Quality Provision and Farmer Inclusion of Agricultural Cooperatives

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Abstract

The paper aims to analyze the quality provision and inclusion of farmers by a farmer-owned cooperative (co-op) when it competes with an investor-owned firm (IOF). A model of mixed oligopsonistic competition is developed to capture the endogenous participation of farmers who are heterogeneous in their efficiency in providing quality. The results highlight an advantage of the co-op: by imposing a similar quality standard to the one imposed by the IOF, the co-op may drive the IOF out of the market. Thus, it is more likely that the co-op will set a high quality standard when the minimum quality standard is costly to farmers. However, in the presence of a high fixed cost of quality, the coop “monopsonizes” the upstream market by imposing a sub-optimally low quality standard.

JEL classification: Q12, Q13, L1, L2

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1 Introduction

In the agro-food industry, farmers often form cooperatives (co-ops) to enhance their coordination with each other and with food processors. One important type of co-op is the marketing co-op, which forward-integrates the processing industry and competes directly with private processing firms (known as investor-owned firms (IOF)). In many countries, co-ops hold substantial shares in the agriculture sector. In the EU, co-ops account for more than 50% of agricultural production in many member states (83% in the Netherlands, 79% in Finland, 55% in Italy and 50% in France) (EC Legal notice on cooperatives). In the US, cooperatives account for between 25% and 30% of total farm marketing and supply expenditure (Giannakas and Fulton (2005)).

With increasing concerns surrounding the quality and safety of agro-food products, co-ops are orienting towards higher value-added production and controlling the quality of raw product more closely. For example, in the EU, the Committee of Professional Agricultural Organizations and the General Confederation of Agricultural Co-operatives (COPA-COGECA) recommend that farmers and their cooperatives participate in the quality assurance schemes, such as organic food or geographical indication systems (COPA-COGECA (2006)). These systems provide regulation to agro-food production by imposing various quality standards to farmers.\footnote{For example, the organic farming system requires that production is conducted without the use of synthetic chemicals antibiotics and hormones and that animals be bred in a natural and sounding environment (for example, to have access to pasture) (Dimitri and Greene (2001)). The geographical indication system specifies geographic origin of the products and/or particular production methods used in that region. (Moschini et al.(2008)).}

Similar quality provision schemes can also be found in the US (See Hardesty (2004) and Dimitri and Greene (2001) for the example of organic product provision and Lence et.al (2007) for the provision of geographically differentiated products). As co-ops play an important role in coordinating the production of farmers in the agro-food chain, the question on whether a co-op is able to provide high quality products is important for welfare of farmers and the value of the entire production chain. In this paper, we analyze the quality provision of an agricultural co-op when it competes with an IOF in procuring high quality supply of farmers.
Both success and failure of co-ops in high quality business can be observed in practice. For example, the US organic co-op, Valley/CROPP exhibits an ability to attract high quality supply of farmers. Started in 1988 with 7 members to market organic products and dairy products, the co-op distinguishes itself as a group of "small organic family farms". Its membership had expanded to 655 producers and its sales increased from $15 million in 1998 to $122 million in 2003 (Hardesty(2004)). In contrast, the bankruptcies of some large co-ops such as Farmland Industries and Tri Valley Growers in the US demonstrates that these co-ops experience difficulties in undertaking value-added business. The report of McKinsey in 2002 even alleged that agricultural co-ops "destroy value" (Hardesty and Salgia(2004)). In the context of competition between co-ops and IOFs, several questions may arise: first, under what condition can co-ops succeed in providing qualities, which generate high values? Second, does the presence of co-ops in the competition lead to efficient outcomes from a social welfare point of view? And finally, what is the implication of public intervention on the competition?

The debates on co-ops in competition with IOFs have attracted much attention in recent years. As a vertically integrated organization, co-ops enjoy various advantages in quantity competition both on the downstream final markets (See for example Tennbakk (1992), Albeak and Schultz (1998), Giannakas and Fulton (2001) and (2005)) and for procuring raw products on the upstream markets (See for example, Sexton (1990)). In a setting of mixed oligopoly competition, Tennbakk (1992) models the co-op as a vertically integrated firm which competes à la Cournot with an IOF that maximizes the downstream profit. It turns out that the co-op captures a larger market share and farmers benefit more by joining the co-op. Albeak and Schultz (1998) pointed out that the members of a co-op often over produce, which gives the co-op a credible commitment to produce large quantities when it competes with IOFs. Giannakas and Fulton (2001) and (2005) studied the competition between an open membership co-op and an IOF and demonstrated the advantages of co-ops regarding member commitment and innovation, respectively. In a setting of mixed oligopsony competition, Sexton (1990) analyzed the spatial competition between a co-op and a processing firm in procuring raw products from farmers. He emphasized that a co-op may have a pro-competitive effect on the behavior of rival non-cooperative processors and that the presence of an open-membership co-op may mitigate the
model of Tennbakk (1992) and analyzed the competition between a co-op and an IOF in providing quality-differentiated products to the downstream market. He showed that either the co-op or the IOF can promote higher levels of quality, depending on the structure of cost of providing quality. However, the paper only deals with the competition on the downstream level without specifying the policies or contracts that an organization may apply to motivate the quality provision of farmers. Bontems and Fulton (2005) compared the incentive compatibility contracts that a co-op and an IOF offer to farmers in the presence of imperfect information. They showed that the co-op benefits from an information cost advantage compared to the IOF because its objective is consistent with that of farmers. However, in their analysis, each organization is treated as a monopsony dealing with a fixed number of farmers. Therefore their paper does not provide analysis on the competition between co-ops and IOFs.

The present paper focuses on the mixed oligopsonistic competition between a co-op and an IOF in attracting high quality farmers at the upstream level. By allowing endogenous participation of farmers, who are heterogeneous in their efficiency of providing quality, the model analyzes quality provision and farmer inclusion of the co-op when it competes with the IOF in setting quality standards and procurement prices to farmers. The paper first derives the equilibrium conditions under which the co-op or the IOF provides high quality product (by means of imposing a high quality standard to farmers). Then by comparing with other types of competitions, such as competition between two IOFs, the paper analyzes the role that the co-op and the IOF play in the mixed oligopsonistic competition and distinguishes different sources of inefficiency of these organizations in terms of farmer inclusion and quality provision. Finally by introducing the minimum quality standard as a factor that raises the cost to farmers of meeting the low quality standard, the paper sheds some light on how the public intervention will affect the incentive of the co-op to provide monopsony power of the for-profit firms towards farmers. This analysis provides insights into how co-ops can succeed in competition with their IOF counterparts. However, they do not take into account the quality strategy of these organizations.
qualities.

The paper is organized as follows: the next section describes the basic setting. Section 3 analyzes the competition between two organizations in three scenarios: a benchmark scenario in which a regulator sets quality standards to maximize the social welfare; a scenario in which two IOFs compete and a scenario of mixed duopsonistic competition between a co-op and an IOF. Then Section 4 compares farmer inclusion and welfare under different scenarios and provides some insight into the implementation of the minimum quality standard. Section 5 extends the model to the case where the co-op has to share some up-front cost among its members before producing the high-quality product. The last section gives the conclusion.

2 Basic Setting

Consider the vertical structure of a food production chain, where farmers supply raw products for processing of final products. Assume that the upstream market consists of a unit mass of farmers. Each farmer produces at most one unit of raw product. The quality of raw product and production practice are controlled by a quality standard (denoted by $s$), which may take two values: $s_l$ and $s_h$. $s_l$ is a loose and low quality standard, which might correspond to the mandatory minimum quality standard and $s_h$ is a stringent and high quality standard which is stipulated voluntarily by the organization. In order to meet a certain quality standard, a farmer has to make an "effort", which involves a cost depending on the stringency of the quality standard. Farmers differ in their ability to meet the quality standard. We use a parameter $\theta$ to capture the difference. $\theta$ is uniformly distributed over $[0, 1]$. The cost of a farmer indexed by $\theta$ to meet the standard $s_i$ ($i = l, h$) is

\[3\] This assumption suggests that the farm production is capacity constrained, with a large number of farmers producing similar quantities of raw product. A case that corresponds to this assumption is the EU dairy sector, where numerous small farmers produce under the constraint of milk quotas. According to EuroStat (2008), over 80% of dairy farmers in EU-27 countries only have less than 10 cows. The EC milk quota is distributed among individual producers in the Member States based on their historical production.
\[ C(\theta, s_i) = \theta c_i \] with \( c_l < c_h \). Furthermore, for notation convenience, we denote by \( \sigma = \frac{c_l}{c_h} \) \((\sigma \in (0, 1])\), the relative cost of a farmer of meeting the low quality standard and the high quality standard. Note that by construction, \( \sigma \) is independent of the type of farmers, implying that the relative cost is the same across farmers. The smaller \( \sigma \), the larger the incremental cost for a farmer to provide the higher quality product. In return for complying with the quality standard, farmers receive a payment for its unit production under the standard \( s_i \) (we denote by \( w_i \)). The utility function of a farmer indexed by \( \theta \) is thus

\[ v(s_i, w_i; \theta) = w_i - \theta c_i \] (1)

The quality of final product has a direct relationship to the quality of the raw product. We assume that one unit of raw product under quality standard \( s_i \) \((i = l, h)\) can be processed into one unit of final product and then sold at a price \( p_i \) in the final market\(^4\). \( p_l < p_h \), implying a more stringent quality standard for the raw product results in a higher market price for the final product.\(^5\) Furthermore, we denote by \( \rho = \frac{p_l}{p_h} \) \((\rho \in (0, 1])\) the relative price of final products produced with the low quality input and the high quality input, respectively. Thus the smaller \( \rho \), the higher price incremental accruing from the high quality standard. The variable cost of processing is assumed to be zero.\(^6\) However, in order to process and promote the high quality

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\(^4\)We assume that organizations are price-takers of \( p_i \), in the sense that they cannot influence the price by adjusting their production. An example of this is the provision of the Geographical Indication labels or common labels. Once the label is established by a group of producers, other producers complying with the quality requirements can not be excluded from using the label. Therefore, the competition in the downstream final product market is so intensive that each organization can hardly influence the market price (See Moschini et al. (2008)). In other words, this assumption suggests that the two organizations face perfect elastic demand and they compete only for the supply of farmers at the upstream level just like two local duopsonists.

