Coalition Development in the Agricultural Marketing System*

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ABSTRACT: The theory of agricultural coalition formation is enhanced by incorporating non-monetary benefits, risk, and fairness. Producers' expected utility and investment decisions in the agricultural cooperative are affected by their perception about non-monetary benefits, risk and fairness associate with the cooperative investment.

KEY WORDS: coalitions, game theory, cooperatives, investment theory.

Coalition Development in the Agricultural Marketing System

"People are still very ignorant about institutions, a unified theory that accepts pluralism is expected." (Oliver E. Williamson, 2000)

Introduction

Within agricultural markets in the United States, new generation cooperatives are one of the most important new institutional innovations. In many states, agricultural producers are investing in relatively risky new generation cooperative ventures. Developing a theoretical explanation of this phenomenon is the goal of this paper.

The investment in many closed cooperatives involves a high degree of risk. Investors should carefully consider the risks associated with alternative investments before making an investment decision. Some of the risks that cooperatives face relate to the ability of the cooperative to attract and retain a reliable customer base and qualified personnel, to expand the marketing channels, and to refine the quality and quantity of the product to meet customer needs.

Institutions[1] like new generation cooperatives potentially have significant impacts on economic growth and development. The capacity of institutions to change, in response to changes in culture and society, resource endowments, and technology is an important determinant of economic progress (Ruttan and Hayami, 1984). The theme of this study is that the efficiency of the market for institutional innovation is a critical determinant of economic progress. New generation cooperatives[2] are among the most important institutional innovations reshaping agricultural markets in rural areas.

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[1] Institutions are seen both as rules of a society or of organizations that facilitate coordination among people by helping them form expectations which each person can reasonably hold in dealing with others (Ruttan and Hayami, p.204) and unplanned and unintended regularities of social behavior that emerge from the repetitive play of games (Schotter, p. 118).

[2] Traditional cooperatives have struggled to acquire equity because cooperative ownership per se conveys no benefit. Benefits generally come only on the basis of patronage. New generation cooperatives attempt to solve the equity problems of traditional cooperatives by changing the property rights structure (Cook and Iliopoulos, 2000).

Greater understanding of forces influencing new generation cooperative development could help existing cooperatives make changes to survive and facilitate the creation of new cooperatives. For agricultural economists to be in a position to provide appropriate and effective policy advice to groups considering new generation cooperative formation, they must first understand the nature of the overall cooperative formation process, including its driving forces and essential features. Evaluation of new generation cooperatives requires an understanding of factors that influence the commitment of agricultural cooperative participants to invest and be loyal members.

Clearly the importance of institutional change suggests a need for theoretical models to analyze institutional change as well as empirical analyses. Williamson (2000) suggests that people are still very ignorant about institutions, and he expects a unified theory that accepts pluralism. Coase (1998), Williamson (2000) and Demsetz (1997) proposed the New Institutional Economics that promises more new ideas for the study of institutions including cooperatives.

A very rich theoretical foundation for the analysis of institutional change can be developed in game theory. Schotter (1986) argued that because of the explicit treatment of rules, game theory is a particularly useful way of analyzing and understanding the probability of institution or rule evolution. Cooperative game theory remains particularly under-exploited by agricultural economists. The strength and capacity of cooperative game theory for application has been recognized by only a few agricultural economists (Horowitz, Just, and Netanyahu, 1996).

New generation cooperatives have a more clearly defined membership policy (closed, or well defined), a secondary market for members' residual claims, patronage and residual claimant status restrictions, and an enforceable member pre-commitment mechanism. Frequently, new generation cooperatives vertically integrate forward in the distribution chain. Farmers as members/owners, attempt to maintain control over their operations, reduce risk, stabilize income, and secure new and existing markets. New generation cooperatives can contribute as an extension of the farm operation that allows farmers to make decisions and have some control over the processing and marketing of products.

As discussed by Togerson, Reynolds, and Gray (1997), the theory of agricultural cooperatives has a rich history. The development of theory of agricultural cooperatives has led to a greater understanding of many practical problems. For example, the Helmberger and Hoos model provided better understanding of the incentives to limit membership and revealed conflicts of interest (Torgerson, Reynolds, and Gray).

This paper extends the previous theory of agricultural cooperatives by integrating investment theory, non-monetary benefits, and fairness into a theory of cooperative development. Most responses to the forces inducing change involve the formation of coalitions[3] that frequently require financial investments and have the potential to create monetary and non-monetary benefits for members. New generation agricultural cooperatives are coalitions of agricultural producers. The theory of coalitions has been developed largely independently in the economics literature. Both Staatz (1983) and Sexton (1986) have used cooperative game theory to study agricultural cooperatives.

Some evidence indicates that behavioral and economic decisions are driven by fairness considerations (Fehr and Schmidt, 1999; Rabin, 1993; Akerlof, 1979; Okun, 1981; Kahneman et al., 1986). This literature suggests that producers' perceptions of fairness in distribution of patronage refunds affects their investment decisions in new generation cooperatives. Fairness behavior in cooperative investment involves strategies and decisions either from the cooperative or investors to achieve their maximum expected utility.

The essential difference between this paper and previous studies is that it treats the decision to join a closed cooperative as an investment decision and suggests that non-monetary payoffs may influence investment decisions. Closed cooperative investments are considered

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[3] Coalitions in agricultural marketing systems are horizontal and/or vertical groups of individuals or firms within the agricultural marketing system for whom a new set of binding rules or contracts are formed.

within the context of a portfolio of investment choices a producer can make. A member of a closed cooperative receives specific rights (frequently delivery rights) in return for his/her investment. These rights are often transferable and may change in value. Payoffs are based on the amount of investment and whether the delivery obligation has been met. The value of the delivery right is expected to be directly related to both the size of the monetary distributions to the members as well as the perceived non-monetary benefits created for members. This is consistent with Staatz's finding that the non-monetary benefits that some members may derive from belonging to a cooperative broaden the set of potentially stable solutions (Staatz 1989, p.20).

