THE TRANSITION TO NEW GENERATION COOPERATIVES: A GAME THEORETIC APPROACH

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Abstract. This paper analyzes the issue of non-commitment in cooperatives, in light of the transition of Traditional Agricultural Cooperatives to New Generation Cooperatives. Non-commitment is expressed as members' choice not to sell their products exclusively through their cooperative, and is an important form of member free riding. Non-commitment also includes members' reluctance to invest significant amounts of risk capital in their cooperative. Members' commitment is crucial for the competitiveness of the cooperative, as it appears to affect in a great extent its financial performance. The conditions under which non-commitment may be manifested are derived, employing a model of non-cooperative game theory. The results can be employed to determine optimal delivery rights as well as the conditions that can create a self-sustained cooperation in the cooperative. The paper suggests that the transition to New Generation Cooperatives can, under certain conditions, resolve the non-commitment problem.

Keywords : New Generation Cooperatives, agricultural cooperatives, non-cooperative game theory, non-commitment, industrial organization.

1. Introduction

Traditional Agricultural Cooperatives are joint member-owned and controlled agricultural enterprises for producing goods and/ or services. Each member contributes directly, and by joint business activities improves and protects its economic and professional interests. Over the last decades, the market for agrifood products has become more competitive, due to reduced market protection, and more diversified, due to stringent consumer demand for variety, convenience and innovations. Traditional Cooperatives are responding to these changes either by making all the required adjustments in their organizational and management structure in order to become more market oriented, more diversified and more innovative, or by developing new organizational forms such as New Generation Cooperatives (Bijman and van Dijk, 2009; Bijman and Ruben, 2005; Kyriakopoulos et al., 2004; Fulton and Gibbings, 2000; Fulton, 1999; Trechter, 1996).

New Generation Cooperatives (NGCs) first emerged in the USA, during the 1990s, to provide their members with strong incentives to contribute risk capital in vertically integrated industries. In order to provide such incentives, they needed to ameliorate constraints emanating from traditional cooperatives' ownership structure and employed characteristics of investor-oriented firms (IOFs) (Iliopoulos and Hendrikse, 2009; Vitaliano, 1983). The main differences of NGCs from traditional cooperatives are the closed membership policy, the use of marketing agreements, the strong membership commitment through delivery contracts and investments as well as the different policy on delivery rights and obligations (the members have to purchase delivery rights in advance) (van Dijk et al, 2005; Harris et al, 1996).

The main organizational characteristics of New Generation Cooperatives include (Iliopoulos, 2005; Chaddad and Cook, 2004):

- Membership is defined and the NGC accepts only a predetermined quantity from each member. However, production can be expanded by adding new members or by increasing accepted quantity from each member.
- Each member has transferable and appreciable delivery rights. The quantity each member sells to his/her NGC is pre-specified in a marketing agreement signed by both the member and the cooperative.
- Each member's upfront equity is tied to the quantity of product required to be delivered.

One of the critically important issues cooperatives (both traditional and NGCs) face as they undergo the market transformation is member commitment. Member commitment is a sort of "glue" that allows membership and business volume to be maintained even as trade becomes more fluid and barriers to reorganization are broken down. Member commitment is based not only on economics benefits but also on sharing the basic values of the cooperative (Fulton, 1999). The sociology literature characterizes commitment based on how loyal a person is to a social unit, in this instance the agricultural cooperative. Commitment means individuals intend to continue their relationships (Gundlach et al. 1995) and a major reason for failed cooperation is lack of commitment (Wildeman 1998). When there is commitment, members are more likely to cooperate because it reduces risk (Pesamaa and Hair 2007).

The issue of commitment in cooperatives (Traditional or New Generation) is a topic that has attracted the interest of many scientists (Cook, Chaddad and Iliopoulos, 2004; Fulton and Giannakas 2003; Fulton and Giannakas, 2001; Fulton 1999 and Schotter, 1981). This paper contributes in this direction, by employing game theoretic concepts to study the issue of non-commitment in agricultural cooperatives. More specifically, we developed a model that employs concepts of non-cooperative game theory, and regards farmers acting as individuals that form a coalition, the New Generation Cooperative, to promote their own self-interests. The coalition remains strong as long as producers have a higher incentive to remain within the coalition than to "defect". Then, we derive the condition necessary first for self-sustained cooperation in the agricultural cooperative and second for the members' commitment. Self-sustained cooperatives are those who are able to continue in an economically healthy state without outside assistance. These conditions do not take into consideration management efficiency of the cooperative, only individual producers' profits as members of the cooperative, compared to profits selling directly to market or to another firm. The next section provides a literature review concerning game theory models applied on cooperatives as well as the basic problems of cooperatives that are related to non-commitment of the delivery of the products. The following section presents the specification of the model and derives the conditions under which commitment can be maintained. The last section concludes.