\(^5\)For example, for the organic grains, oilseeds and legumes, which are produced under the ecologically based practices such as biological pest management and composting and on land that has had no prohibited substances applied to it for at least three years prior to harvest, the price premium in the US market ranges from 59% for corn to 177% for soybeans in 2001.(Dimitri and Greene (2001))

\(^6\)This assumption can be relaxed to be in line with the case where the unit cost of processing the final product is constant. In this case, \( p(s) \) can be interpreted as the net revenue gained from
final product (which is produced with the high quality raw product), a fixed cost $g$ is involved at the processing and marketing stages.\(^7\)

The processing and marketing of final products are undertaken by different organizations in the market. In order to control the quality of supply and participation of farmers, an organization announces its policy to farmers, which specifies the quality requirement and the payment scheme associated with quality. Providing that the type of a farmer ($\theta$) is not observable for the organizations and that the quality of raw product is verifiable, we assume that an organization provides a uniform policy to farmers which can be specified by a contract ($s, w$).\(^8\)\(^9\) In this paper, we are interested in the incentive of quality provision by an organization, when it competes with another organization. Therefore we assume that there are potentially two organizations and hence two standards in the market.

Note that each farmer produces one unit of raw product, which can be processed into one unit of final product. To this extent, the production of each organization is directly linked to the participation of farmers. We assume that a farmer can choose to supply only one organization or produce elsewhere in the economy which brings it zero profit. The organization that will be chosen by a farmer depends on the comparison of the utilities that the farmer gains from supplying the two organizations.

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\(^7\)The fixed cost will be argued in more details in Section 5.

\(^8\)In some other cases, an organization discriminates farmers by offering premium to farmers with higher quality products. In this paper, we assume that in order to provide a final product with certain quality characteristics, all farmers who participate in the delivery should comply with the same quality standard. An example of this is the application of common label or Geographical Indication label. Any farmer failing to meet the particular standard regarding land use, choice of input or particular production practices in that region will be excluded from using the label. Similarly, all farmers participating in the organic farm system should comply with the ecological standard. In the US, the label “100 percent organic” is granted to products which contain only organically product ingredients. This suggests that an organization applying such labels cannot accept farmers with lower quality products.

\(^9\)Since we assume that a farmer produces at most one unit of raw product, the payment for each farmer is just the procurement price for the unit raw product.
We denote by \( \theta_i = \{ \theta | v(s_i, w_i; \theta) = 0 \} \) the marginal farmer who is indifferent to producing elsewhere and participating in the organization setting quality standard \( s_i \). The farmer indexed by \( \theta \) with \( \theta < \theta_i \) prefers supplying the organization with standard \( s_i \) to producing elsewhere. In order to analyze the participation of farmers, we assume that \( \theta_i < 1 \) for \( i = l, h \) so that there are always some farmers who produce elsewhere rather than joining either of the two organizations. Furthermore if the two organizations apply respectively the policies \((s_l, w_l)\) and \((s_h, w_h)\) to farmers, there is a marginal farmer \( \tilde{\theta} = \{ \theta | v(s_l, w_l; \theta) = v(s_h, w_h; \theta) \} \), who is indifferent to participating in either of the two organizations. Thus the farmers indexed by \( \theta \) with \( \theta < \tilde{\theta} \) prefer to supply the organization with standard \( s_h \). Therefore, for given policies of the two organizations, three cases may occur:

1. if \( w_l \geq w_h \ (\tilde{\theta} \leq 0) \), the organization with standard \( s_l \) monopsonizes the market \((q_h = 0)\). The total raw product supply is

\[
q^m_l(w_l) = \theta_l = \frac{w_l}{c_l}
\]

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

\[
q^d_l(w_l, w_h) = \theta_l - \tilde{\theta} = \frac{w_l}{c_l} - \frac{w_h - w_l}{c_h - c_l}
\]

\[
q^d_h(w_l, w_h) = \tilde{\theta} = \frac{w_h - w_l}{c_h - c_l}
\]

3. if \( w_l < \sigma w_h \ (\tilde{\theta} > \theta_h > \theta_l) \), the organization with standard \( s_h \) monopsonizes the market \((q_l = 0)\). The supply is

\[
q^m_h(w_h) = \theta_h = \frac{w_h}{c_h}
\]

An organization can take either of the two forms: a farmer-owned cooperative (co-op) or an investor-owned firm (IOF). Due to their different ownership structures, co-ops and IOFs control the participation of farmers in different ways. A

\[\text{The fact that organizations can not observe the type of farmers implies that they have no other means of excluding the participation of farmers other than the policy \((s, w)\). In this sense, the co-op can be seen as a kind of "open-membership co-op", which accepts all delivery of farmers, but with restrictions on quality. The firm has full bargaining power over the individual farmers. Its policy can be seen as a "take-it-or-leave-it" offer.}\]
co-op is owned by farmers. Its objective is to maximize the total welfare of members. In order to analyze the participation of farmers, we assume that the co-op applies an open-membership policy, which implies that the co-op can not reject the participation of farmers who satisfy the production requirement. All revenue and cost accruing in the processing and marketing stages are shared among the members by means of the payment \( w \). In contrast, an IOF aims to maximize the profit at the processing and marketing stages, regardless of the interest of farmers. The IOF bears the fixed cost but leaves as low as possible a rent to farmers. Therefore, in our context, the co-op and the IOF differ in two aspects: the objective functions and the cost and revenue sharing rules. In order to distinguish the two aspects, we first analyze the case where there is no fixed cost to be shared by farmers in providing the high quality product (Section 3). Then we extend the analysis to the case with a fixed cost (Section 5).

3 Competition between two organizations

In this section, we assume that the cost of providing high quality accrues only at the farming stage. Thus, in order to induce farmers to choose the high quality standard, an organization has to compensate farmers by high payments. Assume that the two organizations compete in a two-stage game: in the first stage, they decide their respective quality standards \((s_l \text{ or } s_h)\) simultaneously and commit to the standards in the following stage of the game. In the second stage, they announce their respective payments (prices of raw products) simultaneously to farmers. Farmers then choose either to participate in an organization or to produce elsewhere.

\footnote{A cooperative can have various objectives. According to Tennbackk (1992), A co-op might 1) maximize the profit of the cooperative firm by outsourcing input; 2) maximize the total profit of members and the cooperative plant; 3) maximize throughput or production 4) maximize membership and 5) maximize the patronage refunds per unit without considering the cost. In the present paper, we take the "cooperative as a firm" approach, which is frequently employed by Sexton (1990), Tennbakk (1992), Albeak and Schultz (1998) etc. and assume the objective 2)
Two questions may arise in the presence of competition between two organizations: first, which organization is more likely to impose a high quality standard in equilibrium? Second, does mixed oligopsonistic competition results in an efficient outcome compared to the other types of competition such as the pure oligopsonistic competition? Or equivalently, is the presence of a co-op in the place of an IOF in the competition socially desirable? To answer these questions, we analyze three scenarios, the first two of which serve as a comparison: 1) a benchmark case in which a social planner allocates farmers to follow $s_l$ or $s_h$ so that total welfare is maximized. 2) pure duopsonistic competition between two IOFs 3) mixed duopsonistic competition between a co-op and an IOF.

### 3.1 Benchmark case

We assume that a social planner with complete information aims to maximize the total social welfare. With two quality standards available for the social planner, its problem is to decide which farmer follows which level of quality standard. Lemma 1 shows the optimal inclusion of farmers under two quality standards.

**Lemma 1** It is optimal for the social planner to implement both $s_l$ and $s_h$ if and only if $\rho > \sigma$. Otherwise, it is optimal to implement only $s_h$. In the former case, there are two thresholds $\tilde{\theta}_* = \frac{p_h - p_h}{c_l - c_h}$, $\theta_l^* = \frac{p_l}{c_l}$ such that

- farmers with $\theta \in [0, \tilde{\theta}_*]$ follow standard $s_h$.
- farmers with $\theta \in [\tilde{\theta}_*, \theta_l^*]$ follow standard $s_l$.
- The other farmers produce elsewhere.

**Proof** We first specify the social welfare function. If the social planner chooses two quality standards, the two thresholds $\tilde{\theta}$ and $\theta_l$ should be defined in such a way that farmers with $\theta < \tilde{\theta}$ produce under standard $s_h$ and those with $\tilde{\theta} < \theta < \theta_l$ follow standard

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12 Assume it is costless for the social planner to verify the two quality standards
The problem of the social planner is described as follows:

$$\max_{\theta, \theta_l} W \equiv p_h \hat{\theta} - c_h \int_0^{\hat{\theta}} \theta d\theta + p_l (\theta_l - \hat{\theta}) - c_l \int_{\hat{\theta}}^{\theta_l} \theta d\theta$$  \hspace{1cm} (6)$$

To solve the program, we derive the optimal thresholds as defined in the lemma. The optimal social welfare is thus:

$$W^* = \frac{p_h^2}{c_h} \left( \frac{\sigma - 2\rho \sigma + \rho^2}{2\sigma(1 - \sigma)} \right)$$  \hspace{1cm} (7)$$

If only one quality standard is imposed, the social welfare is maximized as if farmers face a co-op.\(^\text{14}\) Thus we have \(W_i = \pi^{mc}(s_l) = \frac{p_l^2}{2c_l}\). Compared with the case with two standards, \(W^* > \pi^{mc}(s_l)\), \(\forall \rho \in (0, 1), \sigma \in (0, 1)\). However \(W^* > \pi^{mc}(s_h)\) only if \(\rho > \sigma\). Q.E.D.

