Quality Provision and Farmer Inclusion of an Agricultural Cooperative

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1 Introduction

Coexistence of producer cooperatives and private firms (or investor-owned firms) is common in agricultural markets. With increasing concerns on quality and safety of agricultural products, both organizations are enhancing their coordination with farmers and control more closely the quality of raw product. In the US, marketing contract, which specifies quality requirement and payment for farmers governs 36 % of the value of agricultural production, up from 12 % in 1969 (USDA report (2004)). In France, quality-specified agreements are also widely used by various professional groups (French quality report (2005)). The coordination of different organizations with farmers pays a crucial role in creating values for the vertical production chain and sharing surplus with farmers. Therefore, the question about which organization form controls better the quality of farmers is of great importance.

Quality control takes various forms in the vertical contracts with farmers. The one which is widely used by both coops and private firms is the quality standard for raw products. In this type of control, farmers are required to comply a certain standard during their production in order to obtain payments from the firm or coop purchasers. [1] Those unable to meet the standard may be sanctioned or excluded from the delivery system. For example, the largest slaughterhouse in Denmark Danish Crown imposes a set of quality standards for primary pig production. Members who do not meet the defined standard will bear a reduction in the price for the unqualified pork supply. Karantininis and Nielsen (2002) Sometimes quality standard can be so high that only a few farmers can be involved in delivery system. For example, the Italian ham processor group "Parma Ham" provoked an anti-trust debates for its restriction on pork leg supply. Sometimes, the standard just follows

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[1] In dairy sector, standards for raw milk is mainly in regard to the composition of raw milk, including specific technical requirements such as the numbers of germ, cell numbers and spores in raw milk (Karantininis and Nielsen (2002)). In wine industry, standards focus more on production procedures such as the restriction on maximum grape yield and requirement on age of wood and bottles (Fayes et al. (2005)).

the Minimum Quality standard (MQS), which is mandated by the public authority. The low quality standard gives farmers more flexibility in their production, however it implies low market premium that they can benefit from the vertical production chain. For example, the vineyards for Italian wines with low quality grade (IGT wine) yield only \$20,000 to \$24,000 per acre, compared to \$120,000 per acre for vineyards of wines with high grade (DOCG). Therefore, the choice of standard for farmers influences not only their participation 1 in delivery but also the value of the whole production chain and hence the total welfare of farmers.

Since coops and privete firms are different organziation structures, their policy towards farmers are different. A coop is owned by farmers. Its objective is to maximize the total welfare of farmer members. Therefore, it cares more about the participation of farmers than the market premium associated with quality of final products. In contrast, a private firm is owned by investors (we abbreviate it by IOF). Its objective is to maximize the downstream profit. Therefore it cares more about the market premium than participation of farmers. However, both organizations face a trade-off that setting high quality standard creates high premium but also large cost for farmers. In a context of coexistance of the two organziations, this raises a question on which organization can benefit a high market premium without too much restricting the production and participation of farmers.

The debates on coops versus IOFs have attracted much attention in recent years. Coops, as a vertically integrated organization, enjoy various advantage compared to the IOFs. For example, Sexton (1986) stated that marketing coop has pro-competitive effect in mixed oligopsony market. Albeak and Schultz (98) indicated that the members in a coop often over produced, which gives the coop a credible commitment to produce large quantity when it competes à la Cournot with the IOF. Bontems and Fulton(2005) showed that in absence of perfect information, coop benefit from a information cost advantage because its objective is in consistent with that of farmers. Giannakas and Fulton (2001, 2005) also argues advantages of coop in respect to the member commitment and competition in innovation, respectively.

Dispite the advanteges, coop also receives debates due to its collective ownership structure and inefficient revenue sharing rule. For example, Fulton and Vercammen(95) argued that average cost pricing rule may induce inefficiency if members in the coop are heteogeneous. Nilsson and Bänheim (2000) indicated that the rise of price (thus an increase in payment), members of a coop may over produce, which erode the profit at processing level. Many other articles such as Sykuta and Cook(2001), Cook and Chaddad(04), Tirole and Rey (2007) argued that the vaguely defined property rights influences the viability of the coop.

In this paper, we analyze the competition of coop and IOF in setting quality standard and related payment to attract the participation of farmers. In doing so, we develop a product differentiation model, allowing farmers to be heterogeneous in their efficiency to provide quality. Our results assess another advantage of coop: a

coop tends to set a higher quality standard and attract more farmers as compared to an IOF rival.

