Producer Organizations and Quality Management

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Abstract

A market with asymmetric information on product quality that entails both adverse selection and moral hazard problems is considered. Producers can sell their items either on a competitive market or through a quality labeled channel of distribution managed by a producer organization. We study the management of such a marketing organization, deriving the optimal price and the optimal monitoring policy. We then conduct a welfare analysis of alternative forms of public intervention: quality standards, costs subsidies and credit facilities.

Keywords: producer organization, product quality, asymmetric information, collective reputation, public intervention.

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1 Introduction

Many markets do not conform to the conditions of perfect competition. These are typically markets in which information on products' quality is imperfect and competition among producers (sellers) is not exclusively expressed in price rivalry but also in quality. In this context, grading or certification systems are one aspect of the merchandising strategy.

Quality grades affect the consumer's perception of the quality of goods by supplying a public information about product attributes. Moreover, as products can be differentiated either vertically (quality is then associated with an objective scale ranging from inferior to superior) or horizontally (quality is then a highly subjective property of foods that differs from one consumer to another), quality grades facilitate the matching of consumers' needs with the different qualities available.

These grades help also marketing organizations to build consumer loyalty in order to remove the products of their members from the generic category. They create price differentials and give rise to market premia in sectors where the numbers of producers and buyers are large. Certified producers are rewarded for establishing the reputation for quality of the marketing organization. They are paid for shifting their production from low to high quality: grades then act as an incentive device to stimulate the provision of better quality products. However, in order to maintain a reputation for quality, marketing organizations must alleviate opportunistic behavior of producers who may capture market premia without providing any effort, trying to sell low quality items through the distribution channel. An essential activity of the marketing organization is then to monitor quality by screening firms and by maintaining incentives to produce high quality items.

Grading is particularly widespread in markets for agricultural products. The regulation of agricultural markets in the European Union, through the Common Market Organization, greatly encourages the establishment of self-regulated Producer Organizations. Producer set-ups are similarly widespread in the US through either state or federal marketing programs (e.g., marketing orders). In the US as well as in Europe, the marketing programs publicly sponsored are considered as voluntary in the way that they are initiated, approved and financed by producers. However, these programs create obli-

\footnote{See, e.g., the Council Regulations EC #2200/96 and EC #2699/2000, in the Official Journal of the European Communities, L297 and L311.}
gations to producers, in particular the requirement to meet quality standards. In some instances, governmental agencies, often in association with producers and consumers, are in charge of the specification of the standard and they randomly control the quality offered, the producer organization being in charge of the marketing process. Such quality labeling are widespread in Europe, and more particularly in France and Italy where the agribusiness certification system through collective quality brands is widely developed (See C. Péi and D. Gaeta, 1999).

In the following, we analyze the behavior of such groups of producers using a model of collective reputation relying on individual behavior, in the spirit of Diamond (1991) and Tirole (1996).² In our model, producers federate to a marketing organization which reputation depends on the individual behavior of its members and in which discipline is sustained by the threat of the exclusion from the group. This threat of internal exclusion relies on a monitoring activity that the organization performs. Since producers are different both in the quality they are able to offer and in the effort they may exert, the organization faces both adverse selection and moral hazard problems. We study the management of such a marketing organization, deriving the optimal price and the optimal monitoring policy. We show that two types of set-ups may emerge, high or low quality organizations, depending on the incentives given to opportunistic producers. Indeed, a producer organization may find optimal to give up inducing producers to maintain high quality levels in order to reduce the associated costs. We then consider how public intervention can improve the functioning of these markets. We first focus on quality standards (the price being chosen by the producer organization) and show that a self-regulated organization is less demanding than such a partially regulated organization, which explains why the authorities often impose highly demanding quality standards. We also conduct a welfare analysis of public interventions through credit facilities and cost subsidies (monitoring cost and production cost). Simulations show that these policies are welfare improving if the organization is a low quality structure. For a high quality organization incurring incentive costs, credit facilities or subsidization of the production cost may reduce the welfare, whereas a reduction of the monitoring cost generally improves the welfare. Finally, for

²Diamond (1991) proposes a theory of bank loan and of the role of monitoring in circumstances under which reputation effects are important. Tirole (1996) analyses the joint dynamics of individual and collective reputations. He shows how individual reputations are determined by collective reputation and vice-versa.
a given budget, subsidization of the monitoring cost or of the production
cost has approximately the same impact on the overall welfare, but distinct
effects on the organization's behavior (its monitoring and price policies) and
on the market size.

The paper is organized as follows: The next section is devoted to the
related literature. In section three, we describe the model. The optimal
behavior of a self-regulated organization is characterized in section four. We
then consider several aspects of public intervention: quality standards, credit
facilities and costs subsidies. We conclude in the last section.

2 Related literature

Most of the literature studying the functioning of markets with asymmetric
information on quality and moral hazard problems in a competitive setting
focuses on individual reputation of the ...rms (their brand). Klein and Le-
\textsc{\textregistered}er (1981), Shapiro (1983) and Allen (1984) show, in a repeat purchases
framework, that a price premium must be given to producers to obtain the
correct incentives. More specifi..cally, Biglaiser and Friedman (1994) analyze
the \emph{effect} of a middleman (who is not an expert) on the functioning of a
market and show that middlemen allow to decrease the high quality prices
by reducing the incentive to cheat on quality.

Biglaiser (1993), De and Nabar (1991) and Mason and Sterbenz (1994)
analyze the \emph{effect} of certifi..cation on a market that entails an adverse selection
problem \textquoteleft \textquoteleft à la Akerlof\textquoteright \textquoteright (1970). De and Nabar (1991) study the \emph{effect} of an
imperfect but \emph{efficient} certifi..cation, which is a choice variable of the informed
agent. They exhibit two types of equilibrium: a pooling equilibrium where
both high and low quality sellers choose to certify, corresponding to a low
certifi..cation cost, and a semi-pooling equilibrium, where high quality sellers
choose to certify, and low quality sellers are \emph{indifferent} between certifying or
not (they choose a mixed strategy when the certifi..cation cost is high). A
similar result is established in Biglaiser (1993) that focuses on the \emph{effect} of
a middleman behaving as a quality inspector to resolve the adverse selection
problem. These results are in contrast with Mason and Sterbenz (1994)
that reveals the possibility of a worsening of the adverse selection problem
due to certifi..cation. More recently, Hollander, Monier-Dilhan and Ossard
(1999) exhibit conditions on the structure of the industry under which ..rms
producing superior qualities may not engage in grading when ..rms whose
quality is lower do grade. All these models usually resort to the hypothesis that all consumers are able to attribute to each particular brand (or class of producers) a reputation for quality, which seems to be in contradiction with the competitive market assumption of a large number of agents.