Intuitively, a farmer indexed by \(\theta\) contributes \(p_h - \theta c_h\) to the social welfare for its unit production if it is assigned to meet standard \(s_h\), while it contributes \(p_l - \theta c_l\) if it produces under standard \(s_l\). Therefore, the farmer should be assigned to produce quality \(s_h\) if \(p_h - \theta c_h > p_l - \theta c_l\) and \(p_h - \theta c_h > 0\), which leads to \(\theta < \hat{\theta}^* = \frac{p_h - p_l}{c_h - c_l}\) and \(\theta < \theta_h = \frac{p_h}{c_h}\). It can be verified that \(\hat{\theta}^* < \theta_h < \theta_l\) for \(\rho > \sigma\). In this case, farmers with \(\theta > \hat{\theta}^*\) should follow the standard \(s_l\) if \(p_l - \theta c_l > 0\). If on the other hand \(\rho < \sigma\) (\(\hat{\theta}^* > \theta_h > \theta_l\)), the price incremental of the high quality product is greater than the cost incremental of meeting the high quality standard. It is optimal to make all farmers with \(\theta < \theta_h\) meet standard \(s_h\) and leave the rest producing elsewhere. In this case, only one quality standard is implemented.

Note that when two quality standards are implemented, the social optimum can be achieved in the case of two co-ops imposing \(s_l\) and \(s_h\), respectively. In order to

\(^{13}\)Note that it is not optimal to leave some efficient farmers inactive while letting less efficient ones produce (i.e. there is no \(\hat{\theta}\) such that farmers with \(\theta < \hat{\theta}\) do not produce while those with \(\theta > \hat{\theta}\) produce). Nor is it optimal to let some less efficient farmers follow standard \(s_h\) and more efficient ones produce quality \(s_l\) (i.e. if \(\theta_1 < \theta_2\) it is not optimal that a farmer indexed by \(\theta_1\) produces for standard \(s_l\) and \(\theta_2\) produces for \(s_h\)). Therefore, the social planner assigns the highly efficient farmers (with \(\theta < \hat{\theta}\)) to fulfill the high quality standard and the low-efficiency ones (with \(\hat{\theta} < \theta < \theta_l\)) to meet the low quality standard and finally the least efficient ones (with \(\theta > \theta_l\)) to produce elsewhere.

\(^{14}\)In this paper we do not consider the consumer surplus. Therefore social welfare is just the sum of downstream profit of the IOF and the total welfare of individual farmers.
redistribute the co-op profit, the two co-ops pay each member $p_l$ and $p_h$, respectively. The farmer indexed by $\tilde{\theta}^*$ is indifferent to participating in either of the two co-ops. The farmers with $\theta < \tilde{\theta}^*$ participate in the co-op with $s_h$ and each gains $p_h - \theta c_h$, while those with $\tilde{\theta}^* < \theta < \theta_l^*$ produce for the co-op with $s_l$ and each receives $p_l - \theta c_l$.

### 3.2 Competition between 2 IOFs

When two IOFs are present in the market, if both implement the same quality standards, they face intensive competition in quoting procurement prices to attract farmers. By raising the price slightly above its rival’s, an IOF can attract all the farmers who are active in the market and hence drive its rival out of the market. The same strategy is applied by the rival firm, leading to a high price ($w = p_i$ at standard $s_i$) such that neither firm earns positive profit. Therefore in order to avoid this intensive competition, the two IOFs try to differentiate their quality standards.\textsuperscript{15} Thus, their policies are respectively $(s_l, w_l)$ and $(s_h, w_h)$. We denote by "Firm L" and "Firm H", the IOFs with standard $s_l$ and $s_h$, respectively. Furthermore, we superscript the equilibrium variables by "ff". The equilibrium of the second stage competition is summarized in Lemma 2:

**Lemma 2** When two IOFs compete in quoting the procurement prices, three cases may occur in equilibrium:\textsuperscript{16}

\begin{enumerate}
\item **Coexistence** if $\rho > \frac{\sigma}{2 - \sigma}$, the two firms coexist in equilibrium ($0 < \tilde{\theta} < \theta_l$) and their prices are respectively:
\begin{align}
    w_{lf}^{ff} &= \frac{2\rho + \sigma}{4 - \sigma} \\
    w_{hf}^{ff} &= \frac{2 + \rho}{4 - \sigma}
\end{align}
\end{enumerate}

\textsuperscript{15}With the same quality standards, the two IOFs are the same from the farmers’ point of view. Therefore, their competition in quoting raw product prices is similar to the Bertrand competition. Eventually, both IOFs make zero profits. This result stems from two assumptions: the two IOFs face perfect elastic demand and the payment for raw product is the only instrument for controlling the supply of farmers.

\textsuperscript{16}We use $w_i^j$ and $\pi_i^j$ to denote respectively the equilibrium procurement price and the profit of the IOF with the quality standard $s_i$ under the competition pattern $j$. In this subsection, $j = ff, Rf$ or $Mf$, representing three equilibrium cases stated in the Lemma.
The two thresholds are respectively \( \tilde{\theta}_{ff} = \frac{p_h}{c_h} \frac{2-\rho-\sigma}{1-\sigma(4-\sigma)} \) and \( \theta_{ff} = \frac{p_h}{c_h} \frac{2\rho+\sigma}{\sigma(4-\sigma)} \).

ii Restricted monopsony if \( \frac{\sigma}{2} \leq \rho \leq \frac{\sigma}{2-\sigma} \), Firm H just "monopsonizes" the market (\( \tilde{\theta} = \theta_l = \theta_h \)). Its price for farmer is

\[
w_{hf}^R = \frac{p_h}{\rho}
\]  
(10)

iii Pure monopsony if \( \rho \leq \frac{\sigma}{2} \), Firm H is a pure monopsony in equilibrium (\( \tilde{\theta} > \theta_l \)). Its price for farmer is

\[
w_{hf}^M = \frac{p_h}{2}
\]  
(11)

Proof: In the second stage of the game, the two firms simultaneously decide the prices of raw products so as to maximize their profits, anticipating the participation of farmers. Their profits are defined as follows:

\[
\pi_{ff}^l = (p_l - w_l)q_l(w_l, w_h) 
\]  
(12)

\[
\pi_{ff}^h = (p_h - w_h)q_h(w_l, w_h) 
\]  
(13)

where \( q_l(w_l, w_h) \) and \( q_h(w_l, w_h) \) are defined by conditions (2)-(5). Providing that \( w_h \leq \frac{p_l}{2} \), the best response function for Firm L ( \( BR_l(w_h) \) ) is

\[
BR_l(w_h) = \begin{cases} 
\frac{p_l}{2} & \text{if } w_h < \frac{p_l}{2} \quad \text{Pure Monopsony} \\
w_h & \text{if } \frac{p_l}{2} \leq w_h \leq \frac{p_l}{2-\sigma} \quad \text{Restricted Monopsony} \\
\frac{p_l + \sigma w_h}{2} & \text{if } \frac{p_l}{2-\sigma} < w_h \leq \frac{p_l}{\sigma} \quad \text{Coexistence}
\end{cases}
\]  
(14)

The first line, the pure monopsony price is derived by maximizing the profit of Firm L (condition (12)), taking into account \( q_l(w_l, w_h) = q_l^m(w_l) \) defined in condition (2). The first-order condition gives \( w_l = \frac{p_l}{2} \), Firm L is a monopsony if \( w_l > w_h \). Therefore we have \( w_h < \frac{p_l}{2} \). The third line is the duopsonistic price, derived by maximizing the profit, taking into account that \( q_l(w_l, w_h) = q_l^d(w_l, w-h) \) defined in condition (3). When the two firms coexist, \( \sigma w_h < w_l < w_h \), which gives \( \frac{p_l}{2-\sigma} < w_h \leq \frac{p_l}{\sigma} \). There is an intermediate case, the restricted monopsony case, in which \( \frac{p_l}{2} \leq w_h \leq \frac{p_l}{2-\sigma} \). In this case, if Firm L coexists with Firm H by setting \( w_l = \frac{p_l + \sigma w_h}{2} \), one can verify that \( w_l > w_h \). 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 price. On the other hand, if Firm L chooses to monopolize the market by setting \( w_l = \frac{p_l}{2} \), one can verify that \( w_l < w_h \), which induces entry of Firm H. Thus the monopsony
price fails to capture the monopsony profit. In order to maximize profit, Firm L chooses a restricted price \( w_l = w_h \) so as to just cover the most efficient farmer (\( \bar{\theta} = 0 \)) and to just force Firm H to exit the market.

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

\[
BR_h(w_l) = \begin{cases} 
\frac{p_h}{2} & \text{if } w_l < \frac{\sigma p_h}{2} \quad \text{Pure Monopsony} \\
\frac{w_l}{\sigma} & \text{if } \frac{\sigma p_h}{2} \leq w_l \leq \frac{\sigma p_h}{2 - \sigma} \quad \text{Restricted monopsony} \\
\frac{p_h + w_l}{2} & \text{if } \frac{\sigma p_h}{2 - \sigma} < w_l \leq p_l \quad \text{Coexistence}
\end{cases}
\]

Thus the first and the third lines are derived by maximizing the profit for Firm H (Condition (13)), with \( q_h(w_l, w_h) \) to be \( q^m(w_h) \) (defined by condition (5)) and \( q^d(w_l, w_h) \) (condition (4)), respectively. The conditions associated with the two cases are derived by the two conditions \( w_l < \sigma w_h \) and \( \sigma w_h < w_l < w_h \), respectively. The second line reflects the restricted monopsony case where Firm H just drives firm L out of the market, i.e. \( \bar{\theta} = \theta_l = \theta_h \).

The equilibrium price pair lies at the intersection of the best response curves, which can be illustrated by Figure 1 From the figure, \( BR_l(w_h) \) intersects with \( BR_h(w_l) \) at the part

![Best response function of under two-firm competition](image)

Figure 1: Best response function of under two-firm competition

where the two organizations coexist if

\[
\frac{p_l}{\sigma} > \frac{p_h}{2 - \sigma}
\]
which leads to $\rho > \frac{\sigma}{2-\sigma}$. In this case, the equilibrium prices (8) and (9) in item i are decided by combining the two best response functions:

$$w_l = \frac{p_l + \sigma w_h}{2} \quad w_h = \frac{p_h + w_l}{2}$$

Thus we derive the equilibrium threshold levels by inserting the two prices into the thresholds functions $\theta = \frac{w_h - w_l}{c_h - c_l}$ and $\theta_l = \frac{w_l}{c_l}$. There follows item i in the lemma.