2 Basic Model

Assume the upstream market consists of a unit mass of farmers. Each farmer produces at most one unit of raw product. The cost of producing the unit quality is normalized to be zero. If a certain quality standard (denoted by s) is imposed to farmers, they have to make effort to meet the standard.[2] Farmers are differentiated in their ability to meet the quality standard. We use a parameter θ to capture the difference ($\theta \in [0,1]$). The cumulative distribution function is $F(\theta)$ and the density function is $f(\theta)$. The cost of a farmer indexed by θ to meet the standard s is assumed to be $C(\theta, s) = \theta c(s)$ with $c'(s) > 0, c''(s) > 0$. Thus a farmer is less efficient if his index θ is high and he bears higher cost when facing higher quality standard s. Moreover, we assume that the reservation payoff for each farmer is zero.

Farmers can choose whether to supply for a coop or for a private firm. In order to attract participation of farmers, the two organizations make quality standards for raw products and compensate farmers with a payment which is associated with the quality standard. We assume that each organization sets a unique quality standard s ($s \in [\underline{s}, \bar{s}]$) and the cost of farmers are unobservable for both organizations. In sofar, under the unique quality standard, farmers are homogeneous in eye of the two organizations and therefore the payment for a farmer is just a uniform price for his unit production (we denote by w).

Under a high quality standard, the raw product can be processed into a final product with high quality, which generate a large market premium for the vertical production chain. To model this, we assume that the downstream market is segmented into a continuum of markets according to the quality of final products, which relates directly with the standard of raw products. One unit of raw product with quality standard s can be processed into one unit of final product and then sold at a price $p(s)$ in the segmented market, where $p'(s) > 0, p''(s) \geq 0$. The cost of processing is assumed to be zero. In sofar, if an organization wants to position his product to the market associated with premium $p(s)$, it has to impose the quality standard s to farmers. Furthermore, we assume that organizations are price-takers of $p(s)$, in the sense that it cannot influence the price by adjusting its production. This assumption allows us to focus on the strategy of organizations at the upstream level without specifying their interaction in the final product markets.

The choice of quality standard and payment for farmers depends on the objective of the organization. In this paper, we consider the two organizations: a coop and

[2]For example the wheat farmers have to bear extra cost in purchasing pedigreed seed and storing wheat for longer periods than normal. It is estimated that the cost of Canadian farmers to participate in the Identity Preservation Production and Marketing (IPPM) system is 16%-18% above conventional wheat market costs. (Smyth and Philipps (2002))

a private firm, who decide policy (s, w) and accept all participation of farmers who meet their standards.[3] In the following sections, we first analyze the decision of s and w of the coop and the private firm, respectively in a context where farmers face only one organization. This corresponds to the case that there exists only one organization in a region. Then we analyze the situation that the two organizations compete in attracting farmers, which is in line with the coexistance of the coop and the private firm in many agricutural markets.

3 One organization

When there is only one organization presenting in the market and its policy to farmers is $(s.w)$, the farmer, indexed by θ gains a revenue $R(s, w; \theta) = w - \theta c(s)$. We denote by $\hat{\theta}$ the marginal farmer who is indifferent from participating in the organization and staying inactive. Then $\hat{\theta} = \frac{w}{c(s)}$. All farmers with $\theta < \hat{\theta}$ participate in the organization and therefore the total supply (and therefore the total output) of the organization is $q(s, w) = F(\hat{\theta})$. In order to analyze the participation of the farmers, we assume that the upstream market is not covered so that $\hat{\theta} < 1$.

Coop If the organization is a coop, its objective is to set quality standard so as to maximize the total welfare of farmers. The retained earning accruing from the quality of raw product is distributed equally among members by means of payment w. Providing that there is no cost involved in the processing stage, the retained earning is just the market price $p(s)$. Therefore, the coop will share the retained earning by setting $w = p(s)$. The problem of the coop is described as follows:

$$\begin{aligned} \max_{s} \pi^c &= wq(s, w) - \int_0^{\hat{\theta}} \theta c(s) dF(\theta) \\ s.t. \quad & w = p(s) \end{aligned} \tag{1}$$

Private firm If the organization is a private firm, it aims to maximize the downstream profit by setting s and w. The problem for the private firm is

$$\max_{s,w} \pi^f = (p(s) - w)q(s, w) \tag{2}$$

Comparison Taking into account $q = F(\hat{\theta})$ and $\hat{\theta} = \frac{w}{c(s)}$, we derive the conditions of each organization for quantity and quality control and compare them in table 1:

