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On the emergence of new growers' associations: self-selection versus countervailing power

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Summary

Increasing differentiation on the supply side of agricultural and horticultural markets has resulted in the emergence of new growers' associations (GAs). These GAs face a trade-off between self-selection and countervailing power, which is analysed with an incomplete contracting model. Heterogeneous GAs frustrate high-quality growers as a result of the policy of applying the equality principle, but they are strong in terms of countervailing power of the growers collectively. The opposite holds for homogeneous GAs. Homogeneous GAs prevail when the benefits of product differentiation are large, or when low-quality producers can be driven out of the market. An efficiency rationale for EU Regulation (EC) No. 2200/96 is formulated.

Keywords: growers' association, member heterogeneity, countervailing power, self-selection, incomplete contracts

JEL classification: D23, Q13

1. Introduction

Most agricultural producers do not trade with customers on an individual basis. This is not considered an attractive option because of high transaction costs and lack of bargaining power. Therefore, farmers will always seek the benefits of collective action, as in a bargaining association (see Iskow and Sexton, 1992). This paper is about bargaining associations of fresh fruit and vegetable growers. We define a growers' association (GA) as a horizontal arrangement between a collection of farmers. Some tasks of the individual farms are delegated to a GA without vertical integration into the downstream market, which would be the case for a co-operative. This paper studies the efficiency of GAs in a market with differentiated products.[1]

1 Sexton (1986) is an important contribution regarding the emergence of co-operatives. His focus is on sharing the benefits of a decreasing-cost technology and eliminating the double marginalisation problem in vertical relationships. Our focus is on countervailing power and self-selection in horizontal relationships; inefficient outcomes are allowed and occur.

The analysis presented is inspired by the establishment of a large number of new GAs in the Dutch horticultural sector (Bijman, 2002). These new GAs are a response to changing market conditions and the associated dissatisfaction among both suppliers and buyers with the traditional auction. A GA consists of growers of one particular crop or crop variety (such as tomatoes on the vine). The size of the membership varies greatly, but is mostly below one hundred. The main task of the GA is to bargain with wholesalers (and sometimes retailers) on behalf of members. Some have additional tasks, such as quality control, and sorting and packaging, but all tasks relate to the specific product of the association.

In the agrifood sector there is a trend towards differentiation and innovation. Consumers demand more variety and higher quality; producers respond to intensified competition from globalisation and saturated markets by developing and marketing a broader range of new products. Greater differentiation has implications for the organisation of farm product marketing. Traditionally, farmer-owned co-operatives play a major role in processing and marketing of agricultural products. Recently, doubts have been cast over the efficiency of the co-operative in a more differentiated agrifood system. Cook (1995) has argued that traditional co-operatives have difficulty in raising the equity capital needed for investment in product and market innovation, because of ill-defined property rights. Cook and Ilipoulos (2000) have suggested that strengthening individual ownership titles may solve the inefficiency problem. They support their argument with empirical findings from the so-called New Generation Co-operatives in North America. Hendrikse and Veerman (2001) have argued that the trend towards differentiation requires investments in specialised assets, such as brand names, at the processing and distribution stages of the agrifood chain. As the marketing co-operative may be less attractive in these situations, the authors suggest that co-operatives will be replaced by market exchange. GAs are an example.

Following Hansmann (1996), we define a governance structure as the allocation of decision rights and income rights. In other words, the governance structure determines who has control over particular assets and who receives income from those assets. Within a GA, decision rights are allocated democratically; all members have at least one vote. Regarding the allocation of income rights, the GA uses the equality principle,[2] both in the distribution of revenues and in the delivery of output. The equality principle regarding the distribution of revenues entails that each member receives the same remuneration for a unit of output, regardless of the quality of the product.[3] If a grower does not produce, then no remuneration is received. The equality principle regarding the delivery of output entails that a certain quantity of

2 The equality principle simply means that all members are treated equally. Some authors use the term equity principle. However, the word *equity* may be confusing because it has several meanings (as in equity capital) and it is often used with a more normative connotation.

3 As most farm products are sorted into quality classes, our analysis applies to products within a particular quality class. Equal remuneration for different products is chosen because measuring the value of the quality differences is impossible or too costly.

customer demand is met by proportionally delivering from the output of each grower, regardless of the quality. The principle of equal treatment serves to prevent the division of the surplus between the members from becoming a 'political' issue that leads to influence costs (Milgrom and Roberts, 1990) and might endanger the cohesion of the voluntary organisation (Søgaard, 1994). The application of the equality principle in a GA is greatly supported by a homogeneous membership (Hansmann, 1996).

