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## **Contract design for improving membership commitment in French cooperatives**

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## Introduction

European market deregulation is destabilizing the economic environment of French agricultural cooperatives, which in turn affects the relationship between agricultural cooperatives and their members. Furthermore, members are more and more heterogeneous (e.g., differences in farm size, farm technologies and practices, and cultural background). They also have more individualistic goals, which increases difficulties for collective actions and thus, challenges cooperative principles. This heterogeneity questions the egalitarian treatment principle. With respect to this constraint, Fulton (1999) explains how member commitment to their cooperative is important to its stability. He highlights that cooperative ideology, that was the principal source of member commitment, is falling apart. As a result, cooperatives must find another feature that can reinforce member commitment. Otherwise, they will only attract inefficient producers (Karantinis and Zago 2001).

To cope with member heterogeneity and disengagement, cooperatives have several strategies. The first one is to offer differential treatments according to volume (Verammen, Fulton, and Hyde 1996) and therefore, cooperatives can keep attracting large-scale producers. The second strategy is to develop value-added products in order to differentiate themselves from other firms. It can be illustrated by the development of New Generation Cooperatives. They are involved in niche markets with value-added products. They also have key features that disrupt the traditional idea of cooperation : they have closed membership and they link producer capital to its delivery rights (Harris, Stefanson, and Fulton 1996). A third alternative is to innovate and develop marketing programs and services in order to meet individual producer needs (Reynolds 1997). This strategy exists in the U.S. to manage price risk. To cope with price volatility, cooperatives offer risk management strategies to their members. By doing so, they allow farmers to secure a fraction of their revenue (Harrison, Bobst, Benson, and Meyer 1996, Cropp 1997,

Kinser and Cropp 1998, Duvaleix 2000)

In France, the relationship between cooperatives and their members, later on referred as the cooperative contract, is unique. The basic price that members receive for their raw product is the same for all of them. The only variation depends on the composition of raw products. However, because of both the evolution of the economic environment and new expectations from members, the strict application of this rule is questioned.

This paper aims at examining the economic consequences of differentiating members treatments on the current cooperative contract. In order to meet this objective, we develop a model of a representative cooperative that takes into account several types of differentiated contracts. This study also aims at meeting professional's information needs about how French dairy cooperative can offer individualized contracts to cope with the evolution of the European economic environment.

## 1 Model

French agricultural cooperatives do not take much degree of freedom in the relationship with their members even if the juridical statute is less binding than they believe (Duvaleix, Cordier, and Hovelaque 2003). Moreover, the economic environment does not let dairy cooperatives much flexibility on defining the terms of their member contracts. The European quota system sets up the upper limit of milk quantity members deliver to the cooperative. And, in the dairy sector, producers, cooperatives and investor-owned firms agree to determine the national variations of milk prices. Furthermore, European Union commits itself to gradually reduce the intervention price on dairy commodities such as butter and nonfat dry milk. This commitment, in a world context of opening markets, entails a downward trend on milk price and strengthen industrial confrontation in a sector in needs of outlets. Therefore, dairy cooperative should be creative in their relationships with agricultural producers in order to stay competitive, be efficient and keep

members commitment. They should offer contracts, specific to the need of an heterogeneous group of members, and allow these contracts to vary on quantity, quality and pricing. We call them individualized contracts. Furthermore, these contracts should preserve cooperative principles. Rules should be known from and be applied to all members.

To meet the heterogeneous expectations of members and to cope with economic constraints, cooperative managers should offer individualized contracts while preserving fairness among members. Is it conceivable and economically sustainable in a cooperative organization?

### 1.1 Description of the model

Figure 1 illustrates the model of a representative dairy cooperative. To quote Tsay *et al.* (1999) “*supply chain is two or more parties linked by a flow of goods, information and funds*”. Using this definition, the relationship between an agricultural cooperative and its members can be regarded as a supply chain. Using supply chain models allow us to focus on operational information, and thus to explicit the modeling of material, information and financial flows in a marketing cooperative and thus, closely linked members to their cooperative’s downstream markets. Three elements are parts of this supply chain. The first one defines the objective function of a cooperative. The second element deals with the relationships between a cooperative and its downstream markets. The last element handles the relationships between a cooperative and its members, conceptualized as individualized contracts which take into account members’ preferences. We also use simulation techniques to incorporate uncertainty to the model. The model is applied to dairy cooperatives from Western France.