2. Literature Review

Commitment represents a preference for doing business and, hence, maintaining membership, in a cooperative when there are alternatives available, usually investor-owned firms (IOF). The member will remain committed to the cooperative only if the cooperative returns a more favorable price, higher transaction profits or some non-price benefits that cannot be copied by the IOF in the short-run. It is well documented that members care first for their own well-being and then about that of the cooperative (Sergaki, 2010; Iliopoulos, 2005; Stanford and Hogeland, 2004; Cook and Chaddad, 2004; Cross and Buccola, 2004; Holland and King, 2004; Errasti et al., 2003). In many cases, even if profits are adequate for the stability of a cooperative, the existence of a competitor may destabilize the traditional Agricultural Cooperative and incite some members to sell their products directly to market (to retailers or through other market channels), circumventing the cooperative.

The problem of non-commitment has been defined and operationalized in a variety of ways in the organizational studies literature (e.g. Becker, 1992; Randall, 1990; O' Reilly and Chatman, 1986; Reichers, 1985). Recent literature has exploited the dichotomous choice in modeling commitment between a cooperative and an IOF in a duopoly or duopsony (Fulton and Giannakas, 2001; Karantininis and Zago, 2001; Fulton, 1999). In most empirical models, commitment is an outcome variable, usually visible in overt, dichotomous farmer behavior: commitment (continued patronage) or defection.

For example, Fulton and Giannakas (2001) examined the issue of member commitment in the context of a mixed oligopoly where cooperatives and IOFs compete with each other in supplying a consumer good. They develop a two-stage game-theoretical model of price competition between a consumer cooperative and an IOF that provide the same product/service to consumers. Different scenarios concerning the objectives of the cooperative and the nature of the pricing competition are examined within this framework. All formulations of the game were solved using backward induction. Their main result is that the demand faced by the cooperative and the market share it commands in a Bertrand type of oligopolistic market not only depend on the price of the product but also on the degree of member commitment.

Agricultural cooperatives have been modeled both using cooperative game theory (Sexton, 1986; Staatz, 1983), non-cooperative game theory (Bourgeon and Chambers, 1999; Hendrikse, 1998; Staatz, 1987; Schotter, 1981), or a combination (Chaddad and Cook 2004; Menard and Klein 2004; Hendrikse and Bijman, 2002), depending on the problem studied. Schelling (1960) argued that apparently "cooperative" social institutions are maintained essentially by "threats" of punishment and retaliation, therefore modeling agricultural cooperatives does not necessarily dictate the use of cooperative game theory. Scotter (1981) suggests that cooperative non-commitment resembles non-cooperative games, mostly the Prisoner's Dilemma and Coordinating games.

In the present paper, we proceed by first establishing the validity of the non-cooperative game theory methodology, versus the cooperative game theory methodology, for the analysis of the issue at hand. The main difference between the two approaches is that a cooperative game is characterized by a contract that is enforceable by a third party, whereas in a non-cooperative game players may cooperate, but such cooperation must be self-enforcing. In addition, we focus on the problem of non-commitment for the delivery of members' products to the cooperatives with the help of non-cooperative game theory, since it is associated with the unforceability of the members' commitments in a Cooperative, and how commitment is affected by a number of other issues.

According to the literature, the following are the major problems that affect commitment are presented(Nilsson, 2001; Cook and Iliopoulos, 2000; Fulton, 1999; van Dijk,1997; Nilsson, 1996). The **free rider problem**, the most important problem of cooperatives, arises when new members or non-members free ride on the investment of the established members. Most specifically, it is concerned with the disparity between the members' contribution to the financing of investments and the distribution of benefits that results from members' investments. It is also associated with the unforceability of the commitments of Agricultural Cooperatives (Hardesty et al 2004; Sykuta and Cook, 2001; Cook and Iliopoulos, 2000). It seems to be the toughest, yet not a typical cooperative problem, because cooperatives are based on member commitment and performance.

There are two types of free riders: The *internal free riders* are non-committed members who yield no performance at times when this may be expected and when the cooperative firm counts on its members. The new members obtain the same patronage and residual rights as existing members and are entitled the same payment per unit of patronage. This set of equally distributed rights combined with the lack of the market to establish a price for residual claims reflecting accrued and present equivalents of future earnings, potentially creates an intergenerational conflict. Because of the dilution of their rate of return to existing members, a disincentive is created to invest in their cooperative.

The *external free riders* do not participate in cooperatives, even criticize them but still enjoy many benefits of the cooperative's market behavior. It occurs when property rights are not well suited and enforced to ensure that current patrons, or current non-member patrons, bear the full costs of their actions and/ or receive the full benefits they create. This situation occurs particularly in open-membership cooperatives. The fact that new entrants are allowed to become free-riders is an expression of distorted market signals. Such signals reduce the member's motivation to become involved and to invest, thus creating a vicious cycle. Members can be protected against free-riding only by restricting membership and establishing delivery rights (van Dijk et al, 2005; Cook and Iliopoulos, 1999; Cook, 1995; Porter and Scully, 1987; Vitaliano, 1983).

The horizon problem stems from the fact that members are impatient to share the current benefits rather than to invest for higher future returns (Hardesty et al, 2004; Sykuta and Cook, 2001). The existence of inactive, non-committed members who still hold their property rights even though they no longer interact economically with the cooperative and usually they don't care for the long- term viability of the cooperative are mainly responsible for the horizon problem (Thevsen 2006). These members follow opportunistic behavior regarding the commitment of their products. As a result, cooperatives cannot negotiate predetermined quantities of products, which results in reduced countervailing power and fewer investments in R&D, which will affect the cooperative competitive level. Both problems imply that cooperatives either underinvest or run short of capital to finance long-term projects. Therefore, in the long-run competition, traditional cooperatives are highly fragile institutions as they fail to promise their members a high future benefit as their for-profit rivals and drive them to disloyalty (Sanxi et al, 2010).