The two conditions for each organization determines the equilibrium participation and quality standard. We denote by $\hat{\theta}^i$ and s^i where $i = c, f$ for coop and private firm, respectively. Compare the conditions of quantity control for the two organizations. The condition for the private firm has an additional term $\big(F(\hat{\theta})/f(\hat{\theta})\big)c(s) > 0$. Therefore, for a given quality standard s, the private firm tends to include less

[3] In this context, the coop can be seen as a "hybrid" open membership coop in the sense that it accept all delivery of farmers, but with restrictions on quality.

Table 1: Conditions for quantity and quality control

organization	coop	private firm
quantity control	$p(s) = \hat{\theta}c(s)$	$p(s) = \hat{\theta}c(s) + \frac{F(\hat{\theta})}{f(\hat{\theta})}c(s)$
quality control	$p'(s) = \frac{\int_0^{\hat{\theta}} \theta dF(\theta)}{F(\hat{\theta})}c'(s)$	$p'(s) = \hat{\theta}c'(s)$

farmers than the coop ($\hat{\theta}^f(s) < \hat{\theta}^c(s)$). This is comes from the fact that the private firm exerts its monopsony power to lower the payment for farmers so as to benefit a positive mark-up ($p(s) - w^f > 0$). This induces less participation of farmers compared to the payment offered by the coop $w^c = p(s)$.

Now we compare the conditions of quality control for the two organizations. The one for the coop implies that the coop equalizes the marginal premium of quality and the marginal cost of the average farmer (indexed by $\bar{\theta} = (\int_0^{\hat{\theta}} \theta dF(\theta))/F(\hat{\theta})$). Whereas the condition for the private firm shows that the marginal premium of quality should be equal to the marginal cost of quality of the marginal farmer $\hat{\theta}$. Note that $\bar{\theta} < \hat{\theta}$, leading to a higher quality standard of the coop than that of the private firm if they include the same farmers: $s^c(\hat{\theta}) > s^f(\hat{\theta})$. The explanation is in line with the idea of Bontemps and Fulton (2005): the objective of the coop is consistent with that of farmers. Therefore when setting the quality standard, it enjoys a cost advantage compared to the private firm ($\bar{\theta}c(s) < \hat{\theta}c(s)$) even if the cost of farmers are not observable. This allows the coop to set a higher quality standard than that of the private firm for a given membership of farmers.

In sofar, the monopsony power of a private firm implies that the firm includes higher efficient farmers than the coop, while the lower quality cost of the coop gives it advantege in providing quality compared to the firm. In equilibrium, which organization sets a higher quality standard depends on the interplay of the two forces. The result is shown in Lemma 1:

Lemma 1 *The comparison of the equilibrium quality standards of the coop and the private firm depends on their inclusion of farmers in equilibrium:*

- *if* $\hat{\theta}^c < \hat{\theta}^f$*, then* $s^c > s^f$
- *A sufficient and necessary condition for* $s^f > s^c$ *is*

$$\hat{\theta}^f < \frac{\int_0^{\hat{\theta}^c} \theta dF(\theta)}{F(\hat{\theta}^c)}$$

Therefore farmers with average ability to meet the quality standard of the coop are excluded by the private firms.

4 Competition between the coop and the private firm

When both organizations are present in the market, the participation of farmers depends on the competition between the two organizations. We assume that the two organizations compete in a two-stage game: in the first stage, both organizations announce their respective quality standard simultaneously (we shall discuss later the case in which the coop reacts after the private firm). In the second stage, the two organizations set prices to farmers simultaneously.