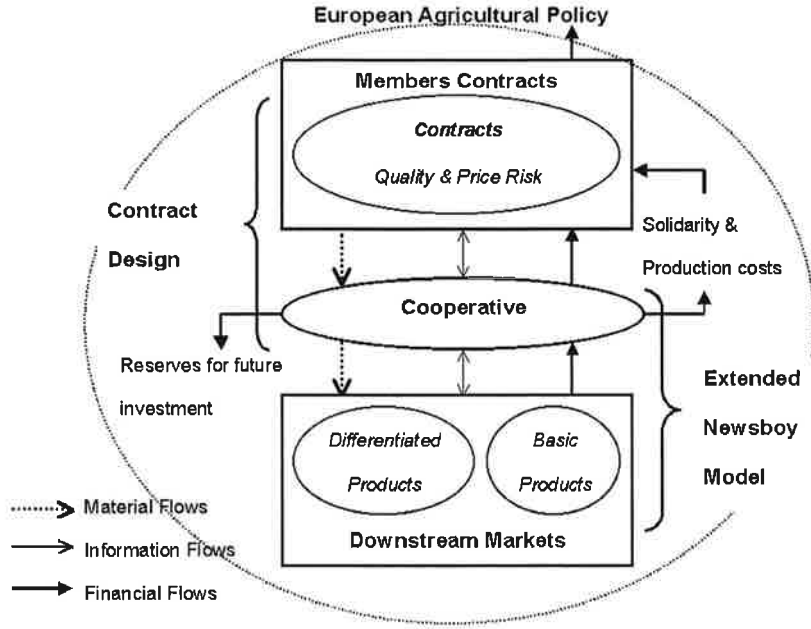


Figure 1: Cooperative Model

### 1.1.1 The objective function of a cooperative

In our model, the cooperative looks for maximizing the “shared value” ( $SV$ ) defined by Deshayes (1988). It consists of the revenue from the sales of final products to which we subtract production ( $C_p$ ) and management ( $C_m$ ) costs like any other firms. We exclude the purchasing cost of milk from all other costs. As cooperative owners, members get returns from their investment in the cooperative through milk pricing. The cooperative also keeps a part of the generated results, the reserves ( $R$ ), in order to be able to grow. The “shared value” can be written as follows.

$$SV = S - C_p - C_m - R$$

### 1.1.2 The relationship between a cooperative and its downstream markets

To model the relationships between an agricultural cooperative and its downstream markets, we extend the Newsboy model, well-known inventory model (Khouja 1999). The optimization program is developed on a one-setting period using *Mathematica*.

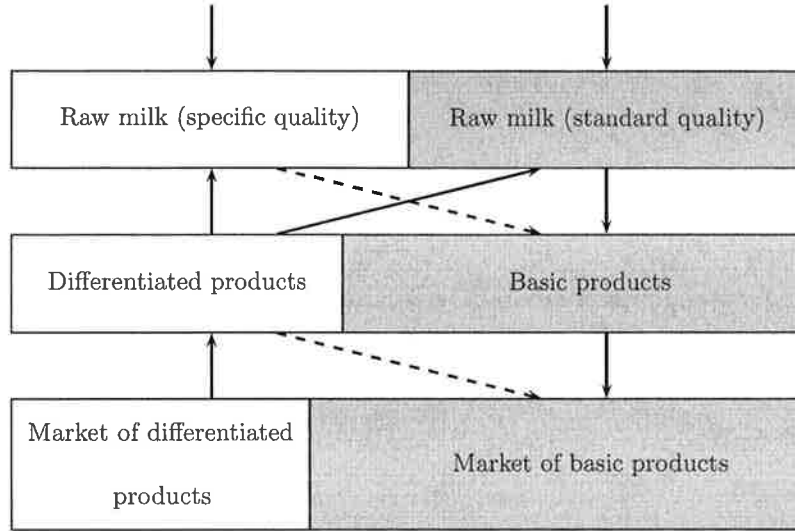


Figure 2: Schematic of the cooperative flows

Figure 2 illustrates the cooperative flows. At the beginning of the period, members deliver an agricultural product to their cooperative which produces differentiated products and basic products. Differentiated products are value-added products because of either the processing technology or the marketing strategy (e.g. products under national brands). Basic products are low value-added products and they have standard characteristics.

The cooperative must accept all the quantity of raw milk delivered. We consider two levels of raw milk quality: standard milk ( $\underline{M}$ ) and specific milk ( $\overline{M}$ ), this level of quality requires a specific system of production as for example producing organic milk. Using specific milk, the cooperative decides to produce the optimal quantity of the differentiated Product 1 ( $\overline{q}_1$ ), this product is a *fromage à pâte pressée cuite*. It also produces the optimal quantity of the differentiated Product 2 ( $\overline{q}_2$ ), a *fromage frais*, using standard raw milk. These two final products are two types of cheese. The cooperative produces two types of basic products ( $\underline{q}_i$ ) using the quantity of raw milk left.