The portfolio problem arises because the members are required to invest capital in an industry in which they already have significant investment in their production (Sanxi et al, 2010; Hardesty et al, 2004). As long as members have unequal time horizons there will be different viewpoints with respect to their cooperative's risk/reward profiles. Here too, the portfolio problem is assumed particularly problematic in traditional cooperatives due to the lack of a trading system of residual rights, which could allow members to develop an investment portfolio that corresponds to their preferred risk/reward profile. This creates inactive members who occasionally exhibit non-commitment, eventually leading the cooperative to failure. In addition, due to this problem, cooperatives may fail to make proper investment decisions. Poor management decisions or practices result in reduced benefits, which can lead to non-commitment of cooperative members (Fulton and Giannakas, 2007).

Another problem associated with the management is the **control (or follow up) problem**. It happens when members lose their interest in monitoring the cooperative and their ability to do so, resulting in the management not being able to promote its own interests (Boettcher, 1980). In cases where the managers are reluctant, it is very difficult for the active members to initiate new strategies (Theuvsen, 2006) and consequently they often hesitate to vote for commitment on the delivery of products.

The **decision problem** relates to the situation of a large and heterogeneous membership, making it challenging for the management to decide how to weight different member opinions (Borgen, 2004). Heterogeneity poses some serious challenges for the cooperative. Decision making may become more laborious, coordination between member firms and the cooperative firm more difficult, member commitment may decrease as well as member willingness to provide equity capital may be reduced. In addition, increasing member heterogeneity may create sub-group lobbying, resulting in control issues and rising influence costs (Bijman and Ruben, 2005).

The **influence cost problem** occurs when there are different groups of owners in the cooperative with opposite interests, each entitled to share in the distribution of benefits and engaging in internal lobbying activities to promote their own selfish interests. In such cases, there usually exists an asymmetrical power relationship. When a subgroup of members knows its relative power, it can clearly achieve some behavioral control over other parties or the Board of Directors. This situation may create disappointment or bad reputation, which facilitates members' disloyalty. (Morrison et al, 1971).

In New Generation Cooperatives, the majority of the above problems can be surpassed in a quite satisfactory level. New Generation Cooperatives have been studied in depth in the past (Cook, 1995) with local adaptations of the New Generation Model being implemented in Australia (Plunket and Kingwell, 2001), New Zealand (Frampton, 2002) and Canada (Ketilson, 1997), among other developed countries. **There can be no free riders** because new members must make a full proportional contribution to equity capital, either by making a full contribution to the capital base at the establishment of the cooperative, or as a second solution, by buying shares from an existing member at the market price. Transferable and appreciable shares would ensure existing members of the ability to capture the full value of their investment in the cooperative and, thus, create an incentive to invest in their organizations, since the fear that new members would also share future earnings associated with their investment is eliminated. The **horizon problem** is entirely overcome by the ability of members to sell their shares at the market price, which reflects the full value of the equity held. This means that all investment decisions can be made based on their expected profitability, unaffected by the timing issues that affect members' attitudes in traditional cooperatives. The **portfolio problem** is not entirely overcome by the NGC structure, but is reduced by the fact that shares can be readily traded, allowing an easy exit for members who do not share the cooperative's risk preferences. However, only those with radically different risk preferences will depart for this reason, so NGCs inevitably have members whose risk preferences vary to some extent. The **control problem** is also partly but not entirely overcome by the NGC structure. The publicly known share price provides a clear indication to members and potential members about the performance and prospects of the business. It also provides management with feedback on performance, allowing problems to be tackled easily. These solutions explain why cooperatives have evolved over the years to form New Generation Cooperatives, which operate as a combination of private firms and traditional cooperatives.

However, not all kinds of NGCs meet in a satisfactory degree their members' needs. There are already examples of NGC failures, but their failure rate in the decade from the mid-1990s to 2005 was less than 10 percent in the Midwestern U.S. states of Minnesota, Iowa and North Dakota. In contrast, there is 50 percent failure rate for all new forms of enterprise, cooperative or not, within three years of startup (van Dijk et al, 2005). According to many economists (Krivokapic, 2002; Leistritz and Sell, 2000; Fulton and Gibbings, 2000; Wanner, 2000; Livingston et al., 1998), some of the main reasons seem to be that the members- producers are locked in for long-term, the lack of member commitment as well as the inadequate communication (Stefanson et al, 1995). Some more reasons the literature identifies are the lack of leadership, the inadequate management, the lack of capital and technical assistance as well as a failure to identify and minimize risk (Krivokapic, 2002).

In the following section the non-cooperative game theory model that is used for the examination of delivery rights and the non-commitment issue is presented, as well as the conditions that can create a self-sustained cooperation in the cooperative are derived. Finally, the last section concludes.