To our knowledge, a study of product certification analyzing it as a tool for producers to federate and to promote their products through a collective brand has not been undertaken. We particularly investigate the question of the management of such producer organizations. To this regard, our paper may be related to the literature on producer organizations analyzing the redistribution of revenues among different producers, as developed in Bourgeon and Chambers (1999), Sexton (1986), and Vercammen, Fulton and Hyde (1996). However, our paper differ from these analyses to the extent that we analyze how such a functioning of market favor the provision of quality. We more particularly investigate the raison d'être of specified rules of production often imposed by the authorities to producer organizations.

3 The model

We consider the market of an agribusiness product with a large number of producers and buyers, that holds in nitely many periods indexed by \( t \), \( (t = 1; 2; \ldots) \). This product can be either of high or low quality and domestic producers and buyers constitute a small part of this market which may be considered as competitive. In particular, we assume that the domestic supply and demand do not affect the world price of the low quality item. At each period, each domestic producer can choose to market his products either through a quality labeled distribution channel, where foreign producers cannot enter, or on a competitive market with free entry of foreign producers.

We suppose that domestic producers could be of three types:
- type-H producers offer high quality goods produced at a unit cost \( c \),
- type-L producers offer low quality goods at unit cost \( c_L \), \( c_L < c \),
- type-O producers have the choice each period to produce either high quality or low quality goods, incurring the corresponding unit cost \( c \) or \( c_L \).

We denote by \( \beta \) and \( \alpha \) the respective fractions of each type of domestic producers. These fractions remain constant over time, but we suppose that each period a fraction \( 1_i \), \( 2 \) \((0; 1)\), of domestic producers exit the market for exogenous reasons and that they are immediately replaced by identical ones. In the following, we assume that \( \beta, \alpha \), i.e.; that the proportion
of high quality producers is larger than the renewal rate of producers.

The labeled quality channel is an organization managed by a board whose task is to maximize the benefits of its producers. Such an organization is for example a cooperative of producers: It does not make profit for its own but it aims at increasing the profits of its members. The organization conducts a quality policy through a monitoring activity. Products are tested, and we suppose that high quality items always pass the test whereas low quality ones may fail. Quality tests can affect both the newborn (entrants) and the established (incumbents) producers. This assumption underlies the fact that a seal of approval is never obtained for ever and that it exists a threat of suppression. Indeed, anytime it has the evidence of low quality production, the marketing organization excludes the malevolent producer, and in such a case, this producer has no other alternative than selling his output on the competitive market.

The quality test has two objectives: To minimize the fraction of low quality producers in the organization and to maintain incentives for type-O producers to keep producing high quality goods. We denote by $x_t$ the probability for a low quality producer to be detected and we assume that $x_t$ is the same whatever the "age" of the producer.\(^3\) We suppose that the monitoring cost incurred by the organization depends only on the efficiency of the test $x_t$ whatever the quantities produced, given by $mx_t$ with $m \geq 1$. The organization funds these costs by charging rms so that its budget is balanced.

Each period, the rms and the organization play a three stage game. In the first stage, the organization announces its monitoring and price policy, the number of goods per member to be produced and the fee it charges. In the second stage, rms produce and decide on the distribution channel (either on the competitive market or through the marketing organization).\(^4\) If they choose to market their products through the organization, they pay the fee and their items are (eventually) tested. If the items have passed the test, they are sold through the distribution channel. Otherwise, the rm is excluded from (or do not enter) the organization, and sells its current and future output on the competitive market.

Domestic consumers are risk neutral and share the same preferences over

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\(^3\)Such a monitoring policy may proceed by a sampling of the products once packaged, before their shipment to the retailers.

\(^4\)This channel decision doesn't concern rms that have been previously excluded from the organization.
high and low quality goods. At equal price, high quality is preferred to low quality by every buyer. However, they differ in their high quality reservation price, \( \mu \), distributed independently among the domestic buyers according to the density function \( g(\mu) \) with cumulative function \( G(\mu) \) over \([a; b]\) with \( b > c \) and \( b - a = 1 \). We assume that the hazard rate is monotonic, i.e.; \( \check{A}(\mu) < 0 \) with \( \check{A}(\mu) \cdot (1 - G(\mu)) = g(\mu) \). A type-\( \mu \) consumer who buys one unit of good at price \( p \) enjoys a surplus \( U \) given by

\[
U = \begin{cases} 
\mu - p & \text{if he buys one unit of high quality good} \\
 a - p & \text{if he buys one unit of low quality good}
\end{cases}
\]

Suppose that the labeled channel offers only high quality goods at price \( p \) and let \( p_c \) denote the competitive price for low quality, with \( p < p_c \). A type-\( \mu \) buyer will choose to buy a labeled good if

\[ \mu > p, \ a < p_c \]

Under imperfect information, when both high and low quality may be found in the labeled channel, consumers cannot identify quality while purchasing. But, at least at steady states, they know the fraction \( \sigma \) of high quality goods on the labeled channel. Thus, a type-\( \mu \) buyer will choose to buy a labeled good if

\[ \sigma(\mu - p) + (1 - \sigma)(a - p) > a - p_c \]

Hence, for a given probability \( \sigma \) and a price \( p \), the indifferent buyer’s type under imperfect information is given by

\[ \mu(p, \sigma) = a + \frac{1}{\sigma}(p - p_c) \]

For a given \( p \), the higher \( \sigma \) the smaller \( \mu \) and the higher the demand for labeled goods. We normalize the total number of domestic buyers to one, so that the demand on the labeled market is given by:\footnote{Recall that domestic buyers constitute the whole demand of labeled goods.}

\[ D(p; \sigma) = 1 - G[\mu(p; \sigma)] \]

and cannot exceed one.
In the following, we normalize the competitive market and the preferences by setting $p_c = c_L = a = 0$. The rms in the competitive market make no profit, while $c$ and $p$ correspond respectively to the increase of marginal cost to produce a high quality item and to the organization’s market premium. This assumption restricts the available range of consumers’ type to the relevant interval $[c_L; b] = [0; 1]$. We also normalize the total number of producers to one, i.e.; $S = 1$.