The size and value of benefits of a cooperative are affected by the business environment and internal decisions of existing cooperatives. The benefits of a coalition are evaluated in utility functions that have monetary and non-monetary benefits, fairness, and risk as arguments.

Without a clear unifying theory of coalitions in agriculture that incorporates the underlying non-monetary motivations and characteristics of the participants, it will be difficult for agricultural economists to develop appropriate hypotheses and complete appropriate empirical work about cooperative development. Most importantly, producers, policy makers, and other marketing channel participants who need solutions to marketing problems, will not have access to the information they need to evaluate new cooperative development.

Consistent with Sexton (1990), producers may be motivated to participate in cooperatives because they understand that cooperatives alter decision-making in non-cooperative firms. In addition, consistent with Ladd (1974) cooperatives may also produce non-monetary benefits which are restricted to members and may motivate membership.

In the next section we present the theoretical model of coalition formation based on the bargaining concept. In section II, we develop a game-theoretic model that incorporates non-monetary benefits and investment theory into the analysis of closed cooperative investment. An initial investment decision analysis and the mean-variance model of agricultural marketing cooperative are discussed in section III. A discussion of the implications of our model in an agricultural cooperative settings and conclusion are presented in section IV.

I. A Model of Coalition Formation

A game in coalitional form specifies, for every coalition of players, a set of monetary payoff vectors that are feasible for players within the coalition if they agree to cooperate. We also specify, for each coalition, the amount of non-monetary benefits available to members. A player can be an agricultural firm or an individual farmer. A coalition is formed and a feasible monetary payoff vector is chosen only when the coalition, the payoff vector and the non-monetary benefits are accepted by all players involved. Membership in the coalitions and the monetary and non-monetary payoffs to each member are the solution to the cooperative game.

The idea of a bargaining set (Aumann and Maschler (1964); Mas-Colell (1989); Zhou (1994)) is used to provide a solution concept that specifies the coalition formation and payoff distribution. By assuming that all players in the game can bargain together with perfect communication, the stability of outcomes of a game depend on objections and counter objections to each coalition that exists. A coalition is stable if all objections can be met by counter-objections. The set of all stable outcomes is called the *bargaining set*.

Consider an *n*-person cooperative game Φ, with a given set of *n* players, $N = \{1, 2, \cdots, n\}$. Let $\{C\}$ be the non-empty subsets C of N, called *the permissible coalitions*. For each C, $C \in \{C\}$, a number $v(C)$ is given and it is called *the value of the coalition C*. In the standard model of

coalitions, $v(C)$ is measured by material payoffs which are a prerequisite to coalition formation and stability. Assume that all 1-person coalitions in $\{C\}$ have a zero value, i.e., $i \in \{C\}$, $v(i) = 0$ and the value of the coalition C is positive, $v(C) \geq 0$, $C \in \{C\}$. A payoff configuration will now defined as an expression of the form,

(1) $$(x;C) \equiv (x_1, x_2, \cdots, x_n; C_1, C_2, \cdots, C_m)$$

where C_1, C_2, ..., C_m are mutually disjoint sets of $\{C\}$ whose union is N, i.e., $C_j \cap C_k = \emptyset$,

$j \neq k$; and $\bigcup_{j=1}^{m} C_j = N$, and the x_i's are the amounts received by each player (real numbers) which satisfy

(2) $$\sum_{i \in C_j} x_i = v(C_j); \qquad j = 1, 2, \cdots, m$$

Thus, a payoff configuration is a representation of a possible outcomes of the game, in which the players divide themselves into groups, so-called coalitions, C_1, C_2, ..., C_m, and each coalition distributes its value among its members, and each player receives the amount x_i, $i = 1, 2, \cdots, n.$

When people are faced with a game, logically, it is reasonable that one does not expect that a payoff configuration will occur if $x_i < 0$, since player i alone can secure more by playing as a 1-person coalition with a zero value. By assuming that $\sum_{i \in C} x_i \geq v(C)$ for each C,

$C \in \{C\}$, $C \subset C_j$, $j = 1, 2, \cdots, m$ the payoff configuration will be a *coalitionally rational payoff configuration*. Thus, the coalition rationality assumption is very strong as it forces the game to be essentially superadditive.[4] Superadditivity requires that a coalition whose value is less than the

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[4] A game is superadditive if the value of the union of two disjoint coalitions exceeds the sum of the values of each coalition.

sum of the values of disjoint subcoalitions cannot occur in any coalitionally rational payoff configuration.

Usually, the bargaining process starts when each player tries to get at least as much as possible. At the same time, there is a desire for fair play. People will be happy with their coalition if they agree that the worthier partners will get more. Thus, during the negotiations prior to coalition formation, each player tries to convince his/her partners that in some sense she/he is worthy of high payoffs. This process can happen in various ways, among which an important factor is a players' ability to show that she/he has other (perhaps better) alternatives. Partners, besides pointing out their own alternatives, may argue in return that even without his/her help they can perhaps keep their proposed shares. A negotiation is a sequence of objections and counter-objections. Stability is reached if all objections can be answered by counter-objections.[5]

The essence of the study of cooperative formation is that producers will not join a cooperative unless they receive a benefit from doing so. Sexton (1986) builds the model of cooperative formation based on the assumptions that cooperative membership is voluntary then individuals decide whether to join or not to join based on profit considerations. Clearly, Sexton's model is based on monetary payoffs that specifically emphasize the individual decision makers and their incentives to undertake joint action based upon monetary payoffs.

II. Theoretical Model of Cooperative Investment

An integrated model of cooperative investment based on game theory is proposed. This model explains coalition development, factors influencing coalition stability, and the producers'

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[5] The formal mathematical definition of objections and counter-objections is found in Aumann and Maschler (1964, p.448-449).

perceptions of the actual payoffs from coalition participation. Coalition structures and their evolution are examined.

Dynamic Games with Perfect Information

We consider the process of decision making in a closed cooperative investment as a dynamic game between the cooperative and the investors. In order to determine the set of strategies for either the cooperative association or the investors, the moves the players have, the order in which they choose these moves, and the information they have when they make their decisions must be specified. One way to organize this information is through the development of a game tree.[6] Decision nodes in game tree are represented by boxes, which contain the identity of the players who move at that node. A branch represents a possible move by a player. Every branch connects two nodes and has a direction which is depicted by an arrowhead.

