On the relative disadvantage of cooperatives

Dieter Pennerstorfer

Vienna University of Economics and Business Administration

dieter.pennerstorfer@wu-wien.ac.at

Christoph Weiss

Vienna University of Economics and Business Administration

christoph.weiss@wu-wien.ac.at

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006

1. Introduction

Cooperatives and investor-owned firms are alternative forms of business organisation that coexist and compete in many markets. The theoretical literature has identified a number of comparative advantages and disadvantages of cooperatives (Fulton, 1995; Albaek and Schultz, 1998; Karantininis and Zago, 2001; Bogetoft, 2005). A classical problem of traditional cooperatives is the quantity control problem of cooperatives, which arises from the decentralised decision making of the members of a cooperative (Phillips, 1953). Each member (farmer) decides how much to deliver to the cooperative and the cooperative thus has no control over what is actually supplied to the market.

Albaek and Schultz (1998) investigate the consequences of this behaviour in a market, where the cooperative competes with an investor owned firm (mixed duopoly). The authors find that due to the decentralisation of output decisions, cooperatives tend to overproduce. Although an individual farmer realizes that an increase in production reduces the price in the final market, he does not internalize the profit loss stemming from the price decrease incurred by the other members of the cooperative. Albaek and Schultz demonstrate, that this negative externality turns out to be a comparative advantage of cooperatives in Cournot competition. Overproduction in the cooperative serves as a commitment device for credibly and profitably gaining market shares: '… the results of this paper suggest that in the long run all farmers would be members of the cooperative' (Albaek and Schlutz, p. 401).

However, this strong prediction is not supported empirically. Table Table 1 summarizes the market shares of cooperatives in different markets. While cooperatives have large market shares in some countries and some markets (e.g. milk production in Ireland) they are virtually non-existent in other markets (e.g. beef production in Belgium or Greece). Within a particular country (e.g. Denmark), the market shares of cooperatives vary between 0 % (poultry and sugar beet) and 97 % (pork), and within a specific market (e.g. vegetables), market shares differ between 8 % (Ireland) and 90 % (Denmark). Furthermore, the predicted increase in the market shares of cooperatives cannot be observed in many markets, even in the long run, as illustrated in table Table 2. While the market share of cooperatives in the market for milk production in the US increased steadily from 46 % in 1951 to 85 % in 1993 and therefore gives some support for the prediction if Albaek and Schultz (1998), the market shares in other markets remained fairly stable (e.g. fruits and vegetables) or even declined slightly (e.g. livestock).

This paper investigates the importance of product quality as a strategic variable for firms in a competitive market. Quality differences are important in many food markets. Frick (2004) and Dilger (2005) have shown that cooperatives in the German wine sector offer a significantly lower quality than investor owned firms (farms), for example. Dilger (2005) argues, that members of the cooperative face a free-rider problem. Whereas the individual member has to bear all costs associated with higher quality of inputs delivered to the cooperative, the benefits of delivering higher quality have to be shared among all members.[1]

There exists a large literature on the quality choice in "pure" duopolies with two investor-owned firms. In pure duopolies it is a well-established result that the firm producing higher quality earns higher profits, irrespective whether producing higher quality increases fixed costs (Lehmann-Grube 1997; Motta 1993), variable costs (Motta 1993) or does not influence costs at all (Choi and Shin 1992).

According to our knowledge Hoffmann (2005) is the only paper that aims at investigating firms' quality choices under different ownership structures (mixed duopoly).[2] The question whether the cooperative or the investor-owned firm produces the high or the low quality product is determined exogenously. Further, the number of upstream firms delivering to the cooperative and the investor-owned firm respectively are fixed (closed membership).

We go beyond the existing literature by analyzing firms' quality decisions endogenously in a mixed duopoly. Further, the number of upstream firms delivering to the investor-owned firm and the cooperative will also be determined endogenously (open membership).

In the next section (section 2) we set up the model. Section 3 investigates the quality decision of the profit maximizing firm and the cooperative, when the number of members of the cooperatives and the number of primary producers delivering to the firm is exogenous (closed-membership). In section 4 the primary producers are allowed to choose between being a member of the cooperative and delivering to the firm (open-membership). Section 5 concludes.

2. The Model

We follow Albaek and Schultz (1998) as well as Karantininis and Zago (2001) and consider a situation where there are two manufacturers and n farmers who sell through one or the other. We call one manufacturer the cooperative (C) and the other the profit maximizing firm, for short the firm (F). From the n farmers, n_C deliver to the cooperative and n_F to the firm ($n = n_F + n_C$). The manufacturers use the components delivered from the farmers and produce a composite good which is then sold to consumers. Depending on the quality level of the components delivered, each manufacturer's product is associated with a number $s^g > 0$, $g \in \{H, L\}$ which represents its quality level (with $s^H > s^L$). For simplicity, we follow Economides (1999) and assume that the quality of the manufacturers' composite good is the minimum of the quality levels of its components (the inputs delivered by the individual farmers).

We assume that manufacturers have constant marginal costs which are normalized to zero. Farmers, on the other hand, have positive production costs. Producing high quality inputs is assumed more costly then producing low quality inputs: $c(q) = \frac{1}{2} c^g q^2$ with $c^H > c^L$.

