E C O N O M I C S B U L L E T I N

Standards and Labels

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Abstract

This paper explores the effects of a standard and/or a label influencing care choice. An effort by the firm may increase the probability of offering safe/high-quality products and a label may also be chosen to provide additional information to consumers. It is shown that, except for a few cases, a safety standard maximizing welfare corrects the safety underinvestment by the firm. The safety standard also changes the label choice compared to the private choice that would be made without any regulation. In particular, the enforcement of a safety standard may lead to the absence of a label or to the emergence of a voluntary/mandatory label.

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1. Introduction

Guaranteeing safety/quality to consumers is difficult for firms and lack of care results in failures of goods or services. It is rarely economically feasible to achieve zero risk/failure with respect to safety/quality. Regulatory interventions have strong economic and political support, despite risks of inefficiency and bureaucracy.

Despite mandatory standards, some dangerous products may be offered by firms on the market, which explains the use of voluntary or mandatory labels/certifications for also informing consumers. This is the case with occupant safety that varies significantly among cars. For instance, *Status Report* (2003, p. 5) provides side impact crash tests and frontal offset crash tests for 12 small SUVs in the US. These types of information are precious for helping consumers in their purchasing choice. The hospital sector also offers a wide range of regulatory instruments for improving quality and safety. Beyond various mandatory standards in the US, voluntary accreditations by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) or by the Health Care Financing Administration (HCFA) help improve patient's information about hospitals quality/safety.

These examples raise the issue of the tools combination for an optimal level of safety/quality. This paper examines firms' strategies and regulatory decisions when safety is at stake. We seek to answer the question: How do safety standards and labels influence market mechanisms and safety choices?

The minimum safety standard (MSS) consists of determining a minimum level of care (influencing the safety probability) with which all sellers should comply in offering their products. The available information about products safety for consumers depends on voluntary or mandatory labelling. The MSS or/and the label are selected by a regulator seeking to maximize welfare defined by the sum of the firm's profits and consumers' surplus.

This paper shows that the firm's choices regarding the effort and the label do not correspond to the regulator choices maximizing the welfare. It is shown that, except for a few cases, a standard maximizing welfare corrects a safety underinvestment by the firm. The safety standard also changes the label choice compared to the private choice that would be made by the firm without any regulation. In particular, the safety standard may lead to the absence of a label or to the emergence of a voluntary/mandatory label in comparison with the situation without regulation.

The results of this paper differ from the literature on regulation of safety via standards or labels. The issue of the combination of both instruments has been overlooked. For the minimum quality standard, either the quality is known (Ronnen, 1991) or unknown by consumers (Leland, 1979 or Garella and Petrakis, 2008). In our paper, the information context is endogenous and depends on the voluntary/mandatory label choice decided by the firm or the regulator. The combination of instruments deserves a careful examination by the regulator for improving both safety and economic efficiency.

The paper is organized as follows. The next section introduces the stylized model. Following that, both market equilibrium and regulatory choices are successively detailed. The last section presents some conclusions.

2. The Model

In this stylized framework, trade occurs in a single stage, with one firm able to produce the good. The ability to offer safe/high-quality products is determined by a combination of firms' effort and randomness. The firm offers either safe products or dangerous products. The firm's ability to reduce risks and offer safe products is dependent on the firm's care choice but is also to some degree uncertain.

For simplicity, we let the firm's effort be equivalent to the probability of a safe product emerging. (Making the probability a function of the effort just adds a degree of complication that is unnecessary for the point being made in this paper.) With a probability $0 \le \lambda \le 1$, the firm only offers safe products and with a probability, $(1-\lambda)$, the firm only offers dangerous products. We assume that the care choice, namely, the effort to increase the probability of offering safe products, implies a cost equal to $f\lambda^2$ with $f \ge 0$.[1] Firms may select a label that perfectly signals the safety of the facility/goods.[2] In this case, the firm incurs a cost *C* guaranteeing that no dangerous products will hit the supply chain and the shelves. Labelling is equivalent to a certification on an item by item base and allows no cheating by the firm, which is a strong simplifying assumption. For simplicity, the marginal cost is zero whatever the safety.