If both organizations set the same quality standard for farmers, they face intensive competition in offering payment to attract farmers. Providing that the coop will offer a payment $w^c = p(s)$, in order to attract farmers, the private firm has to offer $w^f \geq p(s)$, which drives its profit to zero. This induces the private firm to set a different quality standard in order to soften the competition. We denote by s_l and s_h ($s_l < s_h$), the two different standards. Thus the policies that the two organizations apply to farmers are respectively (s_l, w_l) and (s_h, w_h). We call the organization with the former policy "organization L" and the latter "orgnaziation H". Under such policies, the marginal farmers who are indifferent from staying inactive and joining in the two organizations are respectively $\theta_l = \frac{w_l}{c(s_l)}$ and $\theta_h = \frac{w_h}{c(s_h)}$. We assume that the market is uncovered so that $\theta_i < 1$ for $i = l, h$. Furthermore, we denote by $\tilde{\theta}$ the farmer who is indifferent of participating in the two organizations. Therefore $\tilde{\theta} = \frac{w_h - w_l}{c(s_h) - c(s_l)}$. In the following analysis, we use $c_i = c(s_i)$ and $p_i = p(s_i)$, $i = l, h$ to simplify the notation. Moreover, we denote relative market premium and cost low quality and high quality product by $\rho = \frac{p_l}{p_h}$ and $\sigma = \frac{c_l}{c_h}$, respectively ($\rho, \sigma \in [0, 1]$).

The participation of farmers thus depends on the policies of the two organizations. Providing that $s_l < s_h$, three cases may occur:

1. if $w_l \geq w_h$ ($\tilde{\theta} \leq 0$), the organization with lower quality standard monopolizes the market (Case ML). The supply of farmers is

$$q_{ml}(w_l) = \theta_l = \frac{w_l}{c_l} \tag{3}$$

2. if $\sigma w_h < w_l < w_h$ ($0 < \tilde{\theta} < \theta_h < \theta_l$), the two organizations may coexist in the market (Case D). The supply functions are respectively

$$q_{dl}(w_l, w_h) = \theta_l - \tilde{\theta} = \frac{w_l}{c_l} - \frac{w_h - w_l}{c_h - c_l} \tag{4}$$

$$q_{dh}(w_l, w_h) = \tilde{\theta} = \frac{w_h - w_l}{c_h - c_l} \tag{5}$$

3. if $w_l < \sigma w_h$ ($\tilde{\theta} > \theta_h > \theta_l$), the organization with higher quality standard monopolizes the market (Case MH). The supply is

$$q_{mh}(w_h) = \theta_h = \frac{w_h}{c_h} \tag{6}$$

The strategy of organizations to attract farmers differ from the objective of the organizations. In the following section, we shall deal with three cases: the competitions between two private firms, which serves as a benchmark in contrast to the competition with the coop; the competition between a coop setting low standard s_l and a private firm with high standard s_h and the reverse case. Anticipating the participation of farmers, the two organizations decide their policies in two stages. Proceeding recursively, we analyze first the competition in the second stage, given s_l and s_h decided in the first stage.

5 Upstream price competition

5.1 Two firms

If two firms are present in the market, they decide simultaneously the prices of raw products so as to maximize their profits, which are described as follows:

$$\pi_l^{ff} = (p_l - w_l)q_l \tag{7}$$
$$\pi_h^{ff} = (p_h - w_h)q_h \tag{8}$$

We analyze first the best response function of firm L, $BR_l(w_h)$. Given w_h ($w_h \leq \frac{p_l}{\sigma}$), we have

$$BR_l(w_h) = \begin{cases} \frac{p_l}{2} & \text{if } w_h < \frac{p_l}{2} \\ w_h & \text{if } \frac{p_l}{2} \leq w_h \leq \frac{p_l}{2-\sigma} \\ \frac{p_l+\sigma w_h}{2} & \text{if } \frac{p_l}{2-\sigma} < w_h \leq \frac{p_l}{\sigma} \end{cases} \tag{9}$$

The first line corresponds to the case ML, in which firm L sets $w_l > w_h$ so as to monopolize the upstream market. The third line reflects the strategy of firm L to accommodate with firm H, i.e. case D ($\sigma w_h < w_l < w_h$). There is an intermediate case, in which $\frac{p_l}{2} \leq w_h \leq \frac{p_l}{2-\sigma}$. In this case, if firm L chooses to accommodate with firm H by setting $w_{d,l} = \frac{p_l+\sigma w_h}{2}$, one can verify that $w_{d,l} > w_h$. Thus the price is so high that firm H is pushed out of the market. Therefore, the profit of firm L is not maximized at this accommodation price. On the other hand, if firm L chooses to monopolize the market by setting $w_{ml} = \frac{p_l}{2}$, one can verify that $w_{ml} < w_h$, inducing entry of firm H. Thus the monopsony price fails to capture the monopsony profit. In order to maximize profit, firm L chooses $w_l = w_h$ so as to just cover the most efficient farmer ($\tilde{\theta} = 0$) and to just deter the entry of firm H. We call this case "R", which means that the firm is a monopsony but is restricted from setting the monopsony price.

