Improving Food Quality through Institutional Innovations: Using a Free-Rider Approach for Collective Action

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Abstract

This paper outlines how a team work approach, recently suggested in institutional economics to overcome the problem of externalities, can be used to promote better food quality. Cost sharing as "team work" is considered a novel institution to improve food quality by giving incentives to overcome the public good character of quality. We translate the approach from negative to positive externalities. Hereby: (1) We make a reference to the current state of the discussion on how food quality depends on efforts of a food industry to get a better image and discuss how much need there is to improve quality. (2) An outline of a mathematical approach of a "team work" is presented in the provision of quality as a positive externality and (3) the approach is adapted to a likely team building effort in a food industry. Finally some remarks are made how to stimulate a process of team building and the role of a government is addressed. At the core of the paper we see the argument that free riding on quality can be avoided if collective actions or team building processes occur in a community. A team is modeled as partnership of producers in which costs for quality improvement are shared.

Keywords: *food quality, team*

1 Introduction

There is a big dispute over the means to promote food quality (Henson and Reardon, 2005) and the central theme is the role of governments and public interventions (e.g. standards, monitoring, control, etc.: Codron et al, 2005). In the classical viewpoint, the dispute implies a rigorous approach to show that (1) quality is a common or public good phenomena (Martinez et al. 2007), and that (2) the market does not provide the social optimum and governments have a role to play (Martinez et al. 2007 and Narrod et al. 2009). (3) A mechanism should be outlined, which sets the "right" incentives for the private sector (Holleran, 1999) to overcome the public good problem of food quality. In this paper we argue that framing of food quality as a common property problem is an eye-opener, particularly, on reforming institutions governing quality and also to throw light on possible new institutional arrangements.

Normally, the belief is that quality is a criterion of food which is appreciated by consumers as related to public grading and market segmentation develops at minimal intervention. On the basis of an "objective" grading scheme which shall work in a specific industry (for example meat in Germany: Sönnichsen et al. 2000) consumers make choices. But do consumers know the industry's potentials to go beyond the current standards? Or what happens if the industry does not meet even the perceived standards? In the latter case consumers loose trust. For instance the image of the meat industry in the EU has declined over years (especially this was the case when BSE was strong in public awareness, but also due to market failure). Though we will go in this paper in detail on reasons and such as the role of media etc. (see on the influence of media: Verbeke et al., 2000), it seems that some food industries (especially the meat industry) have an image problem which corresponds to the realization of lower quality compared to the perceived standard. Rational producers under this condition employ cost minimization strategies such as the use of low quality feed, minimal maturing times of animals, etc. The outcome is still lower standards. There seem to be no incentive to change the behavior; though consumers frequently express concerns and might pay more if quality improves..

However, it is the hypothesis of this paper that the image of an industry could be built up if all producers would jointly increase quality, Building up quality also means that the costs increase, for instance by buying better feed or forage, and this has a price effect. The individual producer is faced with the dilemma, that his colleagues may prefer free riding and do not contribute to quality, notably as a rent seeking strategy (Nizan, 1991). The costs of individuals are too high to improve the image, because they fear free-riding. So the question is how can one reduce costs of individuals and assure “team” work in a quality improvement exercise. An appropriate suggestion is to share the additional costs which are to be incurred in realizing higher quality food (here we follow Platteau and Seki, 2000, by reversing their argument of production sharing to cost sharing). To frame a cost sharing arrangement, we suggest a “re”-invention of sharing arrangements such as in natural resource management with negative externalities (Heintzelman et al. 2008). There the idea is to reduce efforts to reach the social optimum. We reverse the argument and say: the social optimum is above current quality.

This requires that we have to set a reference for quality. The reference for quality choices in food markets is normally based on two criteria, an individual criterion associated with “taste (subjective)” and a generic criterion linked to “image (objective)” or pre-knowledge of quality. There are many indications that quality is more of an image issue in an industrial sector than single judgment of consumer. Producers face a situation that prices and quality, which are achievable in a market segment, are correlated with images of industries and that efforts of all participants count on image building and maintenance (markets based on assumptions of perfect knowledge are inefficient and other instrument of coordination seem to be necessary because price and quality do not fit: Hanf and Wersebe, 1994).

It is the objective of the paper to give a theoretical outline of a team work to improve the quality of food in an agricultural sector (for instance, beef or pork). The sector is eventually regionally concentrated and has an image, to which farmers collectively contribute. We start with a problem statement, then give a model outline and provide derivation of individual and team behavior. Finally some hints for policy and implementation will supplement the paper.