4 Steady state equilibria

We focus on steady states and thus omit subscript $t$. We distinguish two types of equilibria: High (low) quality steady states correspond to situations where type-O producers choose to produce high (low) quality items every period. Each type of steady states thus defines a particular structure of the organization. We refer to them respectively as a high quality structure and as a low quality structure (Hereafter HQS and LQS).

At a low quality steady state, or equivalently with a LQS, the number of high quality producers amounts to $\gamma S$ (the type-H producers). Since a perfect quality test would be prohibitively costly, a proportion $! L$ of the low quality producers (type-L and type-O producers) are in the organization. This proportion depends on the monitoring policy and is derived as follows. Each period the flow of low quality entrants equals $(1 - \gamma) (\bar{\gamma} + \delta) S$ and a fraction $1 - x$ of them is not detected as producing low quality. The number of type-L and type-O incumbent producers who remain in the organization is $\gamma (1 - x) ! L S$. Consequently, at a steady state,

$$! L S = (1 - \gamma) (1 - x) (\bar{\gamma} + \delta) S + \gamma (1 - x) ! L S$$

which gives the fraction of low quality producers who are in the organization,

$$! L = \frac{(1 - \gamma) (1 - x) (\bar{\gamma} + \delta)}{1 - \gamma, (1 - x)}$$

This fraction decreases with the probability of test $x$ and increases with the renewal rate $1 - \gamma$. The fraction of high quality producers in the labeled channel is given by

$$\delta_L = \frac{\gamma}{\bar{\gamma} + ! L}$$

(3)
This fraction represents the average quality offered by a LQS for a given level of monitoring $x$. Conversely, we can define the level of monitoring corresponding to a given average quality $º, ® as

$$x_L(º) = \frac{(1_i}_{,i}^{o,i}_i)(º_i}_{,i}^{o,i}_i}{º(1_i}_{,i}^{o,i}_i + ^{o,i}_{,i}^{o,i}_i - (º_i}_{,i}^{o,i}_i)$$

(4)

which is an increasing function of $º$, convex under the assumption $®_+, 1_i$, with $x_L(®) = 0$ and $x_L(1) = 1$.

With a HQS, the number of high quality producers in the organization is equal to $(®+ ^{o})S$, and the number of low quality producers in the setup, denoted $!_HS$, is determined using the same reasoning. Each period, there is a flow of type-L entrants equal to $(1_i}_{,i}^{o}S$ and a fraction $1_i x$ of them is not detected as producing low quality. The number of type-L incumbent producers who remain in the organization is $(1_i x)!_HS$. Consequently, at a steady state, we have

$$!_HS = (1_i}_{,i}^{o}S + (1_i x)!_HS$$

which gives the fraction of low quality producers who are in the organization,

$$!_H = \frac{(1_i}_{,i}^{o}(1_i x)}{1_i (1_i x)}$$

(5)

The fraction of high quality producers in the labeled channel is given by

$$º_H = \frac{®+ ^{o}}{®+ ^{o} + !_HS}$$

(6)

and represents the average quality offered by a HQS for a given level of monitoring $x$. Conversely, we can define the level of monitoring corresponding to a given average quality $º, ®+ ^{o}$ by

$$x_H(º) = \frac{(1_i}_{,i}^{o,i}_i[(º_i}_{,i}^{o,i}_i(®+ ^{o})]}{º(1_i}_{,i}^{o,i}_i(®+ ^{o})}$$

(7)

which is an increasing function of $º$, convex under the assumption $®_+, 1_i$, with $x_H(®+ ^{o}) = 0$ and $x_H(1) = 1$. It is easily shown that we have $x_L(º) > x_H(º)$ for all $º \in [®+ ^{o}; 1]$. As described above, it seems that whatever the quality structure of the organization, the purpose of the monitoring is only to screen producers (to
exclude the low quality ...rms). However, these tests also influence the behavior of the type-O producers belonging to the organization, which in turn determines the structure of the organization. Indeed, an organization is a HQS (LQS) if its type-O producers have the incentives to produce high (low) quality items.

The incentive condition for type-O producers to produce high quality is derived as follows. Each period, a type-O producer faces the same trade-off. If he chooses high quality, he receives a per unit profit equal to \( p - c \). If he chooses to produce low quality items, he enjoys over the period a per unit profit of \( p \) (recall that \( c_L = 0 \)) if he is not detected, that happens with probability \( 1 - x \). But with probability \( x \) he is detected, receives no profit and is excluded from the organization. Denote by \( V \) the discounted payoff of a type-H producer and by \( \tilde{V} \) the discounted payoff of a type-O producer who decides to produce low quality items for the current period only, and then high quality goods (a one-shot deviation strategy from high to low quality). Such a behavior is deterred if \( V \geq \tilde{V} \) or equivalently if

\[
 n(p - c) + x \tilde{V} - F \geq (1 - x)(np + p) - F.
\]

where \( F \) is the fee charged by the organization to each producer to cover the monitoring cost, \( n \) the number of items produced by each producer and \( x \) the discount factor. Since \( V = [n(p - c) - F] + x(p + x) \), this condition reduces to

\[
 p \geq (1 - x)c + x(c + F - n) \quad (8)
\]

We will refer to this condition as the moral hazard or MH constraint. To interpret (8), consider the two polar cases \( x = 0 \) and \( x = 1 \).

If \( x = 0 \), the producers are only concerned about their current profit. In that case, to maintain incentives to produce high quality goods, we must have

\[
 xp \geq c
\]

i.e.; the expected loss of (per item) revenue if the producer is found shirking must be greater than the cost of producing a high quality good. The monitoring effort \( x \) must be sufficiently large for this condition to hold. If \( x = 1 \), the producers do not need incentives to produce high quality items as long as the profits are greater than 0, the profit they would enjoy on the competitive market. Indeed, (8) reduces to

\[
 n(p - c) - F \geq 0.
\]
Since \( F \) is the per producer monitoring cost, the lower the monitoring rate, the more likely this condition holds. Consequently, depending on the discount rate \( \pm \) incentives to produce high quality may or may not be provided by a monitoring rate intended solely to screen the producers.

