

## Quality and Double Sided Moral Hazard in Share Contracts

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### Abstract

*The objective of this paper is to analyze the effect of linear sharing contracts when downstream retail prices are used for compensation in a context of imperfect information about food quality. Such outcome-sharing through retail price contracts can be explained directly by agency theory. While the case of both parties being subject to moral hazard due to supplying unobservable efforts has been considered in the literature, we believe our specification is new and more realistic, as we consider the quantity-quality trade-off for the grower, ignored in previous double moral hazard models. With the help of a simulation exercise, we prove that an outcome-conditioned share reduces an agent's incentive to make an effort in quality input.*

**Key words:** *share-contract, double moral-hazard, quality, agency theory, simulation, incentive*

### Introduction

In the last ten years, the competitiveness of food companies in national and international markets has depended on their ability to adopt production processes which meet food safety and quality requirements. In order to build and maintain consumer trust in food quality and safety, quality assurance is of major importance in the food sector (Van der Spiegel *et al.* 2003).

The best way for a processor to prevent food quality failures is to make sure that he acquires high-quality inputs (Starbird 2005). But the effort a grower makes to produce a high quality input is usually only known to the grower himself and not observable for the processor. Indeed, the grower may have no incentive to share this information with the processor. As quality measurement is subject to significant diagnostic and sampling error, a processor cannot be sure that a grower has fulfilled a promise to deliver high quality inputs. This creates what is known in general economic literature as a moral hazard problem (Holmström 1979; Stiglitz 1989).

Consumers want, and are willing to pay for, food quality. However, before they buy a product, they do not often know whether its quality is good or poor. Most food quality properties can be classified as credence characteristics, as they cannot be inferred before, and sometimes even after, the purchase (Darby and Karni 1973; Caswell and Moduzska 1996). Consequently, food market operations often suffer from imperfect and asymmetric information. In order to mitigate uncertainty about food quality, a strategy adopted by processors is in some way to signal a product's quality level (Akerlof 1970). However, the marketing effort made by processors to reveal private information about quality cannot be equalled by growers as, for example, they may be unable to inspect how salespeople work. Even when it is possible, the costs are prohibitive.

Growers and processors, then, can contribute to final product quality in terms of production and marketing effort, respectively. Since such effort is mutually imperfectly observed, and its impact on final product quality can only be imperfectly measured, there is room for opportunism on both sides. Food quality may therefore present a double moral hazard problem.

This paper makes a direct contribution to the literature on food quality problems within the economics of information field. According to Weiss (1995), a key paradigm for the analysis of incentives and rewards in the presence of asymmetries associated with food quality attributes is principal-agent theory. Rooted in the economics of food quality, Elbasha and Riggs (2003) used a double moral hazard model to show that when preventive measures are not observable, the food safety effort of both producers and consumers will be suboptimal. Subsequently, Balachandran and Rakhakrishnan (2005) examined a supply chain in which the final product consisted of components made by a buyer and a supplier. Examining a warranty/penalty contract between the buyer and the supplier, in a double moral-hazard model, they concluded that the first-best quality is achieved if the supplier is not held responsible for the buyer's defects.

The objective of this paper is to analyze the effect of linear sharing contracts when downstream retail prices are used for compensation in this context of imperfect information about food quality. Such outcome-sharing through retail price contracts can be explained directly by agency theory (e.g. Hart and Holmström 1987; Corbett, DeCroix and Ha 2005; Levy and Vukina 2002). While the case of both parties being subject to moral hazard due to supplying unobservable efforts has been considered in the literature, we believe our specification is new and more realistic, as we consider the quantity-quality trade-off for the grower, ignored in previous double moral hazard models.

One interesting finding of our model is that, in an outcome-sharing contract, an increase in the processor's quality effort is associated with less incentive for the grower to make such an effort. This explains why there are so few outcome-based performance contracts in some specific industries, such as the wine sector, in contrast with their success in other supply chains (Cachon 2004).