From Figure 1, the two response functions intersect at the point which belongs to the part that firm H just monopsonizes the market if

$$\frac{p_h}{2-\sigma} > \frac{p_l}{\sigma} > \frac{p_h}{2}$$

which leads to $\frac{\sigma}{2-\sigma} \geq \rho \geq \frac{\sigma}{2}$. The equilibrium price for the restricted monopsony firm $w_{Rf}^h$ in condition (10) is defined by combining the following conditions

$$w_h = \frac{w_l}{\sigma} \quad w_l = p_l$$

Thus we have item ii in the lemma. If $p_l < \frac{p_h}{2}$, Firm H captures all farmers even with the monopsony price, which is derived by maximizing the monopsony profit (13) with $q_h(w_l, w_h) = q_h^m = \frac{w_h}{c_h}$. Thus there is only one firm in the market which imposes the high quality standard. (item iii) Q.E.D.

Therefore, in equilibrium, only Firm H has the possibility of monopsonizing the upstream market but not Firm L. Note that $\frac{\sigma}{2-\sigma}$ and $\frac{\sigma}{2}$ are increasing with $\sigma$. Thus the larger $\sigma$ compared to $\rho$, the more likely that Firm H will drive Firm L out of the market. This is intuitive since the larger the relative cost of Firm L compared to its relative gain, the less competitive Firm L is compared to Firm H. In the case of coexistence of the two firms (item i), all other things being equal, the larger the relative cost, the higher the purchasing prices paid by the two organizations. In fact, $\sigma = \frac{c_l}{c_h}$ captures the similarity of the two quality standards from the farmers’ point of view. Thus the larger $\sigma$, the more similar it will be for a farmer to produce under these quality standards and therefore the more intensive upstream competition between the two organizations in attracting farmers’ supply. As a result, input prices are higher in equilibrium.
In the first stage, the two IOFs choose either to set standard \( s_l \) or \( s_h \), simultaneously. There are two symmetric pure strategy equilibria, in which either IOF applies the high quality standard \( s_h \) to farmers. The other IOF applies either the low standard \( s_l \) if \( \rho > \frac{\sigma}{2-\sigma} \) or quits the market otherwise.

3.3 Mixed duopsonistic competition

In this scenario, we focus on the competition between a co-op and an IOF. Starting from the second stage of the game, where the two organizations compete in quoting raw product prices to farmers, we analyze two cases: the competition between a co-op setting standard \( s_l \) (denoted by Coop L) and Firm H and the reverse case. By comparing the profits they make in the two cases, we derive the equilibria of the first-stage game, where the two organizations compete in setting quality standards.

3.3.1 Coop sets \( s_l \) and IOF sets \( s_h \)

We use "cf" to denote the equilibrium case where Coop L and Firm H coexist. The equilibrium of the second-stage competition is summarized in Lemma 3.

Lemma 3 When Firm H competes with Coop L, Coop L always sets \( w^c = p_l \). Three cases may occur in equilibrium:

i Coexistence if \( \rho > \frac{\sigma}{2-\sigma} \), both organizations coexist (\( 0 < \tilde{\theta} < \theta_l \)). Firm H will purchase at price

\[
    w_{cf}^h = \frac{p_h}{2} \left(1 + \rho\right)
\]

The two thresholds are \( \tilde{\theta}_{cf}^l = \frac{p_h}{c_h} \frac{2(1-\rho)}{2(1-\sigma)} \) and \( \theta_{cf}^l = \frac{p_l}{c_l} \). Coop obtains

\[
    \pi_{cf}^l = \frac{p_h^2}{c_h} \left(2\rho - \sigma(1 + \rho)\right)^2 \frac{8\sigma(1-\sigma)^2}{8\sigma(1-\sigma)^2} \quad (16)
\]

ii Restricted Monopsony if \( \frac{\sigma}{2} \leq \rho \leq \frac{\sigma}{2-\sigma} \), Firm H just "monopsonizes" the market (\( \tilde{\theta} = \theta_l \)) and prices at

\[
    w_{hf}^{Rf} = \frac{p_h \rho}{\sigma}
\]
iii **Pure Monopsony** if $\rho \leq \frac{\sigma}{2}$, Firm $H$ monopsonizes the market ($\tilde{\theta} > \theta_l$) and sets

$$w_{h}^{Mf} = \frac{p_h}{2}$$

**Proof:** Coop $L$ decides its payment to farmers based on the patronage of farmers, that is, the payment to a member is in proportion to the volume of its production. By assumption, each farmer produces one unit of raw product and the co-op sets a uniform price to call for supply of farmers. Therefore, in order to distribute all vertical profit to farmer members, the co-op raises the payment up to the level of the market price, i.e. $w^e = w_l = p_l$. Thus, if both Coop $L$ and Firm $H$ are present in the market, the "profit" of the co-op, i.e. the total welfare of co-op members $\pi_{dc}^{cl}$ is

$$\pi_{cl}^{cf} = p_l q^d_l(w_l, w_h) - c_l \int_{\tilde{\theta}}^{\theta_l} \theta d\theta$$  \hspace{1cm} (17)

where $q^d_l(w_l, w_h)$ is defined in condition (3). In equilibrium, Firm $H$ will set the procurement price according to the response function (15): $w_{h}^{cf} = BR_h(p_l)$. This gives the three prices as well as the threshold levels in the three items of Lemma 3. By inserting the equilibrium prices into the objective function of Coop $L$ (17), we derive the equilibrium profit of Coop $L$ as defined in condition (16). Q.E.D.

The price offered by Firm $H$ in the case of coexistence is obviously larger than in the two-firm case (condition (9)). The intuition is straightforward: as the co-op repays farmers with all the vertical profit, which gives it a commitment to fix a high price for farmers, the IOF has to respond with a higher payment so as to capture some supply of farmers. To this extent, the organizational structure of the co-op gives it an advantage in the second-stage price competition.

### 3.3.2 Coop sets $s_h$ and firm sets $s_l$

We use "fc" to denote the equilibrium case where Firm $L$ coexists with Coop $H$. The equilibrium of price competition is summarized in Lemma 4

**Lemma 4** When Firm $L$ competes with Coop $H$, Coop $H$ always sets $w^e = p_h$. Two cases may occur in equilibrium:
i **Coexistence** if $\sigma < \rho < 1$, Firm $L$ coexists with Coop $H$ and sets

\[ w_{fc}^L = p_h \frac{\rho + \sigma}{2} \]

the two thresholds are $\tilde{\theta}_{fc}^L = \frac{p_h}{c_h} \frac{2-\rho-\sigma}{2(1-\sigma)}$; $\theta_{fc}^L = \frac{p_h}{c_h} \frac{\rho+\sigma}{2\sigma}$ Coop $H$ obtains:

\[ \pi_{fc}^H = \frac{p_h^2}{c_h} \frac{(2-\rho-\sigma)(2+\rho-3\sigma)}{8(1-\sigma)^2} \] (18)

ii **Monopsony coop** if $\rho < \sigma$, Firm $L$ is out of the market. Coop $H$ obtains

\[ \pi_{Mc}^H = \frac{p_h^2}{2c_h} \]

**Proof** Similar to the former case, Coop $H$ will distribute its profit to farmer members by setting $w^c = w_h = p_h$. Thus if both organizations are present on the market, the total welfare for farmers participating in Coop $H$ $\pi_{dc}^H$ is

\[ \pi_{fc}^H = p_h q_{hc}(w^L, p_h) - c_h \int_0^{\tilde{\theta}_{fc}^H} \theta d\theta \] (19)

where $q_{hc}(w^L, p_h)$ is defined in condition (4). In equilibrium, Firm $L$ will respond according to the best response function (14). Thus we have $w_{fc}^L = BR_L(p_h)$, which gives the equilibrium price and thresholds defined in the Lemma. The equilibrium profit for Coop $H$ is derived by inserting the equilibrium variables into condition (19). Q.E.D.

Compared with the price in the two-firm case (condition (8)), the price of Firm $L$ is higher, suggesting that the commitment of the co-op to repay farmers with the market price forces the IOF to raise its payment. Furthermore, the condition that Firm $L$ is inactive ($\rho < \sigma$) is less stringent than that in the two-firm case ($\rho < \frac{\sigma}{2}$), implying that Firm $L$ is more likely to exit when competing with a co-op than with another IOF.

### 3.3.3 Equilibrium of competition in setting quality standards

Anticipating the outcome of competition in the second stage, in the first stage, the co-op and the IOF decide their respective quality standard. Proposition 1 summarizes the equilibrium:
Proposition 1 When a co-op competes with an IOF in choosing quality standard, there are two increasing functions $\rho^f(\sigma)$ and $\rho^c(\sigma)$ ( $1 > \rho^f(\sigma) > \rho^c(\sigma) > \sigma$ for $\sigma \in (0, 1)$) such that four cases occur in equilibrium:

i CL-FH If $\rho \geq \rho^f(\sigma)$, there is one pure strategy equilibrium in which the co-op chooses $s_l$ and the IOF chooses $s_h$.

ii Mixed equilibrium If $\rho^f(\sigma) > \rho > \rho^c(\sigma)$, there is no pure strategy equilibrium. The IOF always wants to differentiate the standard, but the co-op always chooses the same standard as that of the IOF.

iii FL-CH If $\rho^c(\sigma) > \rho \geq \sigma$, there is one pure strategy equilibrium in which the IOF chooses $s_l$ and co-op chooses $s_h$.

iv MCL If $\rho \leq \sigma$, the co-op "monopsonizes" the market with standard $s_h$.

