Incentives to Efficient Investment Decisions in Agricultural Cooperatives

Carlo Russo
Department "Economia e Territorio" – University of Cassino, Italy
Postal address: via S. Angelo - Località "*Folcara*" - 03043 Cassino (Fr) – Italy
Email: russocar@unicas.it

Massimo Sabbatini
Department "Economia e Territorio" – University of Cassino, Italy
Postal address: via S. Angelo - Località "*Folcara*" - 03043 Cassino (Fr) – Italy
Email: m.sabbatini@unicas.it

Incentives to Efficient Investment Decisions in Agricultural Cooperatives
By Carlo Russo and Massimo Sabbatini[(*)]

Abstract. Recent studies have questioned the competitiveness of agricultural cooperatives in an industrialized food system, based on empirical results and economic theory. New organizational institutions have been proposed to overcome the cooperative main weaknesses (the so called new generation cooperatives). In this paper, we provide a simple model based on a financial approach to address the issue of cooperative competitiveness and to assess the investment efficiency of both traditional and new generation cooperatives. The main conclusions of the analysis are: i) cooperatives (both traditional and new generation ones) may have incentive to adopt projects that do not maximize the Net Present Value of the firm ii) the institutions of new generation cooperatives are not sufficient to ensure net present value maximization, even though they address some of the main concerns of traditional cooperatives iii) traditional cooperatives may have a competitive advantage in businesses that require the aggregation of a large number of farmers.

Introduction

The role of agricultural cooperatives in an industrialized food system is a major concern for researcher in the field. Particularly, since early 1990's, sluggish or even declining performances, illustrious bankruptcies and the rise of new organization forms (such as the new generation cooperatives) have brought new intensity in the debate. The main question is related to the possibility for cooperatives to compete successfully in the food market with Investor Owned Firms (IOF), given their unique institutions. The same question has been posed in many different ways, for a long time and with different approaches and answers. Authors wondered if traditional cooperatives "have outlived their usefulness" (Stewart 1993) or are "under-performers by nature" (Hind 1994), what would be the (grim) implications of industrialization for supply cooperatives (Coffey 1993). The comparative efficiency of cooperatives has been both questioned and supported (Porter and Scully 1987, Lerman and Parliament, 1990; Sexton and Iskow, 1993, Hendrikse 1998, just to quote a few). In mid-90's the future role of cooperative was considered an open question (Fulton, 1995; Cook 1995). Increasingly, literature has been linking the efficiency of cooperatives as ownership structure to market imperfections such as transaction costs, incomplete contracts or moral hazard (Staatz 1987, Fulton 1995, Hendrikse 2001, Hendrikse and Bijman 2002; Hueth, Marcoul and Ginder 2003).

The arguments in support of inefficiency of traditional cooperatives have been summarized and organized in an original framework by Cook et al. using a neo-institutional approach: the "vaguely/ill defined" property rights in traditional cooperative institution hinder competitiveness and makes them more vulnerable in the market (Cook 1995, Iliopoulos and Cook 1999, Cook and Iliopoulos 2000, Sykuta and Cook 2001). New Generation Cooperative (NGC) are then considered as a "new and improved" institutions, overcoming the weaknesses of the traditional associations[1]. However, Recent developments, question the unconditional success of the NGC and call for a critical look at the new trends (Torgerson 2001).

In this paper we focus on a specific attribute of efficiency: the investment of financial resources in value maximizing activities. The topic is relevant since undercapitalization and financial constraints are often considered cooperatives' most important strategic weaknesses. Then the ability of cooperatives of allocating the scarce financial resources in value maximizing projects is a key determinant of efficiency.

[(*)] Carlo Russo and Massimo Sabbatini are, respectively, Associate Professor and Full Professor in Agricultural Economics at the Department "Economia e Territorio" of the University of Cassino, Italy. The paper is a joint effort of the authors, however Conclusions are attributed to Prof. Sabbatini and the rest of the paper and the appendix to Prof. Russo.
[1] The distinctive characteristics of new generation cooperatives, compared to traditional cooperatives are closed (limited) membership and the regulation of patronage via delivery rights (i.e. the quantity of products that members can deliver to the cooperative is proportional to the equity shares). Also, NGC are characterized by relevant upfront capital investment and a value-added focus. For a more detailed description, see Fulton 2001.

The goal of the paper is to provide a simple financial model to evaluate investment efficiency in agricultural cooperatives. Financial theory is particularly useful to address issues related with investment decisions and its use is not new in cooperative studies (Cotterill 1987, Peterson 1992, Sporleder and Zeuli 2000, Bailey and Sporleder 2000). The main objective is to compare the efficiency of traditional and new generation cooperative in the allocation of financial resources.

An efficiency criterion for investment decision

In this section we provide a general efficiency criterion for the investment decision. Such criterion will allow us to compare the investment decision processes of IOF, NGC and TC and to contrast the relative efficiency in the use of the financial resources. In particular, the goal is to assess if any organization form provides better incentive to an efficient allocation of the resources.

The analysis relies on the following assumptions:

- No agency problem arises with managers[2]. The managers simply carry out the majority decision. This assumption implies that the organization (either IOF or cooperative) will adopt the investment decision that is supported by the majority of the shareholders/members. As a consequence, to describe the firm behavior it is sufficient to model the shareholders/members' decision to support or oppose investment projects. Following Staatz's terminology, it is assumed that the cooperative is a coalition composed only of groups of patrons (Staatz 1983).

- The objective of the member/investor is to maximize the present value of their wealth. They will support any (legal) decision if the present value of the *appropriable* differential cash flows is positive. The term *appropriable* indicates that the member/investor only considers his private benefit (the cash flows he can appropriate of) and has no utility from the value of the firm/cooperative *per se*.

- Markets are complete, competitive[3] efficient and in equilibrium.

- All the investment decisions are financed with equity (i.e. no debts and no bankruptcy)

Assume that an IOF and a cooperative are considering adopting a new investment. Given the assumptions, the project is approved if it increases the expected present wealth of the majority of the members/investors. Exhibit 1 compares the evaluation criterion for the *appropriable* differential cash flows of a IOF investor, a TC patron and a NGC member, respectively - for an investment that requires an initial payment of I and yields a stream of differential cash flows for the firm F [4]. The Exhibit reports both the project's NPV and the member's *appropriable* NPV .

In this paper, the investment NPV – i.e. the present value of the asset, evaluated according elementary financial theory (for ex. Brealey and Myers 1996) – is used as an efficiency benchmark. It

---

[2] This assumption is particularly strong in the cooperative case. Authors stressed the influence of managers on the cooperative decision processes and financial structure (Murray 1983, Staatz 1987b, Russo et al. 2000) . In a TC the agency problem is considered more severe than in IOF.

[3] The assumption of perfectly competitive markets simplifies the analysis, but is extremely restrictive. An extensive literature associates cooperatives to imperfect markets and the presence of market power or transaction costs (for example Sexton 1990). Perfect competition can be justified by assuming that the cooperative successfully solved the competitive problem. The assumption simplifies the model because it implies that there is no difference in the prices that TC, NGC and IOF face if operating in the same market.

[4] The goal of the table is to provide a simple comparison, so additional assumptions have been introduced to simplify notation. In particular:

- The firm organization does not influence the differential cash flows (i.e. F is considered the same for an IOF, a TC or a NGC). This assumption requires for example that cooperatives and IOF set production at the same level. The previous assumption of competitive markets makes the this hypothesis less heroic.

- The differential cash flows do not depend on members' participation. Also there is no free rider problem (this hypothesis can be considered as a consequence of the assumption of competitive markets).

- The only effect of the investment on member/investor present wealth is the *appropriable* differential cash flows. This implies that investors do no change their portfolio or members do not adjust the production/demand for the goods that are not marketed/sold by the cooperative. Such assumption will be relaxed later, in a more formal analysis.

is assumed that an investment decision that maximizes the project's NPV is efficient. The criterion is justified by the assumption of perfect markets. In fact the IOF/cooperative can realize the value-maximizing investment, then sell it on the market (for the equilibrium price NPV_f) and use the complete financial market to compose a portfolio to duplicate any other stream of cash-flow. Since the investment is value maximizing and markets are efficient, the price of the portfolio is lower than NPV_f. Then by adopting the value maximizing investment, the IOF/cooperative can grant shareholders/patrons the same stream of cash flows of any other available investment plus a lump-sum differential.