Analogously, giving w_l ($w_l < p_l$), we derive the best response function for firm H ($BR_h(w_l)$) as follows:

$$BR_h(w_l) = \begin{cases} \frac{p_h}{2} & \text{if } w_l < \frac{\sigma p_h}{2} \\ \frac{w_l}{\sigma} & \text{if } \frac{\sigma p_h}{2} \leq w_l \leq \frac{\sigma p_h}{2-\sigma} \\ \frac{p_h+w_l}{2} & \text{if } \frac{\sigma p_h}{2-\sigma} < w_l \leq p_l \end{cases} \tag{10}$$

Thus the first line corresponds to the case where firm H monopolize the upstream market (case MH). The last line is the response of firm H when it coexists with firm

L. The second line reflects the restricted monopsony case where firm H just forces firm L out of the market, i.e. $\tilde{\theta} = \theta_l = \theta_h$. The best response of the two firms can be illustrated in figure 1.

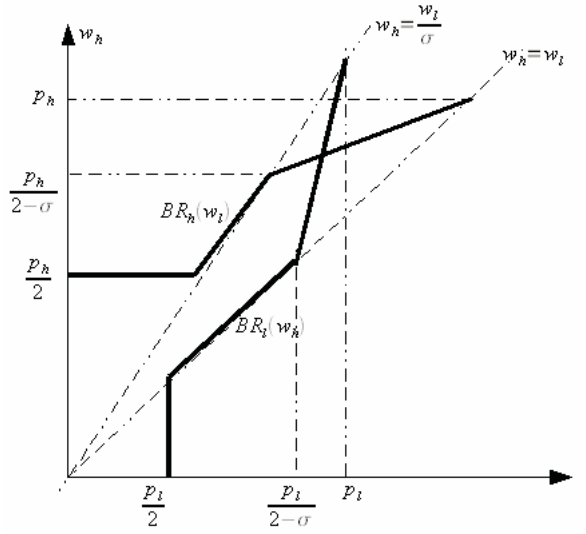

Figure 1: Best response function in upstream price competition

The equilibrium price pair lies in the intersection of the best response curves. Combing condition (9) and (10), we derive the equilibrium prices which are summarized in Lemma 2:

Lemma 2 *The equilibrium of upstream price competition between two firms depends on the relative market premium ρ and the relative cost of farmers σ:*

i if $\rho > \frac{\sigma}{2-\sigma}$, the two firms coexist in equilibrium (case D) and their prices are respectively:

$$w_{dl}^{ff} = p_l \frac{2+\sigma/\rho}{4-\sigma} \tag{11}$$

$$w_{dh}^{ff} = p_h \frac{2+\rho}{4-\sigma} \tag{12}$$

ii if $\frac{\sigma}{2} \leq \rho \leq \frac{\sigma}{2-\sigma}$, firm H is a restricted monopsony in equilibrium (case R). Its price for farmer is

$$w_{rh}^{ff} = \frac{p_l}{\sigma} \tag{13}$$

iii if $\rho \leq \frac{\sigma}{2}$, firm H is a pure monopsony in equilibrium (case MH). Its price for farmer is

$$w_{mh}^{ff} = \frac{p_h}{2} \tag{14}$$

Therefore, in equilibrium only firm H has possibility to deter the entry of firm L but not the reverse. Note that $\frac{\sigma}{2-\sigma}$ and $\frac{\sigma}{2}$ are increasing with σ. Thus the larger σ compared to ρ, the more likely that firm H to deter the entry of firm L. This is intuitive since the larger σ compared to ρ, the lager relative cost of firm L compared to its relative gain and hence the less competitive firm L is in competition with firm H.

In case of coexistence of the two firms (item i), other things equal, the larger the relative cost, the higher the prices that the two organizations pay to farmers. In fact, $\sigma = \frac{c_l}{c_h}$ captures the similarity of the two quality standards in eye of farmers. Thus a large σ implies intensive upstream competition between the two organizations and therefore they set high prices to attract farmers. Inserting the two conditions into the profit conditions of firm 1 and firm 2 ((7) and (8)), we derive the profits for the two firms, which are summarized in Table 2. The question follows is whether the firms can benefit from choosing a high or a low quality standard. The following lemma gives the answer:

Lemma 3 *When two private firms coexist in the market ($\rho > \frac{\sigma}{2-\sigma}$), there exists $\Phi^{ff}(\sigma) \equiv \sqrt{\sigma}$ such that if $\rho > \Phi^{ff}(\sigma)$, firm L gains a larger profit than the firm H and conversely.*

Note that $\Phi(\sigma)$ is increasing with σ, which measures the cost of a farmer under standard s_l relative to s_h, while ρ represents the relative market premium of the low quality and higher quality product. Therefore, the lemma suggests that a firm gains more profit from setting a higher standard if the cost increment for farmers is small (σ is large) compared to the increment of the market premium (ρ is small).