The rest of the paper is divided into four sections. The following section provides the theoretical background. Section 3 describes the model and key assumptions. We then perform a simulation exercise to understand the effects of the contract in Section 4. Section 5 concludes the paper with some discussion on future research.

### **Linear sharing contracts and double moral hazard**

Research on principal-agent theory maintains that when risk-averse agents are facing a trade-off between the provision of incentives and risk sharing, a sharing contract could be an appropriate second-best way in which to address underlying double moral hazard problems (Stiglitz 1974; Eswaran and Kotwal 1985). It involves a two-part compensation scheme,  $w$ , consisting of (i) a fixed payment,  $\alpha$ , which is independent of the observed outcome, and (ii) an incentive payment,  $\beta$ , which amounts to a positive share of the publicly observable outcome.

A large number of studies concerning the economics of sharecropping seem to suggest that the double-moral hazard framework provides a good explanation for revenue-sharing contracts. Thus, Eswaran and Kotwal (1985) analyzed market imperfections in

inputs and established the hypothesis that non-tradable, non-contractible inputs can be efficiently pooled in sharecropping arrangements. But double moral hazard has also been used to explain revenue-sharing in the context of franchising and supply chain contracts. Rubin (1978) first suggested it as an explanation for franchising. Lal (1990) explored the implications of an agent's inability to observe the efforts of the principal (franchisor) when brand name investment matters. The author shows that, in environments where factors affecting retail sales are controlled by both the franchisor and the franchisee, a sharing rule based on royalty payments provides the necessary incentives for the franchisor to invest in its brand name. Brickley (2002) provides empirical support for the two-sided moral hazard explanation for share contracts by examining how state franchise termination laws affect franchise contracts.

Based on this literature, sharing contracts conditioned by retail prices seem to be a good idea in the food industry, as they account for both insurance and incentives to address double-moral hazard problems.

Several authors have provided theoretical and empirical support for the prevalence of simple linear contracts in various industry contexts. One possible explanation given by Holmström and Milgrom (1987) is the high transaction costs of designing different contracts, together with the problem of evaluating contracts in terms of implied performance and value for the parties involved. A second explanation is found in the paper published by Hart and Holmström in 1987. They emphasize that the prevalence of relatively simple incentive schemes could not only be rationalized by transaction costs, but more fundamentally by the need for incentive schemes to perform well across a wider range of circumstances than are specified in "standard" agency models.

Romano (1994) shows that a simple linear contract, in which the principal and the agent proportionally share the output after a given transfer between them, implements second-best outcome when the agent is risk neutral. Bhattacharyya and Lafontaine (1995) emphasize that, in many contexts, contracts involving revenue/profit sharing are not finely adjusted to the particular circumstances of individual agents or markets. By developing a simple model of such arrangements based on double-sided moral hazard, they show that the benefits of different contract provisions may be reduced when contracts are not customised and involve some degree of revenue sharing. In particular, they conclude that linear contracts are optimal and provide empirical evidence that they perform well in franchising contexts. Using the double moral hazard framework, Corbett, DeCroix and Ha (2005) examine incentives for efficient input use in supply chain contracts. They show that the principal can always induce optimal second-best equilibrium with a linear shared-savings contract over input use. The practical significance of their paper is that simple linear contracts are sufficient in many double moral hazard cases.

In this paper, we analyze simple linear contracts because we find that, in practice, much economic activity takes place within a framework of incentive contracts, such as managerial compensation (e.g., Lemmon, Schallheim, and Zender 2000; Murphy 1986), franchising (Lafontaine 1992; Lafontaine and Slade 1999), advertising agencies (Zhao 2005) and, particularly, agriculture (Stiglitz 1974; Newberry and Stiglitz 1979; Otsuka, Chuma, and Hayami 1992; Lanjouw 1999; Akerberg and Botticini 2002).

### **The model and assumptions**

We analyze a vertical structure in which end-markets are differentiated by quality. A

processor-distributor (the principal) engages a grower (the agent) to produce a product which is the processor's input. We assume that one unit of input is needed to produce one unit of output and there is no other input. We further consider that there are no raw material processing costs. Although these unrealistic assumptions are made for the purpose of simplifying our analysis, they do not reduce the model's applicability and implications.

