.

Let us consider case 1—i.e., the firm sells to both types if it does not advertise. In this case, the firm with product quality $\widehat{a}$ would choose to sell to both types of consumers no matter whether it advertises. According to equation 11, the threshold value $\widehat{a}$ is determined as follows

$$\frac{\left(\left(1-\rho_0\right)\alpha+\rho_0\frac{\widehat{a}+\alpha-1}{2}\right)^2}{4}=\frac{\left(\left(1-\rho_1\right)\alpha+\rho_1\widehat{a}\right)^2}{4}.$$

The left-hand side of the equation is the firm's profit in case of no advertisement, while the right-hand side refers to the counterpart when the firm advertises. The firm with quality $\widehat{a}$ is indifferent between advertising and not advertising. We obtain

$$\widehat{a}=\alpha-\frac{\rho_0}{\rho_0+2\Delta\rho}. \tag{12}$$

From (12) we know that the upside of advertising is that it enables the firm to distinguish itself from firms with higher levels of the harmful substance and, thereby, obtain a higher profit, facing aware consumers. The downside of advertising from the firm's point of view is that some initially unaware consumers become aware of the adverse effect. We observe that $\widehat{a}$ is increasing in $\Delta\rho$ and decreasing in ρ_0: The firm's benefit from advertising increases with the fraction of initially aware consumers, while the cost increases with the additional share of consumers who become aware as the result of the advertising.

We observe that $\widehat{a} > \alpha - 1$ if $\Delta\rho > 0$. This means that, as long as advertising makes some consumers aware of the harmful substance, there will not be full unravelling even if the exogenous disclosure cost is zero.

Case 1 applies if the condition $\widetilde{a}_N = \frac{\widehat{a}+\alpha-1}{2} \geq \overline{a}$ holds. We, thus, must have

$$\alpha \geq A \equiv \frac{\rho_0 \left(\rho_0 + \Delta\rho\right)}{\left(\rho_0 - \sqrt{1-\rho_0}\left(1-\sqrt{1-\rho_0}\right)\right)\left(\rho_0 + 2\Delta\rho\right)}.$$

We observe that the critical value A that separates case 1 from case 2 is first increasing and then decreasing in ρ_0 but strictly decreasing in $\Delta\rho$.

Let us now consider case 2—i.e., the firm sells only to unaware consumers if it does not advertise. In this case, according to equation 11, the threshold value $\widehat{a}$ above is given by

$$\frac{\left(1-\rho_0\right)\alpha^2}{4} = \frac{\left(\left(1-\rho_1\right)\alpha + \rho_1\widehat{a}\right)}{4},$$

where the left-hand side is the firm's profit in the case of no advertising and the right-hand side is that in the case of advertising. The above equation gives

$$\widehat{a} = \frac{\sqrt{1-\rho_0} - \left(1-\rho_0-\Delta\rho\right)}{\rho_0 + \Delta\rho}\alpha. \tag{13}$$

The condition of serving both types of consumers requires $\widehat{a} > \overline{a}$. One can check that this inequality holds as long as $\rho_1 \geq \rho_0$. The condition of serving only unaware consumers requires $\widetilde{a}_N < \overline{a}$, which can be rewritten as $\alpha < A$, where A has been defined above.

We summarize our findings in this section in the following proposition:

Proposition 3 *Suppose that a share ρ of consumers is initially aware and advertising informs not only aware consumers but also a share of unaware consumers $\Delta\rho$.*

i) A firm with a high product quality a will advertise, whereas a firm with a low product quality a will not ***even if the cost of advertising is zero****.*

ii) If α and $\Delta\rho$ are large and ρ_0 is either small or large, the firm will sell to both aware and unaware consumers ***no matter whether the firm advertises or not****. For small α and $\Delta\rho$, and intermediate ρ_0, the firm will sell only to unaware consumers if and only if it does not advertise.*

Part i of the proposition reflects that the firm faces an endogenous disclosure cost when there is a mixed population and there is only partial unravelling.[10] According to part ii of the proposition, case 1—i.e., the situation

[10]Notice that $\widehat{a} < \alpha$. Hence, for some realization of the quality, the firm will advertise. However, this does not hold when the exogenous advertising cost is strictly positive—i.e., $c > 0$. Indeed, if ρ_0 is small and $\Delta\rho$ is large—i.e., initially only a small share of consumers are aware, and advertising increases this share significantly—then the benefit of advertising is too small even for the firm with sufficiently high quality. Thus the firm optimally chooses not to advertise if advertising is sufficiently costly.

that the firm will serve both aware and unaware consumers even if it does not advertise—is more likely to occur when (1) the product's highest quality is large, (2) advertising significantly increases the share of aware consumers, (3) the fraction of initial aware consumer is either very small or very large.