Proof: To derive the equilibrium of competition, we first specify the response of each organization. As was mentioned in section 3.2, the IOF has no incentive to impose the same quality standard as its rival's. Therefore, providing that the co-op sets a standard $s^c$, the IOF always imposes a different standard $s^f \neq s^c$. Such reasoning, however, does not hold for the co-op. Providing that the IOF sets $s^f$, the co-op can impose either a different standard $s^c \neq s^f$ or the same standard as that of the IOF $s^c = s^f$. In the former case, the co-op coexists with the IOF and obtains the "duopsonistic" profit. In the latter case, the IOF is driven out of the market because it receives no profit if it raises its price above that of the co-op ($w^c = p_i$), while the co-op receives a monopsony profit. The normal form of the game is represented in the table. Where $\pi^c_{i}$ and $\pi^f_{h}$ are defined by conditions (16) and (19), respectively. $\pi^M_{c} = \frac{p^2}{2\gamma_i}$ are the monopsony profit that the co-op obtain by imposing.
quality standard \( s_i \) \((i = l, h)\). Whether the co-op chooses a different quality standard or the same standard as that of the IOF depends on the comparison of profits that the co-op obtains in the two cases. More precisely, if the IOF chooses standard \( s_h \), the co-op will choose \( s_l \) and coexist with the IOF (we denote by the case "CL-FH") if \( \pi_{cf}^l > \pi_{Mc}^h \), which leads to

\[
\rho > \rho^c_f(\sigma) = \frac{(\sigma + 2\sqrt{\sigma(1-\sigma)})}{2 - \sigma}
\]

otherwise, the co-op chooses \( s_h \), which drives the IOF out of the market. Thus we have item i in the proposition. Analogously, if the IOF sets \( s_l \), the co-op coexists with the IOF (case "FL-CH") if \( \pi_{cf}^h > \pi_{Mc}^l \), which gives

\[
\rho < \rho^c_f(\sigma) = \frac{\sigma^2 + 2\sqrt{(1-\sigma)^3\sigma(4 - 3\sigma)}}{4 + \sigma(-7 + 4\sigma)}
\]

Thus we have item iii. It can be verified that \( \rho^c_f(\sigma) > \rho^c_f(\sigma) \) for \( \sigma \in (0, 1) \). Thus when \( \rho^c_f(\sigma) > \rho > \rho^c_f(\sigma) > \sigma \), the IOF always wants to differentiate its quality standard, whereas the co-op always chooses the same standard as that of the IOF. There is no pure strategy equilibrium for this range of parameters (item ii). If \( \rho < \sigma \), the co-op chooses \( s_h \), while the IOF can only choose \( s_l \). However, by Lemma 4, Firm L can not attract the supply of farmers. Therefore, Coop H totally "monopsonizes" the upstream market (item iv). Q.E.D.

Figure 2 illustrates the equilibrium competition structures under different parameter ranges.

![Figure 2: Equilibrium competition pattern](image)
Note that a large $\rho$ compared to $\sigma$ implies that the relative rise in the market price due to the high quality standard is small compared to the incremental in the cost of meeting the high standard. Therefore, the low quality standard is an attractive strategy for both organizations. Providing that the coop can set the same standard as that of the IOF and that the IOF always differentiates its quality standard from its rival’s, the competition results in Coop L and Firm H in equilibrium. The same reasoning holds for the case where the relative price is similar compared to the relative cost ($\rho$ is similar to $\sigma$). The competition leads to Coop H versus Firm L. If the incremental of price due to the high quality standard totally exceeds the cost incremental, the co-op totally monopsonizes the market with a high standard. To sum up, when quality provision is not so profitable in the sense that the market premium on the high quality product is low compared with the additional cost paid by farmers to meet the high quality standard, it is more likely that the IOF will provide the high quality product. Whereas when the market premium is high compared to the cost incremental, it is more likely that the co-op will choose to provide the high quality.

Traditional co-ops are often known for production of low quality (Zago (2006))\textsuperscript{17}, while it is more flexible for IOFs to choose quality standards. The analysis above suggests that the reason is either due to a large difference between the costs of providing the high and low qualities or a small difference between the benefits of the high and the low quality products. However, with the increasing concern for food quality and safety, consumers are more willing to pay for the high quality products, which leads to an increase in the gap between the prices of the high quality product (for example, the organic products) and the generic one. Meanwhile, innovation and technology progress in production makes it easier for farmers to access the high quality production. The model suggests that the increase in price gap or the decrease in cost difference makes the coop more likely to succeed in the high quality business.

\textsuperscript{17}Zago (2006) argued that due to lack of investment and the difficulty of controlling the quality of production of their members, traditional co-ops suffer from a reputation for low quality.
4 Welfare Analysis and Policy Implication

4.1 Farmer inclusion and welfare

So far we have derived the equilibrium of competition between the co-op and the IOF. A question arises about whether the equilibrium outcome is socially desirable or alternatively, whether the co-op and the IOF include farmers in a socially efficient way. To provide some insight into the question, we focus on the two equilibrium cases in which the co-op and the IOF coexist (i.e. the case "CL-FH" in which $\rho > \rho^c_f(\sigma)$ and the case "FL-CH" in which $\sigma < \rho < \rho^c_f(\sigma)$ in item i and iii of Proposition 1, respectively). Each case is compared with three scenarios: 1) competition between two IOFs 2) the benchmark case 3) the case where there is only one co-op. Figure 3 illustrates the spread of individual farmers’ welfare under different scenarios. The left (or right) panel of the figure compares the welfare of each farmer in the case where $\rho < \rho^c_f(\sigma)$ (or $\sigma < \rho < \rho^c_f(\sigma)$). Curve ABC corresponds to the benchmark case which is equivalent to the case where two co-ops with different quality standards set $w_i = p_i$ ($i = l, h$). Curve DEC (or ADE in the right panel) plots the scenario where the co-op and the IOF coexist. Curve FGH is the scenario of competition between two IOFs and Curve IC (or AI in the right panel) is the case where a co-op monopsonizes the upstream market.

![Figure 3: Welfare of individual farmers](image-url)
We analyze first the left panel where the price incremental of the high quality product is small relative to the cost incremental due to the high quality standard \((\rho > \rho^c(\sigma))\). In this case, the competition between the co-op and the IOF leads to Coop L and Firm H in equilibrium. Compared with the two-firm scenario, a straightforward observation is that curve \textit{DEC} is above curve \textit{FGH}, implying that the welfare of each farmer is improved if a co-op is present in the place of an IOF. Indeed, by repaying members with \(p_l\) for the low standard \(s_l\), Coop L not only includes the low-efficiency farmers which are excluded in the two-firm scenario (i.e. those with \(\theta \in (\hat{\theta}^c_l, \hat{\theta}^l_c)\)), but also attracts farmers with intermediate efficiency, who supply for the high quality IOF in the two-firm scenario (i.e. those with \(\theta \in (\tilde{\theta}^c_l, \tilde{\theta}^l_c)\)). Therefore, Coop L always includes more farmers than Firm L does when competing with Firm H.

Compared with the benchmark scenario (Curve \textit{ABC}), the competition between the co-op and the IOF induces a misallocation of farmers in providing the two different qualities. From the left panel, farmers with intermediate level of efficiency \((\theta \in [\tilde{\theta}^c_l, \tilde{\theta}^*])\) are induced to participate in Coop L in the case of mixed duopsonistic competition, while it is optimal that they follow the high quality standard. To this extent, as the total participation of farmers in the case of "CL-FH" is the same as that under the benchmark case \((\theta^c_l = \theta^*_l)\), Coop L includes more farmers than the socially optimal level, while Firm H induces a suboptimal supply. Such inefficiencies are due to the interplay of two factors: the monopsony power of the IOF which entails an exclusion of the less efficient farmers and the intensive competition triggered by the co-op which erodes the supply base of the IOF. The grey areas in the two panels show the deadweight loss in the mixed duopsonistic competition scenario.

Despite the inefficiency in the presence of the IOF, the absence of the IOF is not socially desirable neither. Compared with the one co-op scenario ("MCL" in the left panel\(^{18}\)), the presence of Firm H under mixed duopsonistic competition induces higher (or at least the same) welfare for farmers. Indeed, by upgrading their product

\(^{18}\text{Under the condition } \rho > \rho^c(\sigma), \text{ it is optimal for the monopsony co-op to choose standard } s_l. \text{ Thus we have the case "MCL" in the one-co-op scenario.}\)
quality and supplying to Firm H, the efficient farmers \((\theta \in [0, \hat{\theta}^{cf}])\) receive a higher rent than they would have gained by supplying for the monopsony Coop L (line \(DE\) is above line \(IE\)). This is due to the fact that farmers with different abilities to produce qualities are more efficient producing two qualities instead of a uniform one. The presence of an IOF serves as a way to introduce another quality standard, which raises the efficiency of farmers.\(^{19}\)

Similar results can be derived from the right panel where \(\sigma < \rho < \rho^{fc}(\sigma)\). In this case, the mixed duopsonistic competition leads to Firm L and Coop H being in equilibrium (curve \(ADE\)). Social welfare is higher than that in the two-firm scenario (curve \(FGH\)). However, compared with the benchmark scenario (curve \(ABC\)), mixed duopsonistic competition entails a misallocation of farmers in providing qualities. Farmers with intermediate efficiency \((\theta \in (\hat{\theta}^{s}, \tilde{\theta}^{fc})\) join Coop H while it would be optimal to assign them to follow standard \(s_l\). The low-efficiency farmers \((\theta \in [\theta^{fc}_{l}, \theta^{*}_{l}]\) produce elsewhere while it would be optimal that they produce for the organization with the low quality standard. Although the inefficiency mainly comes from the oligopsony power of Firm L, the presence of Firm L induces higher welfare than in the one-coop scenario since the less efficient farmers \((\theta \in [\tilde{\theta}^{fc}_{l}, \theta^{fc}_{l}]\) benefit from supplying Firm L instead of participating in a co-op with the high quality standard (line \(DE\) is higher than line \(DI\)).\(^{20}\) The above comparisons can be summarized in Proposition 2:

**Proposition 2** If the co-op and the IOF coexist, the co-op always includes more farmers than an IOF does when competing with another IOF. Compared with the benchmark case, the IOF always induces insufficient supply of farmers. However the competition results in higher social welfare than in the case with only one co-op in the market.

