COMPETITION VS. QUALITY IN AN INDUSTRY WITH IMPERFECT TRACEABILITY

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Abstract

We consider an industry where firms produce goods that have different quality levels but firms cannot differentiate themselves from rivals. In this situation, producing low-quality generates a negative externality on the whole industry. This is particularly true in some food industries or for imports (e.g. fresh produce) where consumers cannot identify producers. In this article, we show that under a "Laissez Faire" situation free entry is not socially optimal. Contrarily to conventional wisdom, we argue that the imposition of a Minimum Quality Standard (MQS) may induce firms to enter the market. Namely, a MQS is not always an anti-competitive policy.

Keywords: Entry; Externality; Minimum Quality Standard; Quality.

JEL: L15, L5

1 Introduction

There exist situations where products are not traceable by consumers, i.e. consumers are not able to identify either the producer or the level of quality of products or services. When doing their choices, consumers mainly base their decisions on the reputation of the entire industry. For example, car mechanics have often a poor "collective reputation" due to lack of information on the part of consumers; anyone can become a garage mechanic but he will suffer from this bad reputation. In this sense, firms share, at least partially, the reputation of the industry. Another empirical evidence for this phenomena is food safety. Food safety is a credence attribute: consumers are not able, because it is too costly, to check the real quality of the product even after consumption. Even if products may have different safety levels, consumers consider products as generic (e.g fresh fruit and vegetables). Indeed, after an outbreak of food poisoning, everyone along the supply chain of the contaminated item may suffer from the safety outbreak. After the Fall 2006 spinach outbreak, the Economic Research Service of the United States Department of Agriculture reported that all US spinach growers suffered a drop in demand for their product even though only one grower's spinach was contaminated. Five months later, the value of retail sales was still down 27% compared to the same period in 2005 (Calvin, 2007).[1]

In this article, we address the issue of entry in an industry where firms produce different quality levels but cannot differentiate themselves from their rivals. Also, producing low-quality generates a negative externality on the whole industry. We build a simple model and we show that the link between market structure and welfare is ambiguous. In the "Laissez Faire" situation, an increase in the

[1] In another example from 1997, more than 200 people contracted hepatitis A after eating frozen strawberries. The USDA reported that concerns over the safety of strawberries affected demand for all berries. Experts estimated that the US berries industry bore losses of between $15 million and $40 million dollars due to the outbreak (Calvin et al. 2004). In March 2007, fresh produce with prohibited level of pesticides residues were imported from Almeria (a region of Spain) to Germany. Even if there is no scientific clue that eating fresh produce with pesticides is bad for health all produce exported from Spain suffered from the crisis. In April 2007, most european countries denied fresh produce from Spain and the experts reported a fall a 30% in the marketing of those produce. In March 2008, dioxin contamination has led to a crisis in the traditional mozzarella cheese industry in Italy. Mozzarella di bufala, which is mozzarella made from buffalo milk, is undergoing something of a crisis. Sales of all Italian mozzarella have dropped by around 50%.

number of firms has two opposite effects. First, it leads the price to decrease increasing welfare. Second, incentives to free ride increase, reducing the average level of quality and then reducing welfare. Free entry is thus not socially optimal. Contrarily to conventional wisdom, we argue that the imposition of a Minimum Quality Standard may induce firms to enter the market and increase welfare.

The closest literature on this issue is the literature about collective reputation. Tirole (1996) considers that collective reputation should be assumed to be the aggregate reputation of individual agents. In a context of imperfect information available to consumers about quality, he shows that the composition of the producer group matters. Winfree and Mc Cluskey (2005) assume that collective reputation is a common property resource and show that the (exogenous) number of firms should be considered closely because of free-rider effects. However, in those studies, the size of the group of producers is taken as fixed and then does not allow for entry in or exit from the group. Our model, although static, endogeneizes the entry decision.

Moreover, our article directly participates to the controversial debate in the industrial organisation literature as regards to the effect of a Minimum Quality Standard (MQS) on competition (for instance, see Leland (1979)). Ronnen (1991) shows that an adequate MQS can increase both quantities sold and quality and then social welfare. The intuition of this result is that an increase in the low quality induces an increase of the high quality (in order to soften price competition) but equilibrium prices are however lower and more consumers buy the product (see also Crampes and Hollander (1995) for a similar result). The robustness of this result has been questioned in few direction. Valetti (2000) shows that this statement is sensitive to the mode of competition and Scarpa (1998) shows that it depends on the duopolistic market structure. As Ronnen (1991) and Crampes and Hollander (1995) acknowledge, they do not consider the possibility of exit and/or entry. As also underlined in Boccard and Wauthy (2005), who study quality regulation through quantity regulation, MQS would induce firm to exit the market and/or reduce the entry of new firms. Our model of quality differs from previous studies because there is no differentiation but quality externalities.