Figure 1 displays the game tree for a dynamic closed cooperative formation and operation game. The game begins at the top of the game tree where cooperative association initially writes a prospectus for the closed cooperative. For simplicity, it is assumed the cooperative either offers an optimistic or conservative prospectus as shown by each branch. Each branch points to a decision node for the producers since producers make their investment decisions after they learn and evaluate the type of strategies the cooperative has adopted. From each of the two decision nodes extend two branches representing the two possible moves producers can make. Again the decision is simplified as a decision to invest or not to invest. If an insufficient number of producers decide to invest, a cooperative firm does not form.

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[6] A game tree is a picture composed of nodes and branches, where each node in the game tree represents a decision point for one of the players and is said to belong to the player that moves at that point.
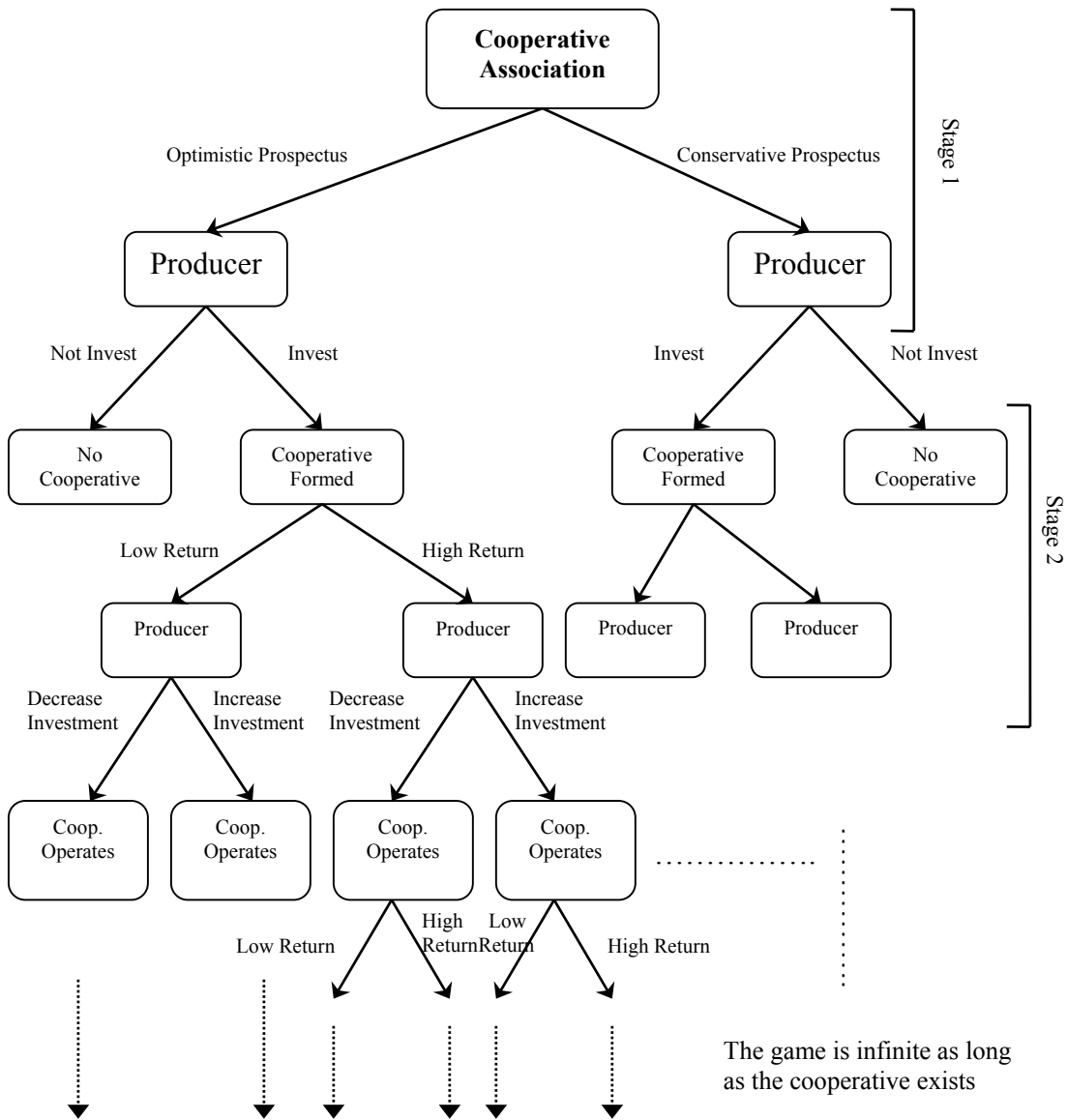
Figure 1. The Game Tree for Dynamic Games in the Case of Closed Cooperatives

Units of investment give the producer delivery rights to the cooperative, and the value of the investment will change if conditions affecting the cooperative's business change. If enough investor capital and delivery commitments are secured, then producers deliver their inputs, and the company operates for the year. As the cooperative operates its business, it develops a history of earnings and cash patronage distributions to its members. At the cooperative's decision nodes, cooperatives elect to distribute high or low cash patronage refunds. Again, to simplify the game tree, a continuous decision is treated as two discrete choices.

Using the outcome for the first year, and expectations for the future, each producer can decide to buy more or sell (transfer) stock/delivery rights. They also decide how much to deliver so they can participate in next year's patronage distribution. The sequential decision making process continues as long as the firm exists.

III. A Model of Agricultural Marketing Cooperative

An integrated model of coalition development is a model that considers major determinants influencing the stability of coalitions. Investment decisions and non-monetary benefits from the cooperative investment are incorporated into the analysis of the model of cooperative membership. The crucial feature of the model is how producers' investment decisions and non-monetary benefits from the investment affect the stability of coalition structures. Another important aspect of this model is the effect of fairness on welfare allocations. Two important elements of fairness are the *actual outcome* of an action, and the *expected outcome* (reference point) from membership.