\(^{19}\)This is under assumption that \(\rho > \sigma\) so that two qualities is better than one from the social welfare point of view. (see Lemma 1)

\(^{20}\)Under the condition \(\sigma < \rho < \rho^{fc}(\sigma)\), it is optimal for the monopsony co-op to choose \(s_h\).
4.2 Minimum quality standard

The above analysis provides some insights into the effect of raising the minimum quality standard (MQS). With increasing concerns surrounding food safety, the public authorities are tightening production requirements and creating new control procedures, new labelling strategies for farmers and their organizations. For example, the on-going EU Common Agricultural Policy reform stipulates that in order to receive a direct payment, farmers have to comply with rules relating to basic standards for the environment, food safety, animal and plant health and animal welfare, as well as standards aimed at the maintenance of land in good agricultural and environmental condition (European Commission (2007)). Naturally, stricter quality control makes the production of farmers more costly. However, higher quality standard does not necessarily also induce a higher market premium. As reported by Marette (2005), the market premium is quite low for products with ethical characteristics, animal welfare and environmental attributes. Moreover, some standards or norms regarding the reduction of pesticide residues and microbial contamination, aim to guarantee product safety and reduce environmental risks rather than to differentiate the final markets and to capture consumers with high willingness to pay. (Giraud-Héraud et al. (2006)) To this extent, imposing a MQS mainly involves high costs for farmers relative to the market premium it might generate. In the model, this feature can be captured by an increase in $\sigma$ (or equivalently an increase in $c_L$) while keeping other variables unchanged.

Extensive literature has analyzed the effects of MQS based on the pure oligopolistic competition framework with vertical product differentiation (see, for example, Ronnen (1991), Crampes and Hollander (1995), Ecchia and Lambertini (1997), Scarpa (1998) etc.) These works focus on the competition between firms in attracting the purchase of consumers. Relatively few analyses have focused on the effect of the MQS on the strategy of downstream firms towards upstream producers. Giraud-Héraud et al. (2008) analyzed the strategy of a downstream firm in setting production standards and controlling production of upstream producers in the presence of MQS and
different degrees of consumer trust. However, as there is only one monopolistic firm providing a uniform standard in the intermediary market, the paper does not analyze the effect of the MQS on the competition to procure the intermediary products. In a similar paper, Giraud-Héraud et al. (2006), the upstream producers face two standards in two spot markets for the intermediary products, respectively: a low standard in the generic market and a high standard in a safe market, which is applied by a coalition of downstream firms. However, they assume that both downstream firms and upstream producers are price takers in the intermediary market. Therefore their analysis fails to provide a close insight into how the downstream firms exert their market power towards the upstream producers. In the present setting, we focus on the effect of the MQS on the quality provision and farmer inclusion in the context of mixed duopsonistic competition.

From Figure 2, for $\rho$ given, if $\sigma$ increases from a small level to a large level, the co-op first provides the low quality product, then the high quality one and finally dominates the upstream market. To this extent, a stringent MQS makes it more likely for the co-op to undertake the high quality business. Indeed, as the cost of providing the low quality standard approaches that of the high quality standard, while the price difference between the high and the low quality products remains unchanged, the high quality business becomes more attractive than the low quality one for both the co-op and the IOF. Due to the advantage of the co-op in setting the same standard as that of the IOF, the co-op wins the high-efficiency farmers by

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21In the model, the upstream producers are heterogenous in terms of equipment level (or technology level), which can be upgraded to meet the requirement of the downstream firm. By imposing the equipment requirement, the downstream firm can reduce the contamination risk, which determines the size of total demand. The model distinguishes various strategies that the downstream firm may apply in the presence of different levels of MQS and different degrees of consumer trust. One of the results concerning the MQS shows that if the MQS is high enough, the downstream firm will set a higher standard and make all selected producers upgrade their equipment levels.

22The paper uses the competitive equilibrium approaches to assume that the downstream and upstream firms make their decision taking the intermediary prices as given. The intermediary prices are thus determined by balancing the demand of the downstream firms for the intermediary product and the supply of the upstream producers.
setting the high quality standard.

The MQS also affects the farmers’ participation decisions as well as the total social welfare. From Lemma 3 and Lemma 4, in either case of competition between the co-op and the IOF ("CL-FH" or "FL-CH"), the total participation of farmers $\theta^j_l$, $(j = cf$ or $fc$) is decreasing with $\sigma$, while the number of farmers meeting the high quality standard ($\tilde{\theta}^j$) is increasing with $\sigma$. Therefore, the MQS induces more farmers to choose the organization with the high quality standard and fewer farmers to follow the MQS (if the competition pattern does not change). The latter effect dominates the former, leading to a reduction in the numbers of total participation of farmers. The impact of the MQS on the welfare of individual farmers varies with their efficiency levels. For the high-efficiency farmers which always participate in the organization with the high quality standard, the MQS does not change the level of their utility if the competition pattern does not change. For the farmers with intermediate efficiency, the level of their utilities declines accordingly. Some switch to produce for the high quality organizations in the presence of a stringent MQS. Finally, for the low-efficiency farmers, their utilities are reduced with the MQS. More farmers switch to produce elsewhere. Since consumer surplus is not taken into account, if imposing the MQS merely raises the cost of farmers in meeting the low quality standard, it is not surprising that total welfare, including total farmer utilities and the profit of the IOF, decreases with the MQS.\footnote{It can be verified that even if the competition pattern changes, welfare is reduced as well. More precisely, if the MQS leads to the change of equilibrium structure from the competition between Coop L and Firm H to the competition between Coop H and Firm L, it can be verified that the welfare in the former case is larger than that in the later case.} The above analysis can be summarized in Proposition 3

**Proposition 3** A stringent MQS benefits the high quality organization by inducing more farmers to follow the high quality standard, while the low quality organization suffers from a reduction in farmer supply. In equilibrium, it is more likely for the co-op to undertake the high quality business.
5 Fixed cost of processing and marketing

In this section, we extend our model by adding a quality-related fixed cost at the processing or marketing stage.\textsuperscript{24} Due to their difference in the ownership structures, the co-op and the IOF treat the fixed cost differently. This may affect their production decisions and hence influence the equilibrium competition pattern as well as the welfare of farmers. To formulate the idea, we assume that an organization announcing quality standard $s_i$, has to bear a fixed cost $g_i$ in order to process and sell its product at price $p_i$ ($i = l, h$). For simplicity, we assume that $g_l = 0$ and $g_h = g > 0$. Sometimes it is useful to measure the fixed cost by $\gamma = g / \frac{p^2}{4c_h}$. Note that the denominator $\frac{p^2}{4c_h}$ is just the monopsony profit of Firm H when the fixed cost is not taken into account.\textsuperscript{25} Therefore $\gamma$ is just the fixed cost relative to the maximum profit that Firm H can obtain. We assume that $0 < \gamma < 1$, which is a necessary but not sufficient condition for the IOF to be active in the market. In the presence of the fixed cost, the two-stage game is described as follows: in the first stage, the co-op and the IOF decide on their respective quality standards, simultaneously. Once the standard is settled, they bear the fixed cost associated with the quality standard. In the second stage, the co-op and the IOF set their respective procurement prices simultaneously, anticipating the effect of these prices on the participation of farmers. Finally, given the standard and price offered by the two organizations, farmers decide whether to join the co-op or the IOF or to produce elsewhere.

\textsuperscript{24}At the processing stage, cost occurs because of management, administration, settling plant and equipment, storage, package, shipment, etc. In particular, the organic products should be shipped and packed in containers without synthetic fungicide, preservative or fumigant. At the marketing stage, in order to inform the buyers (either consumers or retailers), additional costs are involved on certification, advertising, promotion, etc.

\textsuperscript{25}The monopsony profit of Firm H is derived by maximizing the profit defined in condition (13) with the supply function expressed by $q_h(w_l, w_h) = q^m_h(w_h) = \frac{w_h}{c_h}$. Thus the monopsony price for the Firm H is $w^m_f = \frac{p_h}{2c_h}$, which leads to the monopsony profit $\pi^m_h = \frac{p^2}{4c_h}$. 


tion if the fixed cost can be covered by the profit that the organization may obtain from producing the high quality good. Once the high quality standard is chosen by an organization, the fixed cost is paid by the organization. The game suggests that both the IOF and the co-op are able to pay the cost prior to the realization of profits at the second stage if they chooses to produce the high quality product. For the IOF, the fixed cost can be financed by the investors before the realization of profit at the second-stage. Whereas for the co-op, it is its members who bear the fixed cost. Hence when the membership is not fixed at the first stage of the game, it is difficult for the co-op to obtain the funds. To deal with this problem, we assume that the fixed cost can be financed by some debt issued by the co-op and then the debt will be repaid by farmer-members at the second stage of the game. To this extent, the fixed cost will affect the second-stage decisions of the co-op and the IOF in different ways. For the IOF, since the investors are totally independent of the input suppliers, the fixed cost is sunk and hence will not affect the decision of the IOF on the input procurement price. Whereas for the co-op, producers are also investors of the organization. Thus the fixed cost has to be borne by farmer-members once they join the co-op in the second stage of the game. To be in line with the setting without the fixed cost, we assume that the co-op uses the uniform procurement price to share the co-op revenue and cost among farmers.\footnote{We assume that the co-op shares the fixed cost uniformly among its members. There may be other sharing rules that discriminate between members. For example, the membership fee that differs between the old members and new ones (Rey and Tirole (2007)). In this paper, we focus on the sharing rule based on the patronage of farmers (which implies a equal sharing rule in our setting). The issue of using membership fee to finance the co-op is out of the range of our analysis.} As a result, the second-stage decision of the co-op is directly affected by the level of fixed cost and the farmers participation decisions, which depends on the procurement price set by the co-op, is also linked with the level of the fixed cost. The next subsection analyzes the decision of the procurement price in the presence of the fixed cost.

Since the level of the fixed cost does not affect the second-stage decision of the IOF, the response functions of the IOF are identical to those in the case without the fixed cost (condition (14) and (15)), as long as the IOF earns positive profit.
Therefore, the second-stage equilibrium of competition between the two IOFs remains the same as that in the case without the fixed cost (subsection 3.2). Since by assumption, there is no fixed cost involved in the low quality production \((g_l = 0)\), the second-stage equilibrium of competition between Coop L and Firm H is also the same as in subsection (3.3.1). However, the similarity does not hold for the case of competition between Firm L and Coop H, which has to share the fixed cost among its members. In the following analysis, we begin by deriving the second-stage equilibrium of competition between Coop H and Firm L. Then, combining the equilibrium of competition with Coop L and Firm H, we analyze the decisions of the two organizations on quality standards in the first-stage.