The article proceeds as follows. We set up the theoretical model to emphasize the free entry issue in a "Laissez Faire" situation. Next, we analyse the competition effect when a MQS is imposed on the industry. Finally, we provide our conclusions and their policy implications.

2 The Model

We focus on an industry in which identical and risk neutral firms choose their level of quality in order to avoid quality failures. We refer to a situation in which products have different quality levels. We consider situations where quality is a credence attribute: consumers are not able to observe these different quality levels even after consumption. Then, consumers only rely on the reputation of the entire industry.

We consider a two-stage game. In the first stage, profit maximising firms choose whether or not to enter the market. If a firm enters the market, it faces a fixed (sunk) cost $F > 0$. Since we focus on quality, each firm produces one unit of the product. In the second stage, the firm chooses a quality level $s_i \geq 0$ with cost $C(s_i)$ where $C' > 0$ and $C'' > 0$. We assume that the reputation of the industry is "good" with a probability $R(s_a)$ that only depends on the average level of quality (for simplicity) which is given by $s_a = \frac{\sum_{i \in N} s_i}{n}$ where N denotes the set of the n firms which enter the market, with $R' > 0$ and $R'' \leq 0$. The industry reputation is "bad" with probability $1 - R(s_a)$. The inverse demand function is then $P(n)$ (with $P' < 0$) if the reputation of the industry is "good", and the inverse demand function is 0 if the reputation of the industry is "bad"[2]. Therefore, the expected profit of firm i is

$$\Pi_i = R(s_a) P(n) - C(s_i) - F, \tag{1}$$

We make the following assumptions on the profit function which hold all through the paper.

Assumption 1: The profit of a monopolistic firm is non negative when its quality level is optimal,

$$F \leq R(s_M) P(1) - C(s_M), \tag{2}$$

[2] This is simply a normalisation. Indeed, suppose that if the reputation is "bad", the inverse demand drops to $\alpha P(n)$ with $0 \leq \alpha < 1$. The expected inverse demand is $R(s_a) P(n) + (1 - R(s_a)) \alpha P(n)$. It can be rewritten as $(R(s_a) + (1 - R(s_a)) \alpha) P(n)$. To see that our assumption is a normalisation, simply relabel $(R(s_a) + (1 - R(s_a)) \alpha)$ as $R(s_a)$.

where s_M denotes the optimal quality effort of the monopolistic firm, i.e.

$$s_M = \arg\max \{R(s) P_M - C(s), \ s \geq 0\}. \tag{3}$$

Assumption 2: A monopolistic firm's profit is non positive when its quality level is large enough,

$$\lim_{s \to +\infty} (R(s) P(1) - C(s) - F) \leq 0. \tag{4}$$

3 "Laissez faire" situation

In this section, we solve the game described above where there is no intervention from the regulator. We solve the game through backward induction.

3.1 Second stage equilibrium: quality choice

In this section, we solve the second stage of the game. Assume that n identical firms entered the market in the first stage. Firms individually make their quality choice, s_i. The optimisation problem for firm i is then

$$\underset{s_i \geq 0}{Max} (R(s_a) P(n) - C(s_i)), \tag{5}$$

The first order condition is

$$\frac{1}{n} R'(s_a) P(n) = C'(s_i). \tag{6}$$

This condition allows to define firm i's best response as an implicit function of the average quality s_a (and of the number of firms n) as usual in "private provision of a public good" games. Note that $\frac{\partial s_i}{\partial s_a} = \frac{\frac{1}{n} R''(s_a) P(n)}{C''(s_i)} \leq 0$. Hence, as the average quality s_a increases, firm i has an incentive to decrease its quality level.

In an interior equilibrium, the firms' quality levels are identical (due to the convex nature of the cost function C), i.e. for all i, $s_i^* = s^*$ which is characterised by:

$$\frac{1}{n} R'(s^*) P(n) = C'(s^*). \tag{7}$$

This equilibrium condition implicitly defines the equilibrium quality level, s^*, as a function of the number of firms n.