	IOF (investor owned firms)	TC (traditional cooperatives)	NGC (new generation coop.)
Investment NPV (NPV_F)	$\sum_{t=1}^{T} \frac{F_t}{(1+r)^t} - I$	$\sum_{t=1}^{T} \frac{F_t}{(1+r)^t} - I$	$\sum_{t=1}^{T} \frac{F_t}{(1+r)^t} - I$
Individual investor's *appropriable* NPV (NPV_S)	$\alpha \sum_{t=1}^{H} \frac{F_t}{(1+i)^t} + \alpha \frac{SV_H}{(1+i)^H} - \alpha I$ if: $i = r$ $SV_H = \sum_{t=H}^{T} \frac{F_t}{(1+r)^t}$ then $NPV_S = \alpha\, NPV_F$	$\sum_{t=1}^{H} \left(\varphi_t \frac{F_t}{(1+i)^t} \right) + \frac{\beta I}{(1+i)^H} - \beta I$	$\delta \sum_{t=1}^{H} \frac{F_t}{(1+i)^t} + \delta \frac{SV_H}{(1+i)^H} - \delta I$ if: $i = r$ $SV_H = \sum_{t=H}^{T} \frac{F_t}{(1+r)^t}$ then $NPV_S = \delta\, NPV_F$

Exhibit 1: Comparison of investment evaluations in IOF, TC, NGC

In Exhibit 1, F_t is the net differential cash flow from the investment in year t, T is the duration of the investment (economic life), r is the appropriate discount rate for the investment, H is the number of periods after which the investor plan to divest from the project (investor's time horizon), SV_H is the value of the stocks at time H, I is the initial cost of the investment, α is the investor's share in the IOF, φ_t is the TC member's patronage share in year t, β is the TC member's equity share and δ is the NGC member's share of delivery rights and i is the interest rate utilized in the individual investor evaluation (see later).

The formulas for IOFs are elementary financial theory. The cases of TC and NGC need comment. In a TC the *appropriable* NPV depends on patronage: in each year patrons can claim a share φ_t of the cooperative cash flow that, unlike IOF, may vary over time and it is not necessarily proportional to the share of the equity investment (β). Furthermore, since the equity investment is reimbursed at face value (βI), a member leaving the cooperative at time H will not received the value of the expected future benefits – originating the well-known horizon problem (Vitaliano 1983). Because of TC unique institutions (open membership, remuneration proportional to the use and unlimited delivery rights) the member's *appropriable* NPV (NPV_s)is not a fix proportion of the investment NPV (NPV_f). As a consequence, influence and control costs may be more severe in TC than in IOF. Members have two ways to increase NPV_s : either increase the project value (NPV_f) or increase φ_t , being βI given. A member may prefer an investment with a lower total NPV, if he can appropriate of an higher share of the benefits. Managerial practice offer clear examples of this conclusion: in multiproduct cooperatives, individual patrons may support less profitable investments benefiting the commodities they trade, rather than higher value projects benefiting other patrons. Small farmers may support expenditures aimed to reduce on-farm fix costs rather than more profitable investments increasing the per-unit margins.

In general, the principle of separation between investment decision and investors' personal preferences does not apply to TC. This happens because, in a cooperative, the production decision affects the distribution of the benefits across members. As a consequence, production decisions that are not maximizing total value are possible if the majority of members can appropriate of higher value through a different distribution of the surplus. In a TC we have a tension between efficiency and bargaining. Standard corporate finance theory assumes homogeneity of shareholder objectives (i.e. investors are interested only in value maximization). In a cooperative, instead different individual

evaluations introduce heterogeneity in members' objectives and originate well-known management challenges (Emilianoff 1942). The consequences of heterogeneity in the evaluation of the cooperative benefits have been extensively described in literature (Sexton 1986); in the next section the financial approach provides an insight into the causes.

The investment evaluation by a NGC member differs from the TC case. The property rights approach concludes that NGC institutions may overcome (at least partially) TC's efficiency problem. The financial model suggests that the conclusion holds only under two specific conditions, to be discussed in the next section. Exhibit 1 shows that under such conditions: i) NGC the members' evaluation of the investment is analogous to IOF shareholder ii) in IOF and NGC, the expected NPV for the individual investor is a share of the total NPV which equals the stock/delivery right share. This implies that, to maximize the appropriable returns, both IOF shareholder and NGC members must support the maximization of the total NPV (and/or buy more shares/delivery rights). Under the given conditions, no heterogeneous evaluation should be possible.

The proposed framework suggests that NGC may be more efficient in investing financial resources. However the conclusion holds only under two specific conditions, in the next section the implications of such conditions are discussed.

Condition for NGC investment efficiency

In section 1 we just observed that NGC can provide incentives to value-maximizing production decisions. In particular, we have that :

$$\text{NPV}_S = \delta \sum_{t=I}^{H} \frac{F_t}{(1+i)^t} + \delta \frac{SV_H}{(1+i)^H} - \delta I = \delta \left[\sum_{t=I}^{T} \frac{F_t}{(1+r)^t} - I \right] = \delta \, \text{NPV}_F$$

(i.e. the individual member value is a *fixed* proportion of the total value, corresponding to the share of delivery rights held by the patron). This conclusion holds only if:

1) $\quad SV_H = \sum_{t=H}^{T} \frac{F_t}{(1+r)^t} \quad$ i.e. if the salvage value of the cooperative shares equals the present

value of future cash flows

2) $\quad i = r \quad$ i.e. if the discount rate utilized in the individual member's evaluation is the same for all patrons (actual and future) and equals the discount rate for the "market" evaluation. The notions of market and individual interest rates need clarification. The *market* interest rate defines the interest rate that an investor holding the market portfolio would apply. In this paper, we assume that i) such value can be described by the Capital Asset Price Model (Lintner 1965) [5], ii) this value is consistent with the market price for the asset, in equilibrium. The individual member's interest rate is the interest rate that a patron of a cooperative is using in his evaluation.

Condition 1) implies an efficient secondary market for the cooperative stocks/delivery rights. Such assumption may be unrealistic if the number of potential buyers (i.e. of producers in the area) is thin. Also, note that if condition 2) is not satisfied (the member's interest rate differs from the *market* one), then the salvage value of the NGC participation is not equal to the member's evaluation of the present value of the future expected benefit.

Condition 2) requires that all members use in their evaluation the "market" interest rate (CAPM). This implies that patron's individual characteristics/preferences do not influence their required returns, the minimum expected returns that the member is willing to accept for the equity investment . The

---

5 The choice of CAPM as financial framework is due to the goal of providing a simple model. The use of CAPM for cooperative studies has been extensively discussed by Cotterill (1987). Moreover, the existence of a close relation between risk and equity investment in cooperatives has been empirically tested (Parliament and Lerman 1993), providing the basic argument for the applicability of CAPM. Also Arthur, Carter and Abizadeh suggested that, in agriculture, the results obtained using CAPM may be consistent to the ones obtained with more sophisticated model like arbitrage price model (APT) (Arthur, Carter and Abizadeh, 1988).

main point of this section is to prove that i) that the two values may diverge ii) individual interest rate may diverge across members.

It is possible to support the claim that individual preferences and production characteristics are determinants of the individual discount rate for TC and NGC members by comparing the application of the CAPM framework to capital investor and to cooperative members. The following analysis shows that the results of the model can be quite different if the agents considering the investment are patrons of a cooperative (both TC and NGC): in the text a graphical presentation is offered, while a formal proof is reported in appendix (for an almost direct application of standard CAPM to cooperatives, see Cotterill 1987).