We analyse the emergence of GAs from an incomplete contracting perspective (Grossman and Hart, 1986; Hart and Moore, 1990). The starting point is that detailed contracts often cannot be written, because they are too costly, language is insufficiently precise, or observable events may not be verifiable by a third party. The choice of governance structure serves a role in dealing with grower heterogeneity in such situations because the income and decision rights specify how to proceed when situations emerge that are not covered explicitly by contracts. There are two main differences between our model and the models of Grossman and Hart (1986) and Hart and Moore (1990). First, the choice of governance structure is not driven by efficiency considerations, but by strategic considerations. Second, we focus on the aspect of income rights of a governance structure, whereas Grossman–Hart–Moore focus on decision rights. The difference between Hendrikse and Bijman (2002) and this paper is that the former focuses on differentiation on the demand side of agricultural markets, whereas the latter is geared towards differentiation on the supply side.

Two governance structures are distinguished: a homogeneous and a heterogeneous GA. A homogeneous GA is characterised by member homogeneity; all members are identical. A heterogeneous GA consists of at least two types of members. We assume that each member of the heterogeneous GA produces the same quantity of output, but the quality of the output differs. The choice between these two governance structures is analysed by focusing on the trade-off between self-selection and countervailing power. Self-selection means that producers with identical products withdraw from the heterogeneous GA and organise themselves in a homogeneous GA.[4] This is attractive for high-quality producers because they are now able to appropriate the full benefits of their additional effort. However, a disadvantage of the (small) specialised GA is that it has lower countervailing power compared with a heterogeneous GA combining several different producers. We investigate the effect of self-selection and countervailing power on the incentive to invest in new products. Equilibrium conditions are determined in which the creation of countervailing power by establishing a heterogeneous GA is at the expense of efficiency.

4 The choice of governance structure serves a role similar to a non-linear pricing scheme (Vercammen *et al.*, 1996). A non-linear pricing scheme attempts to price-discriminate between heterogeneous members. Such a scheme is not possible in our setting of incomplete contracts. However, price discrimination is established by the decision of the high-quality producers to leave the heterogeneous GA and establish a homogeneous GA. The equality principle now applies in each of these homogeneous GAs separately, and therefore results in a different price for each homogeneous grower association.

The paper is organised as follows. Section 2 describes the emergence of new GAs in Dutch food horticulture. Section 3 develops a model that features the trade-off between self-selection and countervailing power. This model is used, in Section 4, to analyse the influence of governance structure on grower investment decisions. Section 5 concludes with a discussion of the implications for choosing an efficient organisation for producing and marketing differentiated agrifood products.

2. New growers' associations in Dutch horticulture

Over the last two decades, conditions in the European market for fresh produce have shown fundamental changes (OECD, 1997; Meulenberg, 2000). Consumers are demanding higher quality, more convenience products, and more variety. Also, food safety and environmental impact have become important purchase selection criteria. In addition, internationalisation has increased competition in the (European) market for fruit and vegetables. Moreover, the food retail industry has become very concentrated in Northwest Europe (Baas *et al.*, 1998). Finally, retailers now consider fresh produce as one of their core product categories. Fruit and vegetables are not only a good source of profit; they are also of strategic importance in building store image (Bech-Larsen, 2000).

Innovative growers in the Netherlands wanted to respond to new consumer and retailer demands by producing high-quality products in customer-specific packaging. They experienced that the auction system did not support such differentiation. There are at least three reasons why the traditional auction had difficulty in dealing with non-commodity products (Bijman, 2002). First, specialty products require a special marketing effort, for which the auction did not have the expertise. Moreover, most members of the auction did not want to invest in obtaining this expertise. In the democratic decision-making process, the traditional growers outvoted the innovative ones. Second, although the auction clock may have been a very efficient sales mechanism for generic products, the grower had no incentive to improve product quality. The lots that were brought before the auction clock represented one quality class, but often contained products from different growers. The growers supplied products with quality characteristics that were just above the lower boundary of a quality class. Third, the auction was organised in a grower-owned co-operative and the members were obliged to sell all their products through the auction. It was not allowed to use an alternative sales channel for the more innovative products.

In response to changing market conditions and dissatisfaction among both suppliers and buyers at the auction, several changes have taken place. A large number of auctions merged into the new marketing co-operative VTN/The Greenery (Bijman *et al.*, 2000). This new co-operative replaced the auction clock by an internal mediation agency, facilitating direct contracting between growers and wholesalers. It also acquired wholesale activities and implemented an ambitious marketing strategy. This new marketing co-operative can be considered as forward vertical integration of growers into wholesaling.