Proposition 1 *An increase in the number of firms lowers the equilibrium quality level,* $\frac{ds^*}{dn} < 0$.

Proof. Differentiating condition (7) with respect to n we obtain

$$\frac{ds^*}{dn} = \left[-\frac{1}{n} P'(n) + \frac{1}{n^2} P(n) \right] \frac{R'(s^*)}{\frac{1}{n} R''(s^*) P(n) - C''(s^*)}, \tag{8}$$

Since $P' < 0$, we have $0 < \left[-\frac{1}{n} P'(n) + \frac{1}{n^2} P(n) \right]$. Moreover, $R'(s^*) > 0$, then,

$$sign \left[\frac{ds^*}{dn} \right] = sign \left[\frac{1}{n} R''(s^*) P(n) - C''(s^*) \right] < 0. \tag{9}$$

■

When the number of firms increases firms have incentives to decrease their quality level. First, quality efforts are diluted in the industry reputation then firms' incentives to free ride increase (this results is similar to Winfree and McCluskey (2005)). Second, the price of the product decreases. Each firm's benefits decrease then firms provide a lower quality level.

3.2 First stage: Free entry

In this section, we derive the subgame perfect equilibrium of the game. In the first stage, firms anticipate the equilibrium quality level (characterised at stage 2) and decide to enter the market if their ex-ante expected profit is non negative. The number of firms who enter the market n^* is then characterised by:

$$R(s^*(n^*)) P(n^*) - C(s^*(n^*)) = F, \tag{10}$$

where n^* (≥ 1 according to Assumption 1) denotes the equilibrium number of firms which is an implicit function of F, the sunk cost of entry. Differentiating condition (10) with respect to F we obtain:

$$\frac{dn^*}{dF} = \left[\left[R'\left(s^*\right) P\left(n^*\right) - C'\left(s^*\right) \right] \frac{ds^*}{dn} + R\left(s^*\right) P'\left(n^*\right) \right]^{-1}. \tag{11}$$

Note that from condition (7), we have $R'\left(s^*\right) P\left(n^*\right) - C'\left(s^*\right) = \left(n^* - 1\right) C'\left(s^*\right) \geq 0$. When a firm decides to enter the market, it anticipates that the price ($P'\left(n^*\right) < 0$) and the equilibrium quality will decrease ($\frac{ds^*}{dn} < 0$). Consequently, the number of firms increases only if the entry cost decreases:

$$\frac{dn^*}{dF} < 0.$$

This result strongly depends on the fact that the number of firms has a negative impact on the equilibrium quality.

3.3 Market structure and welfare

In order to appraise the welfare effect of the market structure, we consider the equilibrium quality game (stage 2), where each firm provides the same (second stage equilibrium) quality level $s^*\left(n\right)$ defined by condition (7), with $1 \leq n \leq n^*$. We focus on the effect of an increase in the number of firms on consumer surplus and on social welfare.

Consumer Surplus: Under the assumption of quasi-linear consumer utility, when there are n firms, the expected (Marshalian) consumer surplus is

$$CS\left(s^*, n\right) = R\left(s^*\right) \left[\int_0^n P\left(z\right) dz - P\left(n\right) n \right].$$

The marginal effect of an increase in the number of firms on the expected consumer surplus is

$$\frac{dCS}{dn} = \frac{\partial CS}{\partial n} + \frac{\partial CS}{\partial s^*} \frac{ds^*}{dn}.$$

The direct effect is given by

$$\frac{\partial CS}{\partial n} = R\left(s^*\right) \left[-P'\left(n\right) n \right] > 0,$$

i.e. consumer surplus increases through a decrease in the price of the product. The indirect effect, $\frac{\partial CS}{\partial s^*}\frac{ds^*}{dn}$, represents the effect of an increase in the number of firms through its impact on the equilibrium quality. We know from Proposition 1 that $\frac{ds^*}{dn} < 0$. The effect of an increase of the quality level on consumer surplus is given by

$$\frac{\partial CS}{\partial s^*} = R'(s^*)\left[\int_0^n P(z)\,dz - P(n)\,n\right] > 0.$$

Then, $\frac{\partial CS}{\partial s^*}\frac{ds^*}{dn} < 0$, i.e. the indirect effect is negative. Finally, the global effect of an increase of the number of firms on consumer surplus is ambiguous because both the price and the quality of the product decrease.