Merely for comparison purpose, Graph 1 reproduces Lintner's approach to the investment decision by IOF shareholders. The graphs contrast two agents with different degrees of risk aversion (Mr. A is more risk averse than Mr. B) in a risk/return space[6]. Each point in the graph represents the pair of risk and returns; the shaded area represents the risk and returns of each possible portfolio in the market. Under the hypothesis of complete financial market, the such set is convex. According the general framework, both investors will hold the same market portfolio (point M) regardless individual preferences (the two indifference curves are represented). Risk aversion only determines the share of individual wealth invested in the market portfolio and in the risk-free asset. Under the condition of market equilibrium, both investor will have an expected required return for the investment equal to $E_{t-1}\left(y^a\right)=\left(y^m - y^0\right)\beta$, which determines the equation of the *Security Market* line.
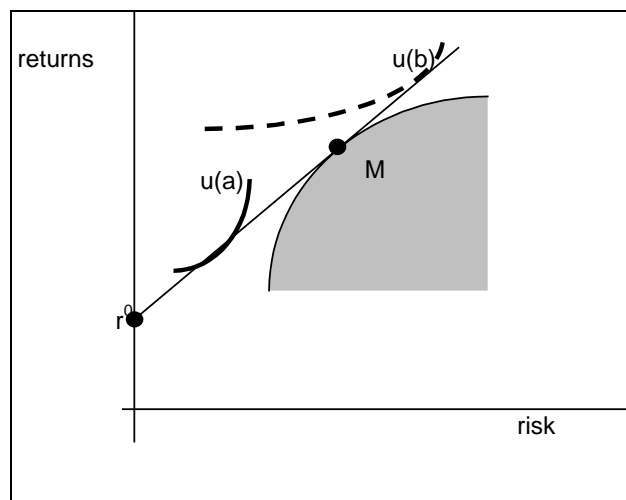

Figure 1: investor in IOF (Lintner 1965)

Graph 1 just repeats the CAPM framework for IOF investors. However the direct application to farmers and cooperatives of the model can be questionable and requires further adjustment. In particular, it must be considered:

- *Cooperative participation constraint*. To be part of a cooperative, the agents need to be farmers. Obviously, this implies that they cannot sell out the farm entirely. Also they need to produce/consume the goods traded by the cooperative. This implicitly means that the farm business cannot be reorganized without constraints (the farm business cannot switch from poultry to organic tomatoes, for example).
- *Limited portfolio*. Because of the constraint on the farm investment, some of the portfolios available in the financial marked may not be feasible for the farmers. Hanson and Myers note that farmers generally "do not hold diversified portfolio, preferring to concentrate most of their assets in on-farm investments and less risky financial investments such as treasury bonds and certificate of deposits" (Hanson and Myers 1995). Then a limited portfolio approach can be more appropriate (Levy, 1978). To keep the presentation simple, in Graph 2, it is assumed

---

[6] Risk is measured by the standard deviation of the returns.

that the only assets available to the farmers are the farm, the risk-free asset and the cooperative; a more general and formal approach is presented in the appendix.

- *Indivisibility equity investment (for TC only)*. In a TC, the equity investment is fixed (the face value of the shares). The farmers cannot either participate or not, they cannot adjust their investment (differentiate) to match their risk aversion (Vitaliano 1983). In the model is assumed that the amount of wealth invested in a TC is fixed.

- *Subsidiary nature of cooperative returns* The cooperative participation is an unique asset. Unlike standard financial investment, it does not yield returns *per se* (i.e. without the farm asset) but it affects the probability distribution (both in expectation and standard deviation) of the farm returns. By joining the cooperative, the farmer creates a composed asset (farm and the cooperative participation, the *farm-cooperative asset*) that yields a return that depends both on the farm characteristics and the cooperative investment. The differential returns from the cooperative can be defined as the difference between the revenues from the cooperative portfolio and the revenues from the farm. Note that the probability distribution of the total revenues from the cooperative portfolio depends on the expected differential returns (μ_c), their variance and their covariance with the farm asset.

Graph 2 illustrates the effects of these conditions in the determination of the investment decision of TC and NGC alike. In the graph, are reported four points, r^0, F, F+C and F+C', representing three assets: respectively the risk-free asset, the farm, the *farm-cooperative asset* without and with the new investment. Unlike the standard CAPM model, the farmers have a limited-asset availability (only three assets are available) and are subjected to the *cooperative participation constraint* (they cannot choose any point on the line connecting point F+C or F+C' to r^0, they can only reach a portfolio on the solid part of the lines). Note that once the farmers join the cooperative they just consider the aggregate returns from the cooperative portfolio.

Graph 2 describes the choice between two alternative investments by the cooperative in two cases: (a) the only two members of the cooperative have identical farm structure (the points F, F+C and F+C' coincide) but different risk aversion and (b) the farmers have the same preferences (the indifference curves Ua and Ub coincide) but different farm structure. The goal of the graph is to provide an intuitive argument supporting the possibility that TC members have divergent evaluation of the same investment project.

The investment that the cooperative is considering will affect the risk/return ratio of the patrons, then – in this simple one-period framework – they will support the project only if it allows them to reach an higher indifference curve . Each farmer has three options: support the new investment, oppose it but stay in the cooperative or oppose it abd leave the cooperative if approved (in this case he can quit farming as well, i.e. invest all his wealth in the risk-free asset). Figure 2 illustrates the options in the risk/return space.
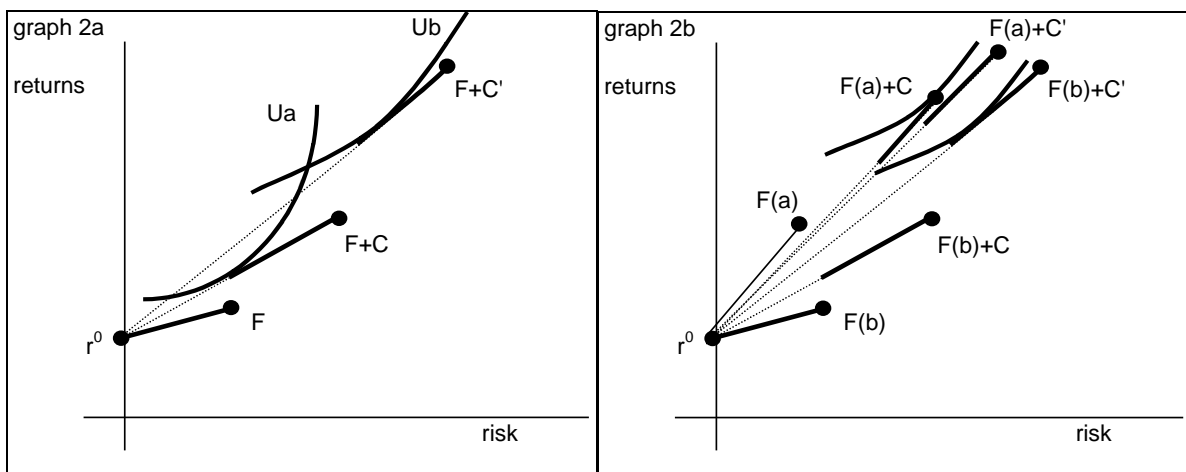

Figure 2: CAPM for TC members (a) Same farm assets, different preferences (b) different farm assets, same preferences

In both cases members have different evaluations: farmer B supports the investment, while farmer A (the more risk-averse one) does not. Since farmer A is not free to mix the portfolio F+C' with the risk-free asset in the optimal proportion (he should divest too much from farm operation), he prefers the less risky portfolio F+C. This result is similar to the portfolio problem detected by Vitaliano (1983) but the causes are linked not only to the indivisibility of the TC investment, but also to the nature of the farm operations that are required to participate to the cooperative.

