Do Cooperatives Offer High Quality Products?

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Abstract:

We investigate the impact of decentralised decision making on product quality. Comparing a cooperative (decentralized decision making) and a firm (centralized decision making) suggests that members of the cooperative have an incentive to produce too much and to free-ride on quality. Free-riding on quantity and quality are interrelated which implies that the final product of the cooperative can even be of higher quality than its entrepreneurial twin, despite free-riding on quality. Whether or not cooperatives deliver higher quality products depends on the way in which the quality of the final product is determined from the quality levels of the inputs delivered (quality aggregation) as well as the number of members of the cooperative. Empirical evidence on the Austrian wine market suggests that wines produced by cooperatives tend to be of significantly lower quality, ceteris paribus.

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Cooperatives exit since the advent of the factory system and still play an important role in a developed market economy. According to the European Commission they hold substantial market shares in most European Member States, especially in the agri-food chain.[1] Cooperatives are attractive as a means of capturing the fruits of a relative large-scale farming enterprise as opposed to an otherwise small scale family farming system as well as a means of obtaining market power for farmers (countervailing power) in relation to buyers of their products and providers of inputs and services to the farm enterprise.

The economic literature, on the other hand, has identified a number of comparative disadvantages of cooperatives (Fulton 1995; Albaek and Schultz 1998; Karantininis and Zago 2001; Bogetoft 2005). A classical problem of traditional cooperatives is the quantity coordination problem, which arises from the decentralized decision making of the members of a cooperative (Phillips 1953; Helmberger and Hoos 1962). Each member (farmer) decides individually how much to deliver to the cooperative and the cooperative thus has no control over what is actually supplied to the market. 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 (free-riding).

Decentralized decision making within a cooperative may also lead to quality coordination problems, which could be considered even more detrimental to the prosperity of cooperatives since, in contrast to quantities, the quality delivered by individual members very often is difficult to verify and might be non-contractible between independent actors. The problem of free-riding on product quality with decentralized decision making is a well-recognized problem in the literature on cooperatives (Cook 1995; Fulton 1995; Saitone and Sexton 2009) and is nicely illustrated in Babcock and Weninger's (2004, p. 14) case study of the Alaskan Salmon Industry: '... suppose two fishermen deliver to a single processor. The fishermen know that part of the investment in quality that increases price will end up in the pocket of the other fisherman. The two fishermen get roughly a half-share of the benefit of quality-control efforts, yet both bear the full cost of those efforts'.

Although the behavior and performance of cooperatives in comparison to other forms of business organization has been the focus of extensive theoretical and empirical research, the issue of product quality has received relatively little attention.[2] In the spirit of Tirole's (1996) model of collective reputation, Winfree and McCluskey (2005) investigate the individual firms' incentive to choose quality levels. The authors assume that firms in the group share a common reputation, which is based on the groups' past average quality. It is shown that individual firms have an incentive to produce lower quality and free ride on the good group reputation. Free-riding becomes more important as the number of firms increases.

Hoffmann (2005) investigates firms' price and quality choices under different ownership structures (mixed duopoly) in a vertically related market. If the downstream firm decides about product quality whereas the fixed costs of producing high quality are to be paid by the upstream supplier, the firm will underestimate the full costs of delivering high quality. If upstream suppliers also sell their products downstream through a cooperative, the fixed costs associated with higher quality are considered in the cooperative's decision about the quality of the final product. Using rather restrictive assumptions about producer costs and consumer demand, Hoffmann (2005) shows that investor owned firms choose a higher level of quality than cooperatives in markets where the costs of producing high quality are fixed. Numerical calculations suggest that the conclusion is reversed in markets where producing high quality raises variable costs of production.

On the basis of similarly restrictive assumptions about consumer demand and producer costs, Yu (2009) investigates the setting of quality standards and input prices of a cooperative and an investor-owned firm in a mixed duopsonistic model. The author finds that cooperatives will set higher quality standards than investor-owned firms in markets where consumers are willing to pay particularly high price premiums for high quality products.

Herbst and Prüfer (2007) compare the decisions about product quality in three organisations (firms, cooperatives and nonprofits). Members of a cooperative not only care about dividends but also care about consumer surplus (per assumption, members also act as consumers of the products they produce). Decision making within the cooperative is assumed costly, the costs of collective decision making increase with the heterogeneity of a cooperative's members. If individual members' preferences for quality differ, the cooperative incurs extra costs of collective decision making. Firms, on the other hand, are assumed to care about profits only (shareholders of a firm do not consume the good produced themselves). The pure focus on financial returns implies a perfect goal alignment among shareholders and a firm thus does not have to bear any costs of collective decision making. Herbst and Prüfer investigate the importance of these differences in incentives as well as the costs of decision making between a firm and a cooperative for the decisions on product quality. They argue that the indirect utility of members from consuming the products produced provides an additional incentive for the cooperative to deliver products of higher quality.

Saitone and Sexton (2009) investigate the revenue pooling practice of a cooperative in a market where farmers face stochastic shocks to their production of vertically differentiated goods. They identify and explore two positive dimensions of cooperative revenue pooling: it counteracts the tendency to overproduce high quality products and it insures risk-averse farmers against adverse realizations of quality.

The present article investigates this free-riding problem in determining quantity and quality within a marketing cooperative in a vertically related market. Upstream firms (farmers) deliver inputs to the downstream market. A monopoly manufacturer (the cooperative or an investor-owned firm) uses the components delivered to produce a composite good which is then sold to consumers. The key difference between the two organizations in the downstream market is the degree of centralization in decision making: whereas each member of the cooperative (farmer in the upstream market) determines quantity and quality of inputs independently (decentralized decision making), decision-making in the firm is centralized. The extent of the free-riding (coordination) problem within the cooperative is shown to depend on the specific form in which the quality of the final product is aggregated from the quality levels of inputs delivered, the consumer's valuation of quality, the costs of producing high quality as well as on the number of members of the cooperative. We find that the cooperative might supply higher quality than its entrepreneurial twin, despite the free-riding problem within the cooperative. The reason for this result is that the quantity- and the quality control problem are interrelated: free-riding on quantity reduces the effects of free-riding on quality. Finally, we also provide some empirical evidence on the differences in product quality between cooperatives and alternative forms of business organization. Econometric results for the wine industry suggest that cooperative products are of lower quality, ceteris paribus.

In the next section we set up the model and compare the quality decision of a firm and a cooperative acting as a monopolist. The third section provides some empirical evidence on the impact of ownership on product quality and the final section concludes.