Consumers are risk neutral. Following Häckner (2000) and Garella and Petrakis (2008) the population of consumers is composed by individuals having the following utility:

$$U(x) = (a + s^e)x - x^2/2 + v, \qquad (1)$$

where x represents the quantity of good bought by the consumer and *v* is the quantity of a composite good. Further, s^e represents a safety expectation for the good by the consumer. Let p denote the unit price for the good, while the price of the composite good is normalized to be equal to 1. The budget constraint is $px + v = y$ where *y* is the income. The substitution of this constraint in (1) leads to the objective function, $(a + s^e)x - x^2/2 - px + y$. Maximization of this objective function for a representative consumer (with the total population of consumers normalized to 1) with respect to x gives the (inverse) demand functions for the consumer, $p(x, s^e) = a + s^e - x$.

The value of the safety expectation depends on the presence/absence of label. If a label is selected, the consumer values the safe products at *s* and the dangerous products at zero (this value is selected for simplifying the mathematics, but results are robust with negative values for dangerous products). If there is no label, consumers only know the expected value $s^e = \lambda.s$ of the safety, since the effort λ can be known or observed without additional cost, which is a simplifying assumption.

The timing of this game is divided into three stages. In stage 1, the regulator chooses

[1] Safety mainly relies on sunk costs spending, such as R&D experiments and/or high-skill workers, such as engineers, designers, or lawyers.

[2] We abstract from safety signaling (via prices, guarantees, brand investment) and reputation in a context of repeat purchases under imperfect information. Rational expectations about safety require consumers to know all parameters (common knowledge) in signaling models, a requirement very unlikely to be met in the presence of contexts in which safety also involves scientific expertise and/or complex experiments.

whether or not to impose a MSS, $\hat{\lambda} \geq 0$ and/or a mandatory label. The regulator influences the effort for reducing the probability of having dangerous products and/or the consumers' information via the label. The minimum level of effort, $\hat{\lambda} \geq 0$, and/or the mandatory label are known by the firm and consumers. The mandatory MSS and/or label are selected by a regulator searching to maximize welfare defined by the sum of the firm's profits and consumers' surplus. For simplicity, the regulatory/inspection cost of the effort is zero and the regulator has perfect information about the selected levels of effort, λ , selected in stage 2 with $\lambda \geq \hat{\lambda}$. Assume that no MSS ($\hat{\lambda} = 0$) and/or no mandatory label are imposed, if the welfare under private choices by the firm without regulation is higher or equal than the maximized welfare under regulation.[3]

In stage 2, the firm chooses the level of effort λ equal to the probability of offering safe products. The firm also decides whether or not to post a label on products if the label is not mandatory. The firm also complies with the regulation and incurs the costs, $f\lambda_i^2$ or *C*. Once these costs are sunk, the safety level (*s* or 0) is determined at the beginning of stage 3, and the firm chooses the quantity in stage 3.

3. The Firm's Decisions

In stage 1, the MSS defining the effort (equal to the probability of getting safe products) is determined by taking into account the effort/label decision in stage 2 and the quantity decision in stage 3.

As the game is solved by backward induction, stage 3 is now detailed. The firm maximizes its gross profit (i.e., profits net of the cost $f\lambda^2$ and *C*) given by $p(x, s^e)x$ with $p(x, s^e)$ detailed in the previous section. The maximization of gross profit with respect to *x* leads to an equilibrium quantity $x_1 = (a + s^e)/2$. The equilibrium profit is defined by $p(x_1, s^e)x_1$ and the consumers' surplus is defined by $(a + s^e)x_1 - x_1^2/2 - p(x_1, s^e)x_1$ (see the objective function by abstracting from *y*). The equilibrium gross profit and the consumers' surplus are, respectively,

$$\begin{cases} \pi(s^e) = (a + s^e)^2/4 \\ cs(s^e) = (a + s^e)^2/8 \end{cases}. \tag{2}$$

In stage 2, the effort (equal to the probability of getting safe products) is determined by taking into account the decisions in stage 3. Label and effort influence the cost $f\lambda_i^2$ and determines the safety level. The situation without the label is presented before the situation with the label.