The same conclusions hold for NGC. In this case, i) the constraint of *indivisibility of equity investment* is not longer applicable, ii) the *participation constraint* depends on the level of the investment in the cooperative (the farmer must be able to honor the delivery rights). Graph 3 illustrates the decision problem for NGC in the case of two farmers with identical farms and different preferences (the case for identical preference and different farms can be easily derived).
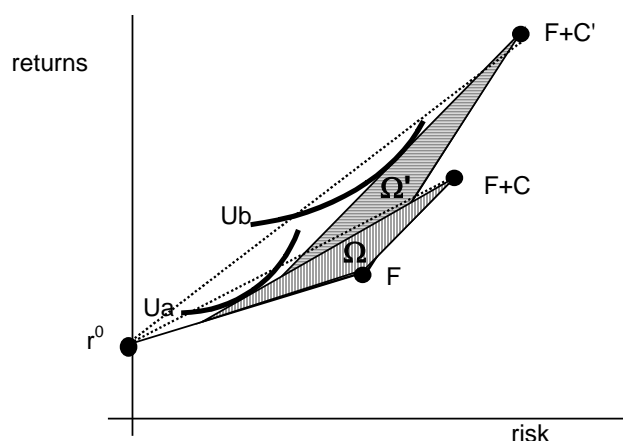
Graph 3: Cooperative investment decision for NGC members with different risk aversion

As in the previous case, four points are reported in the risk/returns space: the risk-free asset (r^0), the farm asset (F), the cooperative portfolio F+C (i.e. the portfolio with the maximum investment in the cooperative, given that the cooperative does not realize the new investment), the cooperative portfolio F+C' (with the new investment). Because the equity investment is not fixed, as in TC, the farmer can mix the investment in the cooperative with the farm asset, moving along the line joining F with F+C or F with F+C'. Moreover by mixing the cooperative portfolio with the risk-free asset the farmer can reach any point in the sets Ω and Ω' (depending on the cooperative investment). Note that the shape of Ω and Ω' is the result of the *limited portfolio* assumption and the *participation constraint*[7]. In the graphical example, we have a divergence in investment evaluation between the two patrons: farmer A, more risk averse, opposes the new investment, while farmer B supports it. In NGC, the final investment decision is influenced by members' preferences (risk aversion) and by the distribution of the specific farm returns (and their covariance with the differential returns from the cooperative).

According to the proposed financial framework, both for TC and NGC, the condition i = r (i.e. the equality of interest rate across members and to *the market*) can be satisfied only if:

- members have similar farm structure / probability of the farm returns
- the participation constraint is not binding (or the farmers have similar risk aversion)
- the farmers have similar off-farm investment
- the farmers invest in the cooperative a similar share of their wealth

A formal proof of these conclusions is provided in the appendix.

---

[7] In particular, because of the *cooperative participation* constraint, the set Ω is a sub-set of the triangle r^0-F-F+C, representing all the possible combination of the three assets. Similarly Ω' is a sub-set of the triangle r^0-F-F+C'.

Heterogeneous evaluations and efficient investment decision in TC and NGC

If farmers have farm operations with different returns probability distribution or different activity portfolio, wealth or preferences, NGC and TC could adopt investment that are not value maximizing. The possibility of inefficient investment needs further discussion. The heterogeneity of evaluations, in fact, suggests that the investment decision should be the result of a bargaining activity among members. Coase theorem, in fact, states that « if the parties bargain to efficient agreement (for themselves) and if their preferences display no wealth effects, then the value-creating activities (y) that they will agree upon do not depend on the bargaining power of the parties or on what asset each owned when the bargaining began. Rather efficiency alone determines the activity choice. The other factors can affect only decisions about how the costs and benefits are to be shared » (Milgrom and Roberts 1992; Coase 1960)

The question is why members do not agree on the value maximizing investment and later on compensate the patrons with higher required returns from the efficient project. Three major obstacles may prevent the efficient bargaining among parties:

i) *the principle of benefit proportional to the use*. In a cooperative, the benefits should be distributed according to the use. This simple and fundamental rule may be incompatible with a full compensation of the members with higher required returns from the efficient investment.

ii) *opportunistic behavior by members*. The compensation of members opposing the efficient investment implies that the individual required returns must be known. However, required returns depends on specific characteristics such as the individual farm operations or risk aversion, that are difficult to monitor for the other members. Then patrons have incentive to pretend to oppose the investment to gain the compensation. The adverse selection problem may prevent the efficient bargaining and may make inapplicable the Coase theorem.

iii) *internal transaction costs*. Bargaining among members can be costly, especially if the patrons have heterogeneous characteristics. If the cost of bargaining is high enough, patrons may agree on an inefficient investment, rather than strive for the value maximizing investment.

Compared to TCs, NGCs are able to reduce members' heterogeneity via a self selection argument. By requiring a sizable upfront capital investment, NGC are implicitly selecting potential members with homogeneous investment evaluations. Farmers, who decide to invest in the cooperative, accept the marketing plan and consequently agree on the main production decision. For any given internal rate of return of the project, the farmers joining the NGC are expected to have lower risk aversion and/or larger farms (the participation constraint is less binding), higher differential returns from the cooperative, lower correlation between the differential returns and the farm returns. Note also that, since the required returns increases with the share of wealth invested in the cooperative (see appendix), the self selection argument is stronger in NGC that in TC. However, the more homogeneity obtained via members' self-selection does not ensure that patrons use in their investment evaluation the CAPM.

Summarizing, NGC institutions do not eliminate the possibility of inefficient investment decision, but can reduce the heterogeneity in the investment evaluation via a more direct link between cost and benefits (delivery rights and close membership, as seen in section 2) and via self-selection.

Conclusions.

The financial framework concluded that cooperative investments are not evaluated *per se*. On the contrary the effect on the members' farm operations is a critical determinant. This point has a major impact when the cooperative is considering a project that affects the core business (for example, dismissing an activity). In this case, members that are willing to patronize the cooperative are requested to adjust their farm operations accordingly. Members with a positive present value of the *appropriable* differential cash-flow of the *farm-cooperative* asset will support the project, while the others will oppose it. The proposed model suggests that both TC and NGC are more likely to reject a value-maximizing business restructuring than IOF, if members have high asset specificity to the

current transaction with the cooperative. If farmers' assets are specific, then the value gain from the cooperative change in strategy may be offset by the loss of asset value. This point may explain why both TC and NGC may be more vulnerable to change in the strategic environment than IOF.

Although no empiric evidence can be provided, this issue is expected to be more relevant for NGC. The value added focus and the large capital investment, in fact, make more likely that farmers invest in specific on-farm assets. In any case, the model suggests that transforming a TC into a NGC may not solve business crisis, if a radical repositioning of the core business is needed.

Finally, the framework suggests that TC may be more efficient in managing business with economies of scale in member participation. Besides the obvious effect of closed membership, the already described member self-selection mechanism can prevent farmers to join the cooperative, even if delivery rights are available. In addition, in NGC farmers' incentive to patronize depends on individual factors that may vary over time, according with preferences, market conditions and the distribution of the farm returns. One of the key benefits of close membership is that a member who has no incentive to participate anymore can sell his share for a price. However if there are no farmers with lower required returns in the secondary market for the delivery rights, the patron may have incentive to stay in the cooperative supporting inefficient investments (to increase the *appropriable* benefit). The long run investment efficiency of NGCs requires the existence of potential buyers of delivery rights. A simple consequence is that a NGC cannot aggregate all the potential members and therefore cannot fully benefit of the economies of scale in membership (for example acting as monopolist/monopsonist, according to Sapiro's approach).

References

Arthur L., C. Carter, F. Abizadeh (1988): "Arbitrage Pricing, Capital Asset Pricing and Agricultural Assets" in *American Journal of Agricultural Economics* 70 (2): 359-365

Bailey M. , Sporleder T. (2000): "The Real Options Approach to Evaluating a Risky Investment by a New Generation Cooperative: Further Processing" Paper presented at the annual meetings of NCR-194 Research on Cooperatives, Las Vegas, NV, December 12-13, 2000.