We divide the grower's effort into two variables for analytical tractability: quantity,  $q$ , and quality,  $s$ . It is usually difficult for the processor to monitor the agent's efforts, either because it is too costly a process or because the processor lacks the expertise to directly evaluate the agent's performance. While quantity ( $q$ ) is perfectly measured for growers, quality measurement by the processor is imperfect and the processor's inability to perfectly observe input quality results in a moral hazard problem. We use  $\bar{s}$  to denote the level of input quality measured by the processor, according to:  $\bar{s} = s\mu_s$ , where  $\mu_s \sim N(1, \sigma^2)$ . The noise term  $\mu_s$  captures underlying uncertainty about measurement errors.

This paper assumes that a grower contributes to final quality output,  $\bar{S}$ , in terms of input quality,  $\bar{s}$ , and that the processor does so in terms of marketing effort,  $b$ , according to  $\bar{S} = f(b, \bar{s})$ , with  $\bar{S}_b > 0$  and  $\bar{S}_s > 0$ . As effort is mutually imperfectly observed and its impact on the final output can only be imperfectly measured, there is room for opportunism on both sides.

We assume that the processor is risk-neutral and the grower is risk-averse for two reasons. First, the cost of risk is generally relatively lower for the processor than for the independent grower or farmer (Milgrom and Roberts 1992). Therefore, it is reasonable to argue that the grower is less risk-averse than the processor, and our assumption is a simplification of this fact. Second, it follows research traditions in agency literature (e.g. Allen and Lueck 1999; Huffman and Just 2000; Dubois and Vukina 2004).

In order to model imperfect quality measurement and grower's risk aversion, we define  $f(y|q, \bar{S})$  as the probability density of the final output, where  $y$  is the monetary value of such output, which depends on both finished product quantity and quality. Depending on the processor's goal,  $y$  can be measured in terms of revenue, profits, sales, etc. We assume that  $f_q/f(y|q, \bar{S})$  and  $f_{\bar{S}}/f(y|q, \bar{S})$  are increasing in  $y$ . This assumption is known as the monotone likelihood-ratio property (MLRP) of the output function.

In general, market prices are higher for good quality than for poor quality goods. Likewise, prices and yields appear to be inversely related in the aggregate market. We assume, then, that  $P = f(q, \bar{S})$ , which satisfies  $P_q < 0$ ,  $P_{\bar{S}} > 0$ . Our price function is supported by Beard and Thompson (2003).

We need to specify how the grower's quantity and quality efforts interact to generate the processor's revenue. Obviously, the total revenue from the sale of a good is the selling price ( $P$ ) multiplied by the quantity sold. This suggests a positive interaction between the two variables in producing the processor's revenue, which means that  $f(y|q, \bar{S})$  must satisfy  $y_{q, \bar{S}} > 0$ . This is in contrast to the substituting effect between multiple tasks studied by Holmström and Milgrom (1991), who assume that

$y = f(q, \bar{S}) = h(q) + g(\bar{S})$ , so  $y_{q\bar{S}} = 0$ .

The grower's cost associated with his  $(q, s)$  decisions is  $c = (q, s)$ . There is a cost associated with effort because it is unpleasant and prevents performing other tasks. The standard vertical-product-differentiation model assumes that cost is increasing in both quality and quantity and convex in quality, and that marginal cost of production is independent of quality (McCannon 2008). In order to account for the trade-off between quality and quantity, we assume that cost of production varies quadratically in line with the given level of quality; that is,  $c_q > 0$ ,  $c_{qq} = 0$ ,  $c_s > 0$ ,  $c_{ss} > 0$  and  $c_{q,s} > 0$ . This cost function is supported by Champsaur and Rochet (1989) and Giraud-Héraud, Soler and Tanguy (1999).