5.1 Competition between Coop H and Firm L

5.1.1 The second-stage response functions

In the second-stage competition, the uniform procurement price for the co-op plays two roles: to share the revenue and the fixed cost and to control the participation of farmers (or equivalently, the quantity of farmer supply). Providing that the the Firm L sets \(w^f = w_l\) and anticipating that the total membership is \(q_h\), Coop H will set \(w_h\) to share the co-op profit in the following way:

\[
    w_h = p_h - \frac{g}{q_h}
\]  

(20)

The right-hand-side term represents the unit rent that Coop H can offer to its members. Each member benefits from a unit revenue of sale \(p_h\) and shares equally the fixed cost \(\frac{g}{q_h}\) for its unit production. The net unit payment \(w_h\) is less than \(p_h\), implying that Coop H has a fixed-cost disadvantage in the second-stage competition. Note that the larger the membership of the co-op \((q_h\) is large), the lower the cost that is borne by each member and hence the higher the rent a farmer can gain from participating in the co-op. This being the case, in order to provide a high quality product, the co-op has to attract a sufficiently large number of farmers so as to cover the fixed cost.
In order to control the participation of farmers $q_h$, the co-op sets payment $w_h$, taking into account the supply function defined in condition (3)-(5), which depends also on the price set by Firm L ($w_l$). Three cases may occur. First, if $w_l$ is too small such that $w_l < \sigma w_h$, the co-op totally monopsonizes the market. Therefore $q_h = q_h^m = \frac{w_h}{c_h}$ (condition (5)). Inserting this into the cost-sharing rule (20), we have $w^c = w^c_h = p_h \frac{1 + \sqrt{1 - \gamma}}{2}$. This defines a threshold of $w_l$, which makes Coop H just monopsonize the market.

$$w_l = \sigma w_h^M = p_h \frac{\sigma(1 + \sqrt{1 - \gamma})}{2}$$

Thus if $w_l < w_l$, Firm L is out of the market.

Second, if $w_l$ is not too small, Coop H coexists with Firm L by producing $q_h = q_h^d(w_l, w_h) = \frac{w_h - w_l}{c_h - c_l}$ (Condition (4)). The decision of $w_h$ can be illustrated by the left panel of Figure 4. The payment made by Coop H is determined by the intersection of the curve of the unit rent $p_h - \frac{\sigma}{q_h^d(w_l, w_h)}$ and the curve of the unit payment $w_h$.

Note that the former curve increases with $w_h$ and decreases with $w_l$. When $w_l$ is not too small such that $w_l < \sigma w_h$, the co-op totally monopsonizes the market. Therefore $q_h = q_h^m = \frac{w_h}{c_h}$ (condition (5)). Inserting this into the cost-sharing rule (20), we have $w^c = w^c_h = p_h \frac{1 + \sqrt{1 - \gamma}}{2}$. This defines a threshold of $w_l$, which makes Coop H just monopsonize the market.

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Figure 4: Decision of $w_h$ by Coop H

\[27\] We take the larger root to ensure the stability of the equilibrium. The choice of the root is discussed in the following analysis.
so large, the unit rent curve intersects with the unit payment curve at two points, which corresponds to two roots for the equation of the cost-sharing rule (20).

\[ w^{fc}(w_l) = \frac{1}{2} \left( p_h + w_l \pm \sqrt{(p_h - w_l)^2 + p_h^2(\sigma - 1)\gamma} \right) \]

If the co-op chooses the smaller root, a slight reduction of \( w_h \) from the smaller root will induce a lower rent for the marginal farmer \( \tilde{\theta} \) than the level of payment that is required to make it produce for the high quality standard \( (p_h - \frac{g}{q_h}(w_l, w_h) < w_h) \). Therefore, fewer farmers participate in the co-op and hence the existing members bear a larger cost, which in turn, results in further members leaving. Eventually, no farmer would participate in the co-op. Thus Coop H is out of the market. On the other hand, if \( w_h \) is increased slightly above the level of the smaller root, the unit rent is greater than what the marginal farmer needs to cover its cost \( (p_h - \frac{g}{q_h}(w_l, w_h) > w_h) \). Therefore, more farmers will participate in the co-op until the available rent and payment re-balance again, i.e. until the rent reaches the level of the larger root. Therefore, the smaller root is not a stable equilibrium. In contrast, if the co-op chooses the larger root, a slight increase in \( w_h \) will lead to a lower rent than the payment needed to induce the participation of farmers. Therefore some farmers exit the co-op, which raises the unit rent compared to the payment needed. Thus the membership returns to the equilibrium level. Therefore, the larger root corresponds to a stable equilibrium. In the following analysis, we keep the larger root as the response of Coop H to the procurement price set by Firm L \( (w_l) \).

Finally, if \( w_l \) is so large that the unit rent curve lies below the unit payment curve, there is no intersection. In this case, whatever the payment that the co-op offers to farmers, the unit rent is lower than the payment required to induce sufficient participation of farmers. Therefore, Coop H is driven out of the market due to the high level of \( w_l \). From the figure, we can find a \( \tilde{w}_l \) that makes the unit rent curve just tangent with the unit payment curve. It is derived by solving the cost-sharing rule for \( w_h \) and letting the discriminant of quadratic equation be zero: \( \Delta = 0 \). Thus

\[ \Delta = 0 \]

The larger root satisfies Marshallian Stability, which views the quantity change in response to a change in price. Such criteria is also used in Moschini et al. (2008) and Fontaine et al. (2008).
we have

\[ \hat{w}_l = p_h(1 - \sqrt{\gamma(1 - \sigma)}) \]

Thus, the Coop H is out of the market if \( w_l > \hat{w}_l \).

For notation convenience, we divide all price variables \( w_i \ (i = l, h) \) by \( p_h \) and denote by \( \omega_i = \frac{w_i}{p_h} \). Then the response function of Coop H given that Firm L sets \( \omega_l \) is thus

\[
\omega_h(\omega_l) = \begin{cases} 
\text{out} & \text{if } \omega_l > \hat{\omega}_l \quad \text{MFL} \\
\frac{1}{2} \left( 1 + \omega_l + \sqrt{(1 - \omega_l)^2 + (\sigma - 1)\gamma} \right) & \text{if } \frac{\rho}{2} < \omega_l \leq \frac{\rho}{2 - \sigma} \quad \text{Coexistence} \\
\omega^{MC}_h & \text{if } \omega_l \leq \frac{\rho}{2 - \sigma} \quad \text{MCH}
\end{cases}
\]

(21)

The response function of the Firm L is the same as condition (14). Dividing by \( p_h \), the response function becomes

\[
\omega_l(\omega_h) = Br_l(\omega_h) = \begin{cases} 
\frac{\rho}{2} & \text{if } \omega_h < \frac{\rho}{2} \quad \text{Pure Monopsony} \\
\omega_h & \text{if } \frac{\rho}{2} \leq \omega_h \leq \frac{\rho}{2 - \sigma} \quad \text{Restricted monopsony} \\
\frac{\rho + \sigma \omega_h}{2} & \text{if } \frac{\rho}{2 - \sigma} < \omega_h \leq \frac{\rho}{\sigma} \quad \text{Coexistence}
\end{cases}
\]

(22)

It can be verified that the response function of Coop H \( \omega_h(\omega_l) \) cuts the response function of Firm L \( \omega_l(\omega_h) \) at the point where \( \omega_l(\omega_h) = \frac{\rho + \sigma \omega_h}{2} \) (if the intersection exists). This implies that if Firm L is present in the market, it coexists with Coop H.

5.1.2 Equilibrium of competition between Coop H and Firm L

The equilibrium lies at the intersections of the two response functions which are plotted in Figure 5. The response curve of Firm L \( \omega_l(\omega_h) \) is increasing suggesting that the procurement price is strategically substitute. However the response curve of Coop H \( \omega_h(\omega_l) \) is non-increasing, implying that the higher the price paid by the IOF, the lower the rent offered by the co-op. Note that as \( \rho \) increases, the response curve of Firm L shifts rightwards parallel. Therefore, it may cut the curve of Coop H in the horizontal part where \( \omega_h(\omega_l) = \omega^{MC}_h \) if \( \rho \) is small and in the decreasing part if \( \rho \) is at an intermediate level. If \( \rho \) is large, the low quality product also worth a high
price as compared to the high quality product. Therefore, Firm L can afford a high procurement price, which induces more supply of farmers. Short of participation to share the fixed cost, Coop H is out of the market. The equilibrium cases are summarized in Lemma 5

**Lemma 5** When Firm L competes with Coop H in setting procurement prices,

1. **MCH** Firm L is out of the market if \( \omega_l(\omega^M_h) \leq \omega_l \), which gives

\[
\rho \leq \rho^f_l = \frac{1}{2} \left( 1 + \sqrt{1 - \gamma} \right) \sigma
\]

Under this condition, Coop H sets the monopsony price \( \omega^c = \omega^M_h = \frac{1 + \sqrt{1 - \gamma}}{2} \) and earns the monopsony profit: \( \pi^M_h = \frac{p^2}{2c_h} \left( \frac{1 + \sqrt{1 - \gamma}}{2} \right)^2 \).

2. **MFL** Firm L monopsonizes the market if \( \omega_l(\hat{\omega}_h) > \hat{\omega}_l \), which gives

\[
\rho > \hat{\rho} = 2 - \sigma - \left( 2 - \frac{\sigma}{2} \right) \sqrt{\gamma(1 - \sigma)}
\]

3. **Coexistence** Firm L and Coop H coexist if \( \rho^f_l < \rho \leq \hat{\rho} \), The equilibrium

\[\text{Figure 5: Response functions of Firm L and Coop H with fixed cost}\]

For notation simplification, we use \( \hat{\rho}, \rho^f_l, \) etc. to denote the threshold functions of \( \sigma \) and \( \gamma \).

\[\hat{\rho} > \rho^f_l \text{ for } \gamma < \frac{4(1-\sigma)}{(2-\sigma)^2}. \]

This condition ensures that the quantity of the IOF (denoted by \( q^f_l \)) is non negative, i.e. \( q^f_l > \hat{q}_l = q_l(\hat{\omega}_l, \hat{\omega}_h) \geq 0 \).
payments \((\omega_l^c, \omega_h^c)\) solve the following equations:

\[
\begin{align*}
\omega_h &= \frac{1}{2} \left( 1 + \omega_l + \sqrt{(1 - \omega_l)^2 + (\sigma - 1)\gamma} \right) \\
\omega_l &= \frac{\rho + \sigma \omega_h}{2}
\end{align*}
\]

Therefore, the second-stage equilibrium is similar to the case without cost-sharing in that the larger the price incremental of the high quality product (i.e. the smaller \(\rho\)), the more likely that Coop H will enjoy a large membership and Firm L will loose the upstream market. However, unlike the case without the fixed cost, with cost-sharing, Coop H has a fixed-cost disadvantage, which prevents it from offering high payment to farmers when the participation is low. Particularly when providing high quality induces a small price incremental \((\rho > \hat{\rho})\), Coop H may be driven out of the market by Firm L. In this case, it is more likely that the co-op will choose the same standard as that of the IOF, i.e. the low quality standard, so as to secure its market position. The next subsection deals with this issue.