From (8) and using \( F = n = mx = D(p; \theta) \), the organization is a HQS if

\[
p \geq g_H(p; \theta) \quad (1 \quad \pm \frac{c}{x_H(\theta)} + \pm c + \frac{mx_H(\theta)}{1 G(p; \theta)}).
\]

(9)

Symmetrically, the organization is a LQS if

\[
p < g_L(p; \theta) \quad (1 \quad \pm \frac{c}{x_L(\theta)} + \pm c + \frac{mx_L(\theta)}{1 G(p; \theta)}).
\]

(10)

Whatever the structure of the organization, we assume that the monitoring and pricing policies are chosen to maximize the expected profit of its producers. The objective of the organization is thus to maximize

\[
\hat{\ell}_i(p; \theta) = D(p; \theta)(p; \theta c) i \quad mx_i(\theta)
\]

\[i = H; L,\]

where \( mx_i(\theta) \) corresponds to the monitoring costs (charged by the organization to the producers) to maintain an average quality \( \theta \). For a LQS (HQS), the relationship between the monitoring rate and the average quality is given by (4) (resp. (7)). However, (7) allows for the targeted quality in the high quality case only if the type-O producers have the appropriate incentives. For a HQS, the maximization of (11) if thus constrained by (9). Symmetrically, the organization is a LQS if the price and average quality that maximize (11) satisfy also (10). For the two types of organizations, the decision variables are the price to set, \( p \), and the average quality \( \theta \) (more precisely, the monitoring policy \( x \) that allows to obtain an average quality \( \theta \)). In the following, we first characterize the optimal pricing rule for a given average quality charged by each type of organization. We then determine their optimal average qualities. This two steps resolution of the organization's problem contributes to the clarity of the exposition and is not due to a backward resolution of the stage game. It refers to the two activities of the producers organization, namely the marketing and the quality management of items. Finally, we derive the optimal quality structure by comparing the producers' profits in each case.
4.1 Price policy

For a given quality \( \theta \), the price of a type-i organization \((i = H; L)\) is determined by maximizing (11) with respect to \( p \), subject to the MH constraint (9) in the HQS case. The results of such a maximization in the LQS case is characterized in the following proposition.

Proposition 1 (LQS).

(i) The average quality produced by a LQS is less than \( \theta_L \) satisfying

\[ g(L, \hat{\mu}, \theta_L) i \theta_L \hat{\mu} = 0: \]

(ii) The price charged by a LQS for an average quality \( \theta_2 \) \((\theta_2 \theta_L)\) is given by

\[ p_L(\theta) = \theta \hat{\mu} \]

where \( \hat{\mu} \) is a constant, given by

\[ \hat{\mu} \hat{\mu}(\theta) = c: \]

(iii) The demand for a LQS is the same whatever the average quality \( \theta_2 \) \((\theta_2 \theta_L)\), given by

\[ Q = \theta \hat{\mu}(\theta) = c: \]

(iv) The profit of a LQS that offers an average quality \( \theta_2 \) \((\theta_2 \theta_L)\) is given by

\[ \pi_L(\theta) = \theta K \max \theta L(\theta) \]

where \( K = (\hat{\mu} \hat{\mu} - c)^2 = g(\theta) \) is a constant.

The total demand is the same whatever the average quality. The price and quantity choices are explained figure 1 (where they are exemplified assuming an uniform distribution of the consumers' tastes).

For an average quality \( \theta \), assuming that the MH constraint (10) is satisfied, the optimal price is solution of

\[ \frac{\partial D(p; \theta)}{\partial p}(p, \theta) + D(p; \theta) = 0 \]
This equation is the usual solution of the monopoly problem, and may be written as \( MC = MR \) with \( MC = \partial c \) and

\[
MR = p^* + \frac{D(p^*; \vartheta)}{\partial D(p^*; \vartheta)} = \vartheta c + \vartheta(\bar{\mu} - \bar{A}(\bar{\mu}))
\]

as depicted figure 1. The specific feature of this monopoly choice when quality matters is that the optimal quantity \( Q^* \) is the same whatever the average quality \( \vartheta \). Indeed, in that case the monopoly solution simplifies to \( c = \bar{\mu} - \bar{A}(\bar{\mu}) \), and thus the indifferent consumer is the same whatever the average quality \( \vartheta \). This is illustrated figure 1: Observe that the unit length of the y-axis is equal to \( \vartheta \). Since all the relevant values on this axis are multiplicative of \( \vartheta \), one can solve the problem for \( \vartheta = 1 \) to find the solution for all \( \vartheta \). In particular, the organization’s revenue is given by \( (p^* - \vartheta c)Q^* = \vartheta A(\hat{\mu}) (1 - G(\hat{\mu})) = \vartheta K \) where \( K \) is the revenue corresponding to \( \vartheta = 1 \).

As a result, the price charged by a LQS is an increasing function of the average quality, given by \( p = \vartheta \hat{\mu} \). However, the MH constraint (10) restricts the range of average quality as depicted figure 2.

In addition to the pricing rule \( p = \vartheta \hat{\mu} \), three curves corresponding to the MH constraint (10) under three different assumptions on the discount factor \( \pm \) are depicted figure 2 in the quality-price plane. The curve indicated \( \pm = 0 \) corresponds to the equation \( p = c + x_L(\vartheta) \). For a LQS with impatient type-O producers, the feasible set is below and on the left of this curve. In that case, the pricing rule \( p = \vartheta \hat{\mu} \) is thus limited to the segment ranging from the point \((\vartheta; \vartheta \hat{\mu})\) to the point where the two curves cross. Above this point, type-O producers choose to produce high quality goods and the organization is no longer a LQS. The curve indicated \( \pm = 1 \) depicts the equation

\[
p = c + \frac{m x_L(\vartheta)}{1 - G(\hat{\mu})}
\]

and corresponds to the set of points quality-price such that type-H producers make no profit. For a LQS with infinitely patient producers, the feasible set is below this curve. Depicted is a situation where type-H producers have a positive profit with the pricing rule \( p = \vartheta \hat{\mu} \) for almost all average qualities. Consequently, very patient type-O producers would mimic type-H firms and the organization cannot have a LQS. The curve \( \pm = 2 (0; 1) \) corresponds to an intermediate case. The higher (lower) \( \pm \) the closer this curve to the
“± = 1” (“± = 0”) curve. As indicated, for the intermediate case, the average qualities produced by a LQS are limited by the quality $\hat{q}_L$ corresponding to the crossing point of the price and MH curves, i.e.; satisfying

$$g_L(\hat{q}_L, \hat{q}_L) = 0;$$

We now turn to the HQS case. The price policy is characterized in the following proposition

Proposition 2 (HQS).