2 Problem statement and approach

We start with the following propositions: (1) consumers may not be able to distinguish reasonably different produces by farmers and the quality (they even may not see better quality in the market at all) and have to place trust on food that they purchase; (2) goods don’t contain full information signals at visible scales; (3) some characteristics are hidden; (4) quality and (5) prices remain below expected and potential levels (Hanf and Wersebe, 1994); and (6) consumers buy food as generic product. In this setup, image has a pivotal role and it can be improved as a result of collective action of farmers and industry.

Against this background we introduce the notion of quality as a collective criterion (image) which is achieved by cost sharing. Costs are associated with efforts to improve quality and the image of the produce of a sector matters. In contrast, if an individual wants to improve quality he is only a marginal contributor and has no incentive to do so. However, we assume a cost function which includes individual and collective efforts to increase quality. The basic idea is: costs for quality and image improvement must be made sharable. Sharing costs means that individual firms can externalize costs (efforts): Though, it means additional costs, it pays off.

However, to make the approach realistic, standard production costs and cost of quality enhancement must be distinguishable. We refer to costs of market development (image) and quality as those to be shared. If quality is a matter of collective action, it means that revenues of individual firms are determined by actions (efforts) of all market participants. Price and quality determine revenues on individual and collective levels. Prices are indirectly changeable by collective action (image). High quality adds up from smaller individual contributions towards quality and finally changes producer revenues. As assumption we state that we can distinguish costs for quality improvement and ordinary production costs. The focus of the paper is on quality costs. However, there is a link to be established between quality and production costs. Production volumes are non-linear in quality in our cost models.

Measures to improve quality are many fold. For special cases (meat) we can easily presume that better ingredients (feed) are more expensive and we take the difference in costs as quality effort based. In physical terms, the amount of better fodder in the diet of an animal is an effort "e" and this effort can be measured as a change in feed ingredients. For instance for beef, a higher percentage of grass in the diet of beef cattle, instead of maize, increases the quality of the meat and we can take the grass percentage in feed as effort. However, the case has to be generalized and we take a cost function approach which is dual of a production function (Sheppard, 1990: see below). Then the quality, as related to effort, follows a non-linear expression (efforts regressed on quality, see below).

Further assumptions are: marketing of quality (image), for instance better beef from an association (team) of farms, is collectively organized and a premium is paid. The problem is that the cost sharing only lifts quality if many producers participate. Our assumption is that an association (of team) can be formed. Producers are capable to reclaim additional effort (cost), i.e. "cost" (from a team) with whom they share the costs of quality improvement (notably only additional costs of production). Sharing is done according to the composition and membership in teams. The size of a team (group) is not predetermined, rather it must be simulated. Hence a three-layer-decision problem occurs for individuals and groups (see Heintzelmann et al., 2008). The layers are: (1) the level of effort is decided assuming each farmer is a member in a team; (2) the group or team formation is depicted and the number of members in each teams is decided; (3) the number of teams is derived. In the subsequent analysis we follow the analytical outline of the above authors, but reverse their argument from output to cost sharing. Furthermore, we integrate the production volume (quantity) decision of farmers on operational size, because we have heterogeneous producers.

3 Model Outline and social optimum

The outline starts with a sector approach on defining the production relationships, the objective functions and the "social optimum". Based, but modified, on Heintzelmann et al. (2008) we work with an average cost function which is: unit cost multiplied by the effort. Notify Heintzelman et al. worked with a production function and looked at revenue. We reverse the argument and state that costs can be shared. In contrast to Heintzelman et al., who pursue the idea that sharing output will reduce effort in favor of the environment, our issue is to increase effort (quality) based on cost sharing. In this respect we follow the assessment that a rigorous institution economic problem analysis would deliver the assertion that quality is a public good and too "few efforts" are provided. We work with a positive externality, rather than negative.

A further complication, if one works on quality of food, is the fact that quantities and qualities are simultaneous decision variables. Moreover, price levels are influenced if quality improvements (price increases with quality: hopefully). A generic problem is that food prices are considered to be too low by farmers to invest in quality, and also quality is mostly obscured by standards which give only minor price signals to consumers. So the modeling should include both, quantity and price effects, to guarantee that farmers' decisions are paying off later. Hence, the complexity of the problem, in order to become policy relevant, has to be increased. On the other hand it is necessary to maintain the core description of the quality enhancing argument.