Each farmer can choose between delivering to the cooperative or to the firm. If the farmer chooses to deliver to the cooperative, he has to decide whether to produce high or low quality and what quantity (q) to produce and deliver. The cooperative uses the inputs received and produces the final good which is then sold to consumers. The cooperative thus operates with an 'individualistic' decision-making process, where each member decides how much and which quality to deliver, whereas the cooperative has no control over what is actually supplied to the market. The cooperative also retains no profit. The unit price paid to the farmer either is p^H, if the product is of higher quality than the competing firms' product, or p^L, in the case where the cooperative offers the product with the lower quality. Depending on the prices received, an individual members' profit is $p_C^g = p^g q_C - \frac{1}{2} c^g q_C^2$.

The situation of farmers, who choose to deliver to the firm, is different. Following Albaek and Schultz (1998), we assume that the firm has a (perfect) contract with the farmers. Hence its behaviour can be described as if the firm maximises the vertically integrated profit of itself and its suppliers (farmers). In fact, the firm makes all the relevant decisions (how much to sell to the market and what level of quality to choose). As the distribution of profits is not essential here, we follow Albaek and Schultz (1998) in assuming that the vertically integrated profit is distributed among all farmers delivering to the firm.[3] Depending on whether the firm supplies high or low quality, its problem is to maximize $p_F^g = p^g Q_F - n_F \frac{1}{2} c^g (\frac{Q_F}{n_F})^2$.

Finally, it remains to describe market demand and prices for high and low quality (p^g). Consumers' preferences are formalized in the spirit of Gabszewicz and Thisse (1979) and Tirole (1988). There is a continuum of consumers distributed uniformly over the interval $[q-1, q]$ with unit density, where $q > 1$. Each consumer either buys high quality, low quality or does not buy at all. The consumer indexed by the parameter $\tilde{q} \in [q-1, q]$ maximizes the following utility function:

$$(1)\quad u_{\tilde{q}} = \begin{cases} \tilde{q} v_i - p_i & \text{if he buys from firm } i \\ 0 & \text{otherwise} \end{cases}$$

All consumers prefer higher quality at a given price, but a consumer with higher $\tilde{q}$ is willing to pay more for higher quality. The parameter q measures the degree of consumer differentiation in evaluating product quality. The inverse demand functions for high and low quality are $p^H = qs^H - s^H Q^H - s^L Q^L$ and $p^L = s^L(q - Q^H - Q^L)$. To simplify notation, we normalize $s^L = c^L = 1$, $s^H = s \geq 1$ and $c^H = c \geq 1$. Note, that if all products are of the same quality ($s = 1$), the inverse demand function is $p^H = p^L = p = q - Q$.[4] If products differ in quality ($s > 1$), consumers are willing to pay more for the higher quality ($p^H > p^L$).

Closed membership equilibrium

To describe the farmers', the cooperative's and the firm's behaviour, we first assume n_F and n_C to be exogenously given. Each farmer has already decided whether to deliver to the firm or to the cooperative (closed membership). Further, we assume for a moment that all farmers delivering to the firm behave identically and that the same is true for all members of the cooperative (symmetric equilibrium).

The cooperative and the firm compete in the market in a Cournot fashion. Suppose that the final product of the cooperative is of higher quality then the competing firm's product. The cooperative receives the higher market price p^H and an individual members' profit is $p_C^H = [qs - s(q_C + Q_{C,-i}) - Q_F]q_C - \frac{1}{2}c^H q_C^2$, where $Q_{C,-i}$ denotes the total output of all other members of the cooperative. If, however, the cooperative's product has lower quality, profits for each member would be $p_C^L = (q - q_C - Q_{C,-i} - Q_F)q_C - \frac{1}{2}q_C^2$. Finally, in the case where there are no quality differences between the cooperative and the firm, profits are $p_C^{HH} = [q - (q + Q_{C,-i} + Q_F)]sq_C - \frac{1}{2}c^H q_C^2$ or $p_C^{LL} = [q - (q + Q_{C,-i} + Q_F)]q_C - \frac{1}{2}q_C^2$.[5]

Assuming Cournot behaviour ($\frac{\partial Q_F}{\partial q_C} = \frac{\partial Q_{C,-i}}{\partial q_C} = 0$), the optimal quantity for an individual member is $q_C^H = \frac{qs - Q_F}{s(n_C + 1) + c^H}$, $q_C^{HH} = \frac{q - Q_F}{n_C + 1 + c^H}$, and $q_C^L = q_C^{LL} = \frac{q - Q_F}{n_C + 2}$.

Profit maximisation for the firm gives different results. If the firm supplies the higher quality, the function to maximise is $p_F^H = [qs - sQ_F - Q_C]Q_F - n_F \frac{1}{2} c^H (\frac{Q_F}{n_F})^2$. If the firm supplies lower quality instead, the function to maximise is: $p_C^L = (q - Q_F - Q_C)Q_F - n_F \frac{1}{2} (\frac{Q_F}{n_F})^2$. The optimal output under the Cournot assumption ($\frac{\partial Q_C}{\partial Q_F} = 0$) is: $q_F^H = \frac{qs - Q_C}{2sn_F + c^H}$, $q_F^L = q_F^{LL} = \frac{q - Q_C}{2n_F + 1}$, and $q_F^{HH} = \frac{q - Q_C}{2n_F + c^H}$, respectively.[6]

From this, we compute profits for the individual members of the cooperative as well as for the farmers supplying the firm for all combinations of quality levels. The results are summarized in Table 3.

The choice of quality levels and the corresponding profits of the members of the cooperative and of the farmers delivering to the firm depend on parameters s and c as well as on the number of firms n_C and n_F. Figure 1 illustrates the farmers' choices for a given number of firms by means of four 'isoprofit' curves.