5.2 Coop–s_l firm–s_h

In this subsection, we analyze the situation where a coop with lower quality standard (we denote by (coop H)) coexists with a firm with higher standard. The profit of the private firm is defined by condition (8). The profit of the coop represents the total welfare of farmer members. To share the retained earning, the coop fixes the payment for farmers to the level of market price $w_l = p_l$. Its profit π_l^{cf} is thus

$$\pi_l^{cf} = p_l q_l(w_l, w_h) - \int_{\tilde{\theta}}^{\hat{\theta}} \theta c_l d\theta \tag{15}$$

Given the payment offered by the coop, the private firm will response according to condition (10). Thus the equilibrium price st by coop L is $w_{cl}^{cf} = p_l$, while that of firm H is just $w_h^{cf} = BR_h(w_{cl}^{cf})$. This price is obviously larger than the one in the case of two firms (condition (12)) (for the same level of quality standards). The intuition is straightforward: as the coop repays farmers with the retained earning, which gives it a commitment to fix a high price for farmers, the private firm has to respond with a high payment so as to attract farmers.

Inserting the prices into the profit conditions, we derive the profits of the two organizations (see Table 2), which are functions of ρ and σ. If both coop L and firm H are present in the market ($\rho > \frac{\sigma}{2-\sigma}$), we can compare the profits of the two organizations, as is summarized in lemma 4

Lemma 4 *If coop L coexists with firm H, there is* $\Phi^{cf}(\sigma)$*, such that*

- *if* $\rho > \Phi^{cf}(\sigma)$*, the coop gains a higher profit than the private firm and conversely.*
- $\Phi^{cf}(\sigma)$ *is increasing in* σ *and* $\frac{\sigma}{2-\sigma} < \Phi^{cf}(\sigma) < \Phi^{ff}(\sigma)$

Again, the high quality firm obtains larger profit than the coop with low quality standard if the cost of a farmer to meet a higher quality standard is relatively small compared to the high market premium created by the higher quality standard. Facing the competition of the low quality coop, this condition is nevertheless more stringent than in the case when the firm faces competition with another firm, in the sense that the increment of market premium should be much higher than the cost increment (ρ is much less). To this extent, it is less likely for a high quality firm to make larger profit.

5.3 Coop–s_h firm–s_l

If the coop positions its product to the high quality market (we denote by coop H) compared to the private firm. Its profit is described as

$$\pi_{ch}^{fc} = p_h q_h(w_l, w_h) - \int_0^{\tilde{\theta}} \theta c_h d\theta \tag{16}$$

Providing that the coop fixes $w_h = p_h$, the firm will respond according to condition (9). The equilibrium is summarized in Lemma 5

Lemma 5 *When firm L competes with coop H in setting prices of raw products, coop H sets always* $w_{ch}^{fc} = p(s_h)$*. If* $\sigma < \rho < 1$*, firm L coexists with coop H and sets* $w_{fl}^{fc} = \frac{p_l + \sigma p_h}{2}$*; it is out of the market if* $\rho < \sigma$*.*

Compared with the price in the two-firm case (condition (11)), for the same level of quality standards, the price of firm L is higher, suggesting that the commitment of the coop to repay farmers with the market premium forces the private firm to raise its payment. Furthermore, the condition that firm L is inactive ($\rho < \sigma$) is less stringent than that in the two firm case ($\rho < \frac{\sigma}{2}$), suggesting that it is easier for coop H to deter entry of firm L.