As with franchise models, we also assume that the private cost of effort for the processor is the same as for the grower (Lafontaine and Slade 1999). The processor's cost,  $C$ , will then be  $C = (q, b)$ , which satisfies  $C_q > 0$ ,  $C_{qq} = 0$ ,  $C_b > 0$ ,  $C_{bb} > 0$  and  $C_{qb} > 0$ .

Although most of our analysis can be carried out with general functional forms, the presentation is significantly improved if specific functional forms are used. Specifically, we assume that  $c(q, s) = (qs^2/2)$ ,  $C(q, b) = (qb^2/2)$ ,  $\bar{S} = \theta b + \bar{s}$  and  $P = \bar{S} - \gamma q$ , where  $\theta$  and  $\gamma$  are positive constants. The efficiency factor  $\theta$  captures the relevance of the processor's effort in the final quality perceived by the consumer. These functional forms satisfy all the above assumptions.

The game is played as follows. The processor starts by offering the grower an incentive-based compensation contract,  $w$ , which is contingent on the processor's revenue, i.e.,  $w \cong w(y)$ . The grower decides whether to accept the contract or not. If he does, he supplies effort in quantity and quality,  $q$  and  $s$ , respectively. The grower's and processor's payoffs are, respectively,  $u = w(y) - c(q, s)$  and  $\pi = y - C(q, b) - w(y)$ . If the grower rejects the contract, he receives the reservation utility,  $\bar{U}$ , the minimum amount for which he is willing to work, and his payoff is therefore zero.

According to principal-agent theory, we focus on a particular class of linear contract, fixed income plus a share of the principal's revenue, in the following form:  $w(y) = \alpha + \beta y$ , with  $\alpha \geq 0$ ,  $0 \leq \beta \leq 1$ .

Likewise, we consider revenue as a performance indicator because it has been shown (Rubin 1978) that when the principal is more likely to have an impact on retail demand due to branding, revenue-sharing are better than profit-sharing contracts for providing appropriate incentives.

Consistent with the mean-variance approach<sup>2</sup>, for a risk-averse grower, net utility is given by  $U = -\exp[\rho(w(y) - c(q, s))]$ , where  $\rho$  describes the grower's risk aversion. It is easier to deal with his certainty equivalent, CE, which is given by  $CE = \alpha + \beta E(y) - c(q, s) - (\rho\beta^2 q^2 s^2 \sigma^2 / 2)$ . The term  $\rho\beta^2 q^2 s^2 \sigma^2 / 2$  is the risk premium that the grower demands to compensate for the risk he bears. As the impact of the grower's risk aversion  $\rho$  and the imperfect quality measurement represented by the standard deviation  $\sigma$  on the risk premium cannot be separated, we use a parameter,

<sup>2</sup> The linear mean-variance utility function is routinely used, especially in agriculture (e.g., Chavas and Holt 1990; Pope and Just 1991; Gaynor and Gertler 1995; Allen and Lueck 1999).

$R(\equiv \rho\sigma^2)$ , called the risk parameter, to describe the combined effect of risk aversion and uncertainty of measurement in the market.

### *Equilibrium analysis of outcome-conditioned sharing contracts*

When the principal also provides an effort which affects outcome, the incentive provision for both the agent's actions and the principal's own effort must be considered when designing the agent's incentive scheme. Thus, the processor chooses the incentive scheme parameters,  $\alpha$  and  $\beta$ , to maximize his expected profit, subject to the constraints that both processor and grower individually choose their efforts to maximize their certainty equivalent and that the grower attains at least his reservation utility,  $\bar{U}$ , i.e.,

$$\underset{\alpha, \beta}{\text{Max}} CE^{\text{Processor}} = E(qP) - C - E(w) = (1 - \beta)q(\theta b + s - \gamma q) - (qb^2/2) - \alpha \quad (1)$$

s.t.

$$\underset{q, s}{\text{Max}} CE^{\text{Grower}} = \alpha + \beta q(\theta b + s - \gamma q) - (qs^2/2) - (R\beta^2 q^2 s^2/2) \quad (2)$$