3. Model Specification and Results

We proceed by employing the standard infinitely repeated Cournot oligopoly model with homogeneous products and constant marginal costs, adopted to the case of NGCs and cooperative non-commitment in a repeated game or supergame (Tirole, 1988). Friedman (1971) was the first to show that cooperation could be achieved in an infinitely repeated game by using trigger strategies that switch forever to the one stage game Nash equilibrium following any deviation. The original application was to collusion in a Cournot oligopoly, as in the present case.

The model is set in a dynamic setting with repeated interaction, where a member of the cooperative must take into account not only the possible increase in current profits or surpluses, but also the possibility of long-run losses when deciding whether to sell by circumventing the cooperative.

In 1929, Chamberlain was the first to suggest that in an oligopoly setting, producing a homogeneous product, firms would recognize their interdependence and, therefore, might be able to sustain the monopoly price without explicit collusion. The threat of a vigorous price war would be a sufficient deterrent to prevent price-cutting. Hence, the firms might be able to collude in a purely noncooperative manner, a "tacit collusion" (Tirole, 1988).

Chamberlinian tacit collusion is enforced by the threat of retaliation. In a cooperative structure, retaliation can occur only when it is learned that some member has deviated, something we assume is easy to determine in an agricultural cooperative where most members know each other and all agricultural production is produced in adjacent or nearby fields, thus permitting visual inspection of quantity and quality produced and whether the production has been harvested. Thus, we assume that there is full information as to the quantity and quality of agricultural production and as to whether the production has been harvested and sold to the cooperative or elsewhere.

Essentially a cooperative operates in this respect similarly to a trade association (Tirole 1988) in that, among other functions, it collects information on the past transactions executed by the cooperatives members (useful for large-size cooperatives when information may not be easy to obtain by direct observation of a members' fields, for example for livestock).

3.1. All producers act as individuals

Suppose there are *N* homogeneous producers, indexed by *i=1,2,...,N* and $N \geq 2$, that produce a product which is sold through a cooperative. The assumption of homogeneous producers is derived from the existence of constant returns to scale in agricultural production. We assume that exogenous factors such as weather and natural disasters, including pest infections, equally affect all producers' quantity, so that production of producer *i* is q_i. Then total output in a given year is $Q = \sum_{i=1}^{N} q_i$. We assume that production exhibits constant returns to scale and therefore producers face homogeneous marginal costs of *c* per unit of output and no fixed costs. The market inverse demand function, net of marginal costs, is $P(Q) = a - Q$, assuming $Q < a$.[1] The producers choose quantities simultaneously.

Each producer maximizes individual benefits. The profit maximization, net of marginal costs, for producer *i,* thus, is:

$$\max_{\{q_i\}} \Pi_i = P(Q)q_i = (a - Q)q_i = (a - \sum_i q_i)q_i \quad (1)$$

The first-order condition is given by:

$$\frac{\partial \Pi_i}{\partial q_i} = 0 \Rightarrow a - \sum_{j \neq i} \bar{q}_j - 2q_i = 0 \Leftrightarrow q_{it}^* = \frac{a - \sum_{j \neq i} \bar{q}_j}{2} \quad (2)$$

Equation (2) is the best-response function of producer *i* as a function of the output levels of all other producers, which are taken as fixed. Since no producer controls the production level of the other producers, the equilibrium quantity produced by each individual producer and the total output level are:

$$q_i^* = \frac{a}{(N+1)} \text{ and } Q^* = \frac{aN}{(N+1)} \quad (3)$$

Equation (3) describes the Cournot equilibrium output level for each individual producer, when there is no effort from the cooperative to control output and negotiate. The equilibrium price and the profit level of each producer are given by:

$$P^* = a - Q^* = \frac{a}{N+1} \text{ and } \Pi_i^* = \frac{a^2}{(N+1)^2} = (q_i^*)^2 \quad (4)$$

These are the price and profit levels achieved by each farmer if he sells his product individually, competing in the market with the other producers.

3.2. Cooperative formation with committed members

We proceed by considering the formation of a New Generation Cooperative where all producers participate and commit to produce the desired and agreed output level. Controlled membership and the existence of delivery rights, both important features of NGCs, imply that there is no free entry or exit and quantities delivered can be controlled. The cooperative's profit maximization problem is:

$$\max_{q_1, q_2, \ldots, q_N} \Pi(q_1, q_2, \ldots, q_N) \equiv \sum_i \pi_i(q_i) = \sum_i P(Q)q_i = P(Q)\sum_i q_i = P(\sum_i q_i)\sum_i q_i \quad (5)$$

The equilibrium level of output for each individual producer and total output are $q_m{}^* = a / 2N$ and $Q_m{}^* = Nq_m{}^* = a / 2$. This is the familiar monopolist equilibrium quantity output level, where marginal revenue equals marginal cost. Profit for each member of the NGC is:

$$\Pi_m^i = P(Q_m^*)q_{mi}^* = \frac{a^2}{4N} \quad (6)$$

Clearly, $q_i{}^* > q_{mi}{}^*$ and $\Pi_{mi} > \Pi_i$ for all $N \geq 2$, therefore it is optimal for producers to form a cooperative when they can influence prices[2].