Recall that case 1 would applies if the aware consumers' expected quality in the absence of advertisement, $\widetilde{a}_N$, exceeds a threshold value $\overline{a}$. Increasing α has two effects. First, it increases the aware consumers' expected quality in the absence of advertising $\widetilde{a}_N$. Second, it also increases the threshold value $\overline{a}$ at the same time. The first effect, however, dominates the second one. As a result, case 1 is more likely to happen as α increases. Now consider an increase in $\Delta\rho$. Because advertising makes more consumers aware, even firms with high product quality are reluctant to advertise. Taking this into account, aware consumers would increase their expected product quality in the absence of advertising. On the other hand, an increase in $\Delta\rho$ has no effect on the threshold value $\overline{a}$. Consequently, increasing $\Delta\rho$ makes case 1 more likely to occur. The effect of an increase in ρ_0, however, is ambiguous. Both $\widetilde{a}_N$ and $\overline{a}$ are decreasing in ρ_0. The decreasing rate of $\widetilde{a}_N$ is larger (smaller) than that of $\overline{a}$ when ρ_0 is small (large). Thus, case 1 is more likely for small and large ρ_0.

5 Discussion and Conclusion

This paper presented a simple monopoly model to compare the effect of a potentially harmful substance in a market with aware in contrast to unaware consumers. We found that total surplus may be larger if consumers are unaware of the harmful substance. This makes them buy too much, which partly corrects for the underconsumption under monopoly. More importantly, we show that full mandatory disclosure may be harmful in the context of unaware consumers and that partial mandatory disclosure may be welfare-superior.

We motivated our analysis by referring to potentially harmful substances. More generally, our analysis applies to products which affect consumers' utilities although they may not be aware of this at the moment of purchase. In particular, it applies to complex products about which information is, in principle, available, but about which consumers may suffer from biased beliefs at the moment of purchase.[11]

[11] Our analysis can also be seen as a reduced-form model of add-on pricing, where consumers may be adversely surprised by the add-on costs—e.g., of cartridges after buying a printer or of watching in-room movies in a hotel.

Whether a certain action is to be considered mis-selling depends on consumer behavior. In a Bayesian world, consumers may lack information but they use correct beliefs given their information. Therefore, they cannot be systematically misled. This also means that non-disclosure and other attempts to hide unfavorable information, does not lead to systematically wrong purchase decision. By contrast, if consumers are unaware of certain product characteristics, the possibility of mis-selling arises. Here, information may be systematically suppressed by a firm. In this context, mandatory testing and disclosure rules are an important policy instrument to protect consumers. In case of non-compliance harsh punishments may be the only means to deter a firm from ignoring such consumer protection policies. Attempts to encourage information gathering by consumers have little relevance if consumers are completely naive in the sense that they are over-confident about their knowledge of the products and believe that adverse effects cannot materialize.

Empirical evidence by Jin and Leslie (2003) is in line with our argument. They consider the effect of a mandatory disclosure rule that, starting 1998, applied to restaurants in parts of Los Angeles: Restaurants were forced to make prominent the results of hygiene inspections by displaying a grade card in a restaurant window. They found that average hygiene scores improved, the number of hospitalization due to food poisoning went down and consumer demand became more sensitive to changes in hygiene. In particular, the third finding is consistent with consumers initially not being aware of the health risks involved. Thus, the key impact of the mandatory disclosure rule may have been direct and indirect effects of increased consumer awareness of the health risks.[12]

Our theory not only applies to how a product directly affects consumers but to the type of production processes that is used and the type of labor contracting within the firm and in vertical supply relationships. To be applicable, the utility that a consumer derives must depend on the use of inputs and contracts that the firm uses. This is the case if the utility function reflects ethical and environmental concerns. Cases in point are the disrespect

[12] Two caveats are in order: First, we do not claim that the findings in Jin and Leslie (2003) contradict the Bayesian model. However, the fact that the policy intervention was triggered by a hidden-camera expose done by a local television news channel indicates that initial consumer unawareness has contributed to the observed effects of the policy intervention. Second, we admit that our model did neither include the incentive aspect of mandatory disclosure nor the analysis of reputation effect absent disclosure through the display of grade cards. As indicated in the modified simple model that includes moral hazard, the distribution of restaurant types endogenously changes due to the policy intervention, which then leads to an improved average record of restaurant hygiene.