In presence of both organizations, proceeding as before, we derive the comparison of profits of the two organizations in the following lemma:

Lemma 6 *If coop H coexists with firm L, there is* $\Phi^{fc}(\sigma)$*, such that*

- *if* $\rho > \Phi^{fc}(\sigma)$*, the private firm gains a higher profit than the coop and conversely.*

- $\Phi^{fc}(\sigma)$ *is increasing in* σ *and* $\Phi^{cf}(\sigma) < \Phi^{ff}(\sigma) < \Phi^{fc}(\sigma)$

Therefore, the low quality firm gains a larger profit only if the farmer's cost under s_l relative to s_h is small (large σ) compared to the relative market premium. In presence of a high quality coop, this condition is more stringent than the one in the two-firm case, making it less likely for the low quality firm to achieve a higher profit. The comparison of profits in different structures is illustrated in figure 2:

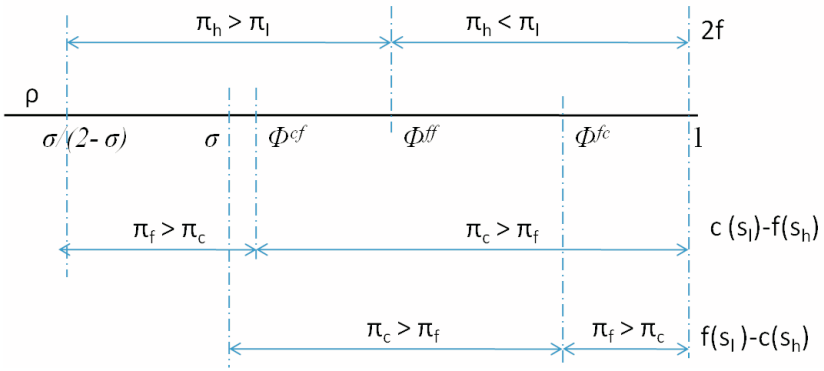

Figure 2: Profits of low quality and high quality organizations

6 Competition in setting quality standard

So far we have derived the prices for farmers and profits of organizations under different competition structures, for given quality standards. We can analyze the decision of the organizations on the quality standards for raw products. The profits of the organizations depend on the structure of price and cost functions. To make the problem tractable, we illustrate the competition by an example where $p(s) = \alpha s$ and $c(s) = \frac{1}{2}\beta s^2$. [4]. Straightforwardly, we have $\rho = \sqrt{\sigma}$. Note that $\sqrt{\sigma} > \sigma > \frac{\sigma}{2-\sigma}$. Therefore from Lemma 2 and Lemma 2, we have duoposonies in all the three cases we have analyzed above. Inserting these conditions into the profit functions of organizations and computing the first derivative of the profit functions with respect to their the respective quality standard of each organization, we find

$$\frac{\partial \pi_l^j}{\partial s_1} < 0 \quad \frac{\partial \pi_h^j}{\partial s_h} > 0 \tag{17}$$

Therefore, in this example, in spite of different organization forms and their competition structures, they will choose the quality standard with maximum differentiations, i.e. $s_l = \underline{s}, s_h = \bar{s}$. This is in line with the product differentiation literatures that the firms competing in quality will choose qualities as different as possbile so as to alleviate the intensive price competitions. (Tirole (1990))

[4]Quadratic form of quality cost is widely used in literatures of product differentiation, such as Motta (1993), Cramps and Hollander (1995), Ecchia and Lambertini (1997)

Now we can compare easily the profits of organizations and welfare of firms in the three cases analyzed above. The major results are summarized as follows:

1. The private firm gains less profit when competing with a coop than when competing with another firm. Under either of the two competition structures, its profit is the same whenever it sets the high or low quality standard.

$$\pi_l^{ff} = \pi_h^{ff} > \pi_{fl}^{cf} = \pi_{fh}^{fc}$$

2. The coop gains a higher profit by setting a higher quality standard than the private firm.

$$\pi_{ch}^{fc} > \pi_{cl}^{cf}$$

3. Farmers are better off when the coop presents in the competition. The total welfare for farmers W is the same whenever the coop sets a higher or a lower quality standard than the private firm.

$$W^{ff} < W^{cf} = W^{fc}$$

Although the total welfare of farmers are the same whenever the coop setting either a higher or lower quality standard than the private firm, the impacts of the two cases on individual farmers are different. Figure 3 shows the surplus of individual farmers under different competition forms. From the figure, the surplus of high efficient