Social Welfare: Social welfare is denoted by $W = W(s^*, n)$, with $W(s^*, n)$ given by:

$$W(s^*, n) = R(s^*)\int_0^n P(z)\,dz - n\left[C(s^*) + F\right], \tag{12}$$

We now evaluate the welfare effect of competition. Differentiating condition (12) with respect to n, we obtain $\frac{dW}{dn} = \frac{\partial W}{\partial n} + \frac{\partial W}{\partial s^*}\frac{ds^*}{dn}$. The welfare effect is twofold. The direct effect is given by $\frac{\partial W}{\partial n} = R(s^*)P(n) - [C(s^*) + F]$. As long as profits remain non negative, $\frac{\partial W}{\partial n}$ has a positive value. This represents the classical positive effect of competition. The indirect effect is given by $\frac{\partial W}{\partial s^*}\frac{ds^*}{dn}$. According to Proposition 1, the quality level decreases with respect to the number of firms, $\frac{ds^*}{dn} < 0$. The welfare effect of an increase in the quality level is given by $\frac{\partial W}{\partial s^*} = R'(s^*)\int_0^{n^*} P(z)\,dz - n^*C'(s^*)$. $P(n^*) < \int_0^{n^*} P(z)\,dz$, thus this term has a positive value. Therefore, the indirect welfare effect, $\frac{\partial W}{\partial s^*}\frac{ds^*}{dn}$, has a negative value. The welfare effect of competition is ambiguous. An increase in the number of firms reduces each firm's market power and prices, thereby improving social welfare. Yet at the same time, it lowers the average quality, reducing social welfare.

Proposition 2 *Under the "Laissez Faire" situation, free entry is not socially optimal.*

Proof. We evaluate the marginal variation of welfare at the free entry point. Differentiating condition (12) with respect to the number of firms n, we obtain

$\frac{dW}{dn}(s^*, n^*) = \left[R'(s^*) \int_0^{n^*} P(z)\, dz - n^* C'(s^*)\right] \frac{\partial s^*}{\partial n}$. According to Proposition 1 and $\frac{\partial W}{\partial s^*} = R'(s^*) \int_0^{n^*} P(z)\, dz - n^* C'(s^*) > 0$, this expression has a strict negative value. ■

Figure 1 represents the ambiguous welfare effect of competition.[3]

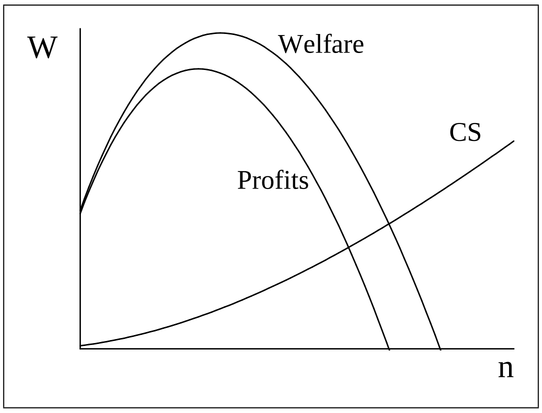

Figure 1. The Welfare Effect of Competition

When n^* firms compete in the market under the "Laissez Faire" situation, the positive welfare effect of competition disappears. Therefore, the regulator needs to intervene in order to avoid free-riding incentives and to prevent the entire industry from failing to perform. This result contributes to the critical debate in the industrial organisation literature that concerns the justification of anti-competitive regulation. For instance, Mankiw and Whinston (1986) have shown that in homogeneous product markets, free entry can lead to a socially excessive number of firms. They model a situation in which the output per firm falls as the number of firms in the industry increases. In our model, we assume that the output per firm is constant, however, the free-riding incentives lead us to the same conclusion.

[3]Figure 1 represents the following specification of the model. The industry reputation is characterized by a logit function of the average quality, s_a: $R(s_a) = \frac{s_a}{1+s_a}$. The inverse demand function is assumed to be linear, $P(n) = \alpha - n$ where $\alpha > 1$. The cost function is $C(s_i) = \frac{1}{2}(1+s_i)^2$.