(i) The price charged by a HQS for an average quality $\hat{q} > \hat{q}_L$ satisfies

$$p_H(\hat{q}) = \begin{cases} \hat{q}_H & \text{if } \hat{q} \leq \hat{q}_H \\ p_H(\hat{q}; p) = p & \text{otherwise} \end{cases}$$

where $\hat{q}_H$ satisfies

$$\hat{q}_H = g_H(\hat{q}_L; \hat{q}).$$

(ii) The demand for a HQS that offers an average quality $\hat{q}$ is less than or equal to $Q^*= (\text{equal when } \hat{q} \leq \hat{q}_H).$

(iii) The profit of a HQS that offers an average quality $\hat{q}$ is less than or equal to $\hat{q}K \leq \max_{H}(\hat{q})$ (equal when $\hat{q} \leq \hat{q}_H$).

The optimal pricing rule implemented by an organization of producers does not depend on whether it is a HQS or a LQS unless the constraint (9) binds. If the constraint (9) binds, the organization charges a higher price than $p = \hat{q}_H$ in order to maintain the incentives to produce high quality items. As long as (9) is lenient, the total demand is the same whatever the average quality. The depiction of the optimal price policy for a HQS is provided Figure 3, which is very close to Figure 2. However, since the inequality sign of the MH constraint (9) is reversed compared to (10), the feasible sets limited by the curves indicated “± = 0”, “± = 1” and “± 2 (0; 1)” are located above and on the right of the curves. Moreover, the price policy is no longer limited to the rule $p = \hat{q}_H$. Consider first the case $\pm = 0$. For low average qualities, such that the points $(\hat{q}; \hat{q}_H)$ are on the left of the MH curve, the organization sets a price $p = c H(\hat{q})$ higher than $\hat{q}_H$ in order to maintain the incentives of type-O producers. The case $\pm = 1$ depicted corresponds to a situation where type-H producers have positive pro...
but the higher average qualities. The intermediate case \( \pm 2 (0; 1) \) is more complex to depict than in figure 2 due to the price increase for low average qualities, that induces a lower demand than \( Q_m \). As a result, this curve is closer to the curve "\( \pm = 0 \)" for low average qualities.

Finally, figure 4 summarizes the feasible set of average qualities (and related prices) that a producer organization may choose from. Observe that medium qualities (between \( \theta_L \) and \( \theta_+ \)) are not possible due to the MH constraints. Consequently, depending on the structure chosen by the producers, the organization will offer either a very high or a very low average quality. This choice of the optimal structure is discussed in the following section.

### 4.2 Optimal average quality and quality structure

We now look at the optimal quality structure of the organization. Using proposition 1, assuming a LQS, the optimal average quality \( \theta^u_L \) satisfies:

\[
\theta^u_L = \arg \max_{\theta_L \in \mathbb{R}} k \cdot m_{\theta_L}(\theta)
\]

For an interior solution, we have \( x_{0 L}(\theta^u_L) = K = m \), and a LQS may emerge if \( \theta^u_L > \theta_L \). For a HQS, denote by \( \theta^u_H \) the optimal average quality when the organization does not take incentives into consideration. We have:

\[
\theta^u_H = \arg \max_{\theta_H \in \mathbb{R}} k \cdot m_{\theta_H}(\theta)
\]

and thus satisfies \( x_{0 H}(\theta^u_H) = K = m \) whenever \( \theta^u_H > \theta_+ \). \( \theta^u_H \) is the optimal average quality if it is greater than \( \theta \). Otherwise, the MH constraint (9) must be taken into account. Let denote by \( \theta^u \) the optimal average quality when (9) is binding. As depicted ..gure 5, without the incentives problem, the organization chooses to be a HQS with an average quality equal to \( \theta^u_H \). Indeed, for a given \( \theta \), the difference between the two unconstrained profit curves corresponds to the difference in monitoring costs, \( m(x_{0 L}(\theta) - x_{0 H}(\theta)) > 0 \). However, the quality structure that emerges at equilibrium also depends on the positioning of the MH constraints. To depict the MH constraints in the \( (\theta; \mu) \) plane, it suffices to observe that (9) and (10) can be written as

\[
\mu > - (g_L(\theta^u L) + c)Q^u L = m_{\theta_L}(\theta)
\]

and

\[
\mu < - (g_H(\theta^u H) + c)Q^u H = m_{\theta_H}(\theta)
\]
respectively. Depicted figure 6 in the \((\varphi; \xi)\) plane is the MH constraint (13) under three different assumptions on the discount factor \(\pm T\) The curve \("\pm = 0\) corresponds to the equation \(\mid \varphi = Q^d(1 \mid \varphi x) = x L \mid mx L\), whereas the line \("\pm = 1\) depicts \(\mid \varphi = Q^d(1 \mid \varphi \varphi)\). Finally the curve \("\pm 2 (0; 1)\) corresponds to the intermediate situation. In each case, the feasible set for a LQS is located below and on the left of the relevant curve. The HQS case corresponding to (12) offers the same type of depictions, the type-O producers having the correct incentives if the protocol is above and on the right of the MH curve. Given these incentive constraints, the optimal quality structure and the average quality of the producer organization depend upon the initial distribution of producers \((\varphi_0; \varphi)\), the distribution of consumers (cumulative distribution \(G\)), the unit cost of quality and monitoring, \(c\) and \(m\), the renewal rate of producers, \(1_i\) and, and the discount factor \(\pm T\) The following proposition identifies the different possibilities

**Proposition 3** The optimal average quality and quality structure of a producer organization is given by\(^6\)

\[
\begin{align*}
\varphi_H^* \text{ and HQS if } \varphi_H^* > \varphi_L^* \text{ and } \varphi > \varphi_H^* \text{ and } \mid H (\varphi_H^*; \varphi_L^*), \mid L (\varphi_H^*; \varphi_L^*), \mid H (\varphi_H^*; \varphi_L^*), \mid L (\varphi_H^*; \varphi_L^*), \mid H (\varphi_H^*; \varphi_L^*)
\end{align*}
\]

The different situations established in the proposition are represented figures 7, 8 and 9. In these figures are depicted the protocol functions of each