of standards in labor contracts such as the use of child labor or forced labor (as exemplified by hand-woven carpets and textiles—recall, for instance, past media coverage on sweat shops for products by Nike), the health and safety risks for workers (this applies, e.g., to mining products and textiles—a recent concrete example is jeans dying in Turkey), disrespect of environmental standards (e.g., in case of textiles and cleaning products), disrespect of indigenous rights (as happened in case of oil extraction), and animal experiments (e.g., for cosmetics).[13] Under mandatory partial information disclosure, the government (or NGOs) makes consumers aware of the possible disrespect of certain standards. Such awareness campaigns make consumers aware of the relevance of a certain product characteristic that enters the consumer's utility function (directly or through peer effects). It is up to the firms to certify that they follow certain business practices and comply with the standard. Such processes are often certified by third parties. This hints at a potential complementarity between mandatory information disclosure and private certification efforts: Partial public information disclosure may be necessary to make private certification efforts viable in market equilibrium.[14]

6 Appendix

6.1 Proof of Proposition 1

In case 1, we have that

$$\begin{aligned} & TS_A - TS_U \\ & = x\left(\int_{\alpha-1}^{\widehat{a}} \left(g\left(\widetilde{a}_N, a\right) - g\left(\alpha, a\right)\right) da + \int_{\widehat{a}}^{\alpha} \left(g\left(a, a\right) - g\left(\alpha, a\right)\right) da\right) \\ & - \left(\left(1-x\right) + \left(\alpha - \widehat{a}\right)\right) c. \end{aligned}$$

$TS_A - TS_U$ is negative if $\widetilde{a}$ is small enough. The other sufficient condition for $TS_A - TS_U < 0$ is $3\widehat{a} + \alpha - 3 > 0$, which holds for sufficiently large α.

[13] A concrete example are the "war diamonds" from Congo; here consumers were concerned about the effect of upstream profits on the suffering of people, as a consequence of war that was financed through these profits. In this context NGOs play an important role in raising awareness; a firm's response consists in certifying the origin of inputs: De Beers certification efforts of the origin of its diamonds can be seen as a response to the consumers being aware that they may be buying war diamonds (which does not make a nice wedding gift).

[14] Whether private certification is fully revealing is a different issue. See Biglaiser (1993) and Lizzeri (1999) on this issue.

Conversely, $TS_A - TS_U$ is positive for sufficiently small α. To show this possibility, consider the extreme case of condition (4) in case 1—i.e., $\alpha = 1 - 2\sqrt{c}$. We have that $\widehat{a} = 1 - \alpha$, and

$$TS_A - TS_U \mid_{\alpha=1-2\sqrt{c}} = x\,(1-\alpha)\,\frac{2\alpha^2 - (2\alpha-1)^2}{8} - ((1-x) + (2\alpha-1))\,c,$$

which is more likely to be positive for larger x.

Let $x = 1$. We have that

$$TS_A - TS_U \mid_{\alpha=1-2\sqrt{c},x=1} = (1-\alpha)\,\frac{2\alpha^2 - (2\alpha-1)^2}{8} - (2\alpha-1)\,\frac{(1-\alpha)^2}{4}.$$

Assumption 1 becomes

$$\frac{(1-\alpha)^2}{4} < \frac{4\alpha - 1}{16}$$

which is equivalent to $\frac{1}{2} < \alpha < \frac{5}{2}$. Since, in the extreme case, $\alpha = 1 - 2\sqrt{c}$ and $c > 0$, $\frac{1}{2} < \alpha < 1$. We receive

$$TS_A - TS_U \mid_{\alpha=\frac{1}{2},x=1} = \frac{1}{128} > 0.$$

Since $TS_A - TS_U$ is continuous function of x, α and c, we know that $TS_A - TS_U$ is positive for (x, α, c) in some vicinity of the point $(1, 1/2, 1/16)$.

Regarding the consumer surplus, we have that

$$CS_A - CS_U = x\left(\int_{\alpha-1}^{\widehat{a}} f\left(\widetilde{a}_N, a\right) - f\left(\alpha, a\right) da + \int_{\widehat{a}}^{\alpha} f\left(a, a\right) - f\left(\alpha, a\right) da\right).$$

We have $f\left(a, a\right) - f\left(\alpha, a\right) > 0$ since $\alpha > a$. Therefore, we have $\int_{\widehat{a}}^{\alpha} f\left(a, a\right) - f\left(\alpha, a\right) da > 0$. Moreover,

$$\begin{aligned}
&sign\left(\int_{\alpha-1}^{\widehat{a}} f\left(\widetilde{a}_N, a\right) - f\left(\alpha, a\right) da\right) \\
&= sign\left(\frac{\left(\widehat{a}^2 - (\alpha-1)^2\right)\left(\widetilde{a}_N - \alpha\right)}{4} - \frac{3\left(\widehat{a} - (\alpha-1)\right)\left(\widetilde{a}_N^2 - \alpha^2\right)}{8}\right) \\
&= sign\left(-\frac{\left(\widehat{a} + (\alpha-1)\right)}{4} + \frac{3\left(\widetilde{a}_N + \alpha\right)}{8}\right) \\
&= sign\left(-2\left(\widehat{a} + (\alpha-1)\right) + 3\left(\frac{\widehat{a} + \alpha - 1}{2} + \alpha\right)\right) \\
&= sign\left(5\alpha + 1 - \widehat{a}\right) > 0.
\end{aligned}$$

Thus $CS_A - CS_U$ is always positive.