(Grower's incentive compatibility constraint)

$$\alpha + \beta q(\theta b + s - \gamma q) - (qs^2/2) - (R\beta^2 q^2 s^2/2) \geq \bar{U} \quad (3)$$

(Grower's reservation constraint)

$$\underset{b}{\text{Max}} CE^{\text{Processor}} = (1 - \beta)q(\theta b + s - \gamma q) - (qb^2/2) - \alpha \quad (4)$$

(Processor's incentive compatibility constraint)

We solve the optimization problem in equations (1-4) sequentially. First, we determine the effort choice made by the processor:

$$\underset{b}{\text{Max}} CE^{\text{Processor}} = (1 - \beta)q(\theta b + s - \gamma q) - (qb^2/2) - \alpha \quad (5)$$

The optimal solution to the processor's effort decision in equation [5] is  $b = (1 - \beta)\theta$ . Secondly, given the processor's choice, we determine the quantity and quality efforts which maximize the grower's certainty equivalent:

$$\underset{q, s}{\text{Max}} CE^{\text{Grower}} = \alpha + \beta q(\theta b + s - \gamma q) - (qs^2/2) - (R\beta^2 q^2 s^2/2) \quad (6)$$

Necessary first-order conditions for maximizing [6] relative to  $q$  and  $s$  yield the following reaction functions:  $q = (\beta(\theta b + s) - (s^2/2) / \beta(2\gamma + R\beta s^2))$  and  $s = (\beta / (1 + R\beta^2 q))$ . A quantitative application of this principal-agent model requires a numerical simulation because  $q$  and  $s$  cannot be solved explicitly. A numerical simulation exercise is found in the following section.

## **Methodology and results**

The principal-agent model proposed by Holmström (1979) has been widely used to analyze various issues in economics. However, the first-order conditions defining decision variable values in share contracts cannot usually be explicitly solved. Quantitative

applications of the principal-agent model therefore require numerical solutions.

We carry out a simulation exercise with a wide range of scenarios in this section, having selected the examples below as being representative of the behaviour we found. We use Mathematica<sup>3</sup> to solve the model, and Matlab to draw the planes using the data produced by Mathematica. We initially choose the following parameter:  $\gamma = 0.00001$ . Note that this initial value is used for convenience and has no special significance and that simulation results do not change substantially if we use different values for  $\gamma$ . We have two free parameters in our model: the processor's efficiency factor,  $\theta$ , and the risk parameter,  $R$ .

It will be seen below that this exercise provides a consistent explanation for many issues relating to incentive contracts. However, before proceeding, we should note the caveat that this simulation exercise uses restrictive assumptions about the shapes of price and cost functions. Although we believe that they are plausible for most situations, there may be cases which are not covered by our simulations.

In order to capture the effect of principal's effort on quality, a key aspect in this paper, we amend the effort/quality relationship to include not only the grower's (agent's) effort, but also that of the processor (principal),  $\bar{S} = \theta b + \bar{s}$ , where parameter  $\theta > 0$  is a proxy for the importance of the principal's effort.

To illustrate the analysis it may be worth first considering a scenario in which the agent is risk-neutral. We then repeat the analysis with a risk-averse agent.

#### *First scenario: risk-neutral agent and principal*

As a benchmark for comparison, we first compute the solution to the agency problem assuming risk neutral agents. For simulation purposes, we consider a wide range of 0 to 0.9, in steps of 0.1, for the efficiency factor  $\theta$ .