3.3. Cooperative loyalty failure

Suppose now that cooperative non-commitment is manifested by some producers who sell directly to the market. Let *n* denote the number of members selling illegally, according to their NGC commitment, directly to the market. These

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[1] We assume that marginal cost is fixed and the role of the cooperative is to maximize final product price. Alternatively, since a function of agricultural cooperatives may be the provision of agricultural inputs at reduced prices, one could hold final product price fixed and minimize the cost of inputs. The nature of our results will remain unaffected.

[2] This does not exclude the formation of a cooperative for other reasons apart from influencing prices. It is, however, a case that we abstract from in this paper.

members may find it optimal to defect if there is no enforcement or penalty for their illegal defection. This is a situation quite common in many agricultural cooperative, who exhibit great reluctance or inability to enforce their contracts. The producers still selling through the cooperative will now be *N-n*.

If the cooperative is going to produce $(N-n)q_m^* = \frac{a(N-n)}{2N}$, then the quantity that maximizes the profit of the producers not selling through the cooperative is:

$$\max_{q_j}\left(a - \sum_{j=1}^{n} q_j - \frac{a(N-n)}{2N}\right) q_j, j = 1,2,...,n \tag{7}$$

The best-response function for producer *j* is found by:

$$q_{dj}^* = \frac{\frac{a(N+n)}{2N} - \sum_{k=1}^{n-1} q_k}{2} \tag{8}$$

where the subscript *k* denotes the other producers who also don't sell to the cooperative. This is the best-response function of producer *j* as a function of the output levels of the other producers not selling to the cooperative. The subscript *d* is used to denote deviators from the cooperative.

Since all producers are identical and no producer controls the production level of the other producers, the common production level is:

$$q_d^* = \frac{a(N+n)}{2N(n+1)} \tag{9}$$

with associated profit of

$$\Pi_d = \left(a - (N-n)\frac{a}{2N} - n\frac{a(N+n)}{2N(n+1)}\right)\frac{a(N+n)}{2N(n+1)} \tag{10}$$

or

$$\Pi_d = \left(\frac{a(N+n)}{2N(n+1)}\right)^2 \tag{11}$$

We have already mentioned that the profits for an individual producer are always higher than the non-cooperative profits for all $N \geq 2$ and equal in the trivial case where there is only one sole producer. What happens though to the profits of the deviator compared to the monopoly's share of profits when participating in a cooperative? We proceed to derive the condition under which the deviator's profit is higher than the committed cooperative member's profit.

Proposition. Producers will find it more profitable to defect (illegaly) from the cooperative and sell directly to market as long as the number of defectors is less than the square root of the total number of producers.

Proof. Profits for deviators are higher than profits when remaining committed to the cooperative if and only if the following condition holds:

$$\Pi_d > \Pi_m \text{ iff } \left(\frac{a(N+n)}{2N(n+1)}\right)^2 > \frac{a^2}{4N} \tag{12}$$

By definition, a, n, N are positive real numbers, therefore the comparison of the above is the same as

$$(N+n)^2 > N(n+1)^2 \tag{13}$$

which can be rewritten as

$$N(N-1) > n^2(N-1) \tag{14}$$

which is further simplified to

$$\Pi_d > \Pi_m \text{ iff } N > n^2 \tag{15}$$

Therefore, as long as the Proposition is met it will be profitable for members of the cooperative to defect and sell directly to market, as long as no penalties for defection exist. There are a maximum number of producers that may find it profitable to deviate from the cooperative, which depends on the number of producers that remain committed to the cooperative, that is, the relative size of the cooperative. The number of successful deviators increases with the number of 'loyal' cooperative members. Due to producer homogeneity, the maximum number of producers that can achieve a higher profit by deviating depends solely on the total number of producers.

In New Generation Cooperatives, producers are allocated delivery rights that determine the quantity of the product they will supply. In this case, N is a single delivery right for a quantity q^* of product. We proceed by presenting an incentive mechanism that will 'punish' deviators, if caught not being committed. This incentive mechanism, or trigger strategy, dictates the condition under which the cooperative structure can be sustained. We compute the values of the discount factor, δ, for which it is a subgame-perfect Nash equilibrium for individual producers to play the following trigger-strategy:

"Produce my share of the cooperative quantity, $q_{mi}^{\ *} = a/2N$, in the first period. In the t^{th} period, produce $q_{mi}^{\ *}$ if all members have produced $q_{mi}^{\ *}$ in each of the *t-1* previous periods; otherwise, produce the Cournot quantity, $q_{ci}^{*} = aN/(N+1)$." (Gibbons, 1992). This trigger strategy allows for only one cooperative to exist.