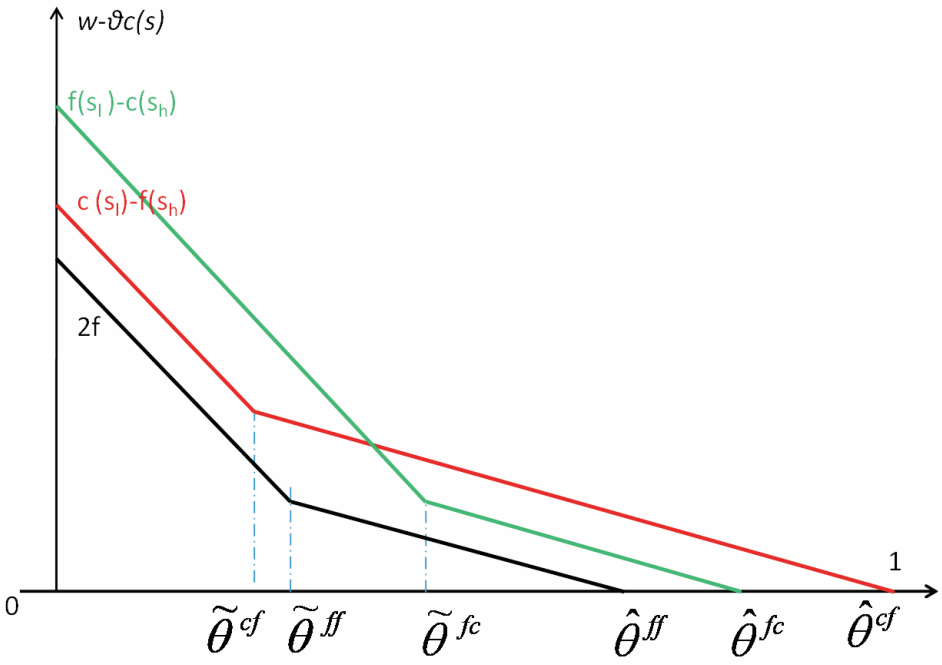

Figure 3: Welfare of individual farmers

farmers (θ close to 0) is the largest when they supply to a coop with high standard (the case $f(s_l) - c(s_h)$), while that of low efficient active farmers (θ close to 1) reaches

maximum when the coop sets a low standard (the case $c(s_l) - f(s_h)$). In the former case, the total number of farmers active in the market are less than in the latter one. This is due to the fact that in the former case the private firm with low quality standard reduces the price for farmers so as to capture large mark-up and therefore less farmers are attracted at the margin. For the same reason, in the latter case, the high quality firm includes only farmers with high efficiency. The number of farmers included is even smaller than the case of two firms ($\theta^{cf} < \theta^{ff}$).

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Table 2: Summary of the second-stage equilibrium

competition	2 firms	coop (s_l)-firm (s_h)	firm(s_l)- coop (s_h)
w_l	$\frac{2c_l p_l + c_l p_h}{4c_h - c_l}$	p_l	$\frac{c_h p_l + c_l p_h}{2c_h}$
w_h	$\frac{c_h(p_l + 2p_h)}{4c_h - c_l}$	$\frac{p_l + p_h}{2}$	p_h
q_l	$\frac{c_h\left(2c_h p_l - c_l(p_l + p_h)\right)}{c_l(c_h - c_l)(4c_h - c_l)}$	$\frac{2c_h p_l - c_l(p_h + p_l)}{2c_l(c_h - c_l)}$	$\frac{c_h p_l - c_l p_h}{2c_l(c_h - c_l)}$
q_h	$\frac{c_h(2p_h - p_l) - c_l p_h)}{(c_h - c_l)(4c_h - c_l)}$	$\frac{p_h - p_l}{2(c_h - c_l)}$	$\frac{c_h(2p_h - p_l) - c_l p_h}{2c_l(c_h - c_l)}$
π_l	$\frac{c_h\left(2c_h p_l - c_l(p_l + p_h)\right)^2}{c_l(c_h - c_l)(4c_h - c_l)^2}$	$\frac{\left(2c_h p_l - c_l(p_h + p_l)\right)^2}{8c_l(c_h - c_l)^2}$	$\frac{(c_h p_l - c_l p_h)^2}{4c_l c_h(c_h - c_l)}$
π_h	$\frac{\left(c_h(2p_h - p_l) - c_l p_h)\right)^2}{(c_h - c_l)(4c_h - c_l)^2}$	$\frac{(p_h - p_l)^2}{4(c_h - c_l)}$	$\frac{(c_h(2p_h - p_l) - c_l p_h)(c_h(2p_h) + p_l) - 3c_l p_h)}{8c_h(c_h - c_l)^2}$