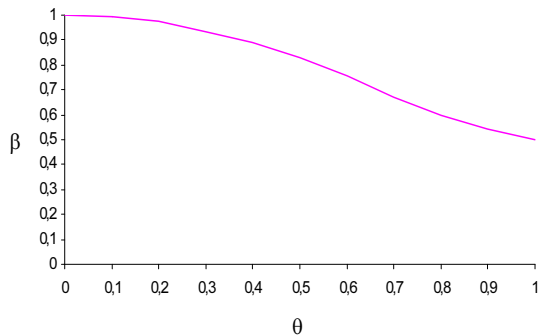
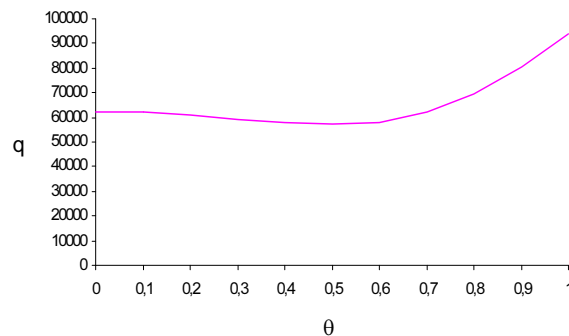
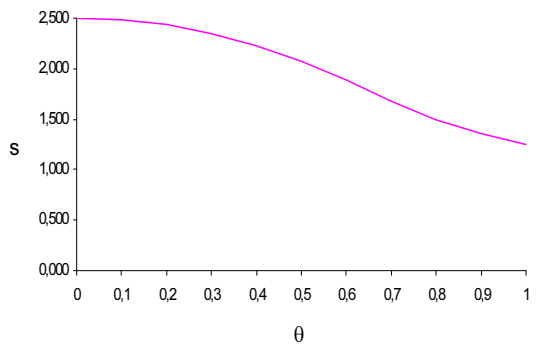
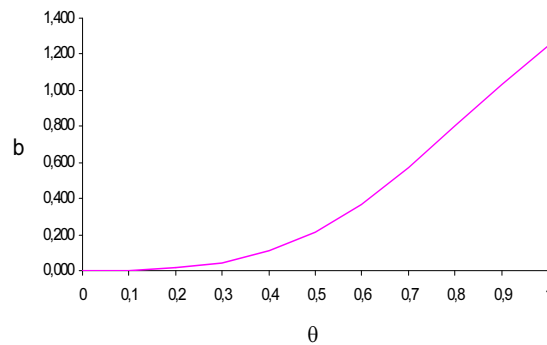
In figure 1a we consider how the share of the outcome,  $\beta$ , varies as a function of the importance of the principal's effort,  $\theta$ . Consistent with the agency theory, the value of  $\beta$  is maximum at  $\theta=0$  when the processor's effort is of no significance in the final quality perceived by the consumer, and its value is 1, implying that the agent receives all revenue. Likewise, as predicted by franchise contracting models, the share of outcome  $\beta$  is decreasing in  $\theta$ . This result is supported by other studies, such as Lafontaine (1992), Minkler and Park (1994). All these papers obtain that when franchisor inputs are more important, there is less vertical separation, as predicted.

Similarly, figure 1b shows that grower's effort in quantity varies as the importance of the principal's effort increases. In this same interval of  $\theta$ , [0-0.9], the quantity input curve is smooth, gradual and concave, with a minimum at  $\theta=0.5$ .

Figures 1c and 1d refer to the quality effort of agent and principal, respectively. The shapes of these efforts as a function of the efficiency factor,  $\theta$ , are considered. Note that the grower makes less effort when the processor's quality effort is more important. Conversely, the processor's effort in quality is increasing in  $\theta$ , as can be deduced from equation [10].

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<sup>3</sup> The Mathematica commands are available from the authors upon request.

**Fig.1a. Share of outcome ( $\beta$ )****Fig.1b. Quantity input ( $q$ )****Fig.1c. Expected input quality ( $s$ )****Fig.1d. Processor's effort ( $b$ )****Figure 1 - Double moral-hazard with risk-neutral agent***Second scenario: risk-averse agent and risk-neutral principal*

In this second scenario, parameter estimates were obtained by searching an equally spaced grid of 100 values for each parameter ranging from  $[0, 0.9]$  for  $\theta$  and  $[0, 0.9 * 10^{-5}]$  for  $R$ .

Figure 2a shows that, as the grower's risk premium  $R$  increases, given the value of  $\theta$ , his share of the outcome,  $\beta$ , decreases. This supports the prediction made by the principal-agent framework with risk-averse agents (by Holmström and Milgrom, 1991). Likewise, an increase in the importance of the principal's effort, given the value of the agent's risk premium, reduces the incidence of  $\beta$ .