Another response came from innovative growers, who set up new GAs. Once the economies of scale, as they existed in the auction, were no longer important—the auction clock was no longer used and products were transported directly from grower to wholesaler—growers discovered they could do the bargaining with wholesalers themselves. Between 1995 and 2001, 74 new fruit and vegetables GAs were established in the Netherlands (Bijman, 2002). New GAs have also received financial support under the European Union *Regulation (EC) No. 2200/96 on the common organisation of the market in fruit and vegetables*. The cornerstone of this new market order is the GA, which takes care of the grouping of supply and marketing of produce (CEC, 2001).

3. Self-selection versus market power

The choice of governance structure and investment is analysed with the incomplete contracting model of Grossman and Hart (1986) and Hart and Moore (1990). It consists of a non-cooperative game of two stages: a governance structure stage and an investment stage. The choice of governance structure determines the bargaining strength of each party, and bargaining positions are determined in the investment stage. Whereas in the Grossman–Hart–Moore model the choice of governance structure in the first stage is driven by efficiency considerations, our model features strategic reasons in the choice of governance structure. The game is solved by backward induction, i.e. the second stage of the game is analysed first, given a certain choice of governance structure in the first stage. Subsequently, the first stage is solved, taking the decisions of the second stage into account. This section focuses on the investment stage of the game, and the next section highlights the governance structure stage.

Incomplete contract theory emphasises the importance of asset ownership for investment incentives in transactions characterised by asset specificity. Asset specificity leads to transaction costs (Williamson, 1985). Whereas transaction costs economics focuses on the cost of safeguarding investments *ex post* (i.e. after the contract has been signed), incomplete contract theory focuses on efficient investment decisions *ex ante*.

A governance structure allocates decision rights and income rights over assets. The particular allocation is important in situations where the incompleteness of contracts leaves room for bargaining about the (continued) use of particular assets. Investments are assumed to be asset-specific, which means that the investment generates surplus only if the investor has access to the particular asset. This implies that control over the asset is important for recuperating an investment. If the indispensable asset is in the hands of another agent, then the investment is also relationship-specific. This means that the investment generates revenues only if the investor continues his relationship with the asset owner. Thus, asset ownership provides bargaining power over the division of the surplus generated by the investment. It even provides the power to appropriate that part of the revenues meant to recover

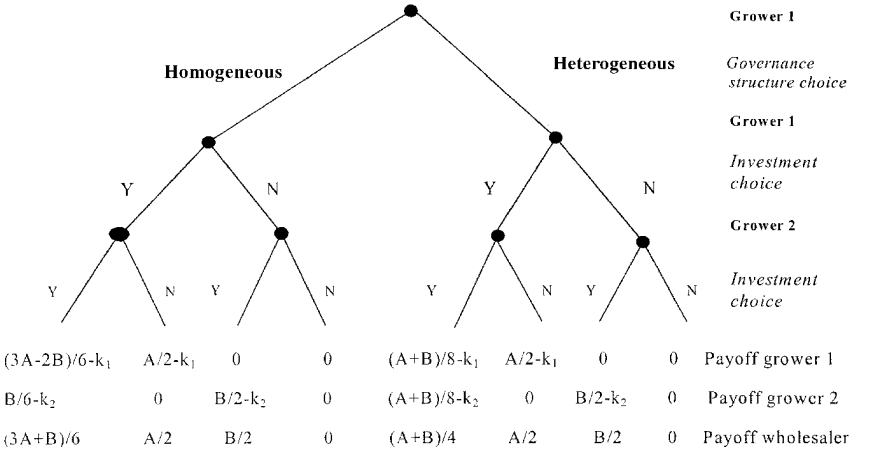

Figure 1. Extensive form of the game.

the investment costs. Because the investment is sunk in the relationship, the investing agent will agree to a new division of revenues even if it means that investment costs are not recovered.

Here we assume there are two types of growers. Each grower produces one unit of output. Both growers take an all-or-nothing decision regarding investment. Investment by grower 1 yields output with a revenue of A; investment by grower 2 yields output with a revenue of B.[5] The product of grower 1 is of higher quality than the product of grower 2; thus, $A > B$. The cost of investment is k_1 for grower 1 and k_2 for grower 2. A third party (a wholesaler) is needed to generate the revenues. This reflects the relationship-specific character of the growers' investments. It is assumed that the wholesaler wants to buy only one unit of the product of the growers.

Figure 1 presents the extensive form of the game.[6] The payoffs reflect the standard incomplete contracting logic in the sense that revenues are distributed between all the involved parties, whereas the costs of investment are paid completely by the investor. The motivation for the division of the revenues between the three players is formulated in Appendix 1.

The game presented in Figure 1 reads as follows. Grower 1 chooses between a heterogeneous and a homogeneous GA. Next, grower 1 makes an investment decision: Y(es) or N(o). Subsequently, grower 2 makes an investment decision: Y(es) or N(o). If only grower 1 invests, the governance structure choice is not decisive, and the revenue is divided between grower 1 and the wholesaler. The payoff for grower 1 is half of the revenue minus the investment costs (i.e.