The individual profit when only one cooperative exists and every producer sells their products through the cooperative is $\Pi_{mi} = a^2/4N$. The profit to the producer if each producer maximizes profit individually is $\Pi_{ci} = a^2/(N+1)^2$. Finally, if every producer is going to produce $q_{mi}^{\ *}$ except for n producers, the profit for the deviators is:

$$\Pi_{di} = \left(\frac{a(N+n)}{2N(n+1)} \right)^2 \tag{16}$$

Thus, it is a Nash equilibrium for all producers to play the trigger strategy, provided that:

$$\frac{1}{1-\delta}\Pi_m \geq \Pi_d + \frac{\delta}{1-\delta}\Pi_c \tag{17}$$

Substituting the values of Π_m, Π_d, and Π_c into the above equation yields:

$$\frac{1}{1-\delta}\frac{a^2}{4N} \geq \frac{a^2(N+n)^2}{4N\left(n+1\right)^2} + \frac{\delta}{1-\delta}\frac{a^2}{(N+1)^2} \tag{18}$$

which, reduces to:

$$\delta \geq \frac{(n^2-N)(1+N)^2}{(n-N)(n+3nN+N(3+N))} \tag{19}$$

If $n=1$ then this equation reduces to:

$$\delta \geq \frac{(N+1)^2}{1+N(6+N)} \tag{20}$$

Since one defection is sufficient to break down the cooperative by means of deviating from the trigger strategy, the above equation shows the necessary and sufficient condition for maintaining the single cooperative structure[3].

A usual caveat cited regarding non-cooperative game theory is the assumption of a credible threat. The trigger strategy is subgame-perfect only if the threat in case of a defection can be credible. For-profit firms and organizations have proven that such a threat is most of the time credible. Such a threat can be credible in a cooperative if, for example, it becomes explicit as part of the cooperative's rules. "Punishment" of deviators will ensure that long-term profits and viability of the cooperative remain unaffected by short-term thinking cooperative members.

The stability of a cooperative increases with the number of members who remain committed to the cooperative (equation 23). Therefore, if the New Generation Cooperatives exhibit firm behavior, i.e., it operates non-cooperatively,

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[3] Note that if n=1 and N=2, then (25) reduces to $\delta \geq 9/17$, which is the familiar condition of a trigger strategy for collusion in a Cournot duopoly (Gibbons, 1992).

the number of active members determines the survival possibility of the cooperative. Thus, we have provided theoretical proof that cooperative commitment can be self-enforcing in a New Generation Cooperative structure.

4. Conclusions

The aim of this paper is to address one of the important issues arising in traditional agricultural cooperatives, cooperative non-commitment. The problem of non-commitment for the delivery of members' products to the cooperative affects or is affected by a number of issues as the poor management, the horizon, the free rider, the control and the portfolio problem. The paper proves theoretically, employing non-cooperative game theory methodology, a well-known empirical result, that implementing New Generation Cooperative (NGCs) in place of traditional agricultural cooperatives, with control over membership and delivery rights, can provide a solution to the problem of non-commitment which firstly leads to lower profitability levels of the Cooperative and secondly complicates the above mentioned issues.

We examine cooperative members' non-commitment, as expressed by their decision to sell their products through the cooperative and evaluate in the case of agricultural cooperatives, why farmers are better off as members of a cooperative compared to selling their products individually. Producers "deviating" from the cooperative and selling directly to market or to another firm are better off, at least in the short run. There is a maximum number of producers that may find it profitable to deviate from the cooperative, a condition that depends on the number of producers that remain committed to the cooperative. If there is producer homogeneity, the maximum number of producers that can achieve a higher profit by deviating depends solely on the total number of producers. Finally, we present an incentive mechanism that will punish deviators if a deviator is caught. This incentive mechanism, or trigger strategy, dictates the condition under which cooperative loyalty can be ensured.

References

Bijman, J. and Ruben, R. 2005. Repositioning Agricultural Cooperatives in the North and the South: Where do the Twain meet?, Paper presented in the 2nd Agri-ProFocus Expert Meeting, Nov. 22nd 2005, Deventer.

Bijman, J and van Dijk, G. 2009. Corporate Governance in Agricultural Cooperatives: A Perspective from the Netherlands, Paper presented in the 21st century: Lessons from the Past, Pathways to the Future", Revot, Israel, 15-17 June.

Becker, T.E. 1992. Fosi and Bases of Commitment: Are They Distinctions Worth Making?, Academy of Management Journal 35: 232-244.

Boettcher, E. 1980. Die Genossenschaft in der Marktwirtschaft, Tubingen: JCB Mohr (Paul Siebeck), 89-93.

Borgen, S.O. 2004. Rethinking incentive problems in cooperative organizations, Journal of Socio-Economics 33: 383-393.

Bourgeon, J.M. and Chambers, R.G. 1999. Producer Organizations, Bargaining, and Assymetric Information, American Journal of Agricultural Economics, 81(3): 602-609.

Chaddad, F. R. and Cook, M. L. 2004. Understanding New Cooperative Models: An Ownership-Control Rights Typology, Review of Agricultural Economics 26(3): 348-360.

Chamberlain, E. 1929. Duopoly: Value Where Sellers are Few, Quarterly Journal of Economics 43:63-100.

Cook, M. L. and Chaddad, F. R. 2004. Redesigning Cooperative Boundaries: The Emergence of New Models, American Journal of Agricultural Economics 86: 1249-1253.

Cook, M.L., Chaddad, F.R., and Iliopoulos, C. 2004. Advances in Cooperative Theory since 1990: A Review of Agricultural Economics Literature, in G.W.J. Hendrikes (ed.), Restructuring Agricultural Cooperatives, 65-90, Haveka, The Netherlands.