Fairness is formalized in the framework developed by Rabin (1993). Rabin's model incorporates fairness into economic research. He modifies conventional game theory by allowing payoffs to depend on fairness. We assume investors are more likely to invest in a cooperative as

part of their portfolio if that investment is perceived to be fair, to have relatively low risk, and to provide non-monetary benefits.

Producers are presented with a prospectus for an agricultural marketing cooperative that will add value to the raw commodity they produce. To join this coalition, an investor must be an agricultural producer and produce the raw material further processed by the cooperative.

Members are provided the rights to subscribe for and purchase shares of common stock in the cooperative, and also agree to deliver for the raw material to the cooperative each year. The cooperative association distributes one delivery right for each share of common stock held on the record date. Each delivery right entitles an eligible member to deliver one unit of commodity. For example, a member may exercise the rights to purchase minimum 1,000 shares for $5,000. Each year the producer has the obligation to deliver 1,000 bushels of wheat. If the cooperative is profitable, the ownership shares and the delivery rights will appreciate in value and surpluses generated by the cooperative will be distributed to the members as stock and/or cash in proportion to how much of the raw product (wheat) they deliver annually. The potential appreciation in share value and the cash patronage refund represent the monetary benefits from membership.

Unlike previous work by Sexton, we assume that investors maximize expected utility of the investment, and their utility function includes the expected monetary benefits from investment, risk, fairness, and non-monetary benefits and is maximized subject to their wealth constraint. Membership in a new generation cooperative is assumed to be voluntary and potential members choose whether to invest or not to invest a cooperative based on monetary, non-monetary benefits, fairness, and risk. Non-monetary benefits are included because the firm is

located in an area in which the producer may want to create employment opportunities and support economic development.

Investment theory and the previous work about "revealed preference" conditions for validity of the utility maximization model are used and extended (Varian, 1983). The mean-variance model of cooperative investment captures the investor's rationality in undertaking investment decision based on the expected return on investment, risk, fairness, and non-monetary return associated with the investment. The substantial difference between this model and Varian's work are the non-monetary benefits and fairness terms in the investor's utility function.

The Mean-Variance Cooperative Portfolio Model

Let $p = (p_1, \ldots, p_A)$ denotes for the vector of prices for the assets. $x = (x_1, \ldots, x_A)$ represents the assets or portfolio choices. The variable $R = (R_1, \ldots, R_A)$ denotes expected return on the portfolio choices 1, …, A, and $G = (G_1, \ldots, G_A)$ represents the non-monetary benefits from portfolio x. The investor's expected return for portfolio x is denoted by $W = Rx$; f is a vector of the investors' perception of fairness for each asset $f = (f_1, \ldots, f_A)$ and W_0 represents initial level of wealth. $U(\cdot)$ is the von Neuman-Morgenstern utility function which is enhanced with non-monetary benefits, risk, and a fairness component.

The risks associated with cooperative investment as a part of producers' portfolio are represented by variance of return on investment from the portfolio x. The variance of return from portfolio x is represented by $\phi x'Vx$ where $\phi < 0$ is the risk-aversion parameter, and V is the variance/covariance matrix of the investment x. The investor's utility from portfolio x has a mean μ and variance σ^2. Utility is a function of expected return on investment, the variance of return from the portfolio, perception of fairness, and non-monetary benefits associated with that portfolio choice. Producers are hypothesized to maximize utility subject to a wealth constraint:

(3)
$$\max_{x} U(Rx, \phi x'Vx, Gx, fx)$$

$$\text{subject to } p \cdot x = W_o$$

$$\text{and } x \geq 0$$

Definition 1. We have observed a portfolio choice x^i for $i = 1, \ldots, n$, a mean-variance utility function rationalizes the observed investor behavior if and only if

(4)
$$U(Rx^i, \phi x^{i\prime}Vx^i, Gx^i, fx^i) \geq U(Rx, \phi x'Vx, Gx, fx)$$

for all portfolios x that cost the same or less than x^i. That is: $p^i x \leq p^i x^i$ or $p^i(x - x^i) \leq 0$. This expression tells us that given the expected return R, variance/covariance matrix V, non-monetary return vector G, and fairness vector f, investors decide to invest in the cooperative membership if the expected utility from a portfolio containing a cooperative investment exceeds any other affordable portfolio.

There are two ways of proving that Equation 4 is true. Necessary and sufficient conditions for Equation 4 can be derived using either Slutsky conditions or revealed preference conditions (Varian, 1983). Revealed preference conditions are used because this approach is more applicable for empirical analysis. The necessary and sufficient conditions for the mean-variance utility maximization of Equation 4 are described in Theorem 1.

Theorem 1. If we assume that the mean-variance utility function is a monotonic, concave, and differentiable, then we know from the standard properties of concave functions that for x^i and x^j,

(5)
$$U(x^i) \leq U(x^j) + U'(x^j)(x^i - x^j) \qquad i, j = 1, \ldots, n.$$

Furthermore the hypothesis of utility maximization implies that first-order conditions must be satisfied by the data. That is

(6) $\qquad\qquad U'(x^j) = \lambda^j p^j \qquad\qquad j = 1,\ldots,n$ and $\lambda^j > 0$

For the utility function represented in Equation 4, Equation 5 and 6 are rewritten as Equation 7 and 8.

(7) $\quad U^i \le U^j + M^j(Rx^i - Rx^j) + E^j(Gx^i - Gx^j) + S^j(\phi x^{i\prime}Vx^i - \phi x^{j\prime}Vx^j) + H^j(fx^i - fx^j)$

$$i, j = 1,\ldots,n$$

(8) $\qquad\qquad M^j R + E^j G + 2S^j \phi x^{j\prime} V + H^j f = \lambda^j p^j \qquad$ with $j = 1,\ldots,n$ and $\lambda^i > 0$

where $\qquad\qquad\qquad U^i = U(Rx^i, \phi x^{i\prime}Vx^i, Gx^i, fx^i);$

$$M^j = \frac{\partial U(Rx^j, \phi x^{j\prime}Vx^j, Gx^j, fx^j)}{\partial(Rx^j)};$$

$$E^j = \frac{\partial U(Rx^j, \phi x^{j\prime}Vx^j, Gx^j, fx^j)}{\partial(Gx^j)};$$

$$S^j = \frac{\partial U(Rx^j, \phi x^{j\prime}Vx^j, Gx^j, fx^j)}{\partial(\phi x^{j\prime}Vx^j)};$$

$$H^j = \frac{\partial U(Rx^j, \phi x^{j\prime}Vx^j, Gx^j, fx^j)}{\partial(fx^j)}$$

λ^j = marginal utility of income.