The cooperative faces demand from downstream markets. At the end of the period, demand is revealed. The cooperative can then face two situations. In the first situation, it produced too

many differentiated products. The excess production is sold on the market of basic products. In the second one, it fails to provide enough products, unmet demand is lost. The cooperative faces penalty costs. The demand of differentiated products ( $\xi_{di}$ ) and that of basic products ( $\xi_{bi}$ ) are assumed stochastic. We assume the product demands are uniformly distributed in an interval  $[min, max]$ . The cooperative sells its differentiated products at price ( $p_{di}$ ) and its basic products at price ( $p_{bi}$ ). The cooperative produces its differentiated products at a constant marginal cost ( $c_{di}$ ) and its basic products at a constant marginal costs ( $c_{bi}$ ).

The cooperative shared value is written as follows.

$$SV = \sum_{i=1,2} ( p_{di} - c_{di} ) \int_{min_{di}}^{max_{di}} \xi_{di} f(d\xi_{di}) d\xi_{di} \quad (1)$$

$$+ (p_{bi} - c_{di}) \int_{min_{di}}^{\bar{q}_i} (\bar{q}_i - \xi_{di}) f(\xi_{di}) d\xi_{di} \quad (2)$$

$$- (p_{di} - c_{di}) \int_{\bar{q}_i}^{max_{di}} (\xi_{di} - \bar{q}) f(\xi_{di}) d\xi_{di} \quad (3)$$

$$- (p_{di} - p_{bi}) \int_{min_{di}}^{\bar{q}_i} (\bar{q}_i - \xi_{di}) f(\xi_{di}) d\xi_{di} \quad (4)$$

$$+ (p_{bi} - c_{bi}) \int_{min_{bi}}^{max_{bi}} \xi_{bi} f(d\xi_{bi}) d\xi_{bi} \quad (5)$$

$$- (p_{bi} - c_{bi}) \int_{\underline{q}_i}^{max_{bi}} \left[ \xi_{bi} - \underline{q} - \int_{min_{di}}^{\bar{q}_i} (\bar{q}_i - \xi_{di}) f(\xi_{di}) \right] f(\xi_{bi}) d\xi_{bi} \quad (6)$$

$$- (c_{bi} - v_{bi}) \int_{min_{bi}}^{\underline{q}_i} \left[ \underline{q}_i + \int_{min_{di}}^{\bar{q}_i} (\bar{q}_i - \xi_{di}) f(\xi_{di}) - \xi_{bi} \right] f(\xi_{bi}) d\xi_{bi} \quad (7)$$

$$+ (p_{bpi} - c_{bpi}) q_{bpi} - C_m - R \quad (8)$$

The cooperative “shared value” can be described by eight elements. The first one (1) is the profit generated from selling the differentiated products, it is equal to the margin multiplied by the expected demand. The second element (2) is the profit generated from selling the excess production of the differentiated products on the basic market. The margin is then the difference between the price of the basic products and the cost of producing the differentiated products. The third part (3) deals with unmet demand. The cooperative faces penalty cost from not

providing enough differentiated products. The penalty cost is the difference between the cost of producing the differentiated products and their price. The fourth element (4) is the losses generated by the excess stock sold in the basic market. Part (5) represents the profits generated from selling the basic products. In Part (6), we deal with unmet demand for the basic products. The penalty cost is equal to the difference between the cost of producing the basic products and their price. The expected quantity of unmet demand is the revealed demand to which we subtract the quantity of the basic products and the expected stock of the differentiated products. In Part (7), we take into account the potential losses from producing too many basic products. Its cost is equal to the cost of producing the basic products minus the salvage price. Lastly (8), we include the profits generated by selling the by-products and we deduce the management costs and the reserves.

The cooperative objective function can be generalized to any agricultural marketing cooperative. Constraints are applied to the dairy case.

Raw milk contains two components, fat content and protein content. Raw milk has  $\alpha$  kilograms per liter of fat content and  $\beta$  kilograms per liter of protein content. The final product  $i$  has  $\alpha_i$  kilograms per liter of fat content and  $\beta_i$  kilograms per liter of protein content. Constraints are written as follows:

$$\overline{M_u} - \gamma_1 \overline{q_1} = 0 \quad (9)$$

$$\beta \overline{M_u} - \beta_1 \overline{q_1} - Prot1 = 0 \quad (10)$$

$$\alpha \overline{M_u} - \alpha_1 \overline{q_1} - Fat1 = 0 \quad (11)$$

$$\underline{M_u} - \gamma_2 \overline{q_2} = 0 \quad (12)$$

$$\beta \underline{M_u} - \beta_2 \overline{q_2} - Prot2 = 0 \quad (13)$$

$$\alpha \underline{M_u} - \alpha_2 \overline{q_2} - Fat2 = 0 \quad (14)$$

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$$\overline{M} - \overline{M_u} - \overline{M_{un}} = 0 \quad (15)$$