Brealey M., and S. Myers (1996): *Principles of Corporate Finance* fifth edition, McGraw Hill

Coase R. (1960): "The problem of Social Cost" in *Journal of Law and Economics* 3 (1960); 1 - 44

Coffey J. (1993): "Implications for Farm Supply Cooperatives of the Industrialization of Agriculture" in *American Journal of Agricultural Economics* December 1993; 75(5): 1132-36

Cook M. (1995): "The Future of U.S. Agricultural Cooperatives: a Neo-Institutional Approach" in *American Journal of Agricultural Economics* 77 (5): 1153-59

Cook M., C. Iliopoulos (2000): "Ill-Defined Property Rights in Collective Action: The Case of US Agricultural Cooperatives" in Menard, C., (editor) *Institutions, contracts and organizations: Perspectives from new institutional economics*. Cheltenham, U.K. and Northampton, Mass.: Elgar :335-48

Cotterill W. (1987): "Agricultural Cooperatives: an Unified Theory of Pricing, Finance and Investment" in J. Royer (editor) : *Cooperative Theory: New Approaches* ACS Service Report 18, USDA Rural Development Services 1987

Emelianoff I. (1942). *Economic Theory of Cooperation : Economic Structure of Cooperative Organizations*. Washington D.C.: Edward Brothers

Fulton M. (1995): "The Future of Canadian Agricultural Cooperatives: a Property Right Approach" in *American Journal of Agricultural Economics* 77 (5): 1144-52

Fulton M. (2001): "Traditional versus New Generation Cooperatives" in Merrett, C. and N. Walzer , (eds.) *A cooperative approach to local economic development*. Westport, Conn. and London: Greenwood, Quorum Books, 2001; 11-24

Hanson S. and R. Myers (1995): "Testing for a Time Varying Risk Premium in the Returns of US Farmland" in *Journal of Empirical Finance* 2 (1995): 265-276.

Helberger P. (1966): "Future Roles for Agricultural Cooperatives" in American Journal of Agricultural Economics 48 (December 1966): 1427-35

Hendrikse G. (1998): "Screening, Competition and the Choice of the Cooperative as an Organisational Form" in *Journal of Agricultural Economics* 49(2): 202-217

Hendrikse G. and C. Veerman (2001): "Marketing Cooperatives: an Incomplete Contracting Perspective" in *Journal of Agricultural Economics* 52(1): 53-64

Hendrikse G. and J. Bijman (2002): "Ownership Structure in Agrifood Chains: the Marketing Cooperative" in *American Journal of Agricultural Economics* 84(1): 104-119

Hind A. (1994): "Cooperatives – Under-Performers by Nature? An Exploratory Analysis of Cooperative and Non Cooperative Companies in the Agribusiness Sector" in *Journal of Agricultural Economics* 45 (2):

213-219

Hueth B. , P. Marcoul and R. Ginder (2003): *Cooperative Formation and Financial Contracting in Agricultural Markets* Center for Agricultural and Rural Development Iowa State University. Working Paper 03-WP 349. December 2003

Iliopoulos C., M. Cook (1999): *The Efficiency of Internal Resources Allocation Decision in Customer-owned Firms: the Influence Cost Problem.* Paper presented at the 3rd Annual Conference of International Society for New Institutional Economics, Washington, D.C. September 1999. http://www.isnie.org/ISNIE99/ISNIEPanels830.html

Lerman Z. and C. Parliament (1990): "Comparative Performance of Cooperatives and Investor-Own Firms in the US Food Industries" in *Agribusiness* 6 (1990) : 527-40

Levy H. (1978): "Equilibrium in an Imperfect Market: a Constraint on the Number of Securities in the Portfolio" in *American Economic Review* 68: 643-58

Lintner J. (1965): "The Valuation of Risk Assets and The Selection of Risky Investments in Stock Portfolios and Capital Budgets" in *Review of Economics and Statistics* 47(1): 13-37

Milgrom P. and J. Roberts (1992): *Economics, Organization and Management* Prentice Hall

Murray G. (1983). "Management Strategies for Corporate Control in British Agricultural Cooperatives" in *Agricultural Administration,* 14: 51-63 (Part I) and 81-94 (Part II).

Parliament C. and Z. Lerman (1993): "Risk and Equity in Agricultural Cooperatives" in *Journal of Agricultural Cooperatives* (1993) : 1-14

Peterson, H. C. (1992): "The Economic Role and Limitations of Cooperatives: An Investment Cash Flow Derivation." Journal of Agricultural Cooperatives (1992): 61-78.

Porter P. and G. Scully (1987): "Economic Efficiency in Cooperatives" in *Journal of Law and Economics* October 1987: 489- 512.

Rubinstein M. (1976): "The valuation of uncertain income streams and the pricing of options" in *Bell Journal of Economics and Management Science* 7: 407-25

Russo C., D. Weatherspoon, H.C. Peterson, M. Sabbatini (2000): "Effects of Managers' Power on Capital Structure: a Study of Italian Agricultural Cooperatives" in *International Food and Agribusiness Management Review* 3 (2000)

Sapiro A. (1923): "True Farmer Cooperation" in *World's Work* May 1923: 84-96

Sexton R. (1986): "The Formation of Cooperatives: a Game-Theoretic Approach with Implications for Cooperative Finance, Decision Making and Stability" in *American Journal of Agricultural Economics* 68(2): 214-225

Sexton R. (1990): "Imperfect Competition in Agricultural Markets and the Role of Cooperatives: a Spatial Analysis" in *American Journal of Agricultural Economics* 72 (3): 709-720

Sexton R., J. Iskow (1993) : "What do we know about the Economic Efficiency of Cooperatives: an Evaluative Survey" in *Journal of Agricultural Cooperation* 1993 (15 –27)

Sporleder T.,K. Zeuli (2000): "Evaluating Producer Investment and Risk in New Generation Cooperatives Using Real Options" Paper presented at the World Congress of the International Food and Agribusiness Management Association, Chicago, Illinois, June 25-28, 2000.

Staatz J. (1983): "The Cooperative as a Coalition: a Geme Theoretic Approach" in *American Journal of Agricultural Economics* 65(5): 1084-89

Staatz J. (1987): "Farmers' Incentives to Take Collective Action via Cooperative: a Transaction Cost Approach" in J. Royer (editor) : *Cooperative Theory: New Approaches* ACS Service Report 18, USDA Rural Development Services 1987

Staatz (1987b): "The Structural Characteristics of Farmer Cooperatives and Their Behavioral Consequences" in J. Royer (editor) : *Cooperative Theory: New Approaches* ACS Service Report 18, USDA Rural Development Services 1987

Stein C. (1973): "Estimation of the Mean of a Multivariate Normal Distribution" in *Proceedings of the Prague Symposium on Asymptotic Statistics* US Bureau of Statistics (1987) Statistical Abstracts of the US: 1988

Stewart A. (1993): "Have Traditional Cooperative Structures Outlived Their Usefulness?" in *Farm Management* 8 (6): 287-291

Sykuta M., M. Cook (2001): "A New Institutional Economics Approach to Contracts and Cooperatives" in *American Journal of Agricultural Economics* 2001; 83(5): 1273-79

Torgerson R. (2001): "A Critical Look at New Generation Cooperatives" in *Rural Cooperative Magazine* January/February 2001

Vitaliano P. (1983). "Cooperative Enterprise: an Alternative Conceptual Basis for Analyzing a Complex Institution". American Journal of Agricultural Economic, 65(5), 1078-1083.

Zerman Z., C. Parliament (1990): "Comparative Performance of Cooperative and Investor Owned Firms" in *Agribusiness* 6 (1990): 527-540

Appendix.

The goal of this appendix is to provide a formal proof of the conclusion stated in section 3. By using a graphical approach, we found that TC and NGC members may use a discount rate that depends on individual characteristics. Here we derive the "required returns" (which, added to the risk-free rate of give the appropriate interest rate) as the solution of the expected utility maximization of a risk averse farmer with a VonNeumann Morgerstern (VNM) utility function.

The analysis modifies the standard CAPM approach (Lintner 1965) by introducing additional assumption to model the investment in a cooperative (TC or NGC). under a budget constraint, a limited portfolio and with no short selling of real assets. Additional constraints are added for the TC and NGC cases. Section 1 proposes – for a direct comparison – the analysis of an investment in a IOF (graph 1 in the text), section 2 describes the participation in a TC (Figure 2) and section 3 apply the model to a NGC (Figure3).