Equation 7 is the standard requirement for utility maximization which is property of concavity from Equation 5, and Equation 8 is the first-order conditions of the utility function that satisfied the Equation 6. Given the information about (p^i, x^i), we can show $U^i, M^i > 0, E^i > 0, S^i < 0$, $H^i > 0$ and $\lambda^i > 0$ then Equation 7 holds and our mean-variance utility function is concave, differentiable, and monotonic.

$\qquad$ **Proof**. Equation 7 describes the standard properties of concave functions and Equation 8 is the usual first-order conditions of the mean-variance utility function. We assume $U(x^i)$ exist,

$M^i > 0, E^i > 0,\ S^i < 0,\ H^i > 0$ and $\lambda^i > 0$. That is the marginal utility of monetary returns is positive, the marginal utility of non-monetary benefits is also positive, the marginal utility of risk is negative, the marginal utility of fairness is positive, and the marginal utility of income is positive as well.

We must show that given any x with $p^i x^i \geq p^i x$, $U(x^i) \geq U(x)$. In deriving the sufficient conditions for the mean-variance utility maximization model we need to define:

(9)
$$U(Rx, Gx, \phi x'Vx, fx) = \min_i \{U^i + M^i(Rx - Rx^i) + E^i(Gx - Gx^i) + S^i(\phi x'Vx - \phi x^i{}'Vx^i) +$$
$$H^i(fx - fx^i)\}$$

Since the variance-covariance matrix V is positive semi-definite, for all x^i and x we can write the variance of portfolio x as $(x - x^i)'V(x - x^i) \geq 0$. By arranging this inequality we get the algebraic identity $(x'Vx - x^i{}'Vx^i) \geq 2x^i{}'V(x - x^i)$.

Now suppose that some x such that $p^i x^i \geq p^i x$. For notational convenience, let us define $U^i = U(x^i)$. Then we have

(10) $\quad U(Rx, Gx, \phi x'Vx, fx) = \min_i \{U^i + M^i(Rx - Rx^i) + E^i(Gx - Gx^i) + S^i(\phi x'Vx - \phi x^i{}'Vx^i) +$

$$H^i(fx - fx^i)\}$$

(11)
$$U(Rx, Gx, \phi x'Vx, fx) \leq U^i + M^i(Rx - Rx^i) + E^i(Gx - Gx^i) + S^i(\phi x'Vx - \phi x^i{}'Vx^i) +$$
$$H^i(fx - fx^i)$$

which can be written as:

(12) $\quad U(Rx, Gx, \phi x'Vx, fx) \leq U^i + M^i R(x - x^i) + E^i G(x - x^i) + 2S^i \phi x^i{}'V(x - x^i) + H^i f(x - x^i)$

(13) $\qquad U(Rx, Gx, \phi x'Vx, fx) \leq U^i + (M^i R + E^i G + 2S^i \phi x^i{}'V + H^i f)(x - x^i)$

because $M^i R + E^i G + 2S^i \phi x^i{}'V + H^i f = \lambda^i p^i$ then we can say

(14) $$U(Rx, Gx, \phi x'Vx, fx) \leq U^i + \lambda^i p^i(x - x^i)$$

Since $p^i(x - x^i) \leq 0$, then

(15) $$U(Rx, Gx, \phi x'Vx, fx) \leq U^i \quad \text{and}$$

(16) $$U(Rx, Gx, \phi x'Vx, fx) \leq U(Rx^i, Gx^i, \phi x^{i\prime}Vx^i, fx^i) \qquad \blacksquare$$

Rationalizing the observed behavior of investors using a differentiable, concave, monotonic utility function will guarantee the existence of $U^i, M^i > 0, E^i > 0, S^i < 0, H^i > 0$ and $\lambda^i > 0$ that satisfy the inequalities: $U^i \leq U^j + \lambda^j p^j(x^i - x^j)$ for $i, j = 1, \ldots, n$. If there exist some values $U^i, M^i > 0, E^i > 0, S^i < 0, H^i > 0$ and $\lambda^i > 0$ for $i = 1, \ldots, n$ that satisfy the inequalities above for some observed behavior of investors (p^i, x^i), $i = 1, \ldots, n$, then there must exist a continuous, concave, monotonic utility function that rationalizes the observed behavior.

Stage I: Initial Investment Decision

The investor's interest is choosing x^i to maximize utility. Changes in x^i are changes in demand for investment. Suppose that x^i is chosen to maximize the investor's utility. Let $\mu(x^i)$ be the monetary returns, $D(x^i)$ be the non-monetary benefits, $\sigma^2(x^i)$ be the variance of returns, and $F(x^i)$ represents fairness[7]. For example, the amount of delivery rights purchased monetary and non-monetary benefits, risks, and perception of fairness. Let us denote the maximum utility as $M(x^i)$ for different choices of x^i.

$$M(x^i) \equiv \max_{x^i} U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big)$$

subject to $g(x^i, W_0) = 0$ and $x^i \geq 0$

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[7] In initial investment decision analysis the notations μ, D, σ^2, and F are used for derivation purposes instead of $Rx^i, Gx^i, \phi x^{i\prime}Vx^i$, and fx^i, to make the utility function more general.

