« Required Vertical Coordination and Derived Risk Management »

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Vertical coordination is required for quality insurance, bringing additional market segmentation. Therefore, producers are contracting more actively with clients in order to deliver quality differentiated products. Contracts affect usually parameters such as quality, quantity and price premium. Farm income as well as income risk are affected by such segmentation and related contracts. This paper presents in three parts, first the types of risk induced by such contracts, then two risk management techniques and finally a marketing approach of "optimal" contracts. The first management technique is traditional but presents real limits for handling all the types of risk created by quality contracting. The second technique starts from the existence of specific risks for designing adapted contracts using the concept of flexibility value. Finally, in a third part, some contract methodology is discussed in order to develop the potential of a new risk management approach.

I – The derived risks of vertical contracting

The need for more vertical coordination in order to fulfill the consumer demand is now well accepted. Contracts along the food chain are offered in order to build "adapted quality". Product and process insurance schemes are required along the chain in conjunction with "identity preserved" tools within and between firms. This required coordination however brings additional risks to the upper part of the food chain, and particularly to the farmers. This is due to contracting for market segmentation. Traditionally, the producer is farming n hectares with a random yield y. With a random price p and a variable cost c, his profit is then

$$\pi = (\tilde{p} - c).n.\tilde{y}$$

Under market segmentation, the farmer is producing "two" products with different prices p_A and p_B (such as $p_A > p_B$), different variable unit costs c_A and c_B (such as $c_A > c_B$). Yields for the two products can be different but their economical effects may be computed within the related costs. One random yield can be kept. Therefore, the farmer profit can be computed as the following :

$$\pi = (\tilde{p}_A - c_A).n_A.\tilde{y} + (\tilde{p}_B - c_B).n_B.\tilde{y}$$

The farmer is basically segmenting his market if he expects an increased profit, meaning the unit profit on product A is greater than the traditional product called product B. Considering product A gets a price premium p_e but supports an extra cost c_e, then $p_A = p_B + p_e$ and $c_A = c_B + c_e$. Then :

$$\pi = (\tilde{p}_B - c_B + p_e - c_e).n_A.\tilde{y} + (\tilde{p}_B - c_B).n_B.\tilde{y} = (\tilde{p}_B - c_B).(n_A + n_B).\tilde{y} + (p_e - c_e).n_A.\tilde{y}$$

Product A is supposed to be specific to a market niche, inducing higher production costs for the producer. This is the case of organic products, GMO/non GMO or bST/non bST dairy derived products. Therefore, the product A contract will specify at least the quality level (intrinsic quality or process quality). At time t_0, the contract specifies the quality to be delivered at time t_1.

It is considered that product A is contracted but not product B. Therefore, two dates are of interest, t_0 the date of contracting and t_1 the date of contract settlement, delivery and payment. Risk occurs from such a situation depending upon the type of contracts which has been designed with the buyer. Contracts are basically related to quality, quantity and price, with all combinations possible.

Quality : product A is supposed to be specific to a market niche, inducing higher production costs for the producer. Most of the time, products type A can be sold on the traditional market. For instance, a current non-GMO product may be sold on the GMO market. But some products type A are more specific. For instance, GMO-plus product should be sold on their market without possibility to be sold elsewhere even with a discounted price.
The contract may specify the process quality, which is only a quality insurance scheme with identity preserved. There is no related technical risk. But the contract can define levels of intrinsic quality attributes to be delivered at time t_1. Penalties can exist for low quality levels on contracted attributes. If quality is too low, the product delivered can be rejected. The quality risk may influence the quantity able to fulfill the contract specifications. The induced financial risk is therefore taken into account under the quantity problem.

Quantity : contracts may specify either a fixed (with some tolerances) or an open quantity. Penalties can exist if the quantity delivered is lower than the quantity contracted.

Price : contracts can specify prices with a large spectrum of possibilities. One extreme situation is no price specification. Another extreme is “full forward pricing”, meaning simultaneous forward pricing of the basic product (or product B) and forward pricing of the quality premium. In between, some contracts are simply pricing the quality premium, letting open the date of fixing the basic product price on a centralized market. All types of such formula pricing exist in relation with practical market circumstances. Finally, and more recently, derivative contracts are offering advanced price risk management opportunities. Such contracts take advantages of options techniques to offer safety nets, profit participation and various insurance schemes.