In case 2, it is straightforward to show that

$$\begin{aligned}
&\frac{\partial (TS_A - TS_U)}{\partial x} \\
&= \frac{1}{8}\left(\left(2+\alpha-4\sqrt{c}-\left(\alpha^2-2\alpha\sqrt{c}+4c\right)\right)2\sqrt{c}+\left(2+\alpha-4\sqrt{c}\right)(1-\alpha)\,\alpha\right) \\
&+\left(1-\left(\alpha-2\sqrt{c}\right)\right)c \\
&> \frac{1}{8}\left(2+\alpha-4\sqrt{c}-\left(\alpha^2-2\alpha\sqrt{c}+4c\right)\right)2\sqrt{c}
\end{aligned}$$

(since $\alpha > 2\sqrt{c}$), which is greater than

$$\frac{1}{8}\left(2+\alpha(1-\alpha)-4\sqrt{c}\right)2\sqrt{c} > 0$$

since $c < \frac{1}{16}$ (because in case 2 we have $2\sqrt{c} < \alpha < 1-2\sqrt{c}$).

Lastly, we have

$$CS_A - CS_U = x\int_{\widehat{a}}^{\alpha}\left(f(a,a)-f(\alpha,a)\right)da > 0.$$

6.2 Proof of Proposition 2

In case 1 (i.e., $\widetilde{a}_N \geq 0$),

$$CS_M - CS_A = -\frac{xB_1}{648}$$

where

$$\begin{aligned}
B_1 \equiv\ & 216c^{\frac{3}{2}} - (\alpha-1)\left(19(\alpha-1)^2-72c\right) \\
& - 6(\alpha-1)^2\sqrt{12c+(\alpha-1)^2} - 2\left(12c+(\alpha-1)^2\right)^{\frac{3}{2}}
\end{aligned}$$

which can be positive or negative as shown in Figure 1. The figure also reveals that, on the set of admissible (α, c)-combinations, this difference tends to be positive for high values of c.

In case 2 (i.e., $\widetilde{a}_N < 0$),

$$CS_M - CS_A = -\frac{xB_2}{648}$$

where

$$B_2 \equiv 216c^{\frac{3}{2}} - (\alpha-1)\left(13(\alpha-1)^2+144c\right) - \left(14(\alpha-1)^2+96c\right)\sqrt{12c+(\alpha-1)^2}$$

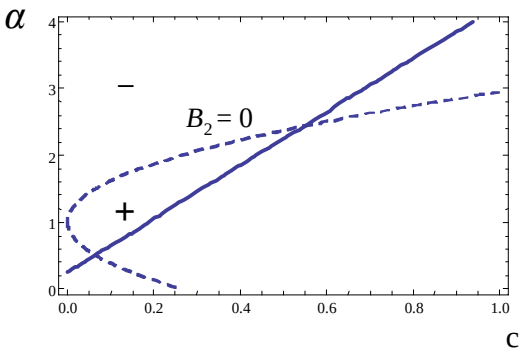

Figure 1: Information disclosure about product quality and consumer surplus

which is always negative. We also recall that $CS_A > CS_U$. Thus consumers also benefit from information disclosure to the realization of I only. With respect to full disclosure we observe that $CS_M > CS_U$ only holds for a subset of the parameter space.α

$$CS_M - CS_U = -\frac{xB_3}{24},$$

where

$$B_3 \equiv 8c^{\frac{3}{2}} - \alpha^3 - 6\alpha + 3\alpha^2.$$

The condition $B_3 < 0$ is equivalent to

$$c < (\frac{3}{4}\alpha - \frac{3}{8}\alpha^2 + \frac{1}{8}\alpha^3)^{\frac{2}{3}}.$$

We can show that, under Assumption 1, $B_3 < 0$.

Thus, in case 1, when $B_3 < 0$ and $B_1 > 0$, we have that $CS_U < CS_M < CS_A$. This means that mandatory information disclosure leads to a larger consumer surplus for ex ante unaware consumers. However, consumers gain if, instead of full disclosure, only partial disclosure is mandated. Overall the following two orderings are possible: (i) $CS_U < CS_M < CS_A$ and (ii) $CS_U < CS_A < CS_M$.

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