Without any label, the expected value of consumers is $s^e = \lambda.s$. By using (2), the firm's overall profit and the welfare (including both profit and consumers' surplus) are respectively,

$$\begin{cases} \Pi^1(\lambda) = \pi(\lambda s) - f\lambda^2 \\ W^1(\lambda) = \pi(\lambda s) + cs(\lambda s) - f\lambda^2 \end{cases}. \tag{3}$$

[3] Only the lowest level of public intervention is defined in this paper.

With a label that costs *C* to the firm, the consumers know the quality equal to *s* or 0 before purchasing and take it into account in their demands. The firm offers safe products with a probability λ and dangerous products with a probability (1-λ). By using (2), the firm's overall profit and the welfare (including both profit and consumers' surplus) are respectively ,

$$\begin{cases} \Pi^2(\lambda) = \lambda\pi(s) + (1-\lambda)\pi(0) - f\lambda^2 - C \\ W^2(\lambda) = \lambda\left[\pi(s) + cs(s)\right] + (1-\lambda)\left[\pi(0) + cs(0)\right] - f\lambda^2 - C \end{cases}. \tag{4}$$

Note that $\pi(0)$ and $cs(0)$ are positive under our simplifying assumptions since *a>0*.

Under the absence of MSS and mandatory label, the firm maximizes its profits depending on its label choice. If no label is selected, the maximization of firm's profits given by $\Pi^1(\lambda)$ in equation (3) leads to the first-order conditions $\partial\Pi^1(\lambda^*)/\partial\lambda = 0$ (or $\partial\Pi^1(1)/\partial\lambda > 0$). Solving the first-order conditions subject to the constraint $0 \le \lambda \le 1$ leads to

$$\lambda^* = Min\left[\frac{a.s}{4f - s^2}, 1\right]. \tag{5}$$

This level λ^* is equal to (respectively lower than) 1 for relatively low values of *f*, namely $f < f_1 = s(a+s)/4$ (respectively high values of *f*, namely $f > f_1$). This leads to the equilibrium profit, $\Pi^1(1) = (a+s)^2/4 - f$ for $f < f_1$ or $\Pi^1(\lambda^*) = a^2 f/(4f - s^2)$ for $f > f_1$.

If the label is selected by the firm, the maximization of firm's profits given by $\Pi^2(\lambda)$ in equation (4) leads to the first-order conditions $\partial\Pi^2(\lambda^{**})/\partial\lambda = 0$ (or $\partial\Pi^2(1)/\partial\lambda > 0$). Solving the first-order conditions subject to the constraint $0 \le \lambda \le 1$ leads to