Additional financial risk from contracting occurs first from the yield variability and also from the quality price premium variability. Financial loss may come from a lower yield than expected. Higher yield may cause financial losses if the product cannot be sold on the main market, but this is situation is quite limited currently. .Risk comes also from the quality variability, as described above, which may limit the deliverable quantity. Finally, financial loss may come from the penalty for not delivering the full contracted quantity.
Even, in the most favorable situation, capacity to sell superior quality on the commodity market and absence of penalty for low delivered quantity, the financial risk of contracts is always greater than without contracting if cost of production is higher for product A and if product A margin is greater in proportion with costs.

Price premium risk is also affecting financial risk. The variability of the premium is created by specific demand and supply of the quality level. Usually, such demand and supply are quite inelastic, inducing a high volatility for the premium.

If segmentation is increasing both financial returns and risk, the producers may find some risk-return equilibrium. Such equilibrium could be durable. But individual efficiency could be also improved by effective risk management techniques, if possible. The potential of two risk management techniques are now presented.

II – The potential of risk management techniques

Risk management has been studied for years and practiced since producers feel the future is uncertain. In terms of methods, Hueth and Ligon (1999) suggest that the type of

intermediation available to farmers can have important consequences for the risks that farmers face. They propose two polar assumptions regarding intermediation. Either there is none or producers have access to an exogenously specified source of intermediation that may take the form of a futures market, a public or private insurance or a particular government program. Then they suggest to work on internal intermediation potential to manage risk. That is why two risk management approaches are proposed. The first one is the exogenous and traditional approach based upon fixed and limited contracts (standardized futures and options contracts traded on futures markets). The second approach is based upon local market situations and the development of customized contracts by local intermediation (traders, cooperatives, local processors but also new intermediaries). This approach is captured by the concept of flexibility value.

2.1. The utility maximization approach

Maximizing expected utility under market constraints is a traditional approach. A great number of situations have been analyzed since Working (1962) changed the vision of hedging and speculation, and since the first publications on optimal hedging (Holthausen, 1979). Without quantity or quality risk and without forward (or future) pricing, the minimum-variance technique brings a very crude proposition for the farmer's decision. Either, he accepts full income risk related to this production or he does not produce at all.

$$E(\tilde{R}) = X_S.E(\tilde{S}) \qquad \text{and} \qquad Var(\tilde{R}) = X_S^2.\sigma_S^2$$

with E(R) the expected income, as a function of X_S the quantity to be produced by the farmer (the cash position) and the expected spot price S, and Var(R) the expected variance of the farmer income as a function of X_S and σ^2_S the variance of the spot price S.

The interest of futures (or forward) markets, comes from the opportunity to diversify price risk, in taking an optimal cash and futures positions. Introducing the cost component into the portfolio model and doing the necessary calculus with respect to the cash position X^*_S, the optimal cash X^*_S and futures X^*_F positions are expressed as :

$$E(R_S) - E(R_F)\frac{\sigma_{SF}}{\sigma_F^2} = c'(X_S) + \lambda X_S^* \sigma_S^2 (1 - r^2) \qquad \text{and} \qquad X_F^* = \frac{E(F_1 - F_0)}{\lambda.\sigma_F^2} - X_S \frac{\sigma_{S,F}}{\sigma_F^2}$$

with the traditional notation. Traditional optimal hedging is related to price risk. But it is feasible to extend the portfolio approach of forward contracting to multiple risks, in particular to quantity and quality risks :

$$X_F^* = \frac{E(F_1) - F_0}{\lambda f(\sigma_{SF}, \sigma_{SQ}, \sigma_{SP})} + \frac{E(Q_1) - Q_0}{\lambda f(\sigma_{SF}, \sigma_{SQ}, \sigma_{SP})} + \frac{E(P_1) - P_0}{\lambda f(\sigma_{SF}, \sigma_{SQ}, \sigma_{SP})} - X_S.\left(\frac{\sigma_{SF}}{f(\sigma_{SF})} + \frac{\sigma_{SQ}}{f(\sigma_{SQ})} + \frac{\sigma_{SP}}{f(\sigma_{SP})}\right)$$

The use of options has been analyzed under the optimal hedging approach. Lapan and Moschini (1991, 1995) present results where options are redundant to futures contracts in diversifying pure price risk but are useful with the simultaneous presence of price and production uncertainty. The key point is that options are an important hedging instrument when profits are not linear in price, which is the case with the multiplicative interaction between price and yield uncertainty. Under the assumption of no basis uncertainty, the random ex ante profit of the producer is :

$$\tilde{\Pi} = \tilde{S}.\tilde{X}_S - c(\tilde{X}_S) + (F - \tilde{S}).X_F + (t - \tilde{v}).z$$

with t the price of a straddle, v the payoff of the straddle and z the straddle position. Lapan et al are using straddles and futures as combinations of futures, calls and puts. The optimal

position on cash, futures and options are quite complex as in all works related to the topic (Wolf, 1987).