Analytical framework

To investigate the coordination (free-riding) problem in determining quantity and quality within cooperatives, we compare the behavior of the cooperative with that of an otherwise identical investor-owned firm in a vertically related market. Upstream firms (farmers) deliver inputs to a downstream monopoly manufacturer, the cooperative (*C*) or the firm (*F*), who uses the components delivered to produce a composite good which is then sold to consumers. Consumer demand for the final product is $P(Q,S)$, which is twice continuously differentiable and satisfies $P_Q < 0, P_S > 0, P_{SS} < 0$. Alphabetic subscripts denote partial derivatives and *Q* and *S* represent quantity and quality of the final product, respectively.

Quantity and quality of the final product are determined by the quantity (*q*) and the quality (*s*) of the inputs delivered by *n* individual farmers. The monopolist uses a 1:1 production technology to produce the final output: $Q = \sum_n q$. To determine the quality of the final (manufacturers') product we distinguish between different cases. In the first, the quality of the final product (*S*) is determined as the (weighted) average of the quality of inputs (*s*) delivered by individual farmers. This assumption is represented by a linear aggregation function for product quality: $S = \sum_n \omega s$, where ω represent the weight attached to the quality of an individual farmer's inputs.

As an alternative, 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 farmer). In this case, the aggregation function of product quality thus has the so-called 'O-Ring' form (Kremer, 1993)[3]: $S = \min[s]$. This implies that the final product will be of high quality if <u>all</u> farmers deliver high quality. As soon as one farmer delivers low quality the final product will be of low quality. For the sake of completeness we also briefly discuss the implications of a third possibility of quality aggregation, which assumes that the quality of the final product is determined by the highest level of quality of the inputs delivered: $S = \max[s]$. We consider this case to be rather unrealistic in the area of food production though.

In producing the final good from the inputs delivered by farmers, we assume that the manufacturer has constant marginal costs which are normalized to zero. Farmers, on the other hand, have positive production costs: producing quantity q at quality level s costs $c(q,s)$, with $c_q \geq 0, c_s \geq 0, c_{qq} = c_{ss} = 0$.[4] Production technology is assumed identical for all farmers.

The basic difference between the firm and the cooperative is the degree of centralisation in decision making. We assume that the firm has a (perfect) contract with farmers specifying the quantity as well as the quality of their inputs ('centralised' decision making). The firm's problem is to choose quantity (q) and quality (s) of inputs to maximize the vertically integrated profit of itself and its suppliers[5]:

$$\Pi^F = P(Q,S)Q - \sum_n c(q,s) \tag{1}$$

In contrast, the cooperative is characterized by an 'individualistic' decision-making process, where each member (farmer) decides how much to produce and which quality to deliver. The maximization problem for each member of the cooperative is:

$$\pi^C = P(Q,S)q - c(q,s) \tag{2}$$

Results with linear form of quality aggregation

In the case of a linear aggregation function for product quality: $S = \sum_n \omega s$, the first-order conditions for each member of the cooperative (assuming that all members of the cooperative are identical ($Q = nq$)) are:

$$\frac{\partial \pi^C}{\partial q} = P_Q Q_q q^C + P(Q^C, S^C) - c_q = P_Q[1+\lambda(n-1)]\frac{1}{n}Q^C + P(Q^C, S^C) - c_q = 0 \quad (3)$$

$$\text{and } \frac{\partial \pi^C}{\partial s} = P_S S_s q^C - c_s = P_S \omega[1+\sigma(n-1)]\frac{1}{n}Q^C - c_s = 0 \quad (4)$$

The extent to which the individual members of the cooperative coordinate their output and quality decisions are represented by the parameters $\lambda \equiv \frac{\partial q_j}{\partial q_i}$ and $\sigma \equiv \frac{\partial s_j}{\partial s_i}$ with $i, j = 1,\ldots,n$ and $i \neq j$. We view λ and σ as the outcome of some unknown game. Perfect quantity and quality coordination would be represented by $\lambda = 1$ and $\sigma = 1$. Uncoordinated (Cournot) behavior within the cooperative corresponds to $\lambda = 0$ and $\sigma = 0$ whereas $\lambda = -1$ would imply sales maximization and $\sigma < 0$ would represent 'sabotage'.[6]

With centralized decision making, the firm decides about the quantity and the quality of inputs delivered. The first-order conditions for the firm are:

$$\frac{\partial \Pi^F}{\partial q} = P_Q Q_q Q^F + P(Q^F, S^F) - c_q = P_Q Q^F + P(Q^F, S^F) - c_q = 0 \quad (5)$$

$$\text{and } \frac{\partial \Pi^F}{\partial s} = P_S S_s Q^F - c_s = P_S \omega Q^F - c_s = 0 \quad (6)$$

To simplify the comparison of quality and quantity decisions between the cooperative and the firm, let us first assume that $c_{qs} = 0$ and $P_{QS} = 0$, i.e. marginal costs of higher quality and the consumers' marginal willingness to pay for higher quality are independent of the quantity produced and purchased. A comparison of equations (3) and (5) as well as (4) and (6) immediately reveals that quantity and quality decisions of the firm and the cooperative are identical if $\sigma = 1$ and $\lambda = 1$. If decisions on quality and quantity are perfectly coordinated between members of the cooperative, the (behavior of the) firm and the cooperative are identical. Equilibrium levels of quantity and quality will however differ as soon as decisions within the cooperative are not perfectly coordinated.

First consider the implications of imperfect quality coordination only ($\sigma < 1$ and $\lambda = 1$). Equation (4) suggests that members of the cooperative have a smaller incentive to deliver high quality inputs as σ declines. A decrease in σ also has an additional (indirect) effect: Lower quality levels of inputs delivered will reduce the consumers' willingness to pay for the (lower-quality) final product (S^C) which reduces the marginal returns of output in the cooperative (in equation (3)). A decline in aggregate output of the cooperative exerts a feed-back effect on the incentive to invest in higher quality (equation (4)).[7] Combining both effects, we conclude that equilibrium levels of quantity and quality in the cooperative will be below that of an otherwise identical investor-owned firm if quality decisions are imperfectly coordinated. This finding reflects the well-known free-rider problem with respect to product quality within the cooperative. Whereas an individual farmer has to bear the full costs of improving product quality, he does not capture the full gains of this effort.

Note that marginal returns to quality also are influenced by the number of members of the cooperative (n) in equation (4). Equation (4) corresponds to equation (6) if $n = 1$. If quality coordination is imperfect ($\sigma < 1$), the free-riding problem with respect to quality increases with n which corresponds to findings in Tirole's (1996) model of collective reputation as well as Winfree and McCluskey (2005).