Since $c = s = 1$ implies that there in fact are no quality differences (neither in production costs nor in the consumers' willingness to pay), the isoprofit curves all originate in this point. As the costs of producing a high quality product relative to a low quality product (c) increases, the consumers' willingness to pay for higher quality (s) also has to increases in order to guarantee each farmer the same level of profits (the isoprofit curves slope upwards).

Suppose the additional costs of producing high quality are c_0. If the price increase which can be realized due to higher quality (measured by s), is small ($s < s_0$) all members of the cooperative as well as the firm will choose to supply low quality (area *A*). The profits for the individual farmers will be p_F^{LL} and p_C^{LL}. Note that $p_C^{LL} > p_F^{LL}$ as long as $n_F > 1$, which corresponds to Albaek and Schultz. If there are no quality differences between the firm and the cooperative, the cooperative will be more successful (in terms of generating higher profits for its members).

According to Figure 1, the firm will first switch to higher quality as s increases above s_0 whereas the members of the cooperative will still prefer to produce lower quality. The reason for this asymmetry in quality choices is a free-rider problem on the side of the members of the cooperative. Assume that the firm decides to produce low quality. If all members of the cooperative deliver high quality, they earn profits of p_C^{H}. An individual member's profit could however be much larger if other members of the cooperative deliver high quality but he delivers low quality only. Still, the cooperative produces higher quality than the firm and thus realises the high market price, but this member now saves production costs by delivering the lower quality only. There is a strong incentive to free ride on the other members of the cooperative. Therefore we should not expect all members of the cooperative to supply high quality. In fact it would be sufficient for the cooperative's final product to be of higher quality than the firm's product if only one member of the cooperative produces higher quality (since the firm decided to purchase low quality products from its suppliers). However, it would not be rational for any of the members to produce high quality. If only one of the members of the cooperative would choose to deliver high quality, this farmer would have to bear higher production costs. The gains from producing higher quality in the form of a higher market price however, would have to be shared with all other members of the cooperative. The individual farmer who produces higher quality thus provides a positive externality, which is not internalised in the decision making process.[7] All combinations of *c* and *s*, where this free-riding problem within the cooperative leads to a Nash-equilibrium with the firm supplying high and the cooperative supplying low quality are represented by area *B* in Figure 1.

As s increases further, the incentives from supplying high quality for each member of the cooperative becomes strong enough to overcome the free-riding problem. In area C, we have two possible Nash-equilibria. If the firm decides to produce high (low) quality, it is in the best interest of the cooperative to produce low (high) quality which again justifies the decision of the firm to produce high (low) quality. The equilibrium will be characterized with products of different quality, but the model does provide a clear prediction of whether the cooperative or the firm will supply the superior or the inferior quality.

As s increases above s_2 (area D), the only equilibrium is one in which the firm prefers to produce low quality whereas the members of the cooperative now choose high quality. To understand this (surprising) result, suppose the firm decides to produce high quality. If all members of the cooperative produce high quality, the equilibrium will be characterised by a situation where each member of the cooperative earns profits of p_C^{HH} whereas farmers delivering to the firm earn p_F^{HH}. This would again correspond to Albaek and Schultz. If there are no quality differences between the firm and the cooperative, the cooperative will gain large market shares at the expense of the firm. Thus, given that the cooperative prefers to produce high quality (for $c = c_0$ and $s_2 < s < s_3$), the firm is better of by saving production costs and producing lower quality.

Finally, if s is large enough ($s > s_3$), the firm as well as all members of the cooperative will supply high quality products (area E).

Figure 1 illustrates, that a free-rider problem in the supply of high-quality products, although important for the members of the cooperative, may not be strong enough to ensure that firms will always supply higher quality than cooperatives. Note that the cooperative will supply high quality particularly in those markets, where delivering high quality is highly rewarded by consumers (s is large) and/or the costs of producing high quality are low (c is small). This will be the case in regions D and E.

Open-membership equilibrium

The previous section considered the choice of product quality given the number of farms n_F and n_C. In an open-membership equilibrium, the number of farmers delivering to the cooperative and to the firm is endogenous. As long as both manufacturers choose to deliver the same level of product quality, analyzing an open-membership equilibrium does not provide new insights. In this case, farmers delivering to the cooperative will receive larger profits as long as $n_F > 1$. In the long run, all farmers will become members of the cooperative, which corresponds to Albaek and Schultz (1998). The open-membership equilibrium however will be different, when the firm and the cooperative offer products of different quality are shown in Figure 2.

Figure 2 illustrates the level of profits per farmer delivering to the firm (p_F) and the cooperative (p_C) in the case where the cooperative produces higher quality (Figure 2a) as well as where the firms' products are of superior quality (Figure 2b). The profit of each farmer depends on the market share of the cooperative and the firm (defined as the share of farmers delivering to the cooperative and the firm). As long as $p_C > p_F$, new farmers would join the cooperative. An additional farmer delivering to the cooperative increases the output of the cooperative and thus reduces the price of its product. Whether this increases or decreases aggregate profits in the cooperative is unclear (and depends on the parameters of the model). As the aggregate profit of the cooperative now has to be shared among more members, the profits per farmer (p_C) decline. On the other hand, profits per farmer delivering to the firm will increase since n_F declines. This process stops as soon as there are no incentives to join the cooperative, that is when $p_C = p_F$.

The number of farmers delivering to the firm and the cooperative in an open-membership equilibrium are determined by the parameters *c*, *s* and *n*. The effects of a change of these parameters on the profits and on the market shares of the firm and the cooperative are summarized in Table 4 in the appendix. Note that an increase in the consumers´ willingness to pay for high quality (an increase in s) causes the profit curve of the manufacturer producing high quality goods to shift up and the profit curve of the manufacturer producing low quality goods to shift down. As a result, the market share of the manufacturer producing high quality goods increases as well.