Operators	
E_{t-1} : conditional expectation to the information available at time t-1	Cov_{t-1}: conditional covariance to the information available at time t-1
	Var_{t-1}: conditional variance to the information available at time t-1
Variables	
x indicates the share of wealth invested in any asset. In particular: $\vec{x}$: is the vectors of share of wealth invested in each asset x^c: is the share of wealth invested in the cooperative x^f: is the share of wealth invested in the farm x^k: is the share of wealth invested in a financial asset k x^0: is the share of wealth invested in the risk-free asset	μ is the rate of return from a unit investment in any asset. In particular μ_f : is the rate of return from the farm *if the farmer does not join the cooperative* (note: the free rider effect is included) μ_{f+c} : is the rate of return from the composed asset farm+ cooperative μ_c : is the virtual rate of return from the cooperative investment. It is calculated by solving $(x^f+x^c)\,\mu_{f+c}=x^f\mu_f+x^c\mu_c$ μ_k : is the rate of return from a financial asset k μ_0 : is the rate of return from the risk-free asset
Ω is the set of the available financial assets (excluding the risk-free asset)	y indicates the excess return of any asset with respect to the risk-free asset. For any asset a we have $y^a = \mu_a-\mu_0$. When y is part of a solution of the umax problem it can be referred as "required returns"
W is the wealth endowment	R indicates the net revenues from the investments
ψ are the states of nature	$\varphi(\psi)$ is the pdf of the states of nature
C is a binary variable describing the presence or absence of investment in a TC	U is the VNM utility function of the farmer
θ is a measure of risk aversion such that: $\theta = -\dfrac{E_{t-1}\left(\partial^2 u/\partial R^2\right)}{E_{t-1}\left(\partial u/\partial R\right)}$	

Table A-1: Notation

Section 1. Investment in a IOF.

This sections reports the problem of the investment decision for an investment in a IOF under the following assumptions:
- The investor is not necessarily a farmer. If the investor is a farmer, he can sell out the farm and act as a pure financial investor
- The investor has a limited endowment W (budget constraint)

- The investor has access to limited investment opportunities (he can choose his asset only from the set Ω)
- The investor considers the rate of returns on the investments as given

The solution of this umax problem is reported only for providing an easy comparison to the next sections. The only difference to the intermediate finance textbook CAPM is the introduction of the constraint on the available investment opportunities, which was derived by Levy (Levy, 1978)

Using the notation described in table A-1, the *umax* problem of the investor is:

$$\max_{\vec{x}} U(\vec{x}, \psi) = E_{t-1} \left\{ u[R(\vec{x}, \psi)] \right\}$$

s.t.

$$R(\vec{x}, \psi) = x^i \mu_i(\psi) + \sum_{\substack{k=1 \\ k \neq i}}^{\Omega} x^k \mu_k(\psi) + x^0 \mu_0$$

$$x^i + \sum x^k + x^0 = W$$

Assuming local nonsatiation of the farmer's preferences and production efficiency, we can substitute the two constraints in the objective function and obtain the following first order conditions.

$$1) \quad E_{t-1} \frac{\partial u}{\partial R} [\mu_i - \mu_0] = 0$$

$$2...\Omega) \, E_{t-1} \frac{\partial u}{\partial R} [\mu_k - \mu_0] = 0 \qquad \text{for any } k \in \Omega$$

Condition 1) describe the rule for the optimal investment in the IOF (marginal benefit – marginal cost =0) and – by applying basic properties of covariance – can be rewritten as:

$$E_{t-1}\left(\frac{\partial u}{\partial R} * y_i\right) = cov\left(\frac{\partial u}{\partial R}, y_i\right) + E_{t-1}\left(\frac{\partial u}{\partial R}\right) E_{t-1}(y_i) = 0$$

Assuming that R and μ_i are distributed according a multivariate normal, we can apply Stein's lemma (Stein 1973, Rubinstein 1976): $cov(x,g(y)) = E(g'(x))cov(x,y)$ to obtain:

$$E_{t-1}\left(\frac{\partial^2 u}{\partial R^2}\right) cov(R, y_i) + E_{t-1}\left(\frac{\partial u}{\partial R}\right) E_{t-1}(y_i) = 0 \qquad \text{and therefore}$$

$$E_{t-1}(y_i) = -\frac{E_{t-1}\left(\frac{\partial^2 u}{\partial R^2}\right)}{E_{t-1}\left(\frac{\partial u}{\partial R}\right)} cov(R, y_i) = \theta \, cov(R, y_i), \text{ which is the standard CAPM formulation. It is}$$

possible to obtain a formulation which is independent from the individual preferences by dividing condition 1) by the sum of condition 2) to Ω):

$$E_{t-1}(y_i) = \frac{cov(R, y_i)}{cov(R, \sum y_k)} E_{t-1}\left(\sum y_k\right)$$

In this basic case, the condition for homogeneous required returns (and evaluations of the IOF investment) is that the set Ω of available financial assets is the same for all farmers. Moreover, if there is no constraint on Ω (i.e. the farmers have full access to the financial market), the result coincide with CAPM.

Section 2. The TC investment decision.

In this section, the standard CAPM is modified to describe the optimal investment in a TC. According to the discussion in the text the following additional assumptions are introduced:
Assumptions:

- *Indivisibility of the cooperative participation.* The cooperative participation is a discrete choice (yes/no). If the farmer choose to join, he must pay a fix equity share $\overline{x}^c$, in exchange, he can claim the returns from the composed asset μ_{f+c}

- *Cooperative participation constraint.* If the farmer joins the cooperative, he must invest in the farm at least $\overline{x}^f$ (he must be a farmer and produce the commodities traded by the cooperative)

- *Subsidiary nature of cooperative returns.* If the farmer join the cooperative, then we have a new real asset: farm+cooperative that yields a return $\mu_{f+c}(\psi)$ which is a function of the state of nature. Note that the probability $\mu_{f+c}(\psi)$ depends among others, on the probability distribution of the farm revenues and of the cooperative revenues (and on their covariance). The differential return rate from the cooperative is $\mu_c(\psi, x^f)$, such that: $\left(x^f + \overline{x}^c\right)\mu_{f+c} = x^f\mu_f + \overline{x}^c\mu_c$.

- As in the previous section, we assume the availability of a *limited portfolio*.

The *umax* problem can be formalized as follows. Defining the variable *c*:

$$c = \begin{cases} = 0 & \text{if the farmer does not join the cooperative} \\ = 1 & \text{if the farmer joins the cooperative} \end{cases}$$

$$\max_{\vec{x},c} E_{t-1}\left\{u\left[R\left(\psi,c,\vec{x}\right)\right]\right\}$$

subject to $R(\vec{x},\psi,c) = \begin{cases} x^f\mu_f(\psi) + \sum_{k=1}^{\Omega} x^k\mu_k(\psi) + x^0\mu_0 & \text{if } c = 0 \\[3mm] x^f\mu_f(\psi) + \overline{x}^c\mu_c(x^f,\psi) + \sum_{k=1}^{\Omega} x^k\mu_k(\psi) + x^0\mu_0 & \text{if } c = 1 \end{cases}$

$x^f + \overline{x}^c + \sum_{k=1}^{\Omega} x^k + x^0 = W$ (with equality, assuming local non satiation)

$x^f \geq \overline{x}^f$ for $c = 1$ (coop. participation constraint)
$x^f \geq 0$ for $c = 0$ (no short selling on farm asset)

The first order conditions are:

F.O.C.

c = 0	c = 1
$1)E_{t-1}\left\{\dfrac{\partial u}{\partial R}\left[\mu_f - \mu_0\right]\right\} = \rho$	$1)E_{t-1}\left\{\dfrac{\partial u}{\partial R}\left[\mu_f + \overline{x}^c\dfrac{\partial\mu_c}{\partial x^f} - \mu_0\right]\right\} = -\lambda - \rho$
$2)E_{t-1}\left\{\dfrac{\partial u}{\partial R}\left[\mu_k - \mu_0\right]\right\} = 0$	$2)E_{t-1}\left\{\dfrac{\partial u}{\partial R}\left[\mu_k - \mu_0\right]\right\} = 0$
$3)\rho x^f = 0$	$3)\lambda\left(\overline{x}^f - x^f\right) = 0$
	$4)\rho x^f = 0$