$$\underline{M} - \underline{M_u} - \underline{M_{un}} = 0 \quad (16)$$

$$\beta \left[ \overline{M_{un}} + \underline{M_{un}} \right] - \beta_1 \underline{q}_1 - \beta_2 \underline{q}_2 - \beta_p \text{Prot3} = 0 \quad (17)$$

$$\alpha \left[ \overline{M_{un}} + \underline{M_{un}} \right] - \alpha_1 \underline{q}_1 - \alpha_2 \underline{q}_2 - \alpha_g \text{Fat3} = 0 \quad (18)$$

$$\overline{q}_1, \overline{q}_2, \underline{q}_1, \underline{q}_2 \geq 0 \quad (19)$$

Constraint (9) and (12) tell us that the cooperative needs  $\gamma_i$  liters of milk to produce one kilogram of Product  $i$ . Constraints (10), (13) and (17) check that the proteins that are contained in raw milk are either in the final products or in the by-products ( $\text{Prot1}$ ,  $\text{Prot2}$  and  $\text{Prot3}$ ). Constraints (12), (14) and (18) check that the fat, contained in raw milk, is either in the final products or in the by-products ( $\text{Fat1}$ ,  $\text{Fat2}$  and  $\text{Fat3}$ ). Constraints (15) and (16) check that the cooperative does not use more milk than its members deliver.

### 1.1.3 The relationship between a cooperative and its members

Initially, all members get the same contract from the cooperative. We call it the basic contract. Then, to satisfy the members' expectations, individualized contracts are offered. We study more specifically two terms of contracts, quality and pricing.

The basic contract represents the current situation between agricultural producers and their cooperative. This contract is used in the results as the reference contract. Membership is open. The cooperative does not set up any volume constraint on the agricultural product delivered by members. However, in the European dairy sector, producers are bound by the quota system. They can only deliver a quantity of milk that does not exceed their individual quota. Standard quality is required. Because of the cooperative nature, members depends on the cooperative's ability to generate gains. Indeed, price is known at the end of the exercise. Under this contract, producers receive what we call the "average price" which is equal to the "shared value" divided by the quantity of milk delivered. The average price is written as  $AP = SV/M$ .

If we assume the cooperative offers individualized contracts then the average price should take into account the total value of the individualized contracts. The average price is then defined as  $AP = (SV - P^c M^c) / M^{bc}$  where  $P^c$  is the price of milk under the individualized contract,  $M^c$  is the milk quantity under contract and  $M^{bc}$  is the milk quantity under the basic contract, which means  $M^{bc}$  is the milk quantity left.

The cooperative determines all contract prices. Producers act as followers. They can only decide whether they take or leave the contract. They act as Stackelberg leaders.

1. The quality contracts

Raw milk is produced under a specific system of production (e.g. organic milk). In our model, the cooperative can set up the maximum bound of milk quantity under this contract. The price is equal to the average price plus a premium. The quality premium is calculated as a fraction of the margin generated by differentiated products.

2. The price risk management contracts

The price risk management contracts are already offered in the U.S. (Ling and Liebrand 1996). In our model, the cooperative offers several pricing possibilities, which present different levels of risks, not only for producers but also for the cooperative. As under quality contracts, the cooperative can limit the milk volume under contract. Within the price risk management contracts we can imagine, we study the four following contracts: the spot price contract, the annual forward contract, the forward contract and the minimum price contract.

- The spot price contract

Under this contract, producers choose to receive the spot price at each delivery. They agree to manage themselves the price variation, upward or downward. The cooperative establishes this price using the cash market price as a reference.

- The annual forward contract

By choosing this contract, producers look for stabilizing their revenue. They receive the same price for the whole year.

- The forward contract

It allows producers to get a known price for a future period. We assume that forward price is given every trimester. The producers can thus take four decisions a year and they can have an opportunistic behavior depending on their beliefs on the market evolution.

- The minimum price contract

The cooperative offers options to their members. It guarantees that the raw milk price producers receive cannot fall under a safe net price. Moreover, they can take advantage of upward price moves on the cash market and at the same time they limit their potential losses.

## 1.2 Implementation of data into the model

The model parameters were set up with the help of professionals from dairy cooperatives.

### 1.2.1 The cooperative

Producers deliver two levels of raw milk quality. Standard quality of raw milk stands for 10 millions of liters per month. Specific quality of raw milk represents 7.5 millions of liters per month. Raw milk contains 40 grams per liter of fat content and 32 grams per liter of protein content. The processing costs of the two products and their by-products are given in Table 1.

The cooperative also faces fixed management costs. They are set up as a fraction of the total margin,  $C_m = \rho (M_d + M_b + M_{bp})$  with  $\rho = 0.1$ .