5 We abstract from variable costs.

6 Notice that grower 1 decides which governance structure will be adopted. This is motivated by the observation that in our model grower 2 will always prefer a heterogeneous to a homogeneous GA. The payoff for grower 1 therefore determines whether a heterogeneous or homogeneous GA will be chosen. This grower is able to implement his choice because he may establish a heterogeneous GA with grower 2, or start a homogeneous GA himself. For computational reasons it is assumed that grower 1 decides first and grower 2 decides second in the investment stage of the game.

$A/2 - k_1$). The wholesaler appropriates half of the revenues, $A/2$. If only grower 2 invests, the payoff for the grower is half of the revenues minus investment costs (i.e. $B/2 - k_2$) and the payoff for the wholesaler is $B/2$.

If both growers invest, the division of revenues among the three agents is determined by the choice of governance structure and by the market power of the wholesaler (who by assumption wants to buy only one unit of the product from the growers). In a heterogeneous GA, total revenue is $(A + B)/2$. Here, the wholesaler cannot choose between products A or B; the association represents all growers and offers for sale a mixture of products A and B. There is a bilateral monopoly, where the growers collectively as well as the wholesaler receive half of the revenues. The growers split these revenues equally. The payoff for each grower is therefore a quarter of total revenues minus the grower's own investment cost; for grower 1 this would be $[(A + B)/8 - k_1]$. With the homogeneous GAs, the situation consists of two independent growers and the wholesaler. The wholesaler receives a larger share of the revenues by exerting his market power. Appendix 1 shows how the total revenue will be divided among the three players: grower 1 will receive $(A/2 - B/3)$, grower 2 will receive $B/6$, and the wholesaler will receive $(A/2 + B/6)$. If we subtract the investment cost, we obtain the payoff for each agent.

Figure 1 yields a number of insights.[7] First, the heterogeneous GA is inefficient from the perspective of the whole chain. If both growers invest, the heterogeneous GA creates a total revenue of $(A + B)/2$, whereas the homogeneous GA generates a total revenue of A (as $A > B$ by assumption). The equality principle applied in the association is responsible for this inefficient outcome. Second, from a bargaining power perspective, the homogeneous GA is not attractive for the growers collectively. If growers choose small, homogeneous GAs, they become competitors in supplying the wholesaler. This is attractive for the wholesaler, who receives a larger share of total revenue when a homogeneous GA is chosen than when the heterogeneous GA is chosen. Third, grower 2 has a stronger incentive to invest in a heterogeneous than in a homogeneous GA. This is caused by the combined effect of countervailing power *vis-à-vis* the wholesaler and the equality principle within the association.

Finally, the heterogeneous GA has two opposing effects on the incentive to invest of grower 1. On the one hand, the bargaining power enhances the investment incentive; on the other hand, the equality principle reduces the investment incentive (because the revenue from the investment has to be shared with others). The opposite holds for the homogeneous GA: the equality principle is not a problem in a homogeneous GA, because all members invest equally and share revenues equally, but the bargaining power towards the wholesaler is reduced. When the heterogeneity among the members of a heterogeneous GA increases, it becomes more attractive for high-quality growers to leave the heterogeneous association and set up

7 The following insights are formulated in four propositions in Appendix 1.

a (small) homogeneous association. In other words, increasing heterogeneity among growers leads to self-selection.

Current developments in agrifood markets, favouring differentiation and higher quality, seem to indicate an increase in the difference between A and B. This implies that high-quality growers will form a homogeneous GA so as to escape the negative effect of the equality principle in the heterogeneous GA. When the difference between A and B is large enough, the advantage of self-selection for the high-quality growers is larger than the loss of countervailing power. The wholesaler gains in two ways from this self-selection. First, the size of the total pie increases from $(A + B)/2$ to A. Second, the wholesaler may obtain a larger share of the pie because there are now two GAs instead of one, which results in competition between the two homogeneous GAs. It is therefore expected that the wholesaler (or any other customer of the growers) will encourage the establishment of homogeneous GAs.

4. Governance structure choice and investment costs

So far, we have focused on the distribution of the revenues from investments by growers 1 and 2, given a certain choice of governance structure. The choice of governance structure, i.e. the first stage of the game, is the focus of attention in this section. Figures 2 and 3 present the subgame perfect equilibrium choice of governance structure, given investment costs k_1 for grower 1 and k_2 for grower 2 (on the x- and y-axes, respectively). As indicated in note 6, grower 1 chooses the governance structure.