3.1 Quality measure and objectives

In terms of measurement, quality is considered as an index to which farmers contribute. As part of production, quality is achieved by a share of better fodder in diets of animals. These shares are called efforts. The shares of individual farmers are summed up to give the total quality index. Individual shares correlate with effort at individual and group level. For simplicity, revenues are described as the product of price multiplied by quantity and quality. On costs we infer the usual curvature of cost functions. Since we have to infer the sizes of teams, formed (shown later), and the number of teams, we moreover assume that no single firm can establish the quality (image), which is appreciated by consumers by higher prices. Due to size limitations it lacks overall capacity to establish "industry quality". Rather only collective action can establish it. We model a typical small or medium sized sector in a competitive food market.
Further assumptions are: (1) we look at a single layer value added chain product. For the moment we do not distinguish producers and processors. Rather we see regulations and team building on raw material producing farmers. (2) Since we want to discuss an alternative to standardized systems, we abstract from existing contracts, hierarchies. etc.; though it might be possible to integrate processing and other contracts. (3) The next step is that we want to make the model operational for numerical simulations. For this sake we introduce a linearized version of objective functions. A first step is to clarify on quality for a mathematical representation of efforts and measurement. For this, it is assumed that a quality index is linked to effort: q=g·e or at aggregated level: Q=g·E; then we assume that weighting of individual quality contributions "q" delivers the overall index Q = S w_i q_i. where we assume that 0 < Q < 1.
The approach starts at the social (aggregated) level. The social problem, to be solved by finding the quality, is: maximizing the value added (surplus) of the sector (association of producers). For the following, the condition is expressed as:

$$L^s = P\ Y\ Q\ - c_a Q\ F(Q(E),Y) - C(Y) \qquad (1)$$

where: P: price
Y: quantity produced
Q: Quality
E: Effort
C_a: average costs for quality
C: usual production costs

In this specification of the sector surplus, the inverse of the production function (cost function) is defined as the production coefficient function F(…). It is flexible with respect to quality (see (1')).

$$C = \gamma \; E \frac{F(E,Y)}{E} = E \; \frac{[\alpha_{11} E^2 + \alpha_{12} Y \; E \;]}{E} = E \; [.5\alpha_{11} E \; + \alpha_{12} Y] \tag{1'}$$

where: E: effort

F: inverse of production function

γ: technology with measurement γ=1 to simplify

Furthermore we use a Taylor approximation for the remaining costs and receive a simplified version (2) as an expression which helps us to apply the analysis of Heintzelman et al. (2008).

$$L^s = P \; [Y_0 \gamma \; E + Q_0 Y] - c_a \gamma \; E \; [.5\alpha_{11} E \; + \alpha_{12} Y] - \alpha_{21} E \; Y \; - .5\alpha_{22} Y^2 \tag{2}$$

In equation (2) we use a Taylor Approximation of a cost function to make it quadratic and resume the current quality 'Q_0' (for instance: Q_0=0.1) and the current output 'Y_0' as benchmarks. The benchmarks serve as references. Applying the approximation has several justifications: (1) Unlike the usual cost function formulation, we assume a minimal joint effect of increasing quality and quantity on costs; (2) we split the total effect into two effects: the ordinary effect (like in other formulations the cost functions is partial) and (3) α_{21}EY the joint effect. Then for the following individual optimizations, individual quantities and qualities are of a joint character with the team levels.

3.2 Social optimization

However, the discussion starts with the derivation of a social optimization which also serves as a reference. Taking the derivative to Q or E, respectively, this would provide an optimum of quality which is analog to the optimum given in Heintzelmann et al. (2008):

$$P \; Y \; - c_a Y_0 \, F(Q^*, Y_0 \,) - Q^* F^{/}(Q, Y_0 \,) = 0 \tag{3}$$

Our problem, however, also depends on Y, the production level. Hence we must do a double optimization. Also we take an explicit function instead of an implicit function used by Heintzelman. For the function F(Q(E),Y) we assumed a representation such as F(Q(E),Y) = $0.5a_{11}$ E^2+ a_{12}Y E (see above) and then we receive for the first derivatives towards E and Y:

$$\frac{\partial L}{\partial E} = P \; Y_0 \gamma \; -_a \gamma \; \alpha_{11} E \; - c_a \gamma \; \alpha_{12} Y \; - \gamma \; c_a \alpha_{11} E \; - \gamma \; \alpha_{21} Y \; = 0 \tag{3a}$$

$$\frac{\partial L}{\partial Y} = P \; \gamma \; E_0 - c_a \gamma \; \alpha_{12} E - \alpha_{21} E - \gamma \; \alpha_{22} Y \; = 0 \tag{3b}$$