The following Figure 3 illustrates some comparative static results. If, for a given $c = c_0$, the consumers willingness to pay for higher quality (s) is small ($s < s_0$), the cooperative and the firm will choose to supply low quality. In this case, the profits of cooperative members will exceed those of farmers delivering to the firm as long as $n_F > 1$ and the market share of firms ($n_F/(n_F + n_C)$) will thus be small. As high quality becomes more important for consumers and s increases above s_0, the firm will start producing high quality whereas the cooperative prefers to produce low quality. As the relative profitability of farmers delivering to the high quality producer (the firm) increases with s (see Table 4), more and more farmers will leave the cooperative. The market share of the firm increases.

As s increases above s_1, there are two Nash-equilibria. If the firm is the high-quality producer and the cooperative supplies low quality, then the share of farmers delivering to the firm further increases with s. However, if the product of the cooperative turns out to be of higher quality, then the market share of the firm decreases with s (see Table 4).

In the interval $s_2 < s < s_3$, the cooperative will produce high quality and the firm will supply a low-quality product. In this interval, the market share of the firm will decrease with an increasing importance of product quality (an increase in s). Finally, if $s > s_3$, only high quality products will be sold. As the product quality between the two manufacturers is identical again, the model again suggests that the market share of the firm is $1/(1 + n_C)$.

3. Conclusions and Extensions

The speed of structural change has not been the same in different parts of the agrifood sector. Whereas processing and distribution of agricultural products now is highly concentrated in most developed countries, farming still is characterized by a large number of small family owned businesses. This combination of dispersed family ownership and highly concentrated processing and distribution sectors poses unique challenges, particularly with respect to vertical coordination and quality control over the supply chain (Menard and Klein, 2004).

The present paper investigates the issue of product quality in a vertically related industry. Quality choices of an investor owned firm and a producer cooperative are analyzed within a mixed duopoly framework. Assuming that the members of the cooperative are paid according to the quantity they deliver and that the quality of the inputs is non-contractible between independent actors, there is a strong incentive to free-ride and deliver low quality. This free rider problem among members of cooperatives is a well-recognized problem in the literature (see, among others, Cook 1995 and Fulton 1995). The investor owned firm on the other hand is assumed to be vertically integrated and thus is not plagued by a quality coordination problem.

The free rider problem within the cooperative with respect to product quality suggests that the investor owned firm will sell products of higher quality. In contrast to Albaek and Schultz (1998) the investor owned firm will be able to gain a large market share. However, we find that free-riding among members of the cooperative may not be strong enough to ensure that firms will always supply higher quality than cooperatives. In markets, where delivering high quality is highly rewarded by consumers (s is large) and/or the costs of producing high quality are low (c is small) the cooperative will produce the higher quality product. Despite the fact that the investor owned firm is vertically integrated (and thus does not face a coordination problem with respect to product quality) the quality of its product will be lower.

To what extent the degree of competition influences the quality decisions in a mixed duopoly has not yet been investigated in detail. The previous discussion assumed Cournot-behaviour between the cooperative and the investor-owned firm. If competition is more aggressive however, the comparative advantage of the cooperative in a homogenous product market disappears. The question whether this influences the incentives of the firm and/or the cooperative to supply high quality products is left for future research.

Appendix A

An alternative would be to follow Karantininis and Zago (2001) and view the firm as a Cournot duopsonist paying the farmers a price w according to the farmers´ supply function. When we assume that the farmers are price takers, the aggregate supply is given by the aggregate marginal costs. The firm's problem then is to maximize $p_F = (a - Q_F - Q_C)Q_F - wQ_F - f$ where $w = \frac{cQ_F}{n_f}$. The output of the firm and the cooperative are presented in table Table **5** and compared to the results when following Albaek and Schultz in modeling the firm.

It can be shown that the output of the cooperative increases and the output of the firm decreases (ceteris paribus) when the firm is modeled as in Karantininis and Zago. Although the situation of the cooperative is strengthened if the firm is modeled in that way, the results do not change significantly.

Appendix B

The results of the comparative statics are reported in table Table **4**.

The case where $s_C > s_F$:

If we take the first derivation of the profit function we can calculate in which direction the profit curve of the firm and of the cooperative shift, if one of the parameters (*c*, *s* or *n*) changes.

(2) $$p_C^H(c,s,n_F,n_C) = \frac{(c+2s)(s-n_F+2sn_F)^2 q^2}{2[c+2cn_F - n_C n_F + s(1+n_C)(1+2n_F)]^2}$$

(3) $$\frac{\partial p_C^H}{\partial s} = \frac{[s+n_F(-1+2s)]\{(c+2cn_F)^2 + 3cs(1+2n_F)^2 + s(1+2n_F)(n_F+s+2n_F s) + n_C[s+n_F(-1+2s)]^2\}q^2}{[c+2cn_F - n_C n_F + s(1+n_C)(1+2n_F)]^3} > 0$$

(4) $$\frac{\partial p_C^H}{\partial c} = -\frac{[s+n_F(-1+2s)]^2[c+2cn_F+3s(1+2n_F)+n_C(n_F-s-2sn_F)]q^2}{2[c+2cn_F - n_C n_F + s(1+n_C)(1+2n_F)]^3}$$

(5) $$\frac{\partial p_C^H}{\partial n_C} = -\frac{(c+2s)[s+n_F(-1+2s)]^3 q^2}{[c+2cn_F - n_C n_F + s(1+n_C)(1+2n_F)]^3} < 0$$