If, in addition, decisions on quantity are not perfectly coordinated ($\lambda < 1$), the cooperative will also face a free-riding problem with respect to quantity. This negative externality (free-riding on quantity) now turns out to be a comparative advantage of the cooperative in terms of reducing the free-riding problem with respect to quality! Despite free-riding, the final product of the cooperative can even be of higher quality than the firm's product. For simplicity, let us first consider the quantity coordination problem in isolation (i.e. assume $\sigma = 1$ and $\lambda < 1$).

According to equation (3), marginal returns of output increases as λ declines. Members of the cooperative tend to overproduce, which reflects the well-known quantity control problem of the cooperative. Note that an increase in aggregate quantity (Q^C) c.p. raises the marginal returns of investing in higher quality (see equation 3). The overproduction problem thus increases the incentive to deliver high quality products. In addition, the model suggests a positive feed-back effect from quality on output decisions of the cooperative: higher quality raises the incentive to expand output which again stimulates quality improvements. In equilibrium output and the level of quality in the cooperative will exceed those of an otherwise identical firm if quantity decisions within the cooperative are not perfectly coordinated. Again, note that the degree of free-riding increases with the number of members in the cooperative.

If decisions on quantity and quality within the cooperative are not perfectly coordinated, the total effect depends on the relative strength of the different countervailing forces. The degree of imperfect quantity coordination which is sufficient to (fully) compensate for a particular degree of imperfect quality coordination cannot be identified from the general model presented so far. Some simulation results when explicitly solving the model for a specific (simplified) version of the model with linear demand and cost function are reported in the Appendix. For this version of the model we find that cooperatives deliver lower quality if

$\lambda = \sigma = 0$ and that the level of quality between the firm and the cooperative is identical if $\lambda = 0$ and $\sigma = 1/2$. In reality the quality delivered by individual members might be more difficult to observe, verify and thus to coordinate than the quantity which would suggest that $\sigma < \lambda$.

Results with alternative forms of quality aggregation

The extent of free-riding within the cooperative also critically depends on the way in which the quality of the final (manufacturers') product is determined from the inputs delivered by farmers (the form of aggregation of product quality). In cases, where the quality of the final product is the (weighted) average of the quality of inputs delivered by farmers, the free-riding problem within the cooperative is particularly strong. In an alternative scenario, where the minimum quality of all inputs delivered determines quality of the final product, free-riding is mitigated since a reduction of the quality of inputs delivered by one member immediately leads to a reduction in the quality of the final product. Any costs savings associated with lower quality have to be weighed against the losses from a price reduction which arises as soon as only one member deviates from a high-quality equilibrium. So free-riding is relatively costly. The implications of an 'O-Ring' form of quality aggregation are illustrated in figure 1.

Figure 1

For simplicity, we ignore the quantity control problem (by assuming $\lambda = 1$). With a linear form of quality aggregation, where the weights attached to the quality of inputs delivered by individual farmers are proportional to the quantity delivered ($\omega = \frac{q}{Q} = \frac{1}{n}$), the marginal returns to quality for individual members of the cooperative are $P_S[1+\sigma(n-1)]\frac{1}{n^2}Q^C$. A high level of product quality ($\bar{s}$) will be delivered under perfect quality coordination (i.e. $\sigma = 1$); $\sigma = 0$, on the other hand, would cause quality to be lower ($\underline{s}$).

Assuming an O-Ring form of quality aggregation instead, the model predicts multiple quality equilibria within the cooperative. In this case, the high level of product quality $\bar{s}$ can be achieved even under imperfect quality coordination: all levels of quality between 0 and $\bar{s}$ in figure 1 can be the outcome of a Nash-equilibrium within the cooperative. The reason for this result is an asymmetry in the incentives to increase or decrease product quality if quality decisions are not perfectly coordinated ($\sigma < 1$).

First, assume $\sigma = 0$. If, initially, members deliver identical levels of quality to the cooperative, an increase in quality of an individual member has no effect on the price of the final product ($\sigma = 0$ implies that other members of the cooperative leave quality unchanged). The marginal return to an individual increase in quality is zero since $S_s = 0$ in equation (4)! Any decrease in quality, on the other hand, would immediately reduce the price of the final product and thus lower the individual member's return. For a quality reduction, the marginal loss is $P_S \frac{1}{n} Q^C$ (since $S_s = 1$ in equation (4)) which exceeds the marginal gain of lowering quality (c_s^C) for all $s < \bar{s}$. All levels of quality between 0 and $\bar{s}$ can be a Nash-equilibrium in the cooperative with an O-Ring form of quality aggregation.

An asymmetry in the incentive to increase and decrease product quality also exists for intermediate degrees of quality coordination ($0 < \sigma < 1$). In this case, all levels of product quality $\underline{s} \le s \le \bar{s}$ can be a Nash-equilibrium in the cooperative (since the marginal returns to quality are $P_S\sigma\frac{1}{n}Q^C$ in the case of increases and $P_S\frac{1}{n}Q^C$ in the case of decreases in product quality). The asymmetry in quality increases and decreases only disappears if quality decisions are perfectly coordinated: marginal returns to quality increases and decreases are $P_S\frac{1}{n}Q^C$ for $\sigma = 1$.

Finally note that the asymmetry in the incentives for quality increases and decreases is reversed in the case where the quality of the final product is the maximum of quality levels of its components: $S = \max[s]$. No Nash-equilibrium exists in this case. If all members of the cooperative deliver a particular quality of $s < \bar{s}$ in figure 1, an individual member has an incentive to increase the quality of its inputs (marginal returns of increasing quality are $P_S\sigma\frac{1}{n}Q^C > c_s^C$ since $S_s = 1$ in equation (4)). If $s > \underline{s}$ however, an individual member has an incentive to lower the quality of its inputs (the resulting marginal loss is $P_S\sigma\frac{1}{n}Q^C < c_s^C$, since $S_S = \sigma$ in equation (4)).

Empirical Evidence

Empirical evidence on the effects of ownership structure on product quality is scarce.[8] The present article uses data on quality, reputation and ownership collected for the Austrian wine market (Huber, 2010).[9] In terms of the analytical framework, the wine market can be characterized by the fact that the quality of the final product is determined by the average of the quality of inputs (grapes) delivered. It also seems plausible to assume that the marginal willingness to pay for higher quality will be larger for individuals consuming more wine ($P_{QS} > 0$). Finally, the quality of inputs delivered by members of a cooperative is more difficult to observe, control and coordinate than the quantity ($\lambda > \sigma$). Under these circumstances, the model would suggest that free-riding on quality within the cooperative will be particularly prevalent and we thus expect to find that cooperatives produce lower quality products.