\(^6\)The case \(\varphi_H^* > \varphi_L^*\) and \(\varphi > \varphi_H^*\) with \(\mid L (\varphi_H^*; \varphi_L^*), \mid H (\varphi_H^*; \varphi_L^*)\) (i.e.; no equilibrium) is ruled out by the following reasoning. Since \(\varphi_H^* > \varphi_L^*\) and \(\varphi_L^* = \varphi_H^*\) we have

\[
\begin{align*}
\varphi_H^* > \varphi_L^* \text{ and } \varphi > \varphi_H^* \text{ and } \mid H (\varphi_H^*; \varphi_L^*), \mid L (\varphi_H^*; \varphi_L^*), \mid H (\varphi_H^*; \varphi_L^*), \mid L (\varphi_H^*; \varphi_L^*)
\end{align*}
\]

where the last equality comes from the facts that the demand \(Q^a\) is the same in both cases and that \(x_H (\varphi_H^*) = x_L (\varphi_L^*)\). If the MH constraint (10) of the LQS is violated at \(\varphi_H^*\), then the MH constraint (9) of the HQS is satisfied with the same monitoring exert. This monitoring level allows the HQS to reach the average quality \(\varphi_H^*\), and we thus have \(\varphi < \varphi_L^*\). Now, considering that \(\varphi > \varphi_H^*\), we have \(\varphi_H^* > \varphi > \varphi_H^*\) and by definition of \(\varphi_H^*\) we have

\[
\begin{align*}
\mid H (\varphi_H^*; \varphi_L^*) > \mid L (\varphi_H^*; \varphi_L^*) = \mid L (\varphi_H^*; \varphi_L^*), \mid L (\varphi_H^*; \varphi_L^*)
\end{align*}
\]

hence a contradiction.
type of quality organization as well as MH curves. Figure 7, an HQS emerges in equilibrium: the optimal average quality, $\bar{q}_H^*$, is on the right side of the high quality MH curve. Moreover, $\bar{q}_L^*$ cannot be implemented since it is on the right side of the low quality MH curve.

A constrained high quality structure is depicted figure 8: the optimal average quality, $\bar{q}_H$, is on the left side of the high quality MH curve. $\bar{q}_L$ could be implemented since it is on the left side of the low quality MH curve. However, the pro..ts of a low quality structure evaluated at $\bar{q}_L^*$ are smaller than the pro..ts evaluated at the optimal constrained average quality, $\bar{q}_L^*$.

Finally, consider figure 9: $\bar{q}_H^*$ is not possible since it is on the left side of the MH curve. $\bar{q}_H^*$ can be implemented since it is on the left side of the MH curve, and the pro..ts of a low quality structure evaluated at $\bar{q}_L^*$ are greater than the pro..ts evaluated at the optimal constrained average quality, $\bar{q}_L^*$. Hence, the optimal quality structure is a low quality one.

The consequences of asymmetric information on quality on the functioning of markets with a producer organization may be summarized as follows. Two kinds of ine¢ciency appear. First, a low average quality o¢ered by the organization: whatever the quality structure, the equilibrium is in fact a pooling equilibrium since both types of quality are sold for the same price by the organization. This type of ine¢ciency is usually observed on markets with adverse selection and rational expectations (Wilson, 1980). However, a producer organization reduces the degree of this ine¢ciency: without the producer set-up, one would have $\bar{q}_L^* = 0$ given our assumptions, i.e. only low quality products would be sold in equilibrium and high quality producers would be driven out of the market. With the marketing organization, high quality producers can sell their item pro..tably and $\bar{q}_L^* > 0$. Hence, organizing markets through producer organization helps to partially alleviates the adverse selection problem.

The second ine¢ciency is the price distortion. There are two reasons for a market premium: The monopolistic setting and the informational problems (adverse selection and moral hazard). With perfect information, the monopolistic situation allows the producer organization to extract a markup equal to $1 - c \left( \bar{q}_H \right)$. Under an unconstrained HQS (or a LQS), the mark-up of a high quality producer equals $1 - c \left( \bar{q}_L \right)$, which is higher than the mark-up obtained with no informational problems. This increase of the price distortion results from the adverse selection phenomenon. When incentives matter, we have shown that the organization sets a price higher than $\bar{q}_H^*$; this price increase corresponds to the premium that must be paid by consumers for type-O pro-
ducers to choose high quality. This price distortion due to a moral hazard problem is usually observed on markets where individual reputation matters (Shapiro, 1983, Allen, 1984).

In our informational context, both types of inefficiency, an average quality lower than 1 and price distortions, are present simultaneously. These inefficiencies induce a welfare loss with respect to a situation where the organization would sell only high quality products ($\sigma = 1$) at the monopoly price. In the following section, we investigate the incidence of different public interventions on the welfare.

### 4.3 Public intervention

Several public policies have been experienced to regulate producer organizations, particularly in agriculture. The imposition of quality standards that must be met by recognized producers is one aspect of government intervention to support quality policies. Other instruments such as subsidies can also be used to promote quality. In Europe, producer organizations may benefit from financial assistance provided by the European Union or from member states grants for recognition. Member states aids are provided either directly or through credit institutions (special loans), e.g., to cover part of the necessary investment to attain recognition. Similarly, in the US, producer groups may benefit from a federal and state funding for advertising and promotion as well as grants from the US department of Agriculture, for instance to promote US farm products in overseas markets. In this section, we shall discuss these different aspects of the governmental intervention.

In our context, public intervention is dedicated to mitigate the problems generated by the imperfect information in a collective environment. It is intended to affect the price and the average quality of the product, or even to improve the quality structure of producer organizations.

We assume that the objective of the regulator is to maximize the social welfare, defined as the weighted sum of producers' profits and consumers' surplus, i.e.,

$$W = \pi(p, \sigma) + wCS(p, \sigma)$$  \hspace{1cm} (14)

where $w > 0$ corresponds to the relative preference of the government for the consumers over the producers and $CS$ to the consumers surplus for a given quality $\sigma$ and a price $p$. This consumers' surplus (evaluated per period) is
given by
\[ CS(p, \theta) = \int_{\mu} f(\mu \mid p)^{\theta} \cdot p(1 - \theta)^{1 - \theta} \cdot g(\mu) \, d\mu \]

Indeed, consumers get high quality or low quality units with probabilities \( \theta \) and \( 1 - \theta \) respectively. Integrating by parts and simplifying gives
\[ CS(p, \theta) = \int_{\mu} \theta \cdot (1 - G(\mu)) \, d\mu \]
and we have \( \frac{\partial CS}{\partial \theta} = (1 - G(\mu)) \cdot \theta \cdot \mu \cdot 0 \) and
\[ \frac{\partial CS}{\partial \theta} = \int_{\mu} [1 - G(\mu)] \, d\mu + \int_{\mu} G(\mu) \, d\mu \cdot 0 \]
i.e.; for a given average quality, consumers are better off with low prices and for a given price, with high average qualities.