(6) $\frac{\partial p_C^H}{\partial n_F} = -\frac{(c^2+3cs+2s^2)[s+n_F(-1+2s)]q^2}{[c+2cn_F-n_Cn_F+s(1+n_C)(1+2n_F)]^3} < 0$

As the first derivation of the profit function is positive with respect to s and negative with respect to n_C and n_F, the profit curve of the cooperative shifts up if s increases and it shifts down if n increases, as expected. The profit curve shifts down as n increases independent of the decision of the "new" farmer to deliver to the firm or to the cooperative. Whether the first derivation with respect to c is negative depends on the parameters. An increase in c reduces the output of the cooperative for sure. It is possible that the induced increase in prices and the reduction in costs (due to a decrease in output) offsets the reduced revenues (due to a lower output) and the higher costs (due to an increase in c) and causes profits to rise.

(7) $p_F^L = \frac{(c+s)^2(1+2n_F)q^2}{2[c+2cn_F-n_Cn_F+s(1+n_C)(1+2n_F)]^2}$

(8) $\frac{\partial p_F^L}{\partial s} = -\frac{n_C(1+2n_F)(c+n_F+2cn_F)(c+s)q^2}{[c+2cn_F-n_Cn_F+s(1+n_C)(1+2n_F)]^3} < 0$

(9) $\frac{\partial p_F^L}{\partial c} = \frac{n_C(1+2n_F)(c+s)[s+n_F(-1+2s)]q^2}{[c+2cn_F-n_Cn_F+s(1+n_C)(1+2n_F)]^3} > 0$

(10) $\frac{\partial p_F^L}{\partial n_C} = -\frac{(1+2n_F)(c+s)^2[s+n_F(-1+2s)]q^2}{[c+2cn_F-n_Cn_F+s(1+n_C)(1+2n_F)]^3} < 0$

(11) $\frac{\partial p_F^L}{\partial n_F} = -\frac{(c+s)^2[c+2cn_F+s+2sn_F+n_C(-1-n_F+s+2sn_F)]q^2}{[c+2cn_F-n_Cn_F+s(1+n_C)(1+2n_F)]^3} < 0$

The first derivation of the profit function of the firm is positive with respect to c and negative with respect to s, n_C and n_F. An increase in c causes the profit curve to shift up and an increase in s or n causes the profit curve to shift down, as expected.

While it is obvious from the shifts of the profit curves that an increase in s decreases the market share of the firm, no clear results can be derived with respect to a change in c or n. To calculate the market share of the firm we substitute $(n - n_F)$ for n_C and equate the two profit functions to get $n_F(c, s, n)$.

(12) $p_C^H = p_F^L$

(13) $n_F(c,s,n) = \frac{-2c^2 - 6cs - 6s^2 + 4cs^2 + 8s^3 - 2(c+s)\sqrt{c+c^2+2s-3s^2}}{2(-c-2s+4cs+8s^2-4cs^2-8s^3)}$

(14) $\frac{\partial n_F}{\partial c} = \frac{(c+3s)[2c^2+2s(1-s+\sqrt{c+c^2+2s-3s^2})+c(1+2s+2\sqrt{c+c^2+2s-3s^2})]}{2(-1+2s)^2(c+2s)^2\sqrt{c+c^2+2s-3s^2}} > 0$

(15) $\frac{\partial n_F}{\partial n} = 0$

An increase in c causes n_F to rise in equilibrium, and as n is fixed the market share of the firm increases. An increase in n does not influence n_F, so all additional farmers choose to deliver to the cooperative. So an increase in n causes the market share of the firm to decrease.

The case where $s_C < s_F$:

(16) $p_C^L = \frac{3(c+sn_F)^2 q^2}{2\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^2}$

(17) $\frac{\partial p_C^L}{\partial s} = -\frac{3n_F[c(2+n_C)+n_C n_F](c+sn_F)q^2}{\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} < 0$

(18) $\frac{\partial p_C^L}{\partial c} = \frac{3n_F[n_C(-1+s)+2s](c+sn_F)q^2}{\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} > 0$

(19) $\frac{\partial p_C^L}{\partial n_C} = -\frac{3(c+sn_F)^2[c+n_F(-1+2s)]q^2}{\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} < 0$

(20) $\frac{\partial p_C^L}{\partial n_F} = -\frac{3c[n_C(-1+s)+2s](c+sn_F)q^2}{\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} < 0$

The first partial derivatives of the profit function give us the expected results: An increase in c causes the profit curve of the cooperative to shift up and an increase in s or n causes the profit curve to shift down.

(21) $p_F^H = \frac{[n_C - s(2+n_C)]^2(c+2sn_F)q^2}{2\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^2}$

(21) $\frac{\partial p_F^H}{\partial s} = \frac{[n_C(-1+s)+2s]\{c^2(2+n_C)^2+3cs(2+n_C)^2 n_F + n_F^2[8s^2+2sn_C(-1+4s)+n_C^2(1-s+2s^2)]\}q^2}{\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} > 0$

(22) $\frac{\partial p_F^H}{\partial c} = -\frac{[n_C(-1+s)+2s]^2[c(2+n_C)+n_F(n_C+4s+2snc)]q^2}{2\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} < 0$

(23) $$\frac{\partial p_F^H}{\partial n_C} = -\frac{2[n_C(-1+s)+2s](c^2+3csn_F+2s^2n_F^2)q^2}{\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} < 0$$

(24) $$\frac{\partial p_F^H}{\partial n_F} = -\frac{[n_C(-1+s)+2s]^2\{c[n_C(-1+s)+2s]+sn_F[4s+n_C(-1+2s)]\}q^2}{\{c(2+n_C)+n_F[4s+n_C(-1+2s)]\}^3} < 0$$

Again, the first partial derivatives of the profit function give us the expected results: An increase in *s* causes the profit curve to shift up and an increase in *c* or *n* causes the profit curve to shift down.