$$\lambda^{**} = Min\left[\frac{s(2a+s)}{8f}, 1\right]. \tag{6}$$

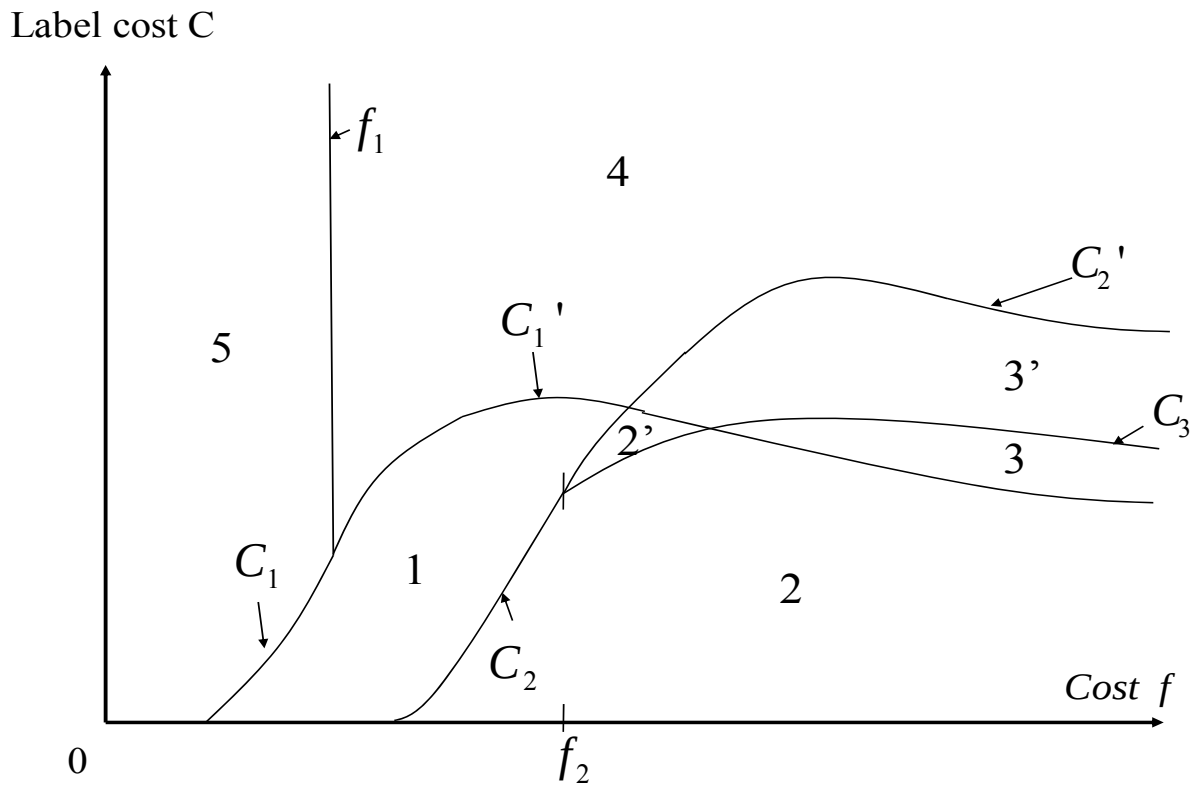
The level $\lambda^{**} = 1$ with a label is never selected, since the firm could choose the same level of effort without incurring the cost *C*, which leads to the profit, $\Pi^1(1)$. The level $\lambda^{**} < 1$ leads to the equilibrium profit, $\Pi^2(\lambda^{**}) = [4as^3 + s^4 + 4a^2(4f + s^2)]/(64f) - C$. Note that the level $\lambda^{**} < 1$ with a label is lower (respectively higher) than the level λ^* for relatively low (respectively high) values of *f*.

First, no regulation at stage 1 is assumed. The label influences the effort made by the firm since it impacts the consumers' demand. The equilibrium profits with a label $\Pi^2(\lambda^{**})$ is compared by the firm to the equilibrium profit without a label, $\Pi^1(1)$ or $\Pi^1(\lambda^*)$. If $\Pi^2(\lambda^{**}) > \Pi^1(1)$ which is equivalent to a cost, $C < C_1$ or if $\Pi^2(\lambda^{**}) > \Pi^1(\lambda^*)$ which is equivalent to a cost, $C < C_1'$, then the label is selected. Conversely, if $\Pi^2(\lambda^{**}) < \Pi^1(1)$ which is equivalent to a cost, $C > C_1$ or if $\Pi^2(\lambda^{**}) < \Pi^1(\lambda^*)$ which is equivalent to a cost, $C > C_1'$, then the label is not selected.

Figure 1 is useful for illustrating the private choices by the firm under the absence of

regulation. The cost parameter, *f*, is located along the horizontal axis, and the label cost, *C*, is located along the vertical axis. The value of *f* influences the firm's optimal strategy. In regions 1, 2 and 2', namely for a cost, $C < C_1$ if $f < f_1$ and $C < C_1'$ if $f > f_1$, then the label is selected, because of a relatively low cost of labeling. This choice leads to an effort λ^{**}. In regions 3, 3', 4 and 5, namely for a cost, $C > C_1$ if $f < f_1$ and $C > C_1'$ if $f > f_1$, then the label is not selected, which leads to an effort λ^{*}.

Figure 1: Private and public choices



4. Regulator's Choices

In stage 1, the MSS and/or the mandatory label are determined by taking into account the effort decision in stage 2 and the quantities decisions in stage 3. A regulator may impose a mandatory label or a MSS, $\hat{\lambda}$, for influencing the level of effort λ selected in stage 2 by the firm. The regulator maximizes welfare by taking into account the firm's profit and the consumers' surplus. Three configurations are taken into account by the regulator, namely, the absence of regulation as above, a MSS without a label, or a MSS with a mandatory label.