The data set includes information on the quality of bottled wine from different editions of the Austrian wine magazine "Falstaff". Collecting data from this magazine for the period 1999 to 2007 generates a data set which includes quality information for 18.709 bottles of wine (produced from 488 wineries). On average, 4.26 wines from each winery are graded per year; this number however differs substantially between wineries (the maximum number of wines graded for a winery is 26). Experts grade on a scale from 1 to 100 on color and appearance, aroma and bouquet, as well as flavor and finish. The data set is not representative for the supply of wine in Austria; the average quality of wines in our sample is 88.8 and only wines on the scale between 82 and 99 are included in the wine magazine. We further use information on the different types of wine (red, white, 'sweet wine', and 'rose'), different types of 'sweet wine' ('Spätlese', 'Beerenauslese', 'Trockenbeerenauslese', and 'Eiswein') and differentiate between 33 varieties of grapes.

The data set also includes information on the 488 wineries, such as ownership structure (i.e. whether or not the winery is a cooperative), location (we differentiate between 16 wine producing regions), size (measured by the number of hectares under cultivation), and reputation. Reputation of a winery is reported only for the period 2004 to 2007 and is classified on a scale from 1 to 3 between 2004 and 2006 and from 1 to 5 in 2007. To avoid the different scaling of this variable to affect our estimation results, we use relative reputation (defined as the level of reputation relative to the maximum level of reputation in that particular year) in the empirical analysis. Table A-2 in the appendix provides descriptive statistics of the variables used in the econometric analysis.

A simple t-test on mean differences in wine quality between cooperatives and non-cooperatives does not reject the Null-hypothesis (of no difference). The average Falstaff-rating for wines from cooperatives is 88.55, which is nearly identical to the rating of wines from non-cooperatives (88.89). The descriptive statistics reported in table A-2 in the Appendix reveal larger differences between cooperatives and non-cooperatives in terms of reputation and size. Our measure of relative reputation for cooperatives is 40% below the average figure for non-cooperatives. At the same time, the average cooperative is approximately 12 times larger than the average non-cooperative. Further note that cooperatives and non-cooperatives also differ with respect to their geographical representation in the 16 wine producing regions as well as with respect to the varieties of wine they produce. Since wine quality is heavily influenced by local production conditions and thus might differ systematically between regions in Austria, we include dummy variables to control for regional and product effects. In addition, vintage effects are captured by including dummy variables for each vintage. The results of the regression analysis are reported in table 1.

Table 1

The results of the first specification shown in table 1 suggest a negative relationship between size (measured by the area under cultivation) and product quality. The parameter estimate is significantly different from zero; the magnitude of this effect however is rather small. An increase in the area under cultivation by 100% corresponds to a reduction in quality by 0.2 Falstaff-points. The effect of farm size diminishes further once we control for ownership (models [2] to [4] in table 1).

Table 1 reports a negative parameter estimate for a dummy variable (*COOP*) which is set equal to one if the particular bottle of wine has been produced by a cooperative and is zero otherwise. After controlling for type and variety of wines, regional and vintage effects, cooperatives tend to offer wines of lower quality. The parameter estimate, which is significantly different from zero at the 1%-level suggests, that the average quality grade of wines from cooperatives is 0.97 Falstaff-points below that of non-cooperatives, ceteris paribus. Given that the range of quality grades of wines in our sample is between 82 and 99, a decrease by nearly one Falstaff-point is quite substantial.[10] Similar results are reported in Frick (2004) and Dilger (2005), who find that cooperatives in the German wine sector offer a significantly lower quality compared to investor-owned firms (farms).

To explore the hypothesis of free-riding on group reputation within cooperatives, models [3] and [4] in table 1 extend the basic specification by including relative reputation (*REP*) as well as an interaction effect between relative reputation and ownership (*REP* x *COOP*). [11] In order to maintain their good reputation, wineries have to continue selling high quality wines and the parameter estimate of *REP* in this case should be positive. Winfree and McCluskey (2005) suggest that members of a cooperative, who share a common reputation, have an incentive to free-ride on reputation by selling lower quality products. This would imply a negative parameter estimate for the interaction effect between *REP* and *COOP*. The impact of relative reputation on quality actually is positive and highly significant. A one unit increase in reputation (on a scale from 1 to 5) raises quality by 0.56 Falstaff-points. In contrast to our second hypothesis motivated by Winfree and McCluskey's analysis, the parameter estimate of the interaction effect between *REP* and *COOP* is not significantly different from zero. Free-riding on group reputation does not seem to be more pronounced in cooperatives.

The theoretical analysis discussed in the previous section also suggests that free-riding within the cooperative aggravates with the number of members. To investigate the importance of this effect, we collected the current number of members for most cooperatives from their homepages.[12] Including an interaction effect between this variable and *COOP* (not reported in table 2) however does not improve the explanatory power of the model. Similarly, the estimated parameter for the interaction effect between *COOP* and *SIZE* turns out not to be significantly different from zero (column [4]).

Additional estimation experiments have been carried out to evaluate the robustness of the empirical results reported. The results when estimating a multi-level random effects model (which allows for a correlation of residuals between different vintages of each wine as well as within each winery) as well as an ordered-logit model (which accounts for the discrete nature of the dependent variable) are reported in table A-3 in the Appendix. The parameter estimates are very similar to those discussed above.

Conclusions and extensions

The present article investigates the incentives of an investor-owned firm and a cooperative to supply high quality products in a vertically related industry. We assume that members of the cooperative independently decide about the quantity and the quality they deliver (decentralized decision making), whereas the investor-owned firm is characterized by a centralized decision making process and is not plagued by a coordination problem.

Decentralized decision making within the cooperative implies that members tend to overproduce, a reflection of the well-known quantity control problem. At the same time, there is a strong incentive to free-ride on product quality. Members of a cooperative do not receive the full benefits of their investment in product quality and thus tend to deliver products of lower quality. The degree of free-riding increases with the number of cooperative members, which corresponds to results reported in Winfree and McCluskey (2005). The theoretical analysis suggests that the quantity and quality control problem within the cooperative are interrelated. The incentives to improve product quality depend on the volume of sales: free-riding on quantity reduces the free-riding problem with respect to quality! Despite imperfect quality coordination within the cooperative, its final product can even be of higher quality than the firm's product.