It is clear from the shifts of the profit curves that an increase in *s* increases n_F and increases the market share of the firm and that an increase in *c* reduces n_F and so reduces the market share of the firm. If an increase in *n* increases or decreases the market share of the firm cannot be said for sure, although an increase in *n* tends to increase the market share of the firm.

Appendix C

The firm chooses the profit-maximizing output, as shown in the graph on the right hand side of figure Figure 4. When the profit function shifts downwards, the profit at the profit maximizing output level has to decrease. Contrary, the cooperative produces too much due to the decentralization of the output decision. When the cooperative produces high quality and when producing high quality gets more costly (*c* increases), the profit curve shifts downwards and the output of the cooperative will decrease. It is possible that the profit will increase, as illustrated in the left hand side graph of figure Figure 4.

Table 1. Cooperatives´ Market Shares in the Sales of Agricultural Products, in Percentages

	Pork	Beef	Poultry	Eggs	Milk	Sugar beet	Grain	Fruits	Vegetables
Belgium	15	1	-	-	65	-	25-30	60-65	70-75
Denmark	97	53	0	60	92	0	50	90	90
Germany	23	25	-	-	56	-	-	20-40	55-65
Greece	3	2	20	3	20	0	49	51	12
Spain	5	6	8	18	16	20	16	30	15
France	80	30	30	25	50	16	70	45	35
Ireland	55	9	20	0	98	0	26	14	8
Italy	15	6	-	5	32	-	35	31	10
Luxembourg	35	25	-	-	81	-	79	10	-
Netherlands	24	16	21	18	84	63	65	78	69
United Kingdom	19.9	5.1	0.2	18	4.1	0.4	21.1	29.6	19.4

Source: Hendrikse 1998, p. 203

Table 2. U.S. Farmer Cooperatives´ Market Shares, 1951-1993, in Percentages

Commodity / Year	1951	1961	1971	1982	1988	1993
Milk	46	58	70	77	76	85
Cotton products	10	19	25	36	41	35
Grains/oil seeds	35	33	34	36	30	42
Fruit/vegetables	20	22	25	20	24	21
Livestock	13	13	11	11	7	10

Source: Cook 1995, p. 1154

Table 3. Profits for Individual Farmers Delivering to the Cooperative or to the Farm

Firm \ Cooperative	Low Quality	High Quality
Low Quality	$p_C^{LL} = \frac{3(1+n_F)^2 q^2}{2(2+n_C+4n_F+n_C n_F)^2}$ $p_F^{LL} = \frac{2(1+2n_F)q^2}{(2+n_C+4n_F+n_C n_F)^2}$	$p_F^{L} = \frac{(c+s)^2(1+2n_F)q^2}{2[c+2cn_F-n_C n_F+s(1+n_C)(1+2n_F)]^2}$ $p_C^{H} = \frac{(c+2s)(s-n_F+2sn_F)^2 q^2}{2[c+2cn_F-n_C n_F+s(1+n_C)(1+2n_F)]^2}$
High Quality	$p_F^{H} = \frac{[n_C-s(2+n_C)]^2(c+2sn_F)q^2}{2\{c(2+n_C)+[2s(2+n_C)]n_F-n_C n_F\}^2}$ $p_C^{L} = \frac{3(c+sn_F)^2 q^2}{2\{c(2+n_C)+[2s(2+n_C)]n_F-n_C n_F\}^2}$	$p_F^{HH} = \frac{s^2(c+s)^2(c+2sn_F)q^2}{2[c^2+s^2(2+n_C)n_F+cs(1+n_C+2n_F)]^2}$ $p_C^{HH} = \frac{s^2(c+2s)(c+sn_F)^2 q^2}{2[c^2+s^2(2+n_C)n_F+cs(1+n_C+2n_F)]^2}$

Table 4. Results of Comparative Static Analysis in Open-Membership Equilibrium

	$s_C > s_F$			$s_C < s_F$		
	p_C^H	p_F^L	$\frac{n_F}{n_C}$ $\frac{n_F}{n}$	p_C^L	p_F^H	$\frac{n_F}{n_C}$ $\frac{n_F}{n}$
Increase in *s*	+	-	-	-	+	+
Increase in *c*	?	+	+	+	-	-
Increase in *n*	-	-	-	-	-	?

Note: More details on the comparative static effects are reported in Appendix B.