so that the Lagrangian is

$$L(x^i, \lambda) = U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big) - \lambda g(x^i, W_0)$$

and the first-order conditions with respect to x^i and λ are

(17)

$$\frac{\partial L}{\partial x^i} = \left(\frac{\partial U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big)}{\partial \mu}\right)\left(\frac{\partial \mu(x^i)}{\partial x^i}\right) + \left(\frac{\partial U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big)}{\partial D}\right)\left(\frac{\partial D(x^i)}{\partial x^i}\right) +$$

$$\left(\frac{\partial U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big)}{\partial \sigma^2}\right)\left(\frac{\partial \sigma^2(x^i)}{\partial x^i}\right) + \left(\frac{\partial U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big)}{\partial F}\right)\left(\frac{\partial F(x^i)}{\partial x^i}\right) -$$

$$\lambda\left(\frac{\partial g(x^i, W_0)}{\partial x^i}\right) = 0$$

(18) $$\qquad\qquad \frac{\partial L}{\partial \lambda} = g(x^i, W_0) = 0 \qquad\qquad \text{for } i = 1, \ldots, n$$

These conditions determine the optimal choice of x^i which in turn determine the maximum

utility function $M(x^i) \equiv U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big)$. Since $\mu = Rx^i$; $D = Gx^i$;

$\sigma^2 = \phi x^{i\prime} V x^i$; $F = fx^i$ and $g(x^i, W_0) = p^i x^i - W_0$ then the investment demand function,

(19) $$\qquad\qquad\qquad x^{i*} = x^{i*}(R, G, \phi V, f, p^i, W_0)$$

The envelope theorem[8] gives a formula for the derivative of maximum utility function

with respect to choice variable x^i:

$$\frac{dM(x^i)}{dx^i} = \frac{\partial L}{\partial x^i}$$

(20) $$\qquad \frac{dM(x^i)}{dx^i} = \left(\frac{\partial U\big(\mu(x^i), D(x^i), \sigma^2(x^i), F(x^i)\big)}{\partial x^i}\right) - \lambda\left(\frac{\partial g(x^i, W_0)}{\partial x^i}\right)$$

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[8] The proof of the envelope theorem can be found in Varian (1992) p. 502.

This equation shows how the maximum utility changes, given changes in x^i.

Stage II: Closed Cooperative's Decision Model

The closed cooperative's objective function is to maximize net surplus, and the cooperative surplus function is determined by revenue, total production costs, and cash patronage refunds. Suppose there is a coalition S of M potential investors in a closed cooperative, $M = (1, \ldots, m)$. We assume that closed cooperative (coalition S) produces consumer product, k, using purchased input from non-members plus input from members, z_k, where the marginal cost of producing k is $c(z_k)$ and the total cost is $C(z_k)$. From our derivation of the investor's demand for cooperative investment we have $x^{i^*} = x^{i^*}(R, G, \phi V, f, p^i, W_0)$. Assume this is a continuous and differentiable for all variables in the model.

The aggregate demand for cooperative investment from the cooperative members in coalition S,

(21)
$$x_S^{i^*} = \sum_{j \in S} x_j^i (R, G, \phi V, f, p^i, W_0) \text{ for } S \subseteq M$$

where $x_S^{i^*}$ is equivalent to owners equity which is determined by Equation 21 in Stage I. Total investment capital, K_k, can be obtained from owners equity and/or loans. Let L_k is the amount of investment capital to produce consumer product k from loans that is proportional to amount of capital invested/owners equity in the cooperative, $L_k = \gamma(x_S^{i^*})$ where γ is the loan leverage parameter. The cooperative investment capital is $K_k = x_S^{i^*} + \gamma(x_S^{i^*}) = (1 + \gamma)x_S^{i^*}$.

Let $\theta_j(z_k, K_k)$ be the revenue that an investor obtains from an investment in a closed cooperative. Then we can say that the revenue for cooperative as a coalition S is

$\theta_S(z_k, K_k) = \sum_{j \in S} \theta_j(z_k, K_k)$ since $j \in S$. If the cooperative's production function is

$y_S^i = h(z_k, K_k)$, then cooperative's revenue can be written as $\theta_S(z_k, K_k) = p_S^k \cdot h(z_k, K_k)$, where

p_S^k is the price of consumer product k. The cooperative's surplus is:

(22) $\qquad\qquad \Pi'(z_k, K_k) = \max(\theta_S(z_k, K_k) - C(z_k)) \quad$ for $z_k > 0$ [9]

where $C(z_k) = w_z \cdot z_k$ is the total production costs associated with producing k and w_z is the price

for one unit of raw material/input. If z_k^* is the optimum quantity of input that maximizes

$\Pi'(z_k, K_k)$, then we will get $z_k^* = 0$ if $\theta_S(z_k, K_k) \leq C(z_k)$ for all $z_k > 0$.

The cooperative's retained earnings (*RE*) are:

(23) $\qquad RE(z_k, K_k) = \Pi''(z_k, K_k) = \Pi'(z_k, K_k) - R_S(z_k) \quad$ for $\Pi'(z_k, K_k) > R_S(z_k)$

where $R_S(z_k) = w_r \cdot z_k$ is the cash patronage refunds which can be earned by investors in

coalition S with w_r as the book value of each share of common stock at the present time. We can

express the cooperative's retained earnings, *RE*:

(24) $\qquad\qquad\qquad RE(z_k, K_k) = \max[\Pi''(z_k, K_k), 0]$

The cooperative's retained earnings $RE(z_k, K_k) = 0$ if cooperatives are not profitable to deliver

$R_S(z_k)$ to investors or if not enough capital and delivery commitments. In either case, the

cooperative fails to operate.

To formally derive the cooperative maximizing behavior, Equation 24 may be rewritten

as an optimization problem:

(25) $\qquad\qquad\qquad \Pi'(z_k, K_k) = \max_{z_k} \Pi\left(p_S^k \cdot h(z_k, K_k) - w_z \cdot z_k\right)$

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[9] The investment capital, K_k, is a constant term which determined and fixed from Stage I of closed cooperative investment game tree. We assume that the cost of owner equity and loans are fixed.

subject to $w_r \cdot z_k \leq E$ and

$$z_k > 0$$

where E is the maximum amount of shares allowable to be offered by the cooperative, and w_r is the initial book value of each share of common stock (one share is equivalent to one unit of input delivered).