The incentives to supply high-quality products also depend on the way in which the quality of the final product is determined from the inputs delivered by upstream firms (farmers). With a 'linear form' of quality aggregation, where the quality of the final product is the (weighted) average of the quality of inputs delivered by farmers, the free-riding problem within the cooperative is particularly strong. If the production process is characterized by an 'O-Ring form' of quality aggregation (which implies that the quality of the manufacturers' composite good is the minimum of the quality levels of its components), the free-rider problem is mitigated since a reduction of the quality of inputs delivered by one member immediately leads to a reduction in the quality of the final product. Assuming an O-Ring form of quality aggregation, the model predicts multiple quality equilibria in a cooperative. No Nash-equilibrium exists in the (rather unrealistic) case where the quality of the final product is determined by the maximum of the quality levels of its components.

Finally, we also provide empirical evidence on the differences in product quality between cooperatives and non-cooperatives for the Austrian wine industry. On the basis of a quality rating obtained from different editions of the Austrian wine magazine 'Falstaff' for wines from 488 wineries over the period 1999 to 2007 (a total of 18.709 bottles of wine), we find that wines produced by cooperatives tend to be of significantly lower quality, ceteris paribus.

These results have implications for the evaluation of cooperatives' performance ex post as well as the judgment concerning their future competitiveness in a market economy. The existing empirical literature evaluating firm behavior and performance attributes observable price differences between cooperatives and other forms of business organization to differences in cost-efficiency and/or to market power effects. Differences in product quality are ignored (mainly due to the lack of adequate data) which leads to biased measures of firm performance as well as a flawed assessment of policy measures (when it comes to evaluating the effects of mergers and take-over's, for example). Our finding of lower product quality in cooperatives also suggests being more skeptical about the competitiveness of cooperatives and future prospects of cooperatives in markets where consumers attach particularly high values on product quality. In a homogenous product market, Albaek and Schultz (1998) predict that cooperatives will eventually crowd out investor-owned firms. We argue that the competitiveness of cooperatives depends on consumers' preferences for quality as well as the way in which the quality of the final product is aggregated from the individual inputs delivered. Since these characteristics need not be identical for all products and might also differ between individual countries we (since the willingness to pay for higher quality varies with income) expect a market structure with varying market shares of cooperatives in different markets to persist.[13]

The incentives of cooperatives to offer higher quality products will, however, also depend on factors which are not explicitly included in the present analysis. The equilibrium outcome might be determined by the visibility of cheating (free-riding) and by the possibility of punishment. It is well known that repeated interaction between members helps to achieve a cooperative outcome.

It is also important to note that cooperatives and investor owned firms typically compete in the same market (Sexton, 1990). Some first attempts to derive optimal levels of product quality in a mixed duopoly framework (Hoffmann 2005; Pennerstorfer and Weiss 2008; Yu 2009) suggest that the results obtained are very sensitive to assumptions about the costs of quality as well as with respect to the specification of consumer preferences for product quality. A further limitation of these models emanates from the fact that the number of farmers delivering to the cooperative and the firm typically is assumed exogenous (closed-membership equilibrium). An interesting extension of this literature as well as the present analysis would be to consider heterogeneous farmers in a mixed duopoly with an open-membership policy.[14] Different forms of selection effects could then be investigated: how many and which types of farmers join the cooperative as opposed to selling their products independently; and what kind of products (high or low quality) do members sell via the cooperative versus selling them directly to consumers.

Finally, the present analysis ignores one of the prime reasons for farmers to establish (or join) a cooperative, which is to avoid the negative consequences of market power exercised from the downstream buyers of their products. Modeling the effects of downstream buyer power for product quality would be another area where future research could improve our understanding of the effects of different forms of business organizations on product quality. We hope that our article will spur further theoretical and empirical research along these lines.

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Appendix A1.:

Following Karantininis and Zago (2001), we assume that the firm maximizes $\Pi^F = P(Q,S)Q - \sum_n v(s)q$, where $v(s)$ is the price of inputs paid to farmers. The first-order conditions are $\frac{\partial \Pi^F}{\partial q} = P_Q Q^F + P(Q^F, S^F) - v(s) = 0$ and $\frac{\partial \Pi^F}{\partial s} = P_S \omega Q^F - v_s q = 0$. In the upstream market, and individual farmers maximize profits $\pi^f = v(s)q - c(q,s)$. The first-order conditions are $\frac{\partial \pi^f}{\partial q} = v(s) - c_q = 0$ and $\frac{\partial \pi^f}{\partial s} = v_s q - c_s = 0$. Combining the f.o.c's for the firm and the individual farmers, we receive equations (5) and (6) in the text.

Appendix A2: Numerical results for a specific (simple) model

To compute the optimum levels of quantity and quality for the firm and the cooperative, we assume the following demand and cost function: $P(Q,S) = \alpha - \beta Q + S^\gamma$ with $\alpha, \beta > 0$ and $0 < \gamma < 1$, and $c(q,s) = q + s$ and $S = \sum_n \omega s$. From this we get: $Q^F = \frac{\alpha - 1 + S^\gamma}{2\beta}$, $Q^C = \frac{\alpha - 1 + S^\gamma}{[1 + (1+\lambda)\frac{1}{n}]\beta}$, $S^F = \left(\frac{1}{\omega\gamma Q^F}\right)^{\frac{1}{\gamma - 1}}$, $S^C = \left(\frac{n}{\omega\gamma[1 + \sigma(n-1)]Q^C}\right)^{\frac{1}{\gamma - 1}}$. For $\alpha = 8, \beta = 1, \gamma = \frac{1}{2}, n = 2$ and $\omega = \frac{1}{n}$, we get $Q^F = 4$ and $S^F = 1$. The following table A-1 provides results for quantity and quality in the cooperative.

Table A-1

Table A-2

Appendix A-3: Results from alternative estimation techniques.