4.3.1 Public determination of quality

We consider the case where the authorities’ focus is only on quality, letting the organization determine the unit price of the product. With the pricing rule \( p = \theta \hat{\mu} \), the consumer surplus simplifies to
\[ CS(\theta) = \theta K_C \]
where \( K_C = \int_{\mu} (1 - G(\mu)) \, d\mu \) is a constant. For the average quality range where the price is higher than \( \theta \hat{\mu} \), the surplus is lower than \( \theta K_C \) (See figure 10). Observe that although the organization charges its profit maximizing price for a given quality, the resulting consumer surplus is increasing with the average quality. We thus have the following result

**Proposition 4** For all \( w > 0 \), the socially desirable average quality when the price is set by the producer organization is higher than the average quality chosen by a self-regulated organization.

Consequently, asymmetric information does not change the result obtained in the perfect information context (see Tirole, 1988), and is in accordance with the fact that authorities often impose highly demanding quality standards. The explanation relies on the fact that (considering \( w = 1 \) and
\( p(\varrho) = \varrho \hat{\mu} \) the social planner seeks to maximize the difference between consumers gross surplus given by

\[
CGS(\varrho) = \int_{\hat{\mu}}^{\varrho} \mu g(\mu) d\mu = \hat{\mu} \varrho Q^\mu + \varrho K_C
\]

and production and monitoring costs. The producer organization behaves so that the difference between its total revenue, \( \varrho \hat{\mu} Q^\mu \), and total cost is maximized, neglecting the surplus of all consumers valuing the quality more than the marginal-indifferent consumer \( \hat{\mu} \) given by \( \varrho K_C \).

This result is illustrated Figure 11. Depicted are the profit-surplus possibility curves corresponding to each type of organization. The straight line \( W \) correspond to the profit-surplus points that result to the same welfare level. The slope of this line is \( -w \). For \( w = 0 \), the government is only concerned by the producers profit, and the resulting choice would be the same as the one of the organization (the iso-Welfare lines \( W \) are horizontal). For \( w > 0 \), the socially optimal choice is on the right of the producer organization choice.

4.3.2 Subsidies

Two types of subsidies are considered: indirect subsidies such as credit facilities and direct subsidies of costs (production and monitoring costs). In order to evaluate the impact of public intervention on the functioning of producer organizations and markets, we conduct a welfare analysis based on simulations, considering a uniform distribution of consumers reservation prices over the interval \([0,1]\) and a distribution of producers given by \( \varrho = 0.7 \), \( \varrho = 0.1 \) and \( \mu = 0.2 \). We set the unit cost of high quality to 0.05, a value which represents 10% of the average reservation price.\(^7\) The monitoring cost is set at its lowest possible value, \( m = 1 \). Each period, 3% of the population of producers exit the market for exogenous reason (\( \lambda = 0.97 \)). We also assume that the government weights equally for consumers' and producers' interests, i.e.; \( w = 1 \). We use as a benchmark the welfare corresponding to the monopoly pricing under perfect information: \( \varrho = 1 \) and \( Q^\mu = 1 \). This welfare is given by: \( W = (1 + \hat{\mu})(1 + 2c + \hat{\mu}) = 3(1 + c)^2 = 8 \) (With \( c = 0.05 \), this perfect information welfare amounts to 0.3384).

\(^7\)We have \( \hat{\mu} = (1 + c)^2 \) and \( K = (1 + c)^2 = 4 \).
We first consider the public intervention through credit institutions with special loans (cf. table 1). In our model, such a measure may be captured by the discount factor $\pm$, credit facilities correspond to an increase value of $\pm(1+r)$, where $r$ denotes the interest rate. A modification of $\pm$ affects the threshold value $\theta$, while maintaining unchanged the optimal unconstrained solutions, $\theta^*_L$ and $\theta^*_H$. Hence, an increase in $\pm$ should favor the implementation of high quality structure by reducing incentives problem. We observe that an increase in $\pm$ indeed favors the implementation of high quality structures. When producers are particularly impatient ($\pm = 0.64$, which corresponds to an interest rate of about 56%), a low quality structure emerges in equilibrium. The quality control is intended to minimize the fraction of low quality producers in the organization, which amounts in that case to approximately 21.62%. A slight decrease in the interest rate ($\pm = 0.645$) allows a shift from a LQS to a constrained HQS which is welfare improving: the loss in welfare is reduced from 26.98% to 26.36%. The proportion of low quality producers in the organization is reduced to 8.02%, and the mark-up $(1 - \frac{c}{p})$ increases from 87.53% to 90.17%.

The shift to an unconstrained HQS occurs for a particularly low interest rate (around 2.5%). However, such a situation is not socially desirable. Indeed, simulations performed on intermediate values of the interest rate, ranging from 33.33% ($\pm = 0.75$) to 4.71% ($\pm = 0.955$), show that the optimal situation is a constrained HQS. Reducing the cost of capital from $r = 33.33\%$ is first welfare and Pareto improving up to a threshold value, $r = 11.11\%$ ($\pm = 0.9$). This efficiency gain is characterized by an increase of the proportion of low quality producers from 9.63% to 13.86% and a reduction of the mark-up from 89.77% to 88.94%. As $\pm$ increases, that is, as producers give more and more weight to future profits, the premium that is necessary to stimulate the provision of high quality products goes down. Reducing the cost of capital from $r = 11.11\%$ to $r = 5.8\%$ (or $\pm = 0.945$) is welfare increasing although not Pareto improving: producers’ profits increase more than consumers’ surplus decreases. And a further reduction of the interest rate from $r = 5.8\%$ is welfare decreasing, with still an increase of the low quality producers fraction in the organization and a reduction in the mark-up. These results are due to two effects: a price effect and a quality effect, and to the fact that consumers’ surplus increases with quality and decreases with price. As

8The costs of the loan facilities policy are not included in the following computations of the welfare levels.
long as the price effect dominates the quality effect, CS increases: reducing the cost of capital is welfare and Pareto improving. When the quality effect dominates the price effect, reducing further the cost of capital is welfare improving but does not constitute a Pareto improvement. And the quality effect may become so important that such a public intervention is welfare decreasing (the decrease in consumers surplus is greater than the increase in pro..ts). These computations suggest that for a given distribution of producers, public intervention must be moderate. (Observe that this result is established neglecting the ..nancing aspect of the public intervention.)