Similarly, figure 2b shows input quantity as a function of the efficiency factor,  $\theta$ , and risk premium,  $R$ . When  $\theta$  converges to zero, an increase in  $R$  decreases the grower's quantity effort. However, when  $\theta$  increases and diverges from zero, input quantity increases and, moreover, the negative impact of an increase in  $R$  on input quantity is reduced.

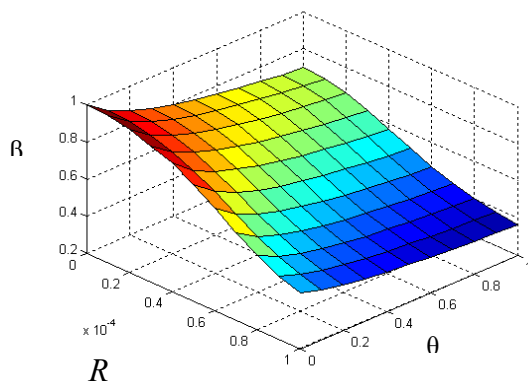
Figures 2c and 2d show the quality efforts of both the agent and the principal, respectively, considering the planes of these effort values as functions of the efficiency factor,



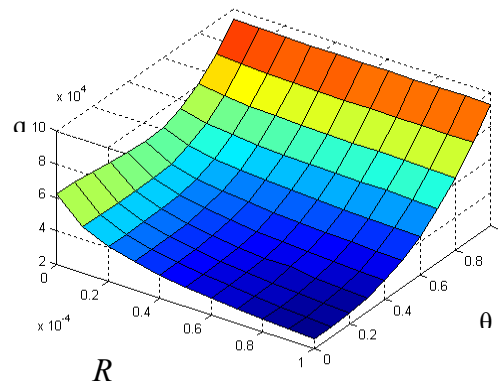
$\theta$ , and risk premium,  $R$ . The charts show that these efforts vary inversely. In other words, when the efficiency factor and/or risk premium increases, so does the processor's effort; on the other hand, the primary producer's quality effort is reduced.

This simulation exercise throws some light on the model's relative importance, including a fact which is often ignored in previous analyses, that the agent makes both quantity and quality efforts. As the exercise shows, when the principal's effort increases, the share contract discourages the agent from making a quality effort in favour of quantity.

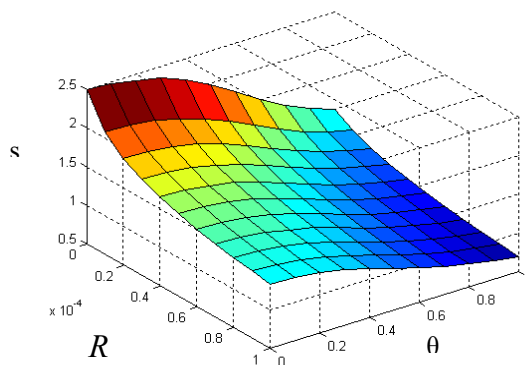
**Fig.2a. Share of outcome ( $\beta$ )**



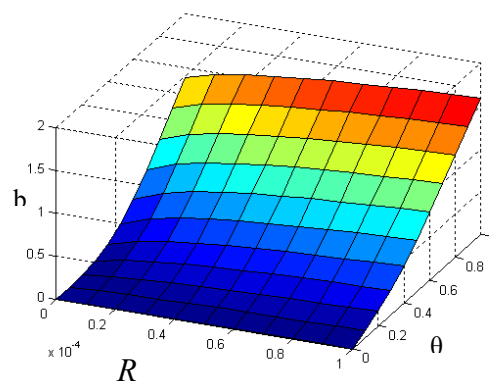
**Fig.2b. Quantity input ( $q$ )**



**Fig.2c. Expected input quality ( $s$ )**



**Fig.2d. Processor's effort ( $b$ )**



**Figure 2 - Double-moral hazard model with risk-averse agent**

The results of this simulation could explain why agreements other than share contracts are used in sectors in which quality is a key competitive variable. We know that the "lemon problem" affects many highly differentiated products. In other words, consumers do not automatically know the product's quality or the accuracy of the information supplied about the product's characteristics. This observed asymmetric information between processors and consumers can therefore hinder how the product market works (Akerlof 1970). The solution applied in many industries has been for processors to create quality signals. One example is the wine market, in which consumers are rarely able