The cooperative reserves are retained to finance future investments. We assume they are dependent on the position of the cooperative on its downstream markets. They are set up as a

	Costs	Price	$\mu$	$\sigma$	$\alpha$	$\beta$	$\gamma$
$\bar{q}_1$	0.9€	5€			0.3kg	0.3kg	11L
$\bar{q}_2$	0.7€	2.25€			0.07kg	0.075kg	2.6L
$\underline{q}_1$	0.6€	4€	0%	2.7%	0.3kg	0.3kg	11L
$\underline{q}_2$	0.7€	1.5€	0%	2.5%	0.07kg	0.075kg	2.6L
$q_{bp1}$	0.2€	3€	-0.05%	5.5%	0.82kg		
$q_{bp2}$	0.1€	2.2€	-0.05%	30%		0.355kg	

Table 1: Data for the model parameters

percentage of sales generated by differentiated products,  $R = \phi CA_d$  with  $\phi = 0.15$ .

### 1.2.2 The cooperative downstream markets

Downstream markets are characterized by the parameters on demands and prices. In our model, the demand of Product 1 in thousands kg per month falls into the interval  $[365, 500]$ . The demand of Product 2 in thousands kg per month falls into the interval  $[1\ 450, 2\ 000]$ . The values of the other parameters are given in Table 1.

### 1.2.3 The individualized contracts

In our study, we assume that the milk quantity under the quality contract is set up to 50% of the total quantity of specific milk. The quality premium ( $p_{qc}$ ) is a fraction  $\theta$  of the differentiated product margin,  $\theta = 2\%$  or  $20\%$ . The volume of milk under the pricing contract represents 50% of the total quantity of standard milk. The contract pricing depends on the spot price (*c.f.* Table2). To model the spot price, we take a geometric Brownian motion (Musiela and Rutkowski 1997). We can write the spot price as follows:

$$P_t = P_{t-1} \exp \left( \sigma W_t + \left( \mu - \frac{1}{2} \sigma^2 \right) \Delta t \right), \quad \forall t \in [0, T]$$

	Quantity	Quality	Price
Basic contract	Variable	$\bar{R}$ or $\underline{R}$	$AP = (SV - P^e R^c)/R^{bc}$
Quality contract	$0.5\bar{R}$	$\bar{R}$	$p_{qc} = \theta M_d/\bar{R}$
Spot price contract	$0.5\underline{R}$	$\underline{R}$	$\tilde{P}_t$
Annual forward contract	$0.5\underline{R}$	$\underline{R}$	$P_{af} = \frac{1}{2} \sum_t^{12} \tilde{P}_t$
Forward contract	$0.5\underline{R}$	$\underline{R}$	$P_{f,t} = \tilde{P}_{t-1}$
Minimum price contract	$0.5\underline{R}$	$\underline{R}$	$P_{m,t} = \text{Max} [\lambda P_{af}, \tilde{P}_t]$

Table 2: Description of the studied contracts

where  $W_t \sim N(0, \Delta t)$ ,  $\mu$  is a constant appreciation rate of the spot price,  $\sigma > 0$  is a constant volatility coefficient. The spot price ( $\tilde{P}_t$ ) allows us to introduce a higher volatility on the milk price received by producers. And consequently, it allows us to examine the effects of market deregulation. For the spot price,  $\mu$  is equal to 0.02% and  $\sigma$  is equal to 13%. The annual forward price ( $P_{af}$ ) is determined as the average of the monthly spot price of the previous year. The forward price ( $P_{f,t}$ ) is set up every trimester using naive anticipation. For example, the forward price observed by producers in January (beginning of trimester 1) for trimester 2 (period from April to June) is the January spot price. The minimum price ( $P_{m,t}$ ) is calculated as a fraction  $\lambda$  of the annual price,  $\lambda = 0.95$ . The study horizon length is six years. The first year allows us to initialize the model. The five other years provide the results.

## 2 Results

In order to examine the economics consequences of differentiating producer treatments on the basic cooperative contract, we mainly study the distributions of the average price when the cooperative offers individualized contracts.

We assume that the cooperative position on downstream markets has an effect on the basic cooperative contract. In order to discuss this hypothesis, we study two *scenarii*. In the first scenario *Scen1*, the cooperative produces 75% of differentiated products and 25% of basic products. In the second one *Scen2*, it produces 25% of differentiated products and 75% of basic products.