Solving the second equation for Y

$$Y \; = \alpha_{22}^{-1} [P \; E_0 - [c_a \alpha_{12} + \alpha_{21}] E \;] \tag{4b}$$

and inserting in the first equation the optimal effort for the social quality is a solution such as:

$$P \; Y_0 - c_a \gamma \; \alpha_{11} E \; + [c_a \alpha_{12} + \alpha_{21}] \alpha_{22}^{-1} [P \; E_0 - [c_a \alpha_{12} + \alpha_{21}] E \; = 0 \tag{4a}$$

Hereby we resumed E_0 and Y_0, which are the reference, as given in a market situation without the suggested institutional innovation of a team work. Notably we receive an optimal E*. A further opportunity is to couple the co-ordination problem of team work with a pricing issue.

For this we introduce a price that dependents on the quality. For an inverse demand for quality

$$P \ = \varepsilon_{11} Q - \varepsilon_{11} Y \tag{5}$$

this is possible (with the above specification of the optimal quantity). It delineates the link between pricing and quality (as well as effort for quality) in equation (6). In which we insert E

$$P \ = \varepsilon_{11}\gamma_1 E \ \ - \varepsilon_{11}\alpha_{22}^{-1}[P \ E_0 - [c_a\alpha_{12} + \alpha_{21}]E \tag{6}$$

ó $$P = [\varepsilon_{11}\alpha_{22}^{-1}E_0 \ +1]_0^{-1}\varepsilon_{11}\gamma_1 \ [E \ \ - \varepsilon_{11}\alpha_{22}^{-1}[c_a\alpha_{12} + \alpha_{21}]E \ \ ] \tag{6'}$$

and this formulation can be inserted into a determination of E (of equation 4a). Then equation

$$Y_0\,[\varepsilon_{11}\alpha_{22}^{-1}E_0 \ +1]_0^{-1}\varepsilon_{11}\gamma_1\,[E \ \ -\varepsilon_{11}\alpha_{22}^{-1}[c_a\alpha_{12}+\alpha_{21}]E \ \ ]-c_a\gamma \ \alpha_{11}E \ \ +[c_a\alpha_{12}+\alpha_{21}]\alpha_{22}^{-1}[[\varepsilon_{11}\alpha_{22}^{-1}E_0 \ +1]_0^{-1}$$

$$\varepsilon_{11}\gamma_1\,[E \ \ -\varepsilon_{11}\alpha_{22}^{-1}[c_a\alpha_{12}+\alpha_{21}]E \ \ ]E_0 - [c_a\alpha_{12}+\alpha_{21}]E \ \ =0 \tag{7}$$

gives us “optimal effort” and quality. For the moment (7) serves as a reference. Next, we provide arguments of individual behavior.

4 Cost sharing and individual optimum

This next step serves to implement the role of cost sharing and to show its implications. The idea is to have two layers of sharing: (1) groups (teams) form themselves and share costs and (2), in these teams, members share costs on equity basis. Hence, shares in total costs are determined by the size of the teams. The overall efforts are taken as reference for (a) the group-wise and (b) the in-group sharing. As a result individual objective functions are to be specified such as:

$$L_{ik}^s = p_{ik}[y_{0,ik}\gamma \ e_{ik} + q_{0,1}y_{ik}] - \{\frac{1}{m_i}[\frac{e_{ik}+E^{-k}}{E}]\}\{.5c_a\gamma \ \alpha_{11}E^2 - c_a\gamma \ \alpha_{12}E \ Y \ \} - \alpha_{21.ik}e_{ik}y_{ik}. - 5\cdot\alpha_{22,ik}y_{ik}^2$$

and (8)

$$L_{ik}^s = p_{ik}[y_{0,ik}\gamma \ e_{ik} + q_{0,1}y_{ik}] - \{\frac{1}{m_i}[e_{ik} + E^{-k}]\}\{.5c_a\gamma \ \alpha_{11}E \ \ - c_a\gamma \ \alpha_{12}Y \ \} - \alpha_{21,ik}e_{ik}y_{ik}. - 5\cdot\alpha_{22,ik}y_{ik}^2 \tag{9}$$