4 Minimum Quality Standard

In this section, while maintaining our focus on the entry issue, we examine the situation where the regulator imposes a Minimum Quality Standard (MQS). We assume that, before stage 1, a MQS $\underline{s}$ is announced. Firms decide to enter the market at stage 1 and choose a quality level $s_i \geq \underline{s}$ at stage 2. Since the purpose of this section is to compare the effect of different levels of MQS, we do not consider the regulator as a player, that is $\underline{s}$ is given.

4.1 Market structure and MQS

In this section, we derive the equilibrium of the game for different levels of the MQS, $\underline{s} \geq 0$. The equilibrium quality and the equilibrium number of firms will depend on the level of the MQS. Let us denote $s^{**} = s^{**}(\underline{s}, n)$ the equilibrium quality of stage 2 and $n^{**} = n^{**}(\underline{s}, F)$ the equilibrium number of firms. In the previous section, we have characterised the equilibrium of this game under the "Laissez Faire" situation, that is for $\underline{s} = 0$. In other words, $s^{**}(0, n)$ and $n^{**}(0, F)$ are such that $s^{**}(0, n) = s^{*}(n)$ and $n^{**}(0, F) = n^{*}(F)$, where s^{*} characterised by condition (7) and n^{*} characterised by condition (10) .

In order to present the next proposition, we need to define a particular quality level and a particular number of firms denoted by s_c and n_c, respectively. s_c and n_c are defined as the equilibrium quality level and the equilibrium number of firms of the following two stage game: at stage 1, firms enter the market if their expected profit is non negative, and at stage 2 firms behave cooperatively, i.e. each firm provides the same quality level in order to maximise the total profit of the industry, $n(R(s)P(n) - C(s))$. s_c and n_c are characterised by $R'(s_c)P(n_c) = C'(s_c)$ and $R(s_c)P(n_c) - C(s_c) - F = 0$.

Proposition 3 *There exists a unique symmetric equilibrium. (i) If* $\underline{s} \leq s^{*}$*, then* $s^{**} = s^{*}$ *and if* $s^{*} < \underline{s}$*, then* $s^{**} = \underline{s}$*. (ii) If* $\underline{s} \leq s^{*}$*, the MQS has no effect on competition, i.e.* $n^{**} = n^{*}$*; there exists* $s' \geq s_c$ *such that for* $s^{*} \leq \underline{s} \leq s'$*,* $n^{**} \geq n^{*}$ *and for* $s' < \underline{s}$*,* $n^{**} < n^{*}$*. The maximal number of firms is* n_c *and is achieved for* $\underline{s} = s_c$*.*

Proof. Point (i) characterises the equilibrium quality level (stage 2). If the number of firms is n, firm i's optimisation problem is given by

$$\underset{s_i \geq \underline{s}}{Max} \left(R\left(s_a\right) P\left(n\right) - C\left(s_i\right)\right), \tag{13}$$

The Lagrangian of this problem is

$$\mathcal{L}_i = R\left(s_a\right) P\left(n\right) - C\left(s_i\right) + \lambda_i \left(s_i - \underline{s}\right),$$

with $\lambda_i \geq 0$ and $s_i \geq \underline{s}$. The equilibrium is characterised by: for all $i \in N$,

$$\frac{1}{n} R'\left(s_a^{**}\right) P\left(n\right) - C'\left(s_i^{**}\right) + \lambda_i = 0, \tag{14}$$