The solution for the case c=0 is trivial and similar to the one presented in section 1. For c=1, condition 1) can be written as:

$$cov_{t-1}\left(\frac{\partial u}{\partial R}, y_f + \overline{x}^c\frac{\partial\mu_c}{\partial x^f}\right) + E_{t-1}\left(\frac{\partial u}{\partial R}\right)E_{t-1}\left(y_f + \overline{x}^c\frac{\partial\mu_c}{\partial x^f}\right) = -\lambda - \rho$$

Assuming that the variables are distributed as multivariate normal, it is possible to apply Stein's lemma to obtain:

$$E_{t-1}\left(\frac{\partial^2 u}{\partial R^2}\right)cov_{t-1}\left(R, y_f + \overline{x}^c \frac{\partial \mu_c}{\partial x^f}\right) + E_{t-1}\left(\frac{\partial u}{\partial R}\right)E_{t-1}\left(y_f + \overline{x}^c \frac{\partial \mu_c}{\partial x^f}\right) = -\lambda - \rho$$

Applying basic property of covariance and expectation:

$$E_{t-1}\left(\frac{\partial^2 u}{\partial R^2}\right)\left\{cov_{t-1}(R, y_f) + cov_{t-1}\left(R, \overline{x}^c \frac{\partial \mu_c}{\partial x^f}\right)\right\} + E_{t-1}\left(\frac{\partial u}{\partial R}\right)\left\{E_{t-1}(y_f) + E_{t-1}\left(\overline{x}^c \frac{\partial \mu_c}{\partial x^f}\right)\right\} = -\lambda - \rho$$

Finally, setting: $\theta = -\dfrac{E_{t-1}\left(\dfrac{\partial^2 u}{\partial R^2}\right)}{E_{t-1}\left(\dfrac{\partial u}{\partial R}\right)}$ and rearranging:

$$E_{t-1}(y_f) = \theta cov_{t-1}(R, y_f) + \theta cov_{t-1}\left(R, \overline{x}^c \frac{\partial \mu_c}{\partial x^f}\right) - E_{t-1}\left(\overline{x}^c \frac{\partial \mu_c}{\partial x^f}\right) - \frac{\lambda + \rho}{u'(R)}$$

The equation can be easily interpreted-by noting that $\dfrac{\partial \mu_c}{\partial x^f} = \dfrac{\mu_{f+c} - \mu_f}{\overline{x}^c}$. Substituting and

rearranging we have $E_{t-1}(y_{f+c}) = \theta cov_{t-1}(R, y_{f+c}) - \dfrac{\lambda + \rho}{u'(R)}$

Which shows that the farmer only considers the returns on the composed asset *farm + cooperative*, disregarding the separate assets[8]. The condition for utility maximization simply compares marginal benefits (the increase in expected returns by switching investment from the risk-free asset to the farm) and marginal cost (the increase in the risk of the portfolio). The marginal benefit is the given by the excess returns on farm operation ($y_f = \mu_f + \mu_0$) plus the expected variation in the returns from the cooperative (the sum of these terms defines the increase in the return on the portfolio composed of the farm and the cooperative participation). The increase in the wealth risk can be broken in several components: the variance of the returns on the farm, the covariance with the financial assets and the effect of the cooperative returns (the direct covariance and an interaction term taking into account the change in the returns of the cooperative due to the change in farm investment).

Note that because of the participation and short sell constraints the solution of the optimization problem still depends on individual preferences. In fact by dividing the following FOCs

$$\frac{E_{t-1}(y_{f+c})}{E_{t-1}\left(\sum y_k\right)} = \frac{cov_{t-1}(R, y_{f+c})}{cov_{t-1}\left(R, \sum y_k\right)} - \frac{\lambda + \rho}{u'(R)\theta cov_{t-1}\left(R, \sum y_k\right)}$$

which is independent from preferences only if $\lambda = \rho = 0$ (i.e. the constraints are not binding). Also note that the required returns on the composed asset f+c:

$E_{t-1}(y_{f+c}) = \dfrac{cov_{t-1}(R, y_{f+c})}{cov_{t-1}\left(R, \sum y_k\right)} E_{t-1}\left(\sum y_k\right)$ may depend on individual characteristics of the farmer,

even for interior solutions. Namely:
- The set of available/held financial assets Ω (Levy1978)

---

[8] This conclusion is relevant because it questions the management practices aimed to grant farmers higher returns on the capital investments to give incentive to provide additional equity (Peterson 1992)

- The characteristics of the farm operations (because y_{f+c} depends both on the cooperative production decision and on the on-farm investments)

The member of the cooperative may have different evaluations of cooperative investments. In fact, by altering the distribution of y_{f+c} (namely E_{t-1} and $cov_{t-1}(R, y_{f+c})$) the cooperative investment causes changes in the solutions of members' umax problem that depends on individual characteristics.

Section 3. The NGC investment decision.

The Umax problem for a NGC is more complex because the farmer must solve the additional problem allocating the financial resources between the farm and the cooperative. While the investment in a TC is fixed, in a NGC the amount of financial resources that are invested in the cooperative is decided by the farmer. Also the amount of resources invested in the cooperative may affect the cooperative differential returns because: $\mu_c = \dfrac{\mu_{f+c}(x^f + x^c) - x^f \mu_f}{x^c}$ where x^c is not constant anymore.

Moreover, unlike TC, in a NGC μ_{f+c} also depends on x^c and x^f (i.e. $\mu_{f+c} = \mu_{f+c}(x^c, x^f)$). The membership does not grant the patron unlimited use of the cooperative, on the contrary, the delivery rights are proportional to the investment x^c. Then the returns of the cooperative portfolio depends not only on the total investment in the composed asset (as in TC) but also on the proportion of financial resources allocated in each asset. For future reference, note that we have:

$$\frac{\partial \mu_c}{\partial x^f} = \frac{1}{x^c}\left[\mu_{f+c} - \mu_f + \frac{\partial \mu_{f+c}}{\partial x^f}(x^f + x^c)\right] \quad \text{and} \quad \frac{\partial \mu_c}{\partial x^c} = \frac{1}{x^c}\left[\frac{\partial \mu_{f+c}}{\partial x^c}(x^f + x^c) - (\mu_{f+c} - \mu_f)\frac{x^f}{x^c}\right]$$

Summarizing the additional assumptions for the NGC case are:
- the cooperative participation is a continuous choice (i.e. is the expenditure for buying the delivery rights)
- the functions $f(x^c)$ - i.e. the minimum investment in the farm for the given investment in delivery rights - and μ_{f+c} are continuous and differentiable on the domains $x^c \in [0, \infty)$, $x^f \in [0, \infty)$
- If the farmer join the cooperative, then we have a new real asset: farm+cooperative that yields a return $\mu_{f+c}(\psi, x^f, x^c)$ which is a function of the state of nature, of the capital investment in the farm and the capital investment in the cooperative. As before such returns can be broken down in the return from farm operation (μ_f , i.e. the returns in absence of cooperative) and the differential cooperative return, μ_c , defined as above.