The argument is backward. The objective function (9) is optimized at a second step after group formation. Our discussion is reciprocal: (1) we optimize the function provided a behavioral function for individual teams exists and (2) we show the team formation. Optimization towards individual rationality is later summed up and number and sizes of groups are derived. For the individual firm, however, the activities of the groups (teams) are given. Firms can choose teams or change membership. This will be discussed later. For the moment we optimize (9) the above function where we see y_i as part of Y, i.e. $Y=\Sigma y_i$, $Q=\Sigma w_i q_i$ and $E=\Sigma w_i e_i$. The inclusion of the weighting for the quality index can be done by knowledge of the industry.

$$\frac{\partial L}{\partial e_{ik}} = p_{ki} y_{0,ik}\gamma - \frac{1}{m_i}\{.5 c_a \gamma\ \alpha_{11}[w_{ik} e_{ik} + w^{-ik} E^{-ik}] + c_a \gamma\ \alpha_{12}[y_{ik} + Y^{-i,k}]\} - \frac{1}{m_i}[e_{ik} + E^{-ik}].5\{c_a \gamma\ \alpha_{11} w_{ik}\} - \alpha_{21,ik} y_{ik}. = 0$$

$$\frac{\partial L}{\partial y_{ik}} = p_{ik} q_{0,ik} - \{\frac{1}{m_i}[e_{ki} + E^{-ik}]\}\{c_a \gamma\ \alpha_{12}\} - \alpha_{21i,k} e_{ik} - \alpha_{22,ik} y_{ik} = 0$$

(9a and b)

Furthermore, in the optimization (9a and b) we recognize only those elements of e_{ik} and y_{ik}, which are controllable. It means that the producer has only information about his optimization and influence on his quantities; others are given to his enterprise, notably as related to quality checks. Information and optimization can be limited to the knowledge on own technologies.

In the given case optimization can be reduced to the behavioral description towards efforts for quality. For this we solve the second equation for y_{ik} and insert it in the first equation.

$$y_{ik} = \alpha_{22,ik}^{-1}[p_i q_{0,i,k} - \{\frac{1}{m_i}[e_{ik} + E^{-k}]\}\{c_a \gamma\ \alpha_{12}\} - \alpha_{21,ik} e_{ik}]$$

(10b)

Then we use (10a)

$$p_{ki} y_{0,ik}\gamma - \frac{1}{m_i}\{5 c_a \gamma\ \alpha_{11}[w_{ik} e_{ik} + w^{-ik} E^{-ik}]\} + \frac{1}{m_i}[e_{ik} + e_i^{-k}]\{5 c_a \gamma\ \alpha_{ik} w_{ik}\} + \frac{1}{m_i} c_a \gamma\ \alpha_{12} Y^{-i,k} - [\frac{1}{m_i} c_a \gamma\ \alpha_{12} + \alpha_{21,ik}] y_{ik}.] = 0$$

to get (10)

$$p_{ki} y_{0,ik}\gamma - \frac{1}{m_i}\{c_a \gamma\ \alpha_{11}[e_{ik} + E^{-k}]\} + \frac{1}{m_i} c_a \gamma\ \alpha_{12} w_{ik} Y^{-i,k} + \alpha_{22,ik}^{-1}[p_i q_{0,i,k} - \{\frac{1}{m_i}[e_{ik} + E^{-k}]\}\{c_a \gamma\ \alpha_{12}\} - \alpha_{21,ik} e_{ik}] = 0$$

In equation (10) "e_{ik}", the effort of the producer "k" in team "I" is a function of E^{-ik}, Y^{-ik}, which are contributions of other community members. And "m_i" is the number of team members; it prevails as sub-team in a sector. In a simple case the weight "w_{ik}" is given by head count, i.e. 1/n, with n farms. However, in a skewed industry weights might be different, for instance, given by previous revenue shares. Note the optimization is contingent on the behavior of the other farms (firms) which makes it necessary to do individual and joint optimization.

5 Team formation

5.1 Team optimization

The crucial thing for a simulation of the team formation through modeling, which shall be based on rational behavior of individuals joining teams (sub-groups: which form a stable equilibrium in a sector), is the determination of the number of teams "n". Then the sizes "m_i" of these teams can be derived. In Heintzelmann et al. (2008), for instance the argument is that the sector is presented by a sum of the individual costs (benefit in our case). For us it is:

$$\sum_i p_i y_{0,i}^a \gamma_i = p_0 y_0^a N \Leftrightarrow p_0 y_0 = \frac{1}{N}\sum_i p_i y_{0,i}^a \gamma_i$$

(11)

In this representation y^a_o is the average production without an incentive scheme on quality. For determining the size of the operation the social optimum can be used. We state that the social optimum is given by n groups and N participants. Then team optimization follows. For this account group wise optimum is a differentiation to "e" and "y" of a "team's objective function".