Three types of equilibrium outcome can be distinguished. First, when only one grower invests, grower 1 is indifferent between the two governance structures. This is indicated by 'Ho/He' in Figures 2 and 3 (where 'Ho' stands for homogeneous GA and 'He' for heterogeneous GA). When investment costs (which were assumed fixed in Figure 1) exceed a certain level, the payoff is

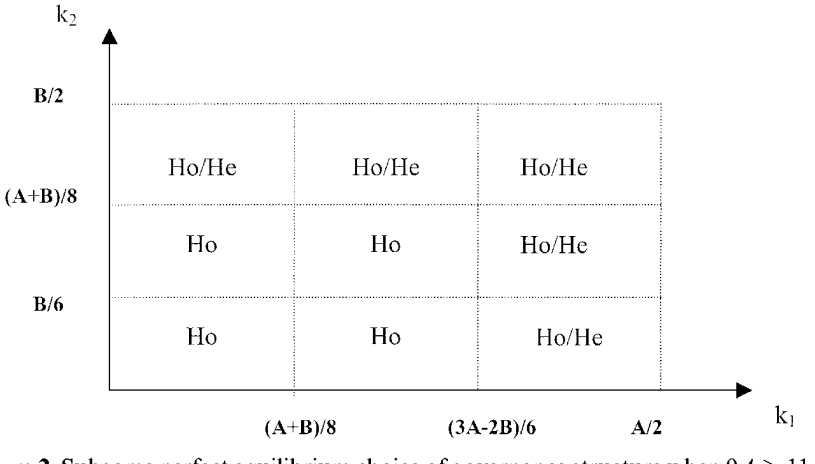

Figure 2. Subgame perfect equilibrium choice of governance structure when $9A \geq 11B$.

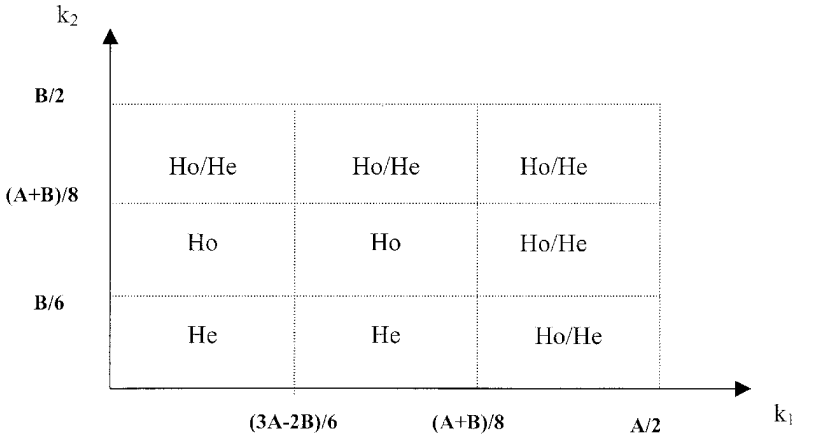

Figure 3. Subgame perfect equilibrium choice of governance structure when $9A < 11B$.

negative and the grower will not invest. Second, when $9A \geq 11B$ (Figure 2), grower 1 always prefers the homogeneous GA (see Proposition 4 in Appendix 1). Third, if the cost of investment is small for grower 2, then the choice of governance structure is determined by the extent of heterogeneity. The homogeneous GA is chosen when $9A \geq 11B$ (Figure 2), otherwise the heterogeneous GA is chosen, which is indicated by 'He' in Figure 3. (See Appendix 2 for a more detailed description of these outcomes.)

A number of observations can be drawn from this analysis. First, if the investment costs of grower 2 are low (i.e. $k_2 \leq B/6$), then the extent of heterogeneity between the growers determines the choice of governance structure. If heterogeneity is low (i.e. when $9A < 11B$), the heterogeneous GA is chosen because the positive effect of countervailing power outweighs the negative effect of the equality principle for grower 1. The opposite holds when grower 1 and grower 2 are sufficiently different, that is, when $11B \leq 9A$.

Second, strategic considerations drive the choice of governance structure when the investment costs of grower 2 are at an intermediate level (i.e. $B/6 < k_2 \leq (A + B)/8$). The governance structure 'Ho' is chosen to drive grower 2 out of the market, regardless of the extent of heterogeneity between the growers. This is attractive for grower 1 because a competitor is eliminated, which yields grower 1 countervailing power towards the wholesaler. This strategic behaviour is also attractive from a welfare perspective because more surplus is created by escaping from the equality principle of the heterogeneous GA.

Third, from the perspective of the whole chain the homogeneous GA is the efficient choice of governance structure, regardless of the values of A and B. The negative effects of the equality principle do not emerge when GAs are homogeneous. However, a homogeneous GA is not an equilibrium governance structure when the heterogeneity between the growers is limited (i.e. when $9A < 11B$), and the investment costs of grower 2 are low (i.e. when

$k_2 \leq B/6$). In this case, considerations of countervailing power are more important than creating value.