Then, the *umax* problem can be written as $\max\limits_{\vec{x}} E_{t-1}\{u[R(\psi, \vec{x})]\}$ subject to:

$$R = x^f \mu_f(\psi) + x^c \mu_c(x^f, x^c, \psi) + \sum_{k=1}^{\Omega} x^k \mu_k(\psi) + x^0 \mu_0$$

$$x^f + \overline{x}^c + \sum_{k=1}^{\Omega} x^k + x^0 = W \text{ (with equality, assuming local non satiation)}$$

$x^f \geq f(x^c)$ with f(0)=0 and f(x^c)>0 $\forall x^c$>0   (participation constraint)   (λ)

$x^f \geq 0$ (no short selling on farm asset)   (ρ)

$x^c \geq 0$ (no short selling on cooperative asset)   (γ)

The first order conditions are:

$$1)\,E_{t-1}\left\{\frac{\partial u}{\partial R}\left[\mu_f + x^c\frac{\partial \mu_c}{\partial x^f} - \mu_0\right]\right\} = -\lambda - \rho$$

$$2)\,E_{t-1}\left\{\frac{\partial u}{\partial R}\left[\mu_c + x^c\frac{\partial \mu_c}{\partial x^c} - \mu_0\right]\right\} = \lambda\frac{\partial f(x^c)}{\partial x^c} - \gamma$$

$$3)\,E_{t-1}\left\{\frac{\partial u}{\partial R}[\mu_k - \mu_0]\right\} = 0$$

$$4)\,\lambda\left[f(x^c) - x^f\right] = 0$$

$$5)\,\rho x^f = 0$$

$$6)\,\gamma x^c = 0$$

Condition 1) gives a solution similar to the case of the TC, for any given level of x^c and $\vec{x}^k$:

$$E_{t-1}(y_f) = \theta cov(R, y_f) + \theta cov_{t-1}\left(R, x^c\frac{\partial \mu_c}{\partial x^f}\right) - E_{t-1}\left(x^c\frac{\partial \mu_c}{\partial x^f}\right) - \frac{\lambda + \rho}{u'(R)}$$

which, by substituting the value of $\dfrac{\partial \mu_c}{\partial x^f}$ can be rewritten as:

$$E_{t-1}(y_{f+c}) + E_{t-1}\left[\frac{\partial \mu_{f+c}}{\partial x^f}(x^f + x^c)\right] = \theta cov_{t-1}(R, \mu_{f+c}) + \theta cov_{t-1}\left[R, \frac{\partial \mu_{f+c}}{\partial x^f}(x^f + x^c)\right] - \frac{\lambda + \rho}{u'(R)}$$

The condition can be interpreted as follows. The marginal benefit of an increase in the investment in the farm asset (the left hand side of the equation) has two components i) the increase is the returns on the *aggregate* cooperative portfolio (remember $y_{f+c}=y_f$ for $x^c=0$), plus ii) a "correction" term taking into account the marginal effect of the increase of x^f on the returns of the cooperative portfolio. Condition 2) gives, for any level of x^f and $\vec{x}^k$:

$$E_{t-1}(y_c) = \theta cov_{t-1}(R, y_c) + \theta cov_{t-1}\left(R, x^c\frac{\partial \mu_c}{\partial x^c}\right) - E_{t-1}\left(x^c\frac{\partial \mu_c}{\partial x^c}\right) - \frac{\lambda}{u'(R)}\frac{\partial f(x^c)}{\partial x^c} - \frac{\gamma}{u'(R)}$$

Noting that since $\dfrac{\partial \mu_c}{\partial x^c} = \dfrac{1}{x^c}\left[\dfrac{\partial \mu_{f+c}}{\partial x^c}(x^f + x^c) - (\mu_{f+c} - \mu_f)\dfrac{x^f}{x^c}\right]$ we have:

$$y_c + x^c\frac{\partial \mu_c}{\partial x^c} = \frac{x^c\mu_c - x^c\mu_0 - (\mu_{f+c} - \mu_f)x^f}{x^c} + \frac{\partial \mu_{f+c}}{\partial x^c}(x^c + x^f) = y_{f+c} + \frac{\partial \mu_{f+c}}{\partial x^c}(x^c + x^f)$$

condition 2 can be written as:

$$E_{t-1}(y_{f+c}) + E_{t-1}\left[\frac{\partial \mu_{f+c}}{\partial x^c}(x^f + x^c)\right] = \theta cov_{t-1}(R, y_{f+c}) + \theta cov_{t-1}\left[R, \frac{\partial \mu_{f+c}}{\partial x^c}(x^f + x^c)\right] - \frac{\lambda}{u'(R)}\frac{\partial f(x^c)}{\partial x^c} - \frac{\gamma}{u'(R)}$$

Again, the condition implies that – for interior solutions – a farmer should invest in the cooperative as long the marginal benefit on the left hand side (increase in revenues from the cooperative portfolio) equals the marginal cost (increase in the total income risk). Both marginal benefit and marginal cost expressions take into account that the farmer invests in the cooperative asset by increasing the participation in the cooperative.

By applying a standard technique, conditions 1) and 2) can be used to find the optimal ratio between the investment in the farm and the investment in the cooperative. By dividing and rearranging the two conditions we have that at the solution, the following equality must hold:

$$\frac{E_{t-1}(y_{f+c})-\theta\,cov_{t-1}(R,\mu_{f+c})}{E_{t-1}(y_{f+c})-\theta\,cov_{t-1}(R,y_{f+c})}=\frac{\theta\,cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^f}\left(x^f+x^c\right)\right]-E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^f}\left(x^f+x^c\right)\right]-\frac{\lambda+\rho}{u'(R)}}{\theta\,cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]-E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]-\frac{\lambda}{u'(R)}\frac{\partial f(x^c)}{\partial x^c}-\frac{\gamma}{u'(R)}}$$

i.e.

$$\frac{\theta\,cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^f}\left(x^f+x^c\right)\right]-E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^f}\left(x^f+x^c\right)\right]-\frac{\lambda+\rho}{u'(R)}}{\theta\,cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]-E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]-\frac{\lambda}{u'(R)}\frac{\partial f(x^c)}{\partial x^c}-\frac{\gamma}{u'(R)}}=1$$

which gives the optimal investment criterion:

$$E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^c}\right]-E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^f}\right]=\theta\left\{cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^c}\right]-cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^f}\right]\right\}+\Theta$$

with $\Theta=\dfrac{\lambda+\rho}{u'(R)}-\dfrac{\lambda}{u'(R)}\dfrac{\partial f(x^c)}{\partial x^c}-\dfrac{\gamma}{u'(R)}$

and $\Theta=0$ for interior solutions

The condition implies that – for interior solutions – the farmer should transfer resources from the farm to the cooperative until the marginal benefit is offset by the marginal cost. The marginal benefit is the net increase of μ_{f+c}, the marginal cost is the net increase in risk (multiplied by a measure of risk aversion).

As seen in the case of TC, the optimal investment in a NGC depends on the specific characteristics of the farmer. Condition 1) and 2) show that the solution is independent from individual preferences only if the *participation constraint* and the constraint on short selling of real assets are not binding. In this case, the differentiation via the financial portfolio can be used to achieve a condition that is independent from risk aversion. The following equation describes such result for condition 2).

$$\frac{E_{t-1}(y_{f+c})+E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]}{E_{t-1}\left(\sum y_k\right)}=\frac{\theta\,cov_{t-1}(R,y_{f+c})+\theta\,cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]}{\theta\,cov_{t-1}\left(R,\sum y_k\right)}$$

rearranging we have:

$$E_{t-1}(y_{f+c})=\frac{cov_{t-1}(R,y_{f+c})}{cov_{t-1}\left(R,\sum y_k\right)}E_{t-1}\left(\sum y_k\right)+\frac{cov_{t-1}\left[R,\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]}{cov_{t-1}\left(R,\sum y_k\right)}E_{t-1}\left(\sum y_k\right)-E_{t-1}\left[\frac{\partial\mu_{f+c}}{\partial x^c}\left(x^f+x^c\right)\right]$$

with: $cov_{t-1}\left(R,y_{f+c}\right)=\left(x^f+x^c\right)var_{t-1}\left(y_{f+c}\right)+\sum\limits_{k=1}^{\Omega}x^k\,cov_{t-1}\left(y_{f+c},\sum y_k\right)$

and: $cov_{t-1}\left(R,\sum y_k\right)=\sum\limits_{k=1}^{\Omega}x^k\,var_{t-1}\left(\sum y_k\right)+\left(x^f+x^c\right)cov_{t-1}\left(y_{f+c},\sum y_k\right)$

Note that the solution still depends on individual character of the farmer. In particular, the optimal investment is influenced by the set Ω (the set of available financial assets) and the probability distributions both of the farm returns and of the cooperative *differential* returns.

Summarizing, the financial framework suggests that NGC members may use different interest rates for their investment evaluations. Also such rates may differ from CAPM. Therefore NGC institutions do not ensure homogeneous investment evaluations.