$$\lambda_i \left(s_i^{**} - \underline{s}\right) = 0, \tag{15}$$

$$\lambda_i \geq 0, \tag{16}$$

$$s_i^{**} \geq \underline{s}. \tag{17}$$

We prove the result in two steps. In step 1 we show that, when $\underline{s} \leq s^*$, $s_k^{**} = s^*$, $\forall k \in N$. In step 2, we show that, when $s^* < \underline{s}$, $s_k^{**} = \underline{s}$, $\forall k \in N$.
Step 1: Suppose that $\underline{s} \leq s^*$. Suppose there exists $j \in N$ such that $\lambda_j > 0$ then, $s_j^{**} = \underline{s}$ and $\frac{1}{n} R'\left(s_a^{**}\right) P\left(n\right) + \lambda_j = C'\left(\underline{s}\right)$. Since $\underline{s} \leq s^*$ and $C'' > 0$, we have $\frac{1}{n} R'\left(s_a^{**}\right) P\left(n\right) + \lambda_j \leq C'\left(s^*\right)$. Using (7) we obtain $\lambda_j \leq \frac{1}{n} P\left(n\right)\left[R'\left(s^*\right) - R'\left(s_a^{**}\right)\right]$. If $R'' = 0$, this is a contradiction. If $R'' < 0$, we have $s^* < s_a^{**}$. Then, $s^* < \frac{1}{n}\left(\underline{s} + \sum_{i \in N \setminus \{j\}} s_i^{**}\right)$. As $\underline{s} \leq s^*$, there exists $k \in N$ such that $s^* < s_k^{**}$. Using (15), we have that $\lambda_k = 0$. Then, using (14), we have $\frac{1}{n} R'\left(s_a^{**}\right) P\left(n\right) = C'\left(s_k^{**}\right)$. Since $s^* < s_k^{**}$, $C'' > 0$ and using (7), we obtain $R'\left(s_a^{**}\right) < R'\left(s^*\right)$ and then, $s^* < s_a^{**}$ which is a contradiction. Hence, for all $i \in N$, $\lambda_i = 0$. Then, the equilibrium is such that $\forall k \in N$, $s_k^{**} \equiv s^{**} = s^*$.
Step 2: Suppose that $s^* < \underline{s}$. Suppose there exists $k \in N$ such that $\lambda_k = 0$. Using (14), we obtain $\frac{1}{n} R'\left(s_a^{**}\right) P\left(n\right) = C'\left(s_k^{**}\right)$. Using (7), (17), $s^* < \underline{s}$, $C'' > 0$ and $R'' \leq 0$, we have $s_a^{**} < \underline{s}$, which contradicts (17). Then, the equilibrium is such that $\forall k \in N$, $s_k^{**} \equiv s^{**} = \underline{s}$.
Now we prove point (ii). The number of firms which enter the market at stage 1,

denoted by n^{**} is characterised by

$$R\left(s^{**}\left(\underline{s},n^{**}\right)\right)P\left(n^{**}\right)-C\left(s^{**}\left(\underline{s},n^{**}\right)\right)=F, \tag{18}$$

If $\underline{s}\leq s^{*}$, we have shown above that $s^{**}\left(\underline{s},n^{**}\right)=s^{*}\left(n^{**}\right)$. Then condition (18) can be rewritten as

$$R\left(s^{*}\left(n^{**}\right)\right)P\left(n^{**}\right)-C\left(s^{*}\left(n^{**}\right)\right)=F, \tag{19}$$

which is the same condition as (10). Hence, $n^{**}=n^{*}$.
If $s^{*}<\underline{s}$, we have shown above that $s^{**}\left(\underline{s},n^{**}\right)=\underline{s}$. The number of firms which enter the market at stage 1, n^{**}, is characterised by

$$R\left(\underline{s}\right)P\left(n^{**}\right)-C\left(\underline{s}\right)=F, \tag{20}$$

Differentiating this condition with respect to $\underline{s}$ leads to

$$\frac{\partial n^{**}}{\partial \underline{s}}=\frac{R'\left(\underline{s}\right)P\left(n^{**}\right)-C'\left(\underline{s}\right)}{-R\left(\underline{s}\right)P'\left(n^{**}\right)},$$

Then,

$$sign\left[\frac{\partial n^{**}}{\partial \underline{s}}\right]=sign\left[R'\left(\underline{s}\right)P\left(n^{**}\right)-C'\left(\underline{s}\right)\right].$$

$R\left(\underline{s}\right)P\left(n^{**}\right)-C\left(\underline{s}\right)$ is the per firm profit when all the quality levels are $\underline{s}$. Per firm profit is increasing for $\underline{s}\leq s_c$ and decreasing for $s_c\leq \underline{s}$. Hence, $\frac{\partial n^{**}}{\partial \underline{s}}\geq 0$ when $\underline{s}\leq s_c$ and $\frac{\partial n^{**}}{\partial \underline{s}}\leq 0$ when $s_c\leq \underline{s}$. Then, n^{**} achieves its maximum, n_c for $\underline{s}=s_c$. Moreover, according to Assumption 2, $\lim_{s\rightarrow+\infty}\left(R\left(s\right)P\left(1\right)-C\left(s\right)-F\right)\leq 0$, then $\lim_{s\rightarrow+\infty}\left(n^{**}\right)\leq 1$. Therefore, there exists $s'\geq s_c$ such that for $s^{*}\leq\underline{s}\leq s'$, $n^{**}\geq n^{*}$ and for $s'<\underline{s}$, $n^{**}<n^{*}$. ■