$$m_i L_{ik}^s = p_i [y_{0,}\gamma \ e_{ik} + q_0 y_i] m_i - [e_i + E^{-i}]\{.5 c_a \gamma \ \alpha_{11} E \ - c_a \gamma \ \alpha_{12} Y \ \} - \alpha_{21,i} e_k y_i - 5 \cdot \alpha_{22,i} y_i^2 \quad (11)$$

In equation (11) the objective is those of a team. We need this objective to specify the number of teams (n: see below) and the members (m_i: consecutive) in a team. The next step is to optimize the "behavior" of the team. The results are similar to the individual optimization; though now it assumed that "the team" optimized. Joint behavior is perceivable as the team formation: it is a special subject. For the moment the optimization of the team's objective yields:

$$\frac{\partial m_i L_i^s}{\partial e_i} = m_i \ p_i^a y_{0,i}^a \gamma \ - c_a \gamma \ \alpha_{11}[e_i + E^{-i}] - c_a \gamma \ \alpha_{11}[y_i + Y^{-i}] - \alpha_{21,i} y_i \ = 0 \quad (12a)$$

$$\frac{\partial m_i L_i^s}{\partial y_i} = p_i q_{0,1} m_i - e_i c_a \gamma \ \alpha_{11}[e_i + E^{-i}] - \alpha_{21,i} e_i - \alpha_{22} y_i \ = 0 \quad (12b)$$

For this optimization (12) of the objective (11) it is again assumed that the knowledge on the quantity and quality elements in the cost function (for the generation of quality) is limited to the team. Note, the derivative to production (12b) includes a fictive team-wise production. Solving of (12b) to the quantity produced by the team gives:

$$y_i \ = \alpha_{22}^{-1}[p_i q_{0,1} m_i \ - e_i c_a \gamma \ \alpha_{11}[e_i \ + E^{-i}] - \alpha_{21,i} e_i \ ] \quad (12b')$$

And the equation (12b') enables us to specify the quality e_i that should prevail at team level:

$$m_i \ p_i^a y_{0,i}^a \gamma \ - c_a \gamma \ \alpha_{11}[e_i + E^{-i}] - c_a \gamma \ \alpha_{11} Y^{-i} - [\alpha_{21,i} + c_a \gamma \ \alpha_{11}][\alpha_{22}^{-1}[p_i q_{0,1} m_i - c_a \gamma \ \alpha_{11}[e_i + E^{-i}] - \alpha_{21,i} e_i \ ] = 0 \quad (12a')$$

In principle one can establish the effort of a team e_i for quality. However, on the one hand the determination is based on the size of the group m_i which is not established yet. Nevertheless, we know the socially optimal effort of the whole sector and see the rest of teams' efforts. The next steps will allow us to get the team numbers and team sizes.

5.2 Team number and size

In this section we show how the team size can be modeled. We follow the argument of Heintzelmann et al. (2008) who show that larger groups have smaller effort. Also we indicate how one can derive the number of teams. As been further argued (Heintzelmann et al., 2008) membership in groups will not differ much between teams and there can be an equilibrium which works along the concept of "being no incentives to switch" between teams. These are theoretical and empirical arguments; the more empirical arguments can settle around the presumption that equal sizes of teams will prevail because of similar transaction costs in teams.

We now show how the number in groups can be established. Joining or leaving a group depends on calculi (Heinzelman et al. 2008). We follow the authors and for simplicity we do not repeat different cases of different yields or costs; though we remind the reader that the case of solo production (not being member of any team) is included; though it makes no economic sense (under conditions to be verifiable).
The theoretical argument goes along the following line: Defined as quality contribution by individual efforts, we have different contributions of producers which, apparently, are distinguishable and producers have a stake in the sector's quality performance. Performance was introduced by a weighted quality index. It means that a team of producers can be of equal size contributing to quality. We defined Q_i as equal Q=gE and Q=Sw_ige_i; though the individuals in the group may differ with respect to efforts offered, they can control each other. This respectively implies that we can maintain equal quality contributions by teams. Knowing the socially optimal quality and dividing it by the number of team contributions is the core of the analysis.
For the following a theoretical outline is sketched. In this outline the above complex mathematical presentation is reduced to equations for which coefficients in front of variables have to be re-calculated. E.g. if we take the ordered variables m_i,e_i,E_{-1}, and Y_{-1} in equation:

$$[p_i^a y_{0,i}^a \gamma - [\alpha_{21,i} + c_a \gamma\, \alpha_{11}][\alpha_{22}^{-1} p_i\, q_{0,1}]]m_i - [[1 + \alpha_{21,i} c_a \gamma\, \alpha_{11}]c_a \gamma\, \alpha_{11} - \alpha_{22}^{-1}\alpha_{21,i}]e_i - c_a \gamma\, \alpha_{11} Y^{-i} + [c_a \gamma\, \alpha_{11}]E^{-i} = 0 \tag{13'}$$