Cook, M.L., and Iliopoulos, C. 2000. Ill-defined Property-Rights in Collective Action: The Case of US Agricultural Cooperatives, in C. Menard (ed.) Institutions, Contracts, and Organizations: Perspectives from New Institutional Economics, 335-348. London, UK: Edward Elgar Publishing.

Cook, M. L. and Iliopoulos, C. 1999. Beginning to Inform the Theory of the Cooperative Firm: Emergence of the New Generation Cooperative, Liiketaloudellinen Aikakauskirja 48(4): 525-535.

Cook, M. L. 1995. The Future of US Agricultural Cooperatives: A Neo-institutional Approach, American Journal of Agricultural Economics 77(5): 1153-1159.

Cross, R. and Buccola, S. 2004. Adapting Cooperative Structure to the New Global Environment, American Journal of Agricultural Economics 86(5): 1254-1261.

Errasti, A. M., Heras, I., Bakaikoa, B. and Elgoibar, P. 2003. The Internationalization of Cooperatives: The Case of the Mondragon Cooperative Corporation, Annals of Public and Cooperative Economics 74(4): 553-584.

Fulton M. and Giannakas, K. 2007. Agency and leadership in Cooperatives, Chapter 6 in Vertical Markets and Cooperative hierarchies, K. Karantininis & J. Nilsson (eds), 93-113, Springer (eds).

Fulton, M.E. and Giannakas, K. 2003. Leadership, Agency and member Commitment in Cooperatives, Paper presented at the conference: Vertical Markets and Cooperative Hierarchies: The Role of Cooperatives in the International Agri-Food Industry, Bad Herrenalb, Germany, June 12-16, 2003.

Fulton, M. E. and Giannakas, K. 2001. Organizational Commitment in a Mixed Oligopoly: Agricultural Cooperatives and Investor-Owned Firms, American Journal of Agricultural Economics 83(5): 1258-1265.

Fulton, M. and Gibbings, J. 2000. Response and Adaptation: Canadian Agricultural Cooperatives in the 21st Century. Centre for the Study of Cooperatives, University of Saskatchewan.
Fulton, M.E. 1999. Cooperatives and Member Commitment, Finnish Journal of Business Economics 4: 418-37.
Frampton, A. 2002. Independent cooperatives in a deregulated New Zealand dairy industry, in I.M. Brookes (ed) Proceedings of the 54th Conference of dairy farmers, Palmerston North, New Zealand: Massey University.
Friedman, J. 1971. A Noncooperative Equilibrium for Supergames, Review of Economic Studies 28:1-12.
Gibbons, R. 1992. Game theory for applied economists, Princeton: Princeton University Press.
Gundlach, G.T., Achrol, R.S. and Mentzer, J.R. 1995. The structure of commitment in exchange, Journal of Marketing 59(1):78-103.
Harris, A., Stefanson, B. and Fulton, M. 1996. New Generation Cooperatives and Cooperative Theory, Journal of Cooperatives 11: 15-28.
Hardesty, S.D., and Salgia, V.D. 2004. Comparative Financial Performance of Agricultural Cooperatives and Investor-Owned firms, Proceedings of the NCR- 194 Research on Cooperatives Annual Meeting, Kansas City, Missouri, USA.
Hendrikse, G. W. J. and Bijman, J. 2002. Ownership Structure in Agrifood Chains: The Marketing Cooperative, American Journal of Agricultural Economics 84(1): 104-119.
Hendrikse, G.W.J. 1998. Screening Competition and the Choice of the Cooperative as an Organizational Form, Journal of Agricultural Economics 49(2): 202-217.
Holland, S. J. and King, R. P. 2004. Trading Mechanisms for New-Generation Cooperative Stock: The Architecture of Organizational Formation and Demise, American Journal of Agricultural Economics 86: 1262-1268.
Iliopoulos, C., and Hendrikse, G.W.J. 2009. Influence Cost in Agribusiness Cooperatives: Evidence from Case Studies, International Studies of Management and Organization 39(4): 60-80.
Iliopoulos, C. 2005. New Generation Cooperatives: The Potential of an Innovative Institutional Arrangement for Mediterranean Food Supply Chains, New Medit: Mediterranean Journal of Economics 4(1): 14-20.
Karantininis, K. and Zago, A. 2001. Endogenous Membership in Mixed Duopolies, American Journal of Agricultural Economics. 83: 1266-1272.
Ketilson, L.H. 1997. The Saskatchewan Wheat Pool in the globalized food sector: can they remain true to their roots? in J. Nilsson & G. van Dijk Strategies and structures in the agro-food industries, 54-73, Assen, The Netherlands: Van Gorcum.
Krivokapic, S.B. 2002. The Concept and Classifications of Agricultural Cooperatives, in ACCORD paper No 8. Australian Centre for Cooperative Research and Development.
Kyriakopoulos, K., Meulenberg, M. and Nilsson, J. 2004. The Impact of Cooperative Structure and Firm Culture on Market Orientation and Performance, Agribusiness 20(4): 379-396.
Leistritz, F.L and Sell, R.S. 2000. Agricultural Processing Plants in North Dakota. Socioeconomic Impacts, Agricultural Economics Report No 437, Department of Agricultural Economics, North Dakota State University.
Livingston, K. 1998. Northeast Missouri Grain Processors, Inc. Community Case Study, Illinois Institute for Rural Affairs.
Menard, C. and Klein, P.G. 2004. Organizational Issues in the Agrifood Sector: Toward a Cooperative Approach, American Journal of Agricultural Economics 86(3): 750-755.
Morrison, B., Enzle, M., Henry, T., Dunaway, D., Griffen, M., Kneisel K. and Gimperling, J. 1971. The effects of electrical shock and warning on cooperation in a non-zero- sum game, Journal of Conflict Resolution 12: 461-470.
Nilsson, J. 2001. Organizational Principles for Co-operative firms, Scandinavian Journal of Management 17: 329-356.
Nilsson, J. 1996. Observations from international market power for cooperatives. Year in Cooperation: A Cooperative Magazine (Online), 2 (2). Available: http://www.wisc.edu/uwcc (Retrieved March 26 2002).
O' Reilly, C.A. and Chatman, J. 1986. Organizational Commitment and Psychological Attachment: the effects of Compliance, Identification, and Internalization on Prosocial Behavior, Journal of Applied Psychology 71: 492-499.
Pesamaa, O. and Hair, J. F. 2007. More than friendship is required: an empirical test of cooperative firm strategies, Management Decision 45(3): 602-615.
Plunkett, B. and Kingwell, R. 2001. New Generation Co-operatives for Agricultural Marketing and Processing in Australia: Principles, Practicalities and a Case Study, Agribusiness Review 9: 42-61.
Porter, P. K. and Scully, G. W. 1987. Economic Efficiency in Cooperatives, Journal of Law and Economics 30(2): 489-512.
Randall, D.M. 1990. The Consequences of Organizational Commitment: Methodological Investigation, Journal of Organizational Behavior 11: 361-378.
Reichers, A. 1985. A Review and Reconceptualization of Organizational Commitment, Academy of Management Review 10: 465-476.
Sanxi, L.I., Bing Y.E and Jianyu, Y.U. 2010. Incentives and Quality Provision in Organizations: Cooperative vs IOF, Paper presented at the 8th Inra- IDEI Conference on "Industrial Organization and the Food Processing Industry", Toulouse, 10-11 June.
Schelling, T.C. 1960. The Strategy of Conflict, Boston: Harvard University Press.
Schotter, A. 1981. The Economic Theory of Social Institutions, New York: Cambridge University Press.
Sergaki P. 2010. The role of networks on the competitiveness of agricultural cooperatives and small-medium enterprises along the supply chain in Greece, Food Economics, Acta Agriculturae Scandinavica, Section C 180-191.
Sexton, R. J. 1986. The formation of cooperatives: a game-theoretic approach with implications for cooperative finance, decision making, and stability, American journal of agricultural economics, May: 214-225.
Staatz, J. 1987. Game-theoretic Analysis of Decision making in Farmer Cooperatives, in J.S.Royer (ed.). Cooperative Theory: New Approaches, USDA-ACS, ACS, Service Report 18, Washington, DC: July 1987, 117-147.
Staatz, J. M. 1983. The cooperative as a coalition: a game-theoretic approach, American journal of agricultural economics, Dec: 1084-1089.
Stanford, L. and Hogeland, J. A. 2004. Designing Organizations for a Globalized World: Calavo's Transition from Cooperative to Corporation, American Journal of Agricultural Economics 86: 1269-1275.