The Lagrangian function is

(26) $$L(z_k, K_k, \lambda) = [p_S^k \cdot h(z_k, K_k) - w_z \cdot z_k] - \lambda(w_r \cdot z_k - E)$$

By assuming that $h(z_k, K_k)$ is differentiable then the first-order and the second-order conditions with respect to z_k and λ are

$$\frac{\partial L}{\partial z_k} = p_S^k \cdot h'(z_k, K_k) - w_z - \lambda w_r = 0$$

$$\frac{\partial L}{\partial \lambda} = -(w_z \cdot z_k - E) = 0$$

$$\frac{\partial^2 L}{\partial z_k^2} = p_S^k \cdot h''(z_k, K_k) \leq 0 \text{ and } \frac{\partial^2 L}{\partial \lambda^2} = 0$$

then we get competitive factor demand,

(27) $$z_k^* = z_k^*(p_S^k, w_z, w_r, E)$$

so the solution for the supply function maximizing the cooperative net surplus is

(28) $$y_S^{i\,*} \equiv h\{z_k^*(p_S^k, w_z, w_r, E), K_k\}$$

The Role of Fairness

Suppose there is a two-player cooperative game with perfect information. The two players are the cooperative and an investor. The mixed strategy sets are T_M and T_C for the investors and the cooperative, respectively. Let $(R \cdot x^i)_M$ be the investor's expected return of

portfolio choice x^i. We assume that maximization of each player's expected utility is determined by their chosen strategy and their beliefs about the other player's strategy choices. Let $a_M \in T_M$ and $a_C \in T_C$ be the strategies chosen by the investor and the cooperative, respectively. The investor's beliefs about the strategy the cooperative is choosing is represented by $b_C \in T_C$, and the cooperative's beliefs about what strategy the investor is choosing is represented by $b_M \in T_M$.

The fairness term f measures how fair an investor perceives the treatment of other players (cooperative) in the coalition. To formalize the investor's perceptions, it is necessary to develop a model that explicitly incorporates beliefs. The term $f_C(a_C, b_M)$ explains how fair the cooperative is being by choosing strategy a_C. If the cooperative believes that the investor is choosing strategy b_M. The term $f_C(a_C, b_M)$ measures how much more than or less than investor's equitable payoff, the cooperative believes the association is giving to the investor. The cooperative has the opportunity to choose the payoff pair $[R_C(a_C, b_M), R_M(b_M, a_C)]$ from among the set of all feasible payoffs if the investor is choosing strategy b_M. The investor's equitable payoff is expressed by the following relationship $R_M^e(b_M) = [R_M^h(b_M) + R_M^l(b_M)]/2$. $R_M^e(b_M)$ provides a reference point against which to measure how fair the cooperative is perceived as being to the investor, where $R_M^h(b_M)$ is the investor's highest payoff in $X(b_M)$ and $R_M^l(b_M)$ is the investor's lowest payoff among points that are Pareto-efficient[10] in $X(b_M)$. The feasible set of Pareto-efficient points are the points in the set $X(b_M) \equiv \{(R_C(a, b_M), R_M(b_M, a)) \mid a \in T_C\}$, where $X(b_M)$ is the set of alternative payoff combinations R_C and R_M; and T_C is the set of pure

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[10] Pareto-efficient is a point in which it is not possible to make one person better off without making at least one other person worse off. The pareto-efficient situation always reflects optimal point in the set of feasible points.

strategies of the cooperative. The term $X(b_M)$ looks at the set of payoff combinations from the cooperative's perspective, and the cooperative takes into account its belief about which strategy the investor will choose (b_M). Accordingly, $X(b_M)$ reflects the cooperative's belief about all players' payoff combinations in the opportunity set.

From these payoffs, the fairness term is defined. This term captures how much more than or less than investor's equitable payoff the cooperative believes the association is giving to investor.

Definition 2. The perception about the cooperative's fairness to the investor is given by

(29)
$$f_C(a_C, b_M) \equiv \frac{R_M(b_M, a_C) - R_M^e(b_M)}{R_M^h(b_M) - R_M^l(b_M)}$$

If $R_M^h(b_M) - R_M^l(b_M) = 0$ then all of the cooperative's responses to strategy b_M provide investor the same payoff. Therefore, there is no fairness issue and $f_C(a_C, b_M) = 0$. Clearly, $f_C(a_C, b_M) = 0$ if and only if the cooperative gives the investor the equitable payoff. If $f_C(a_C, b_M) < 0$ the cooperative is giving the investor less than the equitable payoff. Finally, if $f_C(a_C, b_M) > 0$ the cooperative is giving the investor more than the equitable payoff. The investor's fairness to the cooperative is given by $f_M(a_M, b_C)$. If the investor believes that the cooperative is choosing strategy b_C then the term $f_M(a_M, b_C)$ measures how fair the investors are being to the coopertative. Figure 2 shows the outcome term $f_C(a_C, b_M)$ as a function of the level of payoff (R_M's). This figure captures the producer's perception of fairness: the higher the investor's payoff offered by the cooperative is compared to the equitable payoff, the higher the perception of fairness.
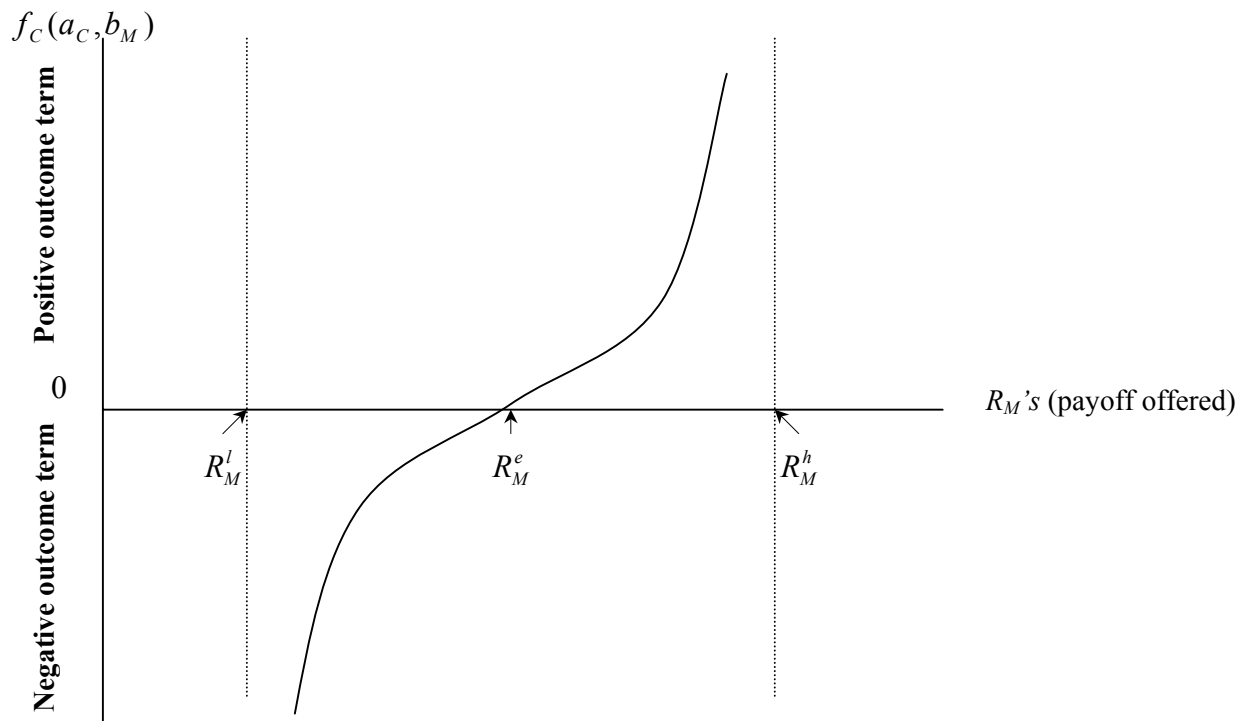
Figure 2: The Outcome Term as a Function of the Level of Payoff Offered for a Given Motivation Factor