We examine the effects of the spot price contract, the annual forward contract, the forward contract, the minimum price contract and the quality contract on the average price in both *scenarii*. To interpret the results, we firstly use a mean comparison test and, we secondly use the concept of volatility. The mean comparison test informs us whether the average price significantly changes between two cases. The concept of volatility, often used in finance, allows us to estimate the risk associated to individualized contracts. Hull (2000) defines the volatility as  $\sigma^* = \frac{s}{\sqrt{\tau}}$  with  $s = \sqrt{\frac{1}{n-1} \sum_i^n \ln\left(\frac{S_i}{S_{i-1}}\right)^2 - \frac{1}{n(n-1)} \left(\sum_i^n \left(\frac{S_i}{S_{i-1}}\right)\right)^2}$  where  $S_i$  represents the price in Period  $i$ ,  $n + 1$  the number of observations and  $\tau$  the length of time interval in years. In our model,  $n + 1 = 500$  and  $\tau = 1/12$ .

In Figure 3, we compare the average price in Scenario 1 (*AP Basic Scen1*) with the average price in Scenario 2 (*AP Basic Scen2*) when no individualized contract is offered. The thick curve represents the difference between the mean of the average price in Scenario 1 and that of the average price in Scenario 2. The two other curves represent the 95% confidence interval when we realize a mean comparison test. The horizon length is five years.

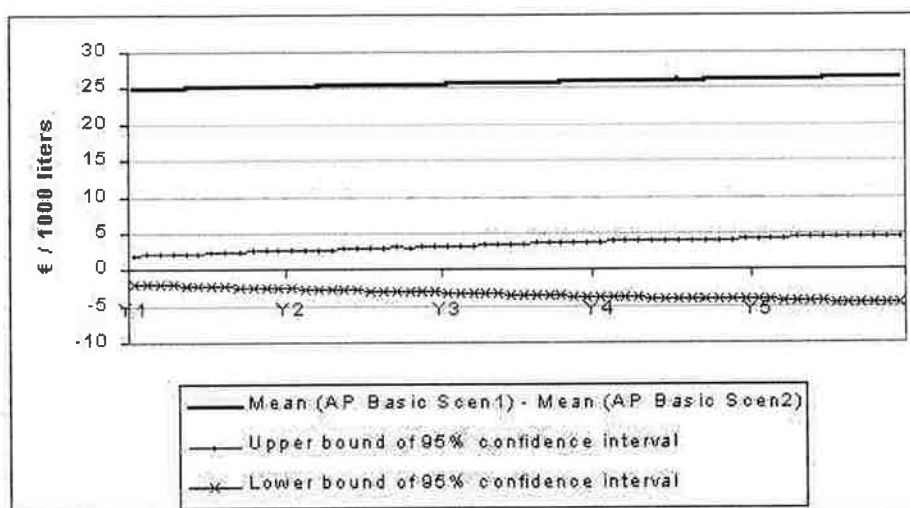


Figure 3: Difference in the average price means between the two *scenarii*

From this figure, we show a first result.

**Result 1:** *A cooperative that increases its proportion of differentiated products increases the average price received by its members. And inversely, a cooperative that increases its proportion of basic products reduces the average price received by its members.*

The difference (about 25€ per 1000 liters) between the two means of the average price is above the 95% confidence interval (at the beginning of study the horizon,  $[-2, 2]$ ; at the end of the horizon study,  $[-4.5, 4.5]$ <sup>1</sup>). The 95% confidence interval increases because of the increase in standard deviation. Uncertainty is higher when time increases. This first results remind us that the price received by agricultural producers depends on the cooperative position on its downstream markets. Today, milk producers should worry about the value created in the processing of their raw milk because their sales increase accordingly. Agricultural producers, through their cooperative, can play a role in the agrofood system in order to capture some value.

We now examine the effects of individualized contracts on the average price.

**Result 2:** *In Scenario 1, members receive a higher average price when their cooperative*

<sup>1</sup>The unit is € per 1000 liters

offers price risk management contract. Whereas in Scenario 2, members does not significantly receive a higher average price when their cooperative offers price risk management contracts.

Figures 4 and 5 illustrate this result. The difference between the mean of the average price when no price risk management contract is offered and the mean of the average price when the cooperative offers them is below the 95% confidence interval in Scenario 1. For exemple when a cooperative in Scenario 1 offers a spot price contract, this difference is approximately equal to -15€ per 1000 liters whereas the 95% confidence interval falls between  $[-2, 2]$  at the beginning of the horizon study and between  $[-5, 5]$  at the end of it. In Scenario 2, the difference between the two means of the average price falls within the 95% confidence interval from Year 3 to the end of the study horizon. We find similar results for the annual forward contract, the forward contract and the minimum price contract.