Table 5. Output of the Firm and the Cooperative

Albaek and Schultz	Karantininis and Zago
$Q_C = \dfrac{an_C(c+n_F)}{c^2+(2+n_C)n_F+c(1+n_C+2n_F)}$	$Q_C = \dfrac{an_C(2c+n_F)}{2c^2+(2+n_C)n_F+2c(1+n_C+n_F)}$
$Q_F = \dfrac{a(1+c)n_F}{c^2+(2+n_C)n_F+c(1+n_C+2n_F)}$	$Q_F = \dfrac{a(1+c)n_F}{2c^2+(2+n_C)n_F+2c(1+n_C+n_F)}$

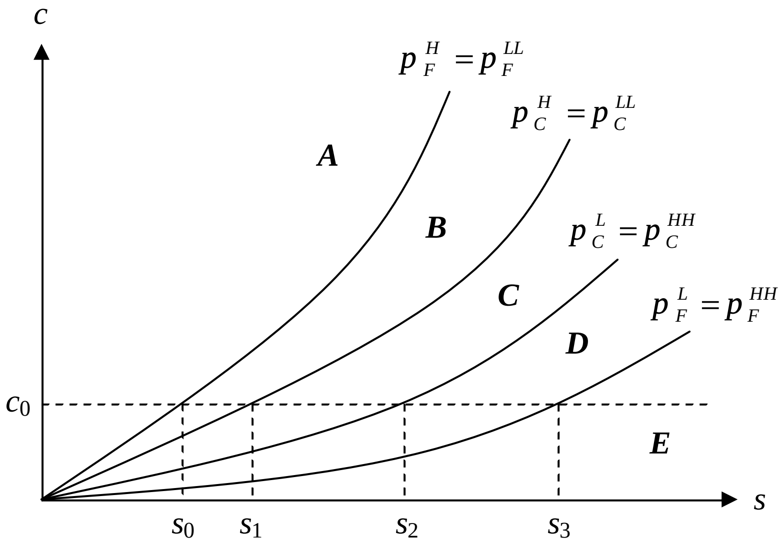

Figure 1. Isoprofit curves of the firm and the cooperative

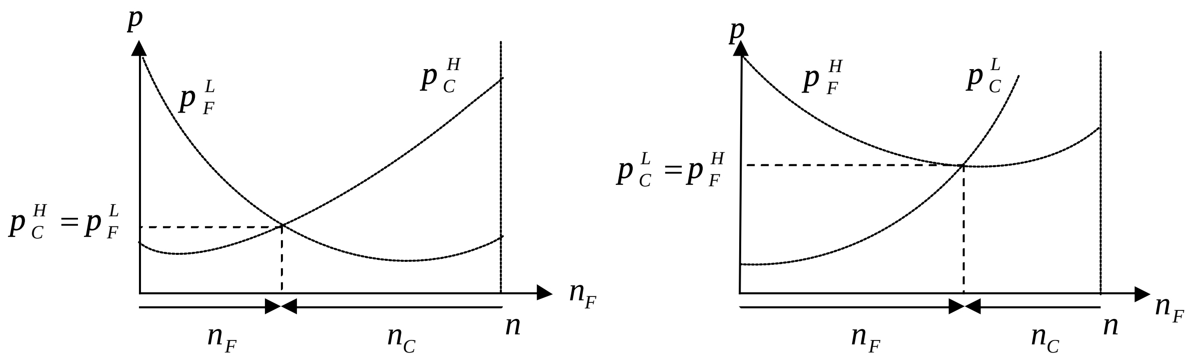

Figure 2. Open-membership equilibrium for different quality levels

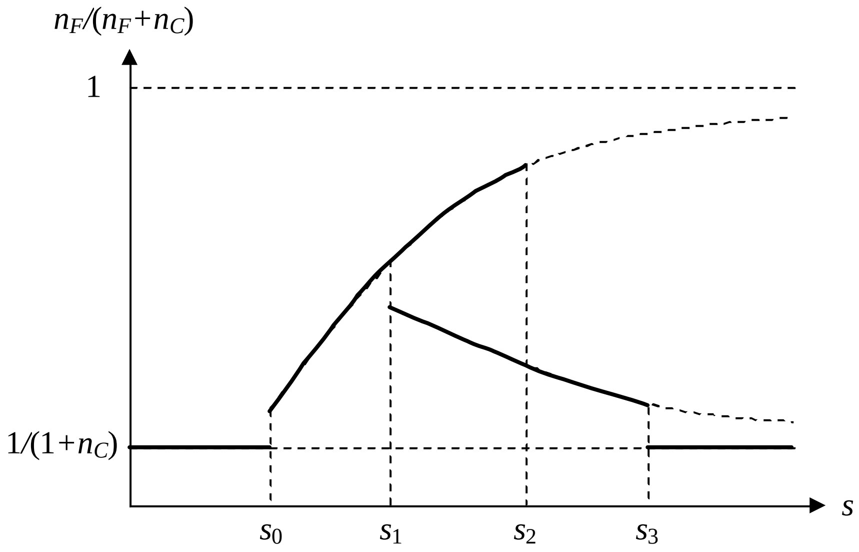

Figure 3. Market shares of the firm and the cooperative

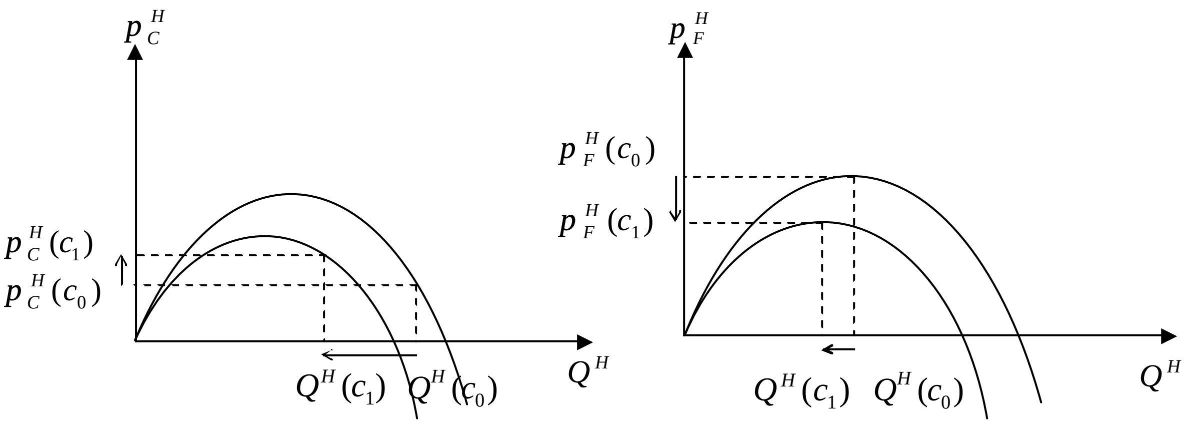

Figure 4. Profit of the firm and the cooperative when c increases from c_0 to c_1

[1] Members are normally paid according to the quantity they deliver as long as they preserve some minimum quality requirements.