Relatively to the "Laissez Faire" situation: If the MQS is sufficiently low ($\underline{s}\leq s^{*}$), the MQS does not alter either competition or the firm's quality level. Increasing the level of the MQS ($s^{*}<\underline{s}<s_c$) increases the level of the industry reputation by increasing firms' quality levels. The MQS induces firms to enter the market as long as the cost of providing the MQS level is sufficiently low. When the MQS equals to the cooperative equilibrium quality level ($\underline{s}=s_c$), the industry

reputation is maximal. When the MQS is imposed at such a level, a maximum number of firms (n_c) enters the market. For MQS levels which are higher than the cooperative equilibrium quality level ($\underline{s} > s_c$), the marginal cost of providing quality overcomes the marginal benefit that leads to a drop in profits. However, the number of firms remains higher than it would be under the "Laissez Faire" situation as long as the MQS is low enough ($s_c < \underline{s} \leq s'$). For the highest MQS levels ($s' > \underline{s}$), the number of firms becomes lower than the number of firms in the "Laissez Faire" situation (n^*). This is the only situation in which the MQS can reduce competition. Figure 2 illustrates those results.

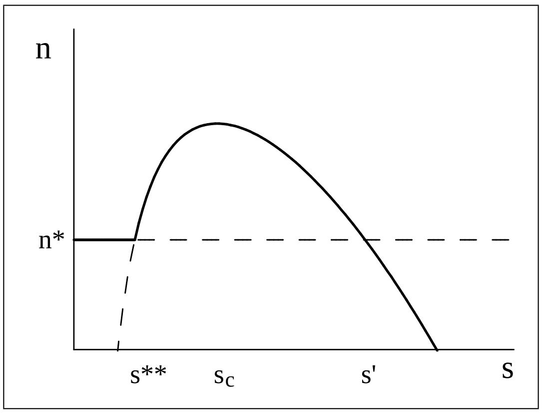

Figure 2. Number of Firms and MQS

In the light of these statements, we turn now to analyse the welfare effect after the introduction of a given MQS.

4.2 Welfare effect of the MQS

When a MQS $\underline{s}$ is imposed, the social welfare function can be written as

$$W(s^{**}, n^{**}) = R(s^{**}) \left[\int_0^{n^{**}} P(z)dz - n^{**} P(n^{**}) \right].$$

According to the result of Proposition 3, we can provide the following relationship between the level of the MQS and social welfare:

Corollary 4 *Relatively to the "Laissez Faire" situation, social welfare is (i) unaffected when the level of the MQS is sufficiently low ($\underline{s} \leq s^*$), (ii) improved when the level of the MQS is in a middle range ($s^* < \underline{s} \leq s'$).*

Proof. When the MQS is low, i.e. $\underline{s} \leq s^*$, according to Proposition 3, social welfare is $W(s^{**}, n^{**}) = W(s^*, n^*)$. When the MQS is in a middle range, $s^* < \underline{s} \leq s'$, according to Proposition 3, social welfare is $W(s^{**}, n^{**}) = W(\underline{s}, n^{**}(\underline{s}, F))$ with $\underline{s} > s^*$ and $n^{**} > n^*$. Since social welfare unambiguously increases with respect to s^{**} and n^{**}, $W(s^{**}, n^{**}) > W(s^*, n^*)$. ■

Relatively to the "Laissez Faire" situation, the introduction of a MQS unambiguously improves welfare as long as the level of the MQS leads to a greater number of active firms.

5 Conclusion

We have considered industries where firms provide different quality levels, cannot differentiate themselves from their rivals but can suffer from externalities due to rivals low-quality levels. We have shown that a "Laissez Faire" situation leads to a sub-optimal number of firms in the market. The regulator face different solutions which all have their positive and negative effects both on quality and competition. In such a case, the regulator face a trade-off between quality and competition. The regulator can choose to restrict the number of firms in the market. On the one hand, such regulation would limit the incentive to free ride and then provide a sufficient level of quality. On the other hand, this regulation has also two negative effects. First, it leads to an increase in the price. Second, free riding incentives are reduced but they are not eradicated. The other solution available is the introduction of a Minimum Quality Standard. We have shown that a Minimum Quality Standard can eradicate incentives to free-ride and can sustain both a high average level of quality and a high degree of competition.

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