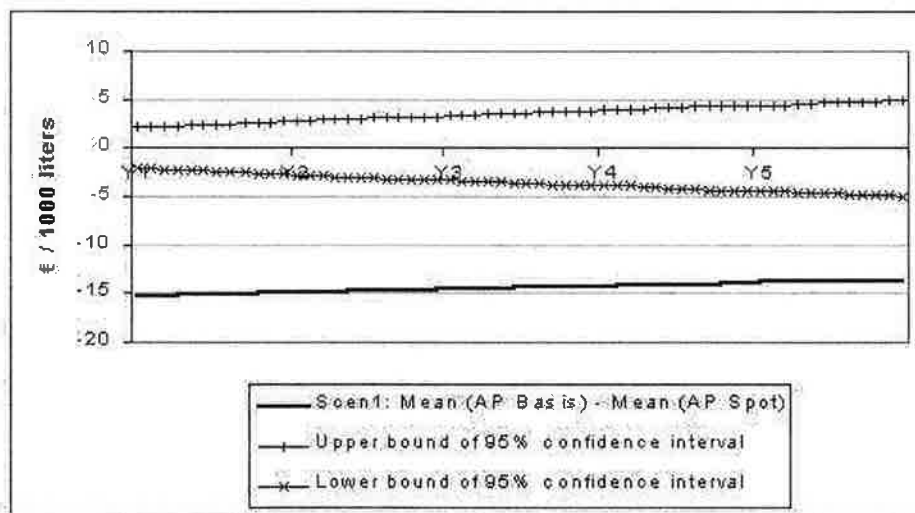


Figure 4: Difference between the average price mean of the basic contract and that of the spot price contract in Scenario 1

This result implies that the price risk management contracts satisfy all members, at least when we observe the change in mean. The members who only take the basic contracts receive a higher average price in Scenario 1 and does not significantly notice any change in Scenario 2.

Moreover, price risk management contracts allows producers to decide the revenue they would like to reach. The following result brings some limit to these contracts.

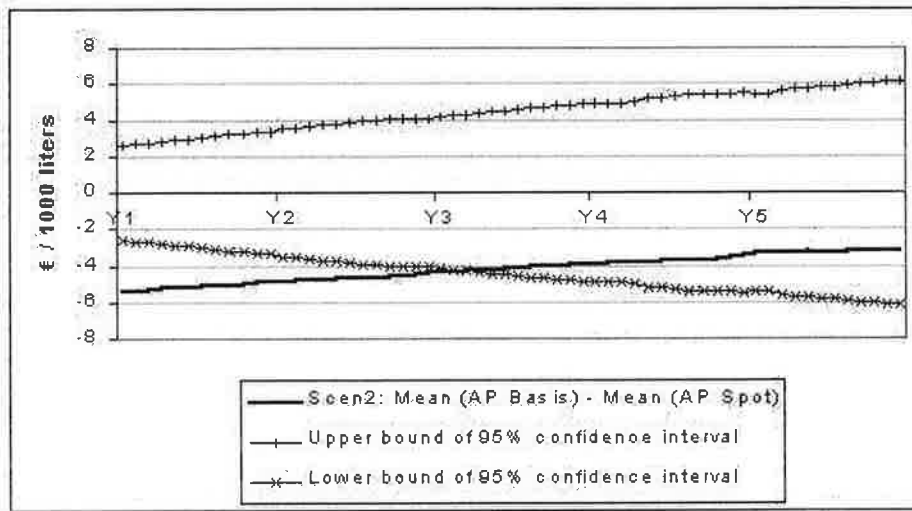


Figure 5: Difference between the average price mean of the basic contract and that of the spot price contract in Scenario 2

*Result 3: In both scenarii, the introduction of price risk management contracts increases the volatility of the average price.*

Tables 3 and 4 illustrate this result. In scenario 1, the volatility of the average price when a cooperative only offers the basic contract is about 4.5%. When it offers price risk management contracts, the volatility of the average price is around 6%. In Scenario 2, the volatility of the average price goes from 5.5% to about 8%. The price risk management contracts allow producers to choose the price they would like to get for their raw material. This choice implies consequences on their cooperative and producers who only choose the basic contract. It induces a higher volatility of the average price and thus, more risks for the cooperative and the producers who only choose to take the basic contract. Consequently, the cooperative cannot offer such contracts without developing strategies in order to avoid potential conflicts among members.