As a partial conclusion to this approach, it is reasonable to underline the great calculus complexity, especially in introducing options. In addition, the optimal hedging approach is not currently taking into account the quality constraints even though studies incorporating basis risk may be considered as a proxy. The particular problem of market segmentation by farmers when quality contracting is not really considered. That is why a more applied approach of risk management is required.

2.2. The flexibility (or customized) approach

A second approach is based upon the valuation of flexibilities in contracts. In a traditional way of thinking, risk has a cost meaning risky returns are discounted by rates augmented with risk premia, or switched by certainty equivalent returns. Returning the problem means that risk may have some time value. This is the approach of real options which consider flexibility of projects as source of value (Trigeorgis 1999). For instance, the flexibility to defer an investment brings a temporal value to the "normal" intrinsic value computed through traditional net present value of expected cash-flows.

Many flexibilities (or options) can be valued. The possibility to abandon a project in a future date, the option to exchange a risky project against another one, the option to have an option on a risky project, the option on averaged parameters (asiatic options) or options starting on barriers, etc.

The normal interest of contracting is to fix in advance some parameters such as price or quality premium, or else. But in doing so, the producer is usually creating additional risk if general conditions are negative and is loosing value if general conditions are positive. In fact, contracting with fixed parameters is basically a loss of flexibility, and therefore a loss of value for the producer.

The very diverse situations of contracting has to be analyzed first with respect to the need of flexibility to manage risky parameters. The first criteria is the potential of risk diversification. If the risk on a particular parameter can be managed independently of the local situation, then contracting on a fixed value is indifferent to the producer. If the buyer is also indifferent, the producer and the user will manage their risk on the diversification market.

For instance, we can consider a contract on quantity, quality and price. If price can be diversified on a futures market, contractors should be indifferent to contract for a specific forward price or not. If they don't sign for a forward price, the seller will manage his long cash position. If they sign for a forward price, the seller can still manage a risk of low forward price in taking a long (partial) future position or call option.

Table 1 classify some types of risk with respect to their potential to be diversified, with the idea that contracting should be indifferent if diversification is possible but contracting is required if not. However, contracts should incorporate flexibilities in order to create values.

Table 1 : Flexibility and Diversification Management

	Risk that can be diversified	Risk that cannot be diversified
Types of risk	Product B price risk (with futures market)	Quality premium risk Yield risk (most of the time) Price risk (no futures market)
Risk Management	Diversification	Flexibility
Types of contracts	No contract Forward fixing	Process quality rather than product qual. Minimum and maximum percentages on quantities delivered Minimum and maximum percentage on price quality premium

If the risk cannot be managed on a diversification market, contracts should include the required flexibility. All types of flexibilities should be checked and adapted to the product/market constraints for mutual benefit to the parties.

For instance, barrier options can be adapted to market contracts. The option to deliver a fraction of a target value of a parameter in relation with one or several independent parameters can bring relevant flexibility to the production conditions. The contract for instance specifies the minimum percentages to be delivered by a producer under contract with respect to total supply on the local market. Scales can be adapted. This flexibility is interesting in case of low yield. But the contract can also specify maximum percentages to be delivered in case of high yields.

The contract can design flexibility in total income when increasing the value of the quality premium when low supply is expected and decreasing its value when high supply is expected.

This technique can be applied also to prices when there is no diversification market such as futures market. This is the case for fruits and vegetables markets where the very high price volatility and/or market structure prevent the development of futures markets.

Flexibility in quality premium (with no potential of diversification) can be found in participative options or in asiatic options depending upon the initial market conditions. For instance, quality premium for non-GMO products depends upon the relative size of supply and demand. Therefore, the contract can specify the minimum premium value if supply is great with respect to demand and indicate the premium paid to the farmer under various situations of excess demand. The premium paid to the producer can be a fraction of the total market premium, stable for a crop season.