Fourth, our model formulates an efficiency rationale for EU Regulation (EC) No. 2200/96 (CEC, 2001). The requirements for receiving financial support seem so demanding that they can be met only by high-quality growers. This implies that a premium is paid for establishing homogeneous GAs. The result may be a shift from an inefficient equilibrium with a heterogeneous GA to an efficient equilibrium with homogeneous GAs.

5. Conclusion and further research

Traditional marketing co-operatives have faced problems in responding to the increasing differentiation in demand as well as supply. New GAs have emerged as a response to the differentiation in demand, but they have also to deal with the differentiation on the supply side caused by increasing member heterogeneity. The trade-off between self-selection and countervailing power in the emergence of these GAs is analysed with an incomplete contracting model. Bargaining strength is determined by the choice of governance structure in the first stage of the non-co-operative game, whereas bargaining positions are determined by the choice of investment in the second stage. There are two main differences compared with the models of Grossman and Hart (1986) and Hart and Moore (1990). First, the choice of governance structure is not driven by efficiency considerations, but by strategic considerations. Second, we focus on the aspect of income rights of a governance structure, whereas Grossman–Hart–Moore focus on decision rights. The effect of a specific income right—the equality principle—is highlighted.

Several results are formulated. First, heterogeneous GAs frustrate high-quality growers because of the policy of applying the equality principle, but they are strong in terms of countervailing power of the growers collectively. The opposite holds for homogeneous GAs. Second, the homogeneous GA may be chosen as a governance structure by the high-quality growers to drive the low-quality growers out of the market. This is attractive for the high-quality growers because a competitor is eliminated and therefore enhances the countervailing power towards the wholesaler. This strategic behaviour is also attractive from a welfare perspective because more surplus is created, as a result of circumventing the equality principle in the heterogeneous GA. Third, the homogeneous GA is the efficient choice of governance structure, regardless of the extent of heterogeneity between the growers. However, the homogeneous GA is not always an equilibrium outcome. EU Regulation (EC) No. 2200/96 may therefore serve an efficiency-enhancing role.

Several extensions of the above model are possible. First, investment by the wholesaler is not considered. This can be incorporated in the above model along the lines of Hendrikse and Bijman (2002). Second, it is implicitly assumed in the above model that each grower owns the assets it is using. This is due to our focus on income rights. The other important aspect of a

governance structure is the allocation of decision rights. Combining the analysis of income and decision rights in one model will allow for the comparison of heterogeneous and homogeneous GAs with other governance structures, for instance the marketing co-operative. This will raise a number of additional questions. For example, can a traditional co-operative be efficient and viable when the difference between low- and high-quality members increases? Under what conditions are grower instructions by the processor or wholesaler efficient? These questions will be addressed in future research.

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Appendix 1: Payoffs in the extensive form

We follow Hart and Moore (1990) in equating the choice of governance structure to the choice of a Shapley value in the first stage of the game. The Shapley value is a solution concept in cooperative game theory,[8] and serves as a measure of the bargaining strength of each player. A co-operative game is summarised by the characteristic function (N, v), where N is the set of players and v specifies a payoff for every possible subset of the set of players. Three players are distinguished. Grower 1 is player 1, grower 2 is player 2, and the wholesaler is player 3.

The type of GA determines the pay-off of a coalition of players. The characteristic function of the homogeneous GA is: $N = \{1,2,3\}$, $v() = 0$, $v(1) = 0$, $v(2) = 0$, $v(3) = 0$, $v(12) = 0$, $v(13) = A$, $v(23) = B$, $v(123) = A$. The analysis of a heterogeneous GA is facilitated by defining the coalition of all growers as $I = \{1,2\}$. The characteristic function of the heterogeneous GA is: $N = \{I,3\}$, $v(\emptyset) = 0$, $v(I) = 0$, $v(3) = 0$, $v(I3) = (A + B)/2$. Notice that the equality principle regarding the delivery of output is responsible for $v(I3) = (A + B)/2$; this means that a certain quantity of customer demand is met by proportionally delivering from the output of each grower, regardless of the quality.

8 Co-operative game theory has nothing to do with (agricultural) co-operatives. Co-operative game theory (as opposed to non-co-operative game theory) is a mathematical tool that starts from the assumption that the parties in the game are willing to collaborate. An application of co-operative game theory to farmer-owned co-operatives is Sexton (1986).