[2] Horowitz and Horowitz (1999, p. 395 f.) also mention that quality concerns have been widely ignored in the literature dealing with labour-managed firms, and that Lambertini (1997) was the first one after Martin (1986) who deals with this topic.

[3] An alternative would be to view the firm as acting in a Cournot duopsony. Given that farmers deliver to the firm are price takers, the firm will pay according to the farmers´ supply function (i.e. aggregate marginal costs). This assumes that the firm can write a perfect contract with its suppliers specifying quantity and quality of the product delivered. Although this version of the model would give very similar results (we consider this situation in more detail in Appendix A) we still prefer to consider the firm as a vertically integrated unit. The reason is that ‘contracting leads to contract enforcement costs, which may be lower for cooperative firms than for IOFs because cooperative firms potentially have more ways to punish members who fail to live up to their contracts than do IOFs. Not only can a cooperative include the same noncompliance clauses in its contracts as does an IOF, but members who act opportunistically toward their cooperative may face social sanctions from their fellow farmers as well’ (Staatz, 19xx, p. 97).

[4] Note that this case exactly corresponds to Albaek and Schultz.

[5] The superscript always denotes whether the organization in question (the firm or the cooperative) produces high or low quality. Two superscripts denote that both the firm and the cooperative produce high (HH) or low (LL) quality, while one superscript indicates that the quality levels are different.

[6] Comparing production of members of the cooperative as well as those delivering to the firm, we find that $q_F^g < q_C^g$. Each member takes into account that increasing output causes the price to fall. In choosing the profit maximising quantity, he considers only the profit loss that this gives himself, not the loss inflicted on the other members of the cooperative. If the firm increases output, prices will fall but this effect is fully internalised within the firm.

[7] There is no such free-riding problem on the side of the firm. If the firm decides to produce high quality, all the additional costs but also all the additional gains will occur to it.

References

Albaek, S., and C. Schultz. 1998. "On the relative advantage of cooperatives." Economics Letters 59:397-401.

Choi, J.C., and H.S. Shin. 1992. "A comment on a model of vertical product differentiation." The Journal of Industrial Economics 40:229-231.

Cook, M.L. 1995. "The Future of U.S. Agricultural Cooperatives: A Neo-Institutional Approach." American Journal of Agricultural Economics 77:1153-1159

Dilger, A. 2005. "Prinzipal-Agenten-Probleme im deutschen Weinbau." Zeitschrift für das gesamte Genossenschaftswesen 55:179-189

Economides, N., 1999. "Quality Choice and Vertical Integration". International Journal of Industrial Organization, 17, pp. 903-914.

Frick, B., 2004. "Does Ownership Matter? Empirical Evidence from the German Wine Industry. Kyklos, Vol. 57(3), pp. 357-386.

Fulton, M.E. 1995. "The Future of Canadian Agricultural Cooperatives: A Property Rights Approach." American Journal of Agricultural Economics 77:1144-1152.

Gabszewicz, J.J., and J.-F. Thisse. 1979. "Price Competition, Quality and Income Disparities." Journal of Economic Theory 20:340-359

Hansmann, H., (1988). Ownership of the Firm. Journal of Law, Economics, and Organization. 4(2), pp. 267-304.

Hoffmann, R. 2005. "Ownership Structure and Endogenous Quality Choice: Cooperatives versus Investor-Owned Firms." Journal of Agricutlural & Food Industrial Organization 3(8):1-24

Horowitz, A.R., ane I. Horowitz. 1999. "Quality Choice: Does It Matter Which Workers Own and Manage the Cooperative Firm?" Atlantic Economic Journal 27:394-409

Karantininis K., and A. Zago. 2001. "Endogenous membership in mixed duopsonies." American Journal of Agricultural Economics 83:1266-1272.

Lambertini, L. 1997. "On the provision of product quality by a labor-managed monopolist." Economics Letters 55:279-283

Lehmann-Grube, U. 1997. "Strategic choice of quality when quality is costly: the persistence of the high-quality advantage." RAND Journal of Economics 28:372-384

Martin, R.E. 1986. "Quality Choice under Labor-Management." Journal of Comparative Economics 10:400-413

Menard, C., and Klein, P.G., 2004. „Organizational Issues in the Agrifood Sector: Toward a Comparative Approach". American Journal of Agricultural Economics, 86(3), pp. 750-755.

Motta, M. 1993. "Endogenous quality choice: price vs. quantitiy competition." The Journal of Industrial Economics 41:113-131

Tirole, J. 1988. The theory of industrial organization. MIT Press, Cambridge, MA.

Staatz, J.M., (1987). Farmers' Incentives to tare collective action via cooperatives: A transaction cost approach. In: Cooperative Theory, New Approaches. U.S.D.A. ACS Service Report 18, pp. 87-107.