*Result 4: In Scenario 1, the average price, when the quality contract is introduced, is more*

Contracts	Year				
	Y1	Y2	Y3	Y4	Y5
AP Basic	4.3	4.3	4.5	4.5	4.5
AP Quality (premium 2%)	4.3	4.3	4.5	4.5	4.6
AP Quality (premium 20%)	4.6	4.7	4.8	4.9	4.8
AP Spot price	6.6	6.6	6.9	7.0	6.9
AP Annual forward	5.7	5.7	6.0	6.0	6.1
AP Forward	6.1	6.0	6.0	6.0	6.0
AP Minimum price	6.0	6.0	6.0	6.1	6.1

Table 3: Average price (AP) volatility in Scenario 1

*sensitive to the level of the quality premium. When the quality premium coefficient is 20%, the average price is significantly lower whereas when the quality premium coefficient is 2%, it is not significant. In Scenario 2, the change in mean is not significant.*

In Scenario 1, the difference in mean is about 2€ per 1000 liters when the quality premium coefficient is 2%, the 95% confidence interval falls between  $[-1.75, 1.75]$  whereas when the quality premium coefficient is 20%, the difference in mean is about 20€ per 1000 liters and the 95% confidence interval falls between  $[-1.75, 1.75]$ . The change in mean is not significant with a quality premium coefficient of 2% whereas it is when the quality premium coefficient is 20%. In Scenario 2, the difference in mean is about 1€ per 1000 liters when the quality premium coefficient is 2%, the 95% confidence interval falls between  $[-2.2, 2.2]$  whereas when the quality premium coefficient is 20%, the difference in mean is about 7€ per 1000 liters and the 95% confidence interval falls between  $[-2.2, 2.2]$  at the beginning of the study horizon. At the end of the horizon, the difference in mean is about 6.2€ per 1000 liters and the 95% confidence interval falls between  $[-5.2, 5.2]$  when the quality premium coefficient is 20%. Consequently, at the end

of the study horizon, we cannot conclude about a significant change in mean of the Scenario 2 average price when the quality contract is introduced.

Contracts \ Year	Y1	Y2	Y3	Y4	Y5
AP Basic	5.4	5.3	5.6	5.5	5.5
AP Quality (premium 2%)	5.4	5.3	5.6	5.5	5.5
AP Quality (premium 20%)	5.5	5.5	5.7	5.7	5.7
AP Spot price	8.1	8.1	8.6	8.6	8.5
AP Annual forward	7.3	7.3	7.7	7.6	7.6
AP Forward	7.7	7.6	7.7	7.6	7.6
AP Minimum price	7.5	7.5	7.6	7.6	7.5

Table 4: Average price (AP) volatility in Scenario 2

Surprisingly, the quality contract may appear more acceptable for all members in Scenario 2 than in Scenario 1. When the cooperative produces more differentiated products, the level of the quality premium is an important decision factor in order to avoid potential conflicts among producers. Indeed, the members who only take the basic contract get a lower average price when quality contracts are offered and the quality premium is 20%. However, the cooperative may justify the difference in the mean of the average price by rewarding the members who make efforts to produce raw milk with a better quality level.

**Result 5:** *In both scenarii, the volatility of the average price does not change much when the quality contract is introduced.*

In Tables 4 and 5, we notice that the volatility of the average price when a cooperative offers the quality contract is about 4.5% with a quality premium coefficient of 2% and 4.8% with a quality premium coefficient of 20% in Scenario 1. In the basic contract, the volatility of the average price is about 4.5%. In Scenario 2, it is respectively equal to 5.5% and 5.6% when the

quality premium coefficient is 2% and 20%. In the basic contract, the volatility is about 5.5%. Consequently, the quality contracts do not introduce more risks for the cooperative.

## Conclusion

In France, offering individualized contracts in agricultural cooperatives is an open debate. They can deeply modify the relationship between a cooperative and its members. These contracts allow members not to receive the same price and as a result, they allow them to make choice about their system of production and about their way to manage risk.

Our model gives us results about the consequences of individualized contracts on the basic cooperative contract. We study different combinations of the terms of contracts such as volume, quality and pricing. We show that price risk management contracts increase the risk faced by members who take the basic contract. Whereas quality contracts change little as far as the level of member risks under the basic contract is concerned.

In order to bring a useful information for French dairy cooperatives, to better define the relationship between producers and cooperatives, we show the limitations of the model.

Firstly, we should develop more sophisticated decision rules as far as producers are concerned in order to take into account the heterogeneity among producers' preferences.

Secondly, the cooperative should manage the risks induced by the price risk management contracts it offers. It can manage those risks either by its own method or by transferring them to financial markets. The point is important to consider because of the destabilizing effect it can produce among the members of a cooperative. The potential conflicts between the members who choose the basic contract and those who have individualized contracts may question the existence of the cooperative.

Lastly, we should thoroughly examine the implications of offering individualized contracts. They may appear to rule out cooperative principles. They are offered in order to meet individual needs.

Can they be justified in a collective organization? We state that solidarity between members must be fulfilled in order to offer such contracts. We think that we should introduce in the study questions about allocation of fixed costs associated to members. If the cooperative contract is unique then all members bear fixed costs, which is the case in our definition of the average price contract. However, if some members accept contracts for their product, they will no longer bear them and they will have opportunistic behavior. We would like to study thoroughly this concept in a future research.

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