Table A1. Computation of the Shapley value of the homogeneous GA when players 1 and 2 invest

	Value added by player 1	Value added by player 2	Value added by player 3
Sequence 123	$v(1) - v(\emptyset) = 0$	$v(12) - v(1) = 0$	$v(123) - v(12) = A$
Sequence 132	$v(1) - v(\emptyset) = 0$	$v(123) - v(13) = 0$	$v(13) - v(1) = A$
Sequence 213	$v(12) - v(2) = 0$	$v(2) - v(\emptyset) = 0$	$v(123) - v(12) = A$
Sequence 231	$v(123) - v(23) = A - B$	$v(2) - v(\emptyset) = 0$	$v(23) - v(2) = B$
Sequence 312	$v(13) - v(3) = A$	$v(123) - v(13) = 0$	$v(3) - v(\emptyset) = 0$
Sequence 321	$v(123) - v(23) = A - B$	$v(23) - v(3) = B$	$v(3) - v(\emptyset) = 0$
Sum value added	$3A - 2B$	B	$3A + B$
Shapley value	$(3A - 2B)/6$	$B/6$	$(3A + B)/6$

The outcome of a cooperative game is a specification of a payoff for each player. The Shapley value is used as solution concept (Shapley, 1953).[9] It is defined as a payoff for each player, where the payoff for a player is equal to the average marginal contribution of that player when every possible emergence of the coalition of all players is equally likely. It is an indication of the bargaining power of each player in appropriating the collectively generated value and is therefore an indication of the incentive to invest.

Table A1 presents the computation of the Shapley value of the homogeneous GA when both growers invest. The numbers are illustrated by elaborating on the sequence 231 in which the grand coalition of players forms. The value added by player 2 is zero because this player is first, thus $v(2) - v(\emptyset) = 0$. Player 2 adds no value because the wholesaler is needed for creating value. The wholesaler (player 3) adds value B when the grower with low quality (player 2) is joined, thus is $v(23) - v(2) = B$. Finally, grower 1 adds value $A - B$ to the coalition consisting of the players 2 and 3, thus $v(123) - v(23) = A - B$. Table A1 specifies the value added for each player for each possible sequence in which the grand coalition of players can form. The Shapley value is determined by adding the value added in each possible sequence, and dividing this number by the number of possible sequences. The Shapley value of the homogeneous GA is the vector $(A/2 - B/3,\ B/6,\ A/2 + B/6)$, where $A/2 - B/3$ is the payoff for player 1, $B/6$ is the payoff for player 2, and $A/2 + B/6$ is the payoff for player 3.

The Shapley value of the heterogeneous GA when both growers invest is $[(A + B)/4, (A + B)/4]$. The equality principle regarding the distribution of revenues entails that each member receives the same remuneration for a unit of output that is sold, regardless of the quality of the product. The first component of this vector has therefore to be split into two equal parts to determine the payoff for each grower, which results in the Shapley value $[(A + B)/8, (A + B)/8, (A + B)/4)]$. Table A2 presents the computation.

Four propositions are formulated based on the differences between Tables A1 and A2.

9 The two most well-known equilibrium concepts in co-operative game theory are the core and the Shapley value. Sexton (1986) has used the core in his game-theoretic approach to studying the formation of co-operatives. Hendrikse and Bijman (2002) have used the Shapley value in their analysis of the efficiency of a co-operative in a three-tier agrifood chain with relationship-specific investments. An important advantage of the Shapley value compared with the core is that it assigns a unique value to each player, whereas the core may be empty or consist of many outcomes. An empirical reason for choosing the Shapley value is that the 'performance of the Shapley value for prediction or analysis turns out rather well' (Dixit and Skeath, 1999: 572).

Table A2. Computation of the Shapley value of the heterogeneous GA when players 1 and 2 invest

	Value added by player I	Value added by player 3
Sequence $I3$	$v(I) - v(\emptyset) = 0$	$v(I3) - v(I) = (A + B)/2$
Sequence $3I$	$v(I3) - v(3) = (A + B)/2$	$v(3) - v(\emptyset) = 0$
Sum added value	$(A + B)/2$	$(A + B)/2$
Shapley value	$(A + B)/4$	$(A + B)/4$

Proposition 1. The homogeneous GA creates more value than the heterogeneous GA.

Proof. $v(123) = A > v(I3) = (A + B)/2$ because $A > B$.

Proposition 2. The wholesaler has more power when faced with the homogeneous GA than with the heterogeneous GA.

Proof. The Shapley value of the wholesaler with the homogeneous GA is $A/2 + B/6$, whereas the total value is equal to A. The Shapley value of the wholesaler with a heterogeneous GA is $(A + B)/4$, whereas the total value is $(A + B)/2$. The wholesaler has more power with the homogeneous GAs than with the heterogeneous GA because $(A/2 + B/6)/A = 0.5 + B/6A > [(A + B)/4]/(A + B)/2 = 0.5$.