Stefanson, N., Fulton, M. and Harris, A. 1995. New Generation Cooperatives: Rebuilding Rural Economics, Centre for the Study of Cooperatives, University of Saskatchewan.

Sykuta, M.E. and Cook, M.L. 2001. A New Institutional Economics Approach to Contracts and Cooperatives, American Journal of Agricultural Economics 5: 1273-1279.

Theuvsen, L. 2006. European Cooperatives: Are they prepared for Food Product Innovations? in: The Food Industry in Europe: Tradition and Innovation, hrsg.v.Tadeusz Sikora und Anna Strada, Krakau 2006, 65-87.

Tirole, J. 1988. The Theory of Industrial Organization, MIT Press, USA.

Trechter, D.D. 1996. Impact of Diversification on Agricultural Cooperatives in Wisconsin, Agribusiness, 12(4): 385-394.

van Dijk, G., Klep, G. and Egerstrom, L. 2005. When markets fails: an Introduction to Cooperation, National CooperatieveRaad. Breukelen, 12.

van Dijk, G. 1997. Implementing the Sixth reason for Cooperation: New Generation Cooperatives in the Agribusiness, Strategies and Structures in the Agro-food Industries, ed. J. Nilsson and G. van Dijk, 94-110. Assen van Gorcum.

Vitaliano, P. 1983. Cooperative Enterprise: An Alternative Conceptual Basis for Analyzing a Compex Institution, American Journal of Agricultural Economics 65: 1078-1083.

Wadsworth, J. 2001. Effective member relations essential to keep co-op spirit alive and kicking, Rural Cooperatives Magazine: 1-5.

Wanner, J. 2000. New Generation Cooperatives and The Future of Agriculture: An Introduction. Illinois Institute for Rural Affairs.

Wildeman, L. 1998. Alliances and networks: the next generation, International Journal of Technology Management 15(1/2): 96-108.

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