Before defining the policy, we first focus on the welfare maximization without or with a label. If no label is selected, the maximization of welfare given by $W^1(\lambda)$ in equation (3) leads to the first-order conditions $\partial W^1(\hat{\lambda}^*)/\partial\lambda = 0$ (or $\partial W^1(1)/\partial\lambda > 0$). Solving the first-order

conditions subject to the constraint $0 \le \lambda \le 1$ leads to

$$\hat{\lambda}^* = Min\left[\frac{3a.s}{8f - 3s^2}, 1\right]. \quad (7)$$

This level $\hat{\lambda}^*$ is equal to (respectively lower than) 1 for relatively low values of *f*, namely $f < f_2 = 3s(a+s)/8$ (respectively high values of *f*, namely $f > f_2$). Except when the private choice λ^* defined by (5) is equal to 1, the level $\hat{\lambda}^*$ is higher than the private choice, λ^*. This level $\hat{\lambda}^*$ leads to the equilibrium welfare, $W^1(1) = 3(a+s)^2/8 - f$ for $f < f_2$ or $W^1(\hat{\lambda}^*) = 3a^2 f/(8f - 3s^2)$ for $f > f_2$. The social choice $\hat{\lambda}^*$ is compatible with a monopoly situation since the equilibrium profit $\Pi^1(\hat{\lambda}^*)$ is always positive.

If a mandatory label is imposed on the firm or if firm voluntary selects the label, the maximization of welfare given by $W^2(\lambda)$ in equation (4) leads to the first-order conditions $\partial W^2(\hat{\lambda}^{**})/\partial\lambda = 0$ (or $\partial W^2(1)/\partial\lambda > 0$). Solving the first-order conditions subject to the constraint $0 \le \lambda \le 1$ leads to

$$\hat{\lambda}^{**} = Min\left[\frac{3s(2a+s)}{16f}, 1\right]. \quad (8)$$

The level $\hat{\lambda}^{**} = 1$ with a label is never selected, since the regulator could choose the same level of effort without incurring the cost *C*. The level $\hat{\lambda}^{**}$ is higher than the private choice λ^{**} defined by (6). This level $\hat{\lambda}^{**}$ leads to the equilibrium welfare, $W^2(\hat{\lambda}^{**}) = [36as^3 + 9s^4 + 12a^2(8f + 3s^2)]/(256f) - C$. The social choice $\hat{\lambda}^{**}$ is compatible with a monopoly situation since the firm gets positive profits, namely $\Pi^2(\hat{\lambda}^{**}) > 0$.

The regulator compares the welfares under the previous configurations for determining its choice in stage 1. Values of welfare under various situations, $W^1(\lambda^*)$, $W^1(\hat{\lambda}^*)$, $W^2(\lambda^{**})$ and $W^2(\hat{\lambda}^{**})$ are compared for determining the best policy. Recall from section 2 that a regulatory tool is not selected, if the welfare under private choices without regulation is higher or equal than the welfare with this tool. This allows us to underline the difference between the firms' choices without regulation (based on profit maximization at the end of section 3) and the socially optimal choice (based on welfare maximization). The optimal regulatory choice for determining the policy is presented in proposition 1 and figure 1.

Proposition 1. *The optimal choice for a regulator is:*

(i) *the absence of intervention in region 5*,

(ii) *a MSS* $\hat{\lambda}^*$ *only in regions 1 and 4*,

(iii) *a MSS* $\hat{\lambda}^{**}$ *only in regions 2 and 3,*

(iv) *a MSS* $\hat{\lambda}^{**}$ *and a mandatory label in regions 2' and 3'.*

Proof: (*i*) If $f < f_1$ and $C > C_1$ (region 5), the private choice $\lambda^* = 1$ corresponds to the social optimal choice $\hat{\lambda}^*$=1 and the regulation is useless.

For (*ii*), $W^1(\hat{\lambda}^*) > W^1(\lambda^*)$, and for (*iii*) and (*iv*), $W^2(\hat{\lambda}^{**}) > W^2(\lambda^{**})$, which means that private choices, λ^* and λ^{**}, selected by the firm are suboptimal from a social point of view.