This detailed description of the optimality shall correspond to a simplified version:

$$\theta_{10,i} + \theta_{11,i} m_i + \theta_{11,i} e_i + \theta_{13,i} E + \theta_{14,i} Y = 0 \tag{13''}$$

The coefficients θ_{ij} in equation (13'') are recalculated from the version (13'). We assume that there are only marginal contributions of individuals to E and Y, which means it does not make a sense to count Y and E as with or without the contribution of a producer under study. Then we can rewrite equation (13'') in a generalized way if we sum up over the number of teams:

$$\sum \theta_{10,i} + \sum \theta_{11,i} m_i + \sum \theta_{11,i} e_i + \sum \theta_{13,i} E + \sum \theta_{14,i} Y = 0 \tag{14}$$

In this general representation of a sector, as a sum of teams, the number of teams is implicitly contained (Heintzelman et al. 2008). For instance, if we postulate that the averages of the coefficients (i.e. gains of team work are given as higher marginal revenues) are obtainable

$$\theta^a = \frac{1}{n}\sum \theta_{10,i} \Leftrightarrow n\theta^a = \sum \theta_{10,i} \tag{15'}$$

The sum translates into an average coefficient multiplied by the number of teams. This enables us to postulate a slightly modified version of equation (15) which is:

$$n\theta_{10}^a + N\theta_{11}^a + E\theta_{11}^a + n\theta_{13} E + n\theta_{14} Y = 0 \tag{15''}$$

From this equation the number of teams is "n" retrievable. Mathematically the equation (15'') can be solved for "n". As a result one gets the number of teams dependent on the number of producers "N" and the social optimal "E" and "Y". In this theoretical derivation different variants can be discussed (Heintzelman et al. 2008): A special variant is the case of only solo-producers which equals a single team. This implies that, if the above equation is solved for "n" which is the number of teams, a recursive calculation of team sizes enables simulations.

5.3 Team size determination

Having advanced to the determination of number of groups, the final step is to determine (simulate) the number of members in teams (as remaining problem in team formation). We work along the given concept and generalize the above detailed findings for the individual, team and social level. The reader should remember that the technical outline of determining variables went along the principle that sub-games and optimization of individuals resulted in teams (summing up) and teams' characteristics specified their number. Knowing the number of teams (15'') the analysis can come back to members in teams and from the membership number we can re-derive the individual behavior. Finally individual behavior (as a sum of effort for quality) delivers the sector quality determination. Notify the approach is embedded in methodological individualism and no mysterious "deus-ex-machine" (social coercion) is needed for team formation.

According to Heintzelmann et al. (2008) one can state that teams will form along a concept of an equilibrium of joining and leaving teams. Incentives are: cost sharing opportunities in various teams and collective benefits. For practical reasons we can assume that the quality is shared and contributed by each team and is the same as between them. However, members m_i in teams are not yet determined. But the deliberations help us to establish the size of the teams in terms of the quality index contribution. The crucial thing from above is that having "n" teams "n" equations of similar type as equation (13'') are given. As definition an average effort in the team i is e^a_i. Then a system of "n" equation (16) for determining the m_i's is system (16). We make a reference to the fact that the sum of team members is N. We add an equation which completes the system. In turn it would mean one team member equation has to be cancelled.

$$\begin{aligned}
\theta_{11,i} m_1 &= \theta_{10,1} + \theta_{11,i} e^a + \theta_{13,1} E + \theta_{14,1} Y \\
\theta_{11,2} m_2 &= \theta_{10,2} + \theta_{11,i} e^a + \theta_{13,2} E + \theta_{14,2} Y \\
&\dots \\
m_1 + m_2 + \dots m_n &= N
\end{aligned} \tag{16}$$

A system like (16) would provide us sizes of teams. Note for decisions to join a team the size is eventually of bigger importance than the costs: Big teams enable producers to externalize costs by sharing, though are difficult to form.