The data set comprises hierarchical data, as there are many wineries in one region (no winery is active in more than one region) and each winery produces different wines. We include dummy variables to control for regional effects, winery specific and wine specific effects are captured in the disturbance term. The model can be written as:

$$s_{rfit} = \boldsymbol{X}_{rfit}\boldsymbol{\beta} + \lambda_{\mathrm{t}} + \delta_r + u_{rfit} \text{ with } u_{rfit} = \mu_{rf} + \varphi_{rfi} + \varepsilon_{rfit}$$

The quality s_{rfit} of wine i of winery f in region r at time t is explained by the variables described above. Differences over time are captured by fixed time effects λ_t. We account for differences between 16 wine growing regions by including fixed regional effects (δ_r) whereas random winery (μ_{rf}) and random wine effects (φ_{rfi}) and a remainder error (ε_{rfit}) are included in the disturbances (u_{rfit}). All components of the disturbances (μ_{rf}, φ_{rfi} and ε_{rfit}) are assumed to be independent and identically distributed with mean 0 and variance σ_μ^2, σ_φ^2 and σ_ε^2. $\boldsymbol{\beta}$ is the vector of parameters. This specification is a multi-level model with random intercepts at the wine and at the winery level.[15] Contrary to 'basic' random effects models we allow for correlation of the disturbance term not only within each product over time, but also within each winery. The variance-covariance matrix is characterized by

$$\begin{aligned} cov(u_{rfit}, u_{rgjs}) &= \sigma_\mu^2 + \sigma_\varphi^2 + \sigma_\varepsilon^2 && \text{for} \quad f = g, i = j, t = s \\ &= \sigma_\mu^2 + \sigma_\varphi^2 && \text{for} \quad f = g, i = j, t \neq s \\ &= \sigma_\mu^2 && \text{for} \quad f = g, i \neq j, t \neq s \end{aligned}$$

The results of different specifications of the the multi-level random effects model are reported in columns [1] – [3] in table A-3.

Despite the fine scaling of the quality measure in our data one might argue that quality indicators are typical examples of discrete and ordered response variables: A wine with a better rating is of higher quality, but the difference between two adjacent quality grades (e.g. between 80 and 81 points vs. between 99 and 100 points) need not be the same. This makes an ordered logit (or an ordered probit) model more appropriate (see e.g. Wooldridge (2001) for an overview). If the quality passes an additional threshold, its evaluation increases by one point. Note that the coefficients of an ordered-logit model are not directly comparable to the parameter estimates discussed above. The results of the ordered-logit model are reported in columns [4] – [6] in table A-3.

Table A-3

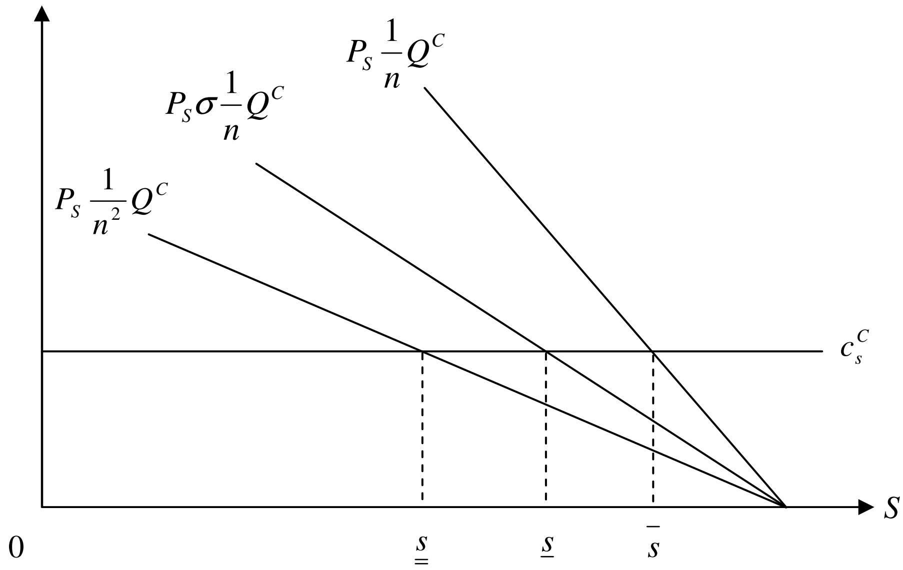

Figure 1: Quality decisions of cooperatives with different forms of quality aggregation.

Table 1: Results on Random-Effects and Error Component Two-Stage Least Square (EC2SLS) Model (Dependent Variable is Quality of Wine, *QUAL*)

Variables	Symbol	Parameter (t–ratio) [1]	Parameter (t–ratio) [2]	Parameter (t–ratio) [3]	Parameter (t–ratio) [4]
Method		Random Effects	Random Effects	EC2SLS	EC2SLS
Constant	*CONST*	86.799	86.791	85.910	85.907
		(139.09)	(139.42)	(92.74)	(94.23)
Size of winery (*1000)	*SIZE*	–0.527	–0.270	–0.208	–0.219
		(–3.42)	(–1.67)	(–1.21)	(–1.24)
Cooperative	*COOP*		–0.968	–0.532	–0.834
			(–5.22)	(–2.86)	(–2.67)
Relative Reputation	*REP*			2.753	2.756
				(31.26)	(31.84)
Rel.Reputation x Coop.	*REP x COOP*				1.581
					(1.57)
Size (*1000) x Coop	*SIZE x COOP*				–0.194
					(–0.33)
Type of Wine		Yes (3)	Yes (3)	Yes (3)	Yes (3)
Type of Sweet Wine		Yes (3)	Yes (3)	Yes (3)	Yes (3)
Variety of the Grape		Yes (31)	Yes (31)	Yes (31)	Yes (31)
Regional Effects		Yes (15)	Yes (15)	Yes (15)	Yes (15)
Vintage Effects		Yes (6)	Yes (6)	Yes (3)	Yes (3)
σ_{φ}		1.423	1.418	1.235	1.217
σ_{ε}		1.173	1.173	1.114	1.158
R^2 (overall)		0.237	0.240	0.407	0.407
Number of observations		16,123	16,123	7,534	7,534

Notes: Parameter estimates on the type and variety of wines, regional and vintage effects are not reported in table 1 but are available from the authors upon request. Reputation is only available since 2004. Creating instruments further reduces the number of observations in columns [3] and [4].