### 5.2 Equilibrium of quality standard competition

In the first-stage of the game, the strategies of the two organizations are similar to the ones developed in the case without fixed cost (subsection 3.3.3): the IOF always prefers to differentiate its quality standard from that of the co-op, whereas the co-op can either differentiate its quality standard or set the same standard as the IOF.\(^\text{31}\)

Therefore, the choice of quality standard by a co-op depends on the comparison of its profits under the two strategies, i.e. if the IOF chooses \(s_l\) (or \(s_h\)), the co-op compares the two profits: \(\pi_{l,l}^f\) (or \(\pi_{l,h}^f\)) if it chooses a different standard and \(\pi^c_{l,l}\) (or \(\pi^c_{h,l}\)) if it chooses the same standards. Thus many cases may occur in equilibrium in the presence of the fixed cost \(\gamma\), depending on the relationship of parameters \(\rho\), \(\sigma\) and \(\gamma\).

\(^{31}\)Note that the co-op in this model is a vertically-integrated organization, which always obtains a larger "profit" than its IOF counterpart does. Therefore, if the co-op cannot cover the fixed cost when setting \(s_h\), nor can the IOF. However, the reverse statement is not true. To this extent, if the co-op triggers the price competition with the IOF by setting the same quality standard as that of the IOF, the co-op can always offer farmers a higher price than the IOF does, which drives the IOF out of the market.
Figure 6 plots the equilibrium competition pattern in a $\sigma - \rho$ space for $\gamma = 0.5$. The threshold functions in the figure are defined respectively by the following conditions:

$$
\rho^f_h : \pi^c_f = 0; \quad \rho^c_f : \pi^c_i = \pi^M_c; \quad \rho^c_h : \pi^M_c = \pi^M_c; \quad \rho^c_f : \pi^c_f = \pi^M_c;
$$

In equilibrium, Coop L and Firm H coexist if $\rho^f < \rho < \rho^f_h$ (which is derived by $\pi^c_f > 0$ for Firm H and $\pi^c_i > \pi^M_c$ for Coop L); Firm L and Coop H coexist if $\rho^l < \rho < \min\{\rho^l, \hat{\rho}\}$ (which is derived from the coexistence condition in item iii of Lemma 5 combined with the condition $\pi^l_c > \pi^M_c$ for Coop H); in case of one co-op in the market, it prefers $s_h$ to $s_l$ if $\rho < \rho^l_h$ (derived by $\pi^M_c > \pi^M_c$).

![Equilibrium competition pattern](image)

Figure 6: Equilibrium competition pattern with cost-sharing ($\gamma = 0.5$)

Note that when $\rho$ is small (for example, at the level of $\rho_1$), the equilibrium competition pattern is similar to that in the case without the fixed cost (see Figure 2 in subsection 3.3). The competition leads to Coop L and Firm H when $\sigma$ is small, Firm L and Coop H when $\sigma$ is at an intermediate level and finally a monopsony Coop H when $\sigma$ is large. Intuitively, the price incremental due to the high quality product is large enough to mitigate the distortion induced by the fixed cost, the co-op acts as it does in the case without the fixed cost.
However, when $\rho$ is at an intermediate level (for example at the level of $\rho_2$), the presence of fixed cost leads to different competition patterns in equilibrium. Particularly when $\sigma$ is small, the competition leads to a monopsony coop with standard $s_l$ (the region "MCL(1)" and "MCL(2)" in Figure 6). The reason is that the larger the cost incremental for farmers to meet the high quality standard, the more likely that the co-op will choose the low quality standard. As in this case, the IOF can not make a profit by setting the high quality standard ($\rho > \rho_f^h$) and nor can it survive by setting the same low standard as that of the co-op, the "CL-FH" case will not occur in equilibrium and hence Coop L monopsonizes the upstream market. It should be mentioned that in the region "MCL(2)" (where $\sigma$ is at an intermediate level such that $\rho^{fc} < \rho < \rho^{ch}_l$), $\pi^{fc}_h < \pi^{Mc}_l < \pi^{Mc}_h$. In this case, if there is no competition from Firm L, the co-op prefers $s_h$ to $s_l$. When competing with Firm L, the co-op receives less profit than it would obtain by setting standard $s_l$. However, the IOF cannot differentiate its quality standard by setting $s_h$, $\pi^{cf}_h < 0$. Therefore, the IOF is out of the market. To this extent, the co-op strategically chooses the low quality standard so as to enjoy the monopsony position on the upstream market.

As has been analyzed in the case without the fixed cost, the presence of the co-op in the place of the IOF improves social welfare. When the fixed cost is required, however, the strategy of the co-op may induce an inefficient outcome. Figure 7 shows how social welfare varies with $\gamma$ under different competition scenarios when $\rho$ and $\sigma$ are at similarly high levels. The thick lines plot the equilibrium welfare. $\gamma^{cf}$ and $\gamma^{ch}_l$ are derived by $\rho = \rho^{fc}(\sigma, \gamma)$ and $\rho = \rho^{ch}_l(\sigma, \gamma)$, implying that $\pi^{fc}_h = \pi^{Mc}_l$ and $\pi^{Mc}_h = \pi^{Mc}_l$, respectively. When $\gamma$ ranges in $[\gamma^{cf}, \gamma^{ch}_l]$, which corresponds to the region "MCL(2)" in Figure 6, the equilibrium welfare is $W^{Mc}_l$, which is lower than that in the case of monopsony co-op H ($W^{Mc}_h$). When $\gamma$ approaches the level of $\gamma^{fc}$, the equilibrium welfare is even lower than that in the case where Firm L and Coop H coexist ($W^{Mc}_f$) and in the two-firm case ($W^{ff}$). To this extent, the introduction of the high quality standard, either by the co-op or by the IOF, induces a higher welfare than that in the case in the absence of the high standard. Due to the advantage of the co-op in setting the quality standard, the co-op chooses a sub-optimally low
quality standard in order to avoid the "high" fixed cost of improving quality and to drive the IOF out of the upstream market.

6 Conclusion and remarks

This paper analyzes the quality provision of a farmer-owned cooperative (co-op) when it competes with a private-owned firm (IOF) in setting quality standards and quoting raw product prices to attract farmers. By developing a model of mixed duopsonistic competition, which allows endogenous participation of farmers, the paper derives the conditions under which a particular competition pattern occurs. The result shows that whether a co-op provides high quality depends on the comparison of costs and benefits of raising the quality standard. Particularly, when quality provision is not so profitable in the sense that the market premium on high quality product is low compared to the additional cost paid by farmers to meet the high quality standard, it is more likely that the IOF will provide the high quality product. Whereas when the market premium is high, it is more likely that the co-op will choose to produce high quality.
The analysis highlights another advantage of the co-op in competing with the IOF: by imposing the same quality standard as that of the IOF, the co-op triggers intensive competition with the IOF in quoting procurement price, which can drive the IOF out of the market. Duo to this advantage, the co-op can more easily implement a profitable quality standard, which induces greater participation of farmers and leaves little supply to the IOF rival.

As a farmer-owned organization, the co-op is seen as a "yard-stick" of competition which serves to mitigate the market power of the IOF rivals. Therefore, co-ops are often exempted from the regulation of competition authority (Sexton (1990)). Hayes et al.(2004) pointed out that the organization which develops "any brand that benefits both the primary producers and improves quality for consumers will be viewed less skeptically by the antitrust authority". The present paper abstracts from the issue of consumer surplus and focuses on the benefit of farmers and total industry welfare. It is shown that the presence of co-ops in competition with IOFs may lead to a higher welfare than the case of competition between IOFs. Indeed, its organizational structure gives the co-op a commitment to repay farmers with all vertical profit and hence the IOF has to respond with a high procurement price. Therefore, all farmers are better off when the co-op is present in the competition. However, the presence of a low-quality monopsony co-op may lead to inefficient outcome because of two reasons. First, farmers with different abilities to provide qualities are more efficient to follow different levels of quality standard. Therefore, a monopsony co-op with low quality standard may fail to provide the high-efficiency farmers a better incentive to provide qualities. Second, when providing quality requires a high up-front fixed cost, the IOF can not make profit with the high quality product, while the co-op can. However due to its advantage to set the same standard as that of the IOF, the co-op may strategically choose a low quality standard so as to drive the IOF rival out of the market and enjoy a "monopsony" position in the market. In this case, the welfare is lower than in the case where the co-op chooses a high quality standard and coexists with the IOF. It is even lower than the case of competition between IOFs. Therefore a low-quality co-op should arouse antitrust
suspicions when it achieves a monopsony position.

The paper also sheds some light on the impact of the minimum quality standard (MQS). A stringent MQS imposed by the public authority implies that the difference between the high and the low quality standards is reduced. Therefore, the two organizations becomes more similar from the farmers’ point of view and hence their competition for farmers is more intensive. However, because of the advantage of the co-op in setting the same quality standard as that of the IOF, the MQS makes the co-op more likely to dominate the upstream market. From a farmer welfare point of view, the MQS raises the cost of meeting the low quality standard. More farmers switch to produce the high quality product and some low-efficiency farmers quit the market. The total welfare of farmers declines in favor of the organization with the high quality standard.

References