Consider now direct interventions, namely costs subsidies. We consider both the reduction of the control cost, \( m \), and of the production cost \( c \) (cf. tables 2 and 3.) These changes affect the positioning of the moral hazard curves as well as the pro..t functions and thus the optimal average qualities, \( \bar{q}_C \) and \( \bar{q}_H \). The evaluation of the impact of these interventions takes into account the ..nancing of these policies, which is covered by taxpayers. (We neglect however the distortions induced by imperfect tax systems on the rest of the economy.)

A ..nancing of the monitoring cost that allows a HQS to abstract from the incentive problem (e.g.: cutting by half the cost bore by the organization, from \( m = 1 \) to \( m = 0.5 \)) is welfare improving. Incentives are less costly to provide: the monitoring activity is more intense (the proportion of low quality producers reduces from 12.07% to 11.55%) and the quality premium is reduced (the mark-up goes down from 89.26% to 89.1%). However, subsidizing a constrained HQS is also welfare improving: with a reduction from \( m = 1 \) to \( m = 0.55 \) only, the organization has still to charge a sufficiently high price to induce opportunistic producers to produce high quality items, but nevertheless the mark-up is reduced (from 89.26% to 89.02%). This reduction corresponds to a reduction of the price distortion due to asymmetric information. Finally, departing from an unconstrained situation (\( m = 0.5 \) and reducing further the monitoring cost (to \( m = 0.45 \)) decreases the welfare: more producers are controlled (better screening) but the cost of subsidization reduces the overall welfare.

Subsidizing half of the unit production cost is also welfare improving (the welfare loss reduces from 20.15% to 18.09%) when incentives matter for the HQS. For a tax burden relatively low, consumers and producers are better off with a lower quality because of the price decrease (the price effect more than offsets the quality effect for consumers). However, for further reduction of the production cost, the tax burden may offset producers and consumers
welfare gains.

For situations where the MH constraint is not binding, reducing the production cost (e.g., from $c = 0.05$ to $c = 0.01$) is welfare improving. The monitoring effort is reduced, the market price diminishes, but the cost reduction leads to a higher mark-up (from 89.26% to 97.6%). However, the average quality decreases since the low-quality producers proportion increases (from 12.07% to 16.85%).

Observe that for a given budget, both types of costs subsidies achieve approximately the same welfare ($W + CS$) improvement, but have distinct impacts on the producer organization management (choice of quality and price): with a 4% reduction of the unit cost of production, the monitoring activity is less intensive and the price lower than with a 5% reduction of the monitoring cost. Also, the former policy allows an increase of the overall production of the organization.\footnote{Remind that the indifferent consumer depends on the production cost. It is given by $\hat{\mu} = (1 + c)^{-2}$ with the uniform distribution.} Because of the price decrease, a larger number of consumers are willing to pay for the organization’s product: the demand for products commercialized through the producer organization is increased by 0.21%.

5 Conclusion

In this paper, we provide an analysis of markets where high quality producers can sell their products profitably by setting up an organization. We study the behavior of such a producer organization in a particular informational context, deriving the optimal monitoring and pricing policies. We show that allowing producers to set up an organization partially alleviates the adverse selection phenomenon. The price distortion due to informational problems may be reduced with a moderate public intervention through credit facilities or by subsidizing the monitoring cost or the production cost. The latter policy allows to reduce the market price, and thus a larger number of consumers are willing to pay for the product.

By underlining that different quality structures can emerge in equilibrium (the optimal quality structure being dependent, among other things, on the distribution of producers), this paper gives a rationale for the diversity of these supply channels, the different collective strategies, that we observe. In this attempt to study collective reputation, we focus on the management of
a producer organization behaving like a monopoly on a particular segment of the market. It would be interesting to extend this analysis to an oligopolistic environment, with several producer organizations being in competition on the same market segment.
References


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<tr>
<th>±</th>
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<th>p</th>
<th>l</th>
<th>CS</th>
<th>Welfare loss</th>
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<td>0.64</td>
<td>0.8640</td>
<td>0.4011</td>
<td>0.1609</td>
<td>0.0862</td>
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<tr>
<td>0.645</td>
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<td>0.75</td>
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Table 1: Impact of an increase of ± (m = 1; c = 0.05)

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<th>g</th>
<th>p</th>
<th>l</th>
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<td>0.4656</td>
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Table 2: Impact of a decrease of m. (± = 0.85; c = 0.05)
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</tr>
<tr>
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<td>0.8680</td>
<td>0.4643</td>
<td>0.1772</td>
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<td>0.0004651</td>
<td>20.02%</td>
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<td>0.4630</td>
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<td>0.0009320</td>
<td>19.93%</td>
</tr>
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<td>0.4616</td>
<td>0.1784</td>
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<td>0.4590</td>
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<tr>
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<td>0.1825</td>
<td>0.0961</td>
<td>0.0047316</td>
<td>19.07%</td>
</tr>
<tr>
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<td>0.4392</td>
<td>0.1878</td>
<td>0.0982</td>
<td>0.0096307</td>
<td>18.33%</td>
</tr>
<tr>
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<td>0.8407</td>
<td>0.4326</td>
<td>0.1903</td>
<td>0.0990</td>
<td>0.012135</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>0.4195</td>
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</tr>
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<td>0.4171</td>
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<td>0.1012</td>
<td>0.0198</td>
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<td>0.1023</td>
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<td>17.61%</td>
</tr>
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Table 3: Impact of a decrease of \(c\). (\(\pm 0.85; m = 1\))
Figure 1: Quantity and price determination for a given average quality
Figure 2: Price policy of a LQS
Figure 3: Price policy of a HQS
Figure 4: Prices charged and average qualities offered by a producer organization
Figure 5: Unconstraint Profits
Figure 6: $M_{H_\chi}$ constraint for a LQS
Figure 7: HQS vs LQS: HQS when the $M_{H_H}$ constraint is lenient at the optimum
Figure 8: HQS vs LQS: HQS when the $M_{H_H}$ constraint is binding at the optimum
Figure 9: HQS vs LQS: LQS when the $M_{H_H}$ constraint is binding at the optimum
Figure 10: Consumers surplus
Figure 11: Producers profit, consumers surplus and welfare