to distinguish wine characteristics. It is also difficult to objectively evaluate grape quality (Oczkowski 2001). Wineries have made an important effort to create quality signals such as wine brands (Lacoeuilhe 2004), exhibition awards (Orth and Krsha 2002), expert wine tasters (Edwards and Mort 1991; Chaney 2000) and winery visits (O'Neil, Palmer and Charters 2000). Consistent with our model, given the importance of the principal's effort, a share contract would not be appropriate because it discourages the agent from making a quality effort. It could explain why bottle-price conditioned contracts are rarely (if ever) used between growers and wineries for the supply of fresh grapes.

## Conclusions

This paper has examined a situation in which both grower and processor can make an effort to increase the quality of a final product. We have extended the double moral hazard literature to allow for a trade-off between quantity and quality and examined linear outcome-conditioned share contracts. With the help of a simulation exercise, we conclude that when a processor makes an effort which affects a product's quality as perceived by consumers, this type of contract weakens the grower's incentive to make a quality effort. This could explain the evidence found in some specific sectors (such as the wine industry), where retail-price conditioned contracts are rarely used.

Note that, although outcome-conditioned share contracts are not used in some markets, they are implicit in modes of governance in which growers have property rights. In particular, the compensation scheme used by producers organized in co-operatives is that of an outcome-conditioned incentive contract. As a co-operative enables risk-averse growers to participate in marketing decisions, the problem associated with information asymmetries is reduced. Therefore, the impact of the double moral hazard problem also diminishes. Despite this advantage, co-operatives face important problems such as free-riding.

This study has certain limitations that need to be taken into account when considering its significance. Some of these limitations, however, suggest promising avenues for future research.

Our analysis has left an interest contract-related question unanswered. The classic paper by Holström (1979) about imperfect information in a moral hazard problem shows that "a signal is valuable if and only if it is informative". According to this, the uncertainty involved in quality measurement led us to choose a compensation scheme based on principal's revenue. But subsequent papers have suggested that if some aspects of the agent's performance cannot be contracted, it might be best to rely on subjective performance evaluation and voluntary bonus payments (for example, MacLeod and Malcomson 1989; Baker, Gibbons and Murphy 1994; Fehr and Schmidt 2004). Hence, an outcome-based contract could encourage quality effort by both the grower and processor in the context of a double moral hazard framework by using subjective quality evaluation.

Another primary limitation of this analysis is that it is not a dynamic study, although in practice, processors tend to contract repeatedly with growers on whom they rely. It does not consider, then, the possibility of a relationship between principal and agent over time, and thus does not consider the effects of insincere behaviour on reputation. However, previous literature has proved that reputation can be an added incentive

mechanism to induce performance under a contract (King, Backus and Gaag 2007). These limitations will be considered in future research efforts.

In spite of these constraints, this paper sheds some light on the role of the regulation of information in correcting the double moral hazard problem. The asymmetric information found in the food quality market (where the grower has pertinent input production information that the processor lacks, and the marketing effort made regarding product quality is known by the processor but not by the producer) is further complicated by the presence of imperfect information. In food quality, information about input production could be expected to be useful for consumers in their purchasing decisions (see, for instance, Caswell 1998; Collins 1997; Roe *et al.* 2000). If the market does not provide enough incentive for growers to disclose relevant information, third-party involvement may also be valuable in enhancing market efficiency (Golan *et al.* 2001; Elbasha and Riggs 2003). As designations of origin set quality standards, provide product testing, certify the validity of information provided by producers, and enforce quality standards, they could enhance market efficiency in this double moral hazard context.

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