Technically one imminent problem is that the system is over-determined. Over-determination can be avoided if we include a correction measure c_p. This correction measure can be considered as a public intervention which guarantees that the individual will form teams.

$$\begin{aligned}
\theta_{11,i} m_1 + \theta_{15,1} c_p &= \theta_{10,1} + \theta_{11,i} e^a + \theta_{13,1} E + \theta_{14,1} Y \\
\theta_{11,2} m_2 + \theta_{15,2} c_p &= \theta_{10,2} + \theta_{11,i} e^a + \theta_{13,2} E + \theta_{14,2} Y \\
&\dots \\
m_1 + m_2 + \dots m_n &= n
\end{aligned} \tag{16'}$$

It can be a special cost (subsidy) taken by government. A correction "c_p" is then endogenous.

So far we assumed E and Y are from the social optimum. Another way of solving the problem is to think about stratifying the problem. For instance we can start with two teams and have.

$$\begin{aligned}
\theta_{11,1} m_1 \quad + \theta_{11,1} e_1^a &= \theta_{10,1} + \theta_{13,1} E^* + \theta_{14,1} Y^* \\
\theta_{11,2} m_2 \quad + \theta_{11,2} e^a &= \theta_{10,2} + \theta_{13,2} E^* + \theta_{14,2} Y^* \\
e_1^a \quad + e_2^a &= E^* \\
m_1 \quad + m_2 &= 2
\end{aligned} \tag{16''}$$

which is a system of four equations and four dependent variables. It implies that a special quality comes out of the two teams as simulated. In this case we have assumed that two teams are established first and the members that join are the important formation category. However our previous result was "n" groups. Note further that approximations are needed. A way to go ahead is to assume that the number of teams can be approximated by 2^x . Then from the first upper layer of two teams we can descend to the next (lower) layer assuming 4 teams. The constraint for each new team is e^a_i or e^a_2. Hence we assume that a new team forms from a given team. It means that for the first sub-teams $m_{11}+m_{12}=m^*_1$ and $e_{11}+e_1=e^*_1$ holds. Similar things happen to team "two". From that we can proceed. With three layers eight teams are established and with four layers, 16 teams are formed. The closest number in this layer creation will give an approximation to number of teams, perceivable form the social optimization (equation 15).

A certain problem, involved in this procedure, is a pre-selection of membership in potential team and its size determination. Because we need to establish the averages for the coefficients, this might be arbitrary dependent on subjective team selections. Again we have to approximate and in reality teams of producers may form also according to similarity between themselves. A plausibility of formation in teams (in itself) is size. Starting with the fist layer the discrimination of joint productivity is small and large teams form easily. Then we break down to "less" large and "more" large in the group of large. Note, we do not know the behavior of individually contributing producer in advance. Though, the idea is to simulate the outcome.

6 Policy involvement

So far the discussion has been on the institution of sharing as a generic policy instrument without direct intervention. Sharing shall be invented by the community itself and is tested at the level of individuals; and then, hopefully, more and more members voluntarily join the scheme. Even one could include participation constraints. This probably is the ideal institution of an economist who does not like government interventions; though it maybe possible to influence the promotion and establishment of the community by active involvement. Still no standards are needed and the teams monitor themselves. Then, the role of government or governance as an active involvement becomes an issue: Are sharing schemes independent from governments? What are measures to promote and are subsidies helpful as stimuli? For the moment we may simply assume that governments can take a share in the cost. This share or contribution shall be specified according to the delivery of Q and its valuation by consumers. Then we receive

$$L^s = P\ [Y_0 \gamma\ E + Q_0 Y] - c_a \gamma\ [E\ [.5\alpha_{11} E\ + \alpha_{12} Y] - r_a^g Q_a] - \alpha_{21} E\ Y\ - .5\alpha_{22} Y^2 \tag{17}$$

as a new objective. Here r_g is a compensation which is provided from the government based on achieved quality. It can be considered an incentive scheme. So r_g adds to the price, but is an independent variable. The involvement of a stimulus raises the question of a cost benefit analysis. But this is beyond the current analysis.

7 Summary

The contribution discussed cost sharing as an alternative institution for quality improvement in food industry. Cost sharing, as an institution, is introduced as an analogical institution compared to benefit sharing in environmental economics. There, benefit sharing is a mean to reduce efforts while cost sharing shall stimulate efforts. In our case we assume that efforts are too low in a food industry to get socially optimal quality. The paper develops a scheme of team work in getting higher levels of quality. A mathematical outline is provided how to specify objective functions for collective and individual actions and it is shown how the number of teams and membership in each team can be calculated on the basis of the behavior.

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