The central feature of this fairness term is that if investors believe that the cooperative is treating them unfairly, then $f_C(a_C, b_M) < 0$, and the investor wishes to respond to the cooperative negatively by choosing strategy a_M such that $f_M(a_M, b_C) < 0$. However, if cooperative is delivering fair action to investors, $f_C(a_C, b_M) > 0$, and then investors will provide the cooperative fair feedback.

Hypotheses

This theory of cooperative investment shows that the cooperative enterprises that generate maximum expected utility to producers are preferred more than those that do not. Joining a closed cooperative may increase the investor's risk, especially if it is a start-up enterprise. There must be a meaningful reason that encourages investors to invest in a closed cooperative. Equation 19 in the previous section clearly generates three hypotheses related to the closed cooperative investment decisions. The first question to be addressed in this analysis then is whether non-monetary benefits from cooperative investment motivate producers to invest in a closed cooperative. Therefore, the first hypothesis is:

H_1: Producers who want to create employment opportunities and support economic development in their local community are more willing to invest in a cooperative as part of their portfolio if that investment provides those non-monetary benefits.

The impact of risks associated with cooperative investment on producer's expected utility and investment decisions is an important issue in this study. The second hypothesis is:

H_2: Risk-averse producers are more willing to invest in a closed cooperative if they perceive that investment to have relatively low risk.

The third hypothesis is related to the psychological literature that eventually was used to study the implications of fairness in economic transactions. Evidence indicates that people's

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notions of fairness are heavily influenced by the status quo and other reference points (Rabin, 1993; Kahneman et al., 1986a, b). Following this reasoning, the third hypothesis is:

H_3: Producers who are concerned about fairness are more willing to invest in a closed cooperative if that enterprise provides treatment that is perceived as fair.

IV. Summary and Conclusion

The forces inducing change in agricultural cooperative institutions have lead to the demand for a clear unifying theory of agricultural marketing cooperative development. A model of new generation cooperative investment based on investment theory is proposed by incorporating monetary, non-monetary, fairness, and risk components in the model. Our model incorporates non-monetary perception of the investors as an essential determinant influencing the formation of a cooperative. Investors judging whether or not to invest in a new generation cooperative not only consider monetary benefits from their investment but non-monetary benefits, fairness and risk as well.

Our theory suggests that the rational investor will choose a new generation cooperative as part of his portfolio if the utility of a new generation cooperative investment exceeds any other affordable portfolio.

The role of fairness in the new generation cooperative investment model captures several important issues of investor behavior. Investors' perception of fairness is heavily influenced by their reference points. For instance, the investors' view of the fairness of closed cooperative' management to the members can be influenced by how that firm has treated them in the past relative to their expectation.

The model of closed cooperative investment can be viewed from a game theoretical approach as a sequential game with perfect information. In the cooperative formation stage, the

potential investors observe the cooperative's management behavior, and this provides information on which investors make their investment decisions. In this game, the cooperative's management behavior can conceivably change the motivation of the investor to invest. A sequential game involves sequential strategies and a decisions process, and it will continue as long as the firm exists.

In the earlier stage, the success of a coalition formation is greatly determined by the prospectus of that cooperative. If the cooperative's prospectus provides overly optimistic investment return expectations, initial positive perceptions may be created. In the second stage of the game, the investors have two alternative strategies: increase or decrease the investment for the next period of the operation. The decision is determined by utility as a member of the closed cooperative. If the cooperative delivers high utility to its members, again the investors will respond positively to the cooperative's management and increase their investment. Investors maximize utility subject to a wealth constraint and they will decide to invest in the cooperative if the expected utility from a portfolio containing a cooperative investment exceeds any other affordable portfolio. Sequentially, the cooperative maximizes net surplus subject to maximum allowable shares to be offered to investors.

The initial investment decision analysis provides the optimal value of demand for a closed cooperative investment in achieving maximum utility as a function of monetary return, social/non-monetary benefits, variance of the return, and fairness. The stage II analysis obtains and derives the supply function of the closed cooperative investment. Further research is obviously required, since comprehensive analysis with respect to the closed cooperative point of view needs to be developed.

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