Table A-1: Optimal Quality and Quantity in a Cooperative

Parameter Values	Q^C	S^C
$\lambda = \sigma = 1$	4	1
$\lambda = 0, \sigma = 1$	5.6	1.96
$\lambda = \sigma = 0$	5.09	0.41
$\lambda = 0, \sigma = 1/2$	5.33	1

Table A-2: Descriptive Statistics of Variables used in the Empirical Analysis

Variable	Symbol	Cooperatives N = 314 Mean (Std.Dev.)	Cooperatives N = 314 Minimum Maximum	Non-Cooperatives N = 15,809 Mean (Std.Dev.)	Non-Cooperatives N = 15,809 Minimum Maximum
Quality (Falstaff-Points)	QUAL	88.554	85	89.036	82
		(2.106)	98	(2.178)	99
Size (Area under	SIZE	367.599	4	32.328	2
cultivation in ha)		(336.525)	1,200	(138.481)	3,000
Relative Reputation	REP	0.217	0	0.334	0
of the winery		(0.163)	0.4	(0.339)	1
Type of Wine					
White wine	WHITE	0.506	0	0.635	0
			1		1
Red wine	RED	0.475	0	0.304	0
			1		1
Sweet wine	SWEET	0.019	0	0.054	0
(‘Süßwein’)			1		1
Rosè wine	ROSÈ	0	0	0.007	0
			1		1
Type of Sweet Wine:					
Spaetlese	SPL	0	0	0.006	0
			0		1
Beerenauslese	BA	0.003	0	0.009	0
			1		1
Trockenbeerenauslese	TBA	0.016	0	0.030	0
			1		1
Eiswein	EW	0	0	0.009	0
			0		1
Variety of Grape:					
Blauburger	BB	0	0	0.001	0
			0		1
Blaufränkisch	BF	0.223	0	0.054	0
			1		1
Blauer Portugieser	BP	0	0	0.001	0
			0		1
Blauer Wildbacher	BW	0	0	0.001	0
			0		1
Chardonnay	CH	0.025	0	0.082	0
			1		1
Cabernet Sauvignon	CS	0.006	0	0.015	0
			1		1
Cuvee Rot	CUR	0.150	0	0.095	0
			1		1

Cuvee Weiss	CUW	0.010	0 1	0.029	0 1
Frühroter Veltliner	FV	0	0 0	0.002	0 1
Gemischter Satz	GEM	0	0 0	0.006	0 1
Gelber Muskateller	GM	0.010	0 1	0.027	0 1
Grüner Veltliner	GV	0.226	0 1	0.198	0 1
Merlot	ME	0	0 0	0.011	0 1
Muskat Ottonel	MO	0.006	0 1	0.004	0 1
Müller Thurgau	MT	0	0 0	0.001	0 1
Neuburger	NB	0.016	0 1	0.006	0 1
Pinot Gris / Grauburgunder	PG	0	0 0	0.014	0 1
Pinot Noir / Blauburgunder	PN	0.006	0 1	0.031	0 1
Rotgipfler	RG	0	0 0	0.007	0 1
Riesling	RI	0.210	0 1	0.130	0 1
Rose	ROS	0	0 0	0.002	0 1
Roter Veltliner	RV	0	0 0	0.007	0 1
Sämling 88 / Scheurebe	SA	0	0 0	0.005	0 1
Sauvignon Blanc	SB	0.003	0 1	0.062	0 1
Schilcher	SCH	0	0 0	0.005	0 1
Sankt Laurent	SL	0.019	0 1	0.022	0 1
Sortenvielfalt Weiss	SVW	0	0 0	0.003	0 1
Syrah	SY	0	0 0	0.007	0 1
Traminer	TR	0	0 0	0.019	0 1
Weissburgunder / Pinot Blanc	WB	0.016	0 1	0.050	0 1
Welschriesling	WR	0.003	0 1	0.025	0 1
Zierfandler	ZF	0	0 0	0.007	0 1
Zweigelt	ZW	0.070	0 1	0.068	0 1

Wine Region:					
Carnuntum	CA	0	0	0.038	0
			0		1
Wagram	DO	0	0	0.072	0
			0		1
Kamptal	KA	0	0	0.095	0
			0		1
Kremstal	KR	0.111	0	0.085	0
			1		1
Thermenregion	TH	0	0	0.052	0
			0		1
Traisental	TT	0	0	0.017	0
			0		1
Wachau	WA	0.420	0	0.098	0
			1		1
Weinviertel	WV	0	0	0.097	0
			0		1
Wien	WI	0	0	0.023	0
			0		1
Neusiedlersee	NS	0.064	0	0.113	0
			1		1
Neusiedlersee-Hügelland	NSH	0.118	0	0.092	0
			1		1
Mittelburgenland	MB	0.188	0	0.065	0
			1		1
Suedburgenland	SBG	0.099	0	0.020	0
			1		1
Suedoststeiermark	SOST	0	0	0.024	0
			0		1
Suedsteiermark	SST	0	0	0.101	0
			0		1
Weststeiermark	WST	0	0	0.008	0
			0		1

Notes: Reputation is only available since 2004. The number of observations with information on reputation reduces to 193 for cooperatives and 9,929 for non-cooperatives.

Table A-3: Results on Multi-Level and Ordered Logit Model (Dependent Variable is Quality of Wine (*QUAL*))

Variables	Symbol	Parameter (t–ratio) [1]	Parameter (t–ratio) [2]	Parameter (t–ratio) [3]	Parameter (t–ratio) [4]	Parameter (t–ratio) [5]	Parameter (t–ratio) [6]
Method		Multilevel	Multilevel	Multilevel	Ordered Logit	Ordered Logit	Ordered Logit
Constant	*CONST*	86.976	86.973	86.561			
		(141.62)	(141.70)	139.80			
Size of winery (*1000)	*SIZE*	–0.469	–0.315	–0.337	–0.465	–0.249	–0.379
		(–1.55)	(–1.01)	(–1.79)	(–5.02)	(–2.51)	(–3.15)
Cooperative	*COOP*		–0.661	–0.392		–0.777	–0.375
			(–1.89)	(–1.77)		(–7.09)	(–2.61)
Reputation	*REP*			2.194			2.841
				(27.92)			(45.57)
Type of Wine		Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)
Type of Sweet Wine		Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Yes (3)
Variety of the Grape		Yes (31)	Yes (31)	Yes (31)	Yes (31)	Yes (31)	Yes (31)
Regional Effects		Yes (15)	Yes (15)	Yes (15)	Yes (15)	Yes (15)	Yes (15)
Vintage Effects		Yes (6)	Yes (6)	Yes (3)	Yes (6)	Yes (6)	Yes (3)
σ_μ		0.891	0.888	0.389			
σ_φ		1.128	1.128	1.169			
σ_ε		1.168	1.168	1.036			
Log-Likelihood		–29,004	–29,002	–17,752	–32,550	–32,525	–18,779
Pseudo-R^2					0.061	0.062	0.115
Number of observations		16,123	16,123	10,122	16,123	16,123	10,122

Notes: Parameter estimates on the type and variety of wines, regional and vintage effects are not reported in table A-3 but are available from the authors upon request. Reputation is only available since 2004 which reduces the number of observations in columns [3] and [6].