Proposition 3. Grower 2 has a weaker incentive to invest in the homogeneous GA than in the heterogeneous GA.

Proof. The Shapley value of grower 2 is $(A + B)/8$ in the heterogeneous GA. The Shapley value of grower 2 is $B/6$ in the homogeneous GA. Grower 2 prefers the heterogeneous GA to the homogeneous GAs for every value of A and B because $(A + B)/8 > (B + B)/8 = B/4 > B/6$.

Proposition 4. Grower 1 has a stronger incentive to invest in the homogeneous GA than in the heterogeneous GA when $9A > 11B$.

Proof. Grower 1 prefers the homogeneous GA to the heterogeneous GA when $(A/2 - B/3) > (A + B)/8$, that is, when $9A > 11B$.

Table A3. Shapley values for two governance structures and eight investment decisions

Growers' association	Investment (x_1, x_2)	Shapley value		
		Player 1	Player 2	Player 3
Homogeneous	$(0, 0)$	0	0	0
Homogeneous	$(1, 0)$	$A/2$	0	$A/2$
Homogeneous	$(0, 1)$	0	$B/2$	$B/2$
Homogeneous	$(1, 1)$	$(3A - 2B)/6$	$B/6$	$(3A + B)/6$
Heterogeneous	$(1, 0)$	$A/2$	0	$A/2$
Heterogeneous	$(0, 1)$	0	$B/2$	$B/2$
Heterogeneous	$(1, 1)$	$(A + B)/8$	$(A + B)/8$	$(A + B)/4$

Tables A1 and A2 present the cases where both growers invest. The other cases are straightforward. The Shapley value of the cases when only one grower invests is easy to determine because only the investor and the wholesaler are essential. They have equal power and therefore receive half the revenues, because a grower receives nothing when nothing is produced. The Shapley value assigns a value of zero to each player when nobody invests.

Define x_i as the investment by grower i, where $i = 1, 2$. Take $x_i = 0$ when grower i does not invest and $x_i = 1$ when grower i invests. Table A3 summarises the above results. It shows that the choice of governance structure does not have an impact on the Shapley value when only one grower invests. Tables A1 and A2 have shown already that the Shapley value differs between the homogeneous and the heterogeneous association when both growers invest. The payoffs in Figure 1 are identical to the numbers in Table A3.

Appendix 2: Equilibrium governance structure choice

The equilibrium choice of governance structure will be outlined for the various classes of parameters. The choice of governance structure does not matter to grower 1 or to grower 2 when either $(A+B)/8 < k_2 \leq B/2$ or $\max[(3A-2B)/6, (A+B)/8] < k_1 \leq A/2$. If $(A+B)/8 < k_2 \leq B/2$, then grower 2 will invest only when grower 1 does not invest, i.e. the costs of investment can be recuperated only when grower 2 is a monopolist. This implies that at most one grower will invest. Figure 1 as well as Table A3 show that grower 1 as well as grower 2 is indifferent with respect to the choice of governance structure in this case. Similarly, at most one grower will invest when $\max[(3A-2B)/6, (A+B)/8] < k_1 \leq A/2$. Again, there is indifference regarding the choice of governance structure in this range of parameter values.

It follows from Figure 1 that grower 1 will always invest when $k_1 \leq \min[(3A-2B)/6, (A+B)/8]$ and that grower 2 will always invest when $k_2 \leq B/2$. If $k_1 \leq \min[(3A-2B)/6, (A+B)/8]$ and $k_2 \leq B/2$, then the homogeneous GA is preferred to the heterogeneous GA when $(3A-2B)/6 > (A+B)/6$, i.e. $9A > 11B$. If $k_1 \leq \min[(3A-2B)/6, (A+B)/8]$ and $B/6 < k_2 \leq (A+B)/8$, then grower 2 will invest only when the heterogeneous GA is chosen. Grower 1 is aware of this and will drive grower 2 out of the market by choosing the homogeneous GA.

If $(A+B)/8 < k_1 \leq (3A-2B)/6$ and $k_2 \leq B/6$, then grower 1 will invest only when the homogeneous GA is chosen. If $(A+B)/8 < k_1 \leq (3A-2B)/6$ and $B/6 < k_2 \leq (A+B)/8$, then the homogeneous GA is chosen, to drive grower 2 out of the market.

If $(3A-2B)/6 < k_1 \leq (A+B)/8$ and $k_2 \leq B/6$, then grower 1 will invest only when the heterogeneous GA is chosen. If $(3A-2B)/6 < k_1 \leq (A+B)/8$ and $B/6 < k_2 \leq (A+B)/8$, then the homogeneous GA is chosen, to drive grower 2 out of the market.

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