(*ii*) If $W^1(1) > W^2(\hat{\lambda}^{**})$ which is equivalent to a cost, $C > C_2$ or if $W^1(\hat{\lambda}^*) > W^2(\hat{\lambda}^{**})$ which is equivalent to a cost, $C > C_2$' (regions 1 and 5), then the MSS $\hat{\lambda}^*$ is only selected and the label is not selected. In this case, the firm has no incentive to voluntary select a label when a MSS $\hat{\lambda}^*$ is imposed, since the profit $\Pi^1(\hat{\lambda}^*)$ is always greater than the profit $\Pi^2(\hat{\lambda}^*)$ for areas 1 and 4.

(*iii*) and (*iv*) If $W^1(1) < W^2(\hat{\lambda}^{**})$ which is equivalent to a cost, $C < C_2$ or if $W^1(\hat{\lambda}^*) < W^2(\hat{\lambda}^{**})$ which is equivalent to a cost, $C < C_2$', then a MSS $\hat{\lambda}^{**}$ with a label is optimal. (*iii*) If $C < C_3$ (regions 2 and 3), the firm voluntary selects a label when a MSS $\hat{\lambda}^{**}$ is imposed, since the profit $\Pi^2(\hat{\lambda}^{**})$ with a label is greater than the profit $\Pi^1(\hat{\lambda}^{**})$ without a label. The mandatory label is useless. As, in regions 2 and 3, the MSS $\hat{\lambda}^{**}$ is greater than the private choice without information, λ^*, the only possible firm's reaction to the MSS concerns the label choice. (*iv*) If $C > C_3$ (regions 2' and 3'), the firm does not select a label when a MSS $\hat{\lambda}^{**}$ is imposed, since the profit $\Pi^2(\hat{\lambda}^{**})$ with a label is lower than the profit $\Pi^1(\hat{\lambda}^{**})$ without a label. The mandatory label is necessary and affordable for the firm, since $\Pi^2(\hat{\lambda}^{**}) > 0$ in regions 2' and 3'.

□

Proposition 1 means that it is optimal to impose a MSS when the cost parameter f is relatively high in regions 1, 2, 2', 3, 3' and 4, which is not the case in region 5 where the private choice equal to one is socially optimal. The MSS imposes a higher effort on the firm compared to the private choice, since the consumers' surplus is taken into account. Sunk costs, $f\lambda_i^2$ or *C,* incurred by the firm are not passed on to consumers in the price in stage 3, leading to private choices further removed from socially optimal choices.

The comparison between the private choice (without any regulation) and the public choice shows that in region 1, the MSS crowds out the label that would be selected by the firm without regulation. As the MSS leads to an effort equal or close to 1, because of a relatively low cost *f*, it makes the label useless from a social point of view. In other words, it is not necessary from a social point of view to inform consumers via a label since a higher effort is selected via the MSS in region 1. The firm would prefer a combination of a label and a lower effort compared to the situation with a relatively high MSS.

The label complements the MSS in regions 2, 2', 3 and 3', since it brings higher profit and/or higher consumers' surplus necessary to offset the relatively high cost *f* linked to the effort. In this case, the effort $\hat{\lambda}^{**}$ is relatively low and the label leads to a higher consumers' surplus by

eliminating dangerous products. In regions 3 and 3', the MSS leads to the emergence of the label compared to the situation without regulation. In region 3, the firm's incentive is sufficient for the voluntary selection of the label because of a relatively low cost *C*, which makes the mandatory label useless. In region 3', the mandatory label is necessary compared to the private choice without any regulation. As the sunk cost *C* (not passed on to consumers) is relatively large, the mandatory label complements the MSS.

4. Conclusion

Using a very stylized framework, various mechanisms were illustrated by which the label or the standard may influence the provision of product safety. Because the effect of consumers' information and regulatory policy are intermingled, the endogenous choice of information contexts via the label decision was considered.

In order to focus on the main economic mechanisms and to keep the mathematical aspects as simple as possible, the analytical framework was admittedly simple. In order to fit different problems coming from various contexts, some extensions could be integrated into the model presented here. As the analysis was performed under monopoly, this paper can be a starting point for future research on the same issue in an oligopoly context. In particular, the regulation may influence the entry/exit of firms (see Marette, 2007). However, this simple model suggests that it is especially imperative for governments to examine information context depending on labels when a standard is selected.

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