[1] According to the EC (2009), market shares are especially large in in agriculture (83% in Netherlands, 79% in Finland, 55% in Italy and 50% in France), forestry (60% market share in Sweden and 31% in Finland) banking (50% in France, 37% in Cyprus, 35% in Finland, 31% in Austria and 21% in Germany) retailing (consumer cooperatives hold a market share of 36% in Finland and 20% in Sweden), pharmaceutical and health care (21% in Spain and 18% in Belgium) and information technologies, housing and craft production. In Italy cooperatives represented almost 15% of the total economy. According to Hansmann (1996), cooperatives also dominate or at least figure prominently in a number of U.S. industries. In the agri-food chain, for example, 32% of the products are produced and processed by cooperatives. Rey and Tirole (2007) suggest that 'cooperatives may become even more prominent with the advent of the new economy' (p. 1061 f)

[2] Product quality is neither mentioned in an extensive survey of theoretical and empirical studies on producer cooperatives (Bonin et al., 1993) nor in a more recent survey on performance measures of agricultural marketing cooperatives (Soboh et al. 2009).

[3] The failure of the launching of the space shuttle was entirely due to the malfunctioning of a small component, the 'O-Ring'. Kremer (1993) analyses the implications of an O-Ring production function for economic development. In an industrial organization framework, Economides (1999, p. 903) motivates this assumption with the following example: ‚a long distance call requires the use of long distance lines as well as local lines at the two terminating points. The fidelity of sound in such a phone call is the minimum of the qualities of the three services used'. The probability of success of a complex process is given by the joint probability of success of all its parts. In the context of aggregating different quality attributes into a single measure of overall quality, Sampson (1999) presents an axiomatic approach to quality aggregation.

[4] The assumption of constant marginal costs with respect to q and s makes sure that our results are not driven by economies or diseconomies of scale.

[5] By assumption, there is no difference between the firm and the cooperative in our model with respect to the degree of vertical integration: the cooperative is vertically integrated and the firm acts as if it is vertically integrated. This allows us to focus solely on the implications of coordination in decision making for the provision of product quality. The distribution of profits within the firm is not essential for our argument. As an alternative, we could follow Karantininis and Zago (2001) and explicitly

include input prices in the firm's maximization problem, which gives identical results (see Appendix A1).

6 The existing literature (Reitzes and Woroch (2007) for example) models sabotage as an activity which directly lowers the quality of the final product. We deviate somewhat from this approach by considering sabotage to be an activity that foils any attempt of other members to increase quality. Sabotage however turns out to be incompatible with $S > 0$ in equilibrium: for $S > 0$, σ must satisfy $\sigma > 1/(1-n)$ for the cooperative.

7 If $P_{QS} \neq 0$, the direction of the indirect (interaction) effect depends the sign of the expression $P_{QS}\omega[1+\sigma(n-1)][1+\lambda(n-1)]\frac{1}{n}Q^C + P_S\omega[1+\sigma(n-1)]$. The above discussion has assumed this expression to be positive, which will always be satisfied if P_{QS} is not 'too strongly negative' (i.e., the demand schedule must not rotate too much counter-clockwise as quality increases). More specifically, the above expression is positive if $\vartheta \equiv \frac{\partial P_S}{\partial Q^C}\frac{Q^C}{P_S} > -\frac{n}{1+\lambda(n-1)}$. Many standard demand functions satisfy this assumption. For instance, for demand $P(Q,S) = \alpha - \beta Q + S^\gamma$ with $\alpha, \beta, \gamma > 0$, an increase in S gives rise to a parallel shift of the demand schedule: $P_{QS} = 0$ (we consider this demand schedule in more detail in the numerical example in the Appendix). For $P(Q,S) = \alpha - \beta Q/S$ with $\alpha, \beta > 0$, we have a clock-wise rotation and $\vartheta = \beta Q/S^3 > 0$. Assuming $P(Q,S) = Q^\beta S^\gamma$ with $\beta < 0$ and $\gamma > 0$, we get $\vartheta = \beta$. The interaction effect will thus be positive as long as β is not 'too negative' ($\beta > -\frac{n}{1+\lambda(n-1)}$).

8 According to our knowledge, the health care market is one of the few sectors of the economy where systematic econometric analyses on the relationship between ownership and quality have been carried out. This literature, however, is inconclusive: 'Overall, the empirical evidence has yielded mixed findings regarding the ownership effects on cost and quality of care' (Lien et al. 2008, p. 1210). Some evidence also is available for wine production in Germany (Frick 2004).

9 We are grateful to Andreas Huber for sharing this data set with us.

10 A hedonic pricing model estimated on the basis of the same data set (Huber 2010) suggests that a quality decrease of 0.97 index-point in product quality corresponds to a price reduction of about 13 %.

11 Note that relative reputation, defined as the quality of the wines produced by the winery in the past, is an endogenous variable. We therefore apply an error component two-stage least squares (EC2SLS) estimator developed by Baltagi (1981) and instrument the variables *REP* as well as the interaction effect between *REP* and *COOP* in models [3] and [4]. We use the lagged average grade of all wines of a winery per vintage (with lags up to four years), the previous years' reputation of the winery, all exogenous variables as well as various interaction terms as instruments. The estimation results from the auxiliary regression reveals that the average quality of wines from previous vintages has a strong positive impact on the reputation of a winery; this effect diminishes with higher order lags.

As an alternative, we also apply the generalized two-stage least square estimator (G2SLS) developed by Balestra and Varadharajan-Krishnakumar (1987). This estimator differs in the choice of instruments and is asymptotically equivalent to the EC2SLS estimator (see Baltagi and Li (1992) for a more profound treatment of the differences and Baltagi (2005) for an overview). The empirical results of the G2SLS estimator are very similar to the EC2SLS estimator and are available from the authors upon request.

12 Note that the quality of this variable is rather poor. Information on membership only refers to 2009 and data on changes in membership over the period 1999 to 2007 are not available. Further, we did not succeed in obtaining any membership information for two cooperatives.

13 Focussing on the agri-food sector, Hendrikse (1998) finds substantial differences in the success of cooperatives between products and countries. 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). For the U.S.A., Cook (1995) observes that the market share of cooperatives in the market for milk production in the US increased steadily from 46 % in 1951 to 85 % in 1993. The market shares in other markets remained fairly stable (e.g. fruits and vegetables) or even declined slightly (e.g. livestock).

14 It is well known that the viability of cooperatives is closely related to their access policy (see Rey and Tirole (2007) for a recent paper stressing this point).

15 See Hox (2002) for a comprehensive treatment of multi-level analysis.