If the production is continuous over a period of time, such as fruits and vegetables, the premium paid for a particular quality may be an average of daily (or weekly) premium paid on some reference market for the same product or equivalent. It is equivalent to an asiatic option where the strike price is computed at the end of the period.

Finally, for extreme cases, the option to abandon can be included within contracts. In case of catastrophic event or *force majeure*, the possibility not to deliver should be considered. This possibility concerns usually international contracts with a positive list of reasons. Domestic contracts should include such flexibility and very positively take into consideration as back-to-back financial settlement a private crop insurance or a public programs.

As a partial conclusion to this second approach, it is important to emphasize the great diversity of market situations and the interest of adapted contracts. Flexibility potential exists for each parameter that can be contracted but also in combining two or more parameters. The objective is not to spread risk among many market participants but to build a contract with a good equilibrium of chances between the seller and the buyer. All types of reference can be used to build such flexibility and quite a lot of techniques are available to compute either a

well-balanced contract or an unbalanced contract with more value for one contractor against some reasonable payment. It is a very applied task to design such contracts. That is why a marketing approach of contracts is important.

III – Marketing approach

The development of contracts is obvious. Quite a large family of contracts is already observable coming from historical grounds or starting from the general ambiance. For instance, organic products in Europe developed charts and qualification systems for segmenting markets. However, the contracts for organic products are not dealing very much with prices, the reason being the current excess demand for such products. To the opposite, new contract types are offered on internet by traditional intermediaries but also by start-up companies. These companies try to offer contracts customized to new market situations and new farmers needs. Competition will develop among all these initiatives and a sound marketing approach will be important for launching and expand contracting techniques.

Why to contract

The financial interest of contracting is the main motivation. This is the case for vertical coordination when market segmentation brings additional value added to the food chain. Then contract should fulfill three tasks, (i) allow effective coordination of partners for creating an economical rent, (ii) share the rent with mutual benefit, meaning in relation with the efforts of the partners and (iii) guarantee the effective efforts in order to capture the rent.

How to contract

Contracting is a difficult task for both parties. Some mechanisms are required for running efficiently a contract. Four of them are crucial, (i) basic rules, (ii) general authority of the contract, (iii) control system and (iv) incentives for contractors.

(i) basic rules that automatically compute the financial benefit/loss of partners in relation with external events. The financial techniques are useful to elaborate on contract basic rules. Simulations can be performed in order to check for mutual benefit of contracting. The potential innovation in these rules is very important. The main constraint is to benefit from “good” reference parameters. For instance, futures market are providing very satisfactory reference prices for futures contracts and options. Ministries of Agriculture and local administration provide good references on yield and quality levels in many countries. But good reference parameters are more difficult to find for quality price premium.

(ii) pre-designed authority to manage situations outside the frame of automatic rules. Usually, the authority is given to the “main” contractor, very often the industrial partner, or to a specialized organization created by a group of producers. The authority may come also from the technology providers who try to preserve control over intellectual property and the resulting returns (Goodhue, 1999). Trust is an important component for accepting the authority of an organization. Then the potential organization should present and communicate on all the required trust components.

(iii) a control system to insure the contract is efficiently run, with the required mutual efforts. This system can vary widely from a minimum when the contract is purely financial. Outcomes of contracting is straightforward. In the other hand, the contract can require internal

constraints on production technique, such as control to limit the effects of asymmetric information has to be well conceived and implemented.

(iv) positive and negative incentives to assist the control system and reduce potential opportunistic behavior of contractors are finally required. Again these incentives are much more important for contracts with heavy qualitative components as opposed to financial contracts based on external reference parameters.

We expect to present to IAMA Agribusiness Forum a practical case of contracts developed for a producer organization of producers (vegetables) using the concepts of flexibility and following a marketing approach for buyers of food retailing companies.

Conclusion :

Contracting is a satisfactory mean to answer the consumer demand. However, apart for specific problems of contract enforcement, these contracts can increase financial risk for producers. Of course, it depends of contract characteristics.

It is reasonable to say that the traditional risk management technique of optimal hedging has great practical difficulties to handle all new types of risk. Additional risk management technique based upon flexibility contract design should be used to complete the basic interest of optimal hedging. When diversification is possible, it is a powerful mean to balance expected return and risk. But when market conditions are not in line with the requirements of vertical coordination, innovative contracts have to be designed specifically.

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