

Spot market versus Incentive Contract

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Jel classification: L140, C150

1. Introduction

With the constant pressure to meet the consumer demand and the need to be competitive, the issue of quality is becoming a central point in the organization of agri-food chains. It is well known that quality is dependent upon the characteristics of inputs obtained from growers. But the action of the grower in producing a quality product is rarely observed by the processor, a fact that generates moral hazard problems. Consequently, once a processor decides to satisfy his input needs, a difficult question must be resolved. Should his input be acquired via contracts with growers, or is it better to buy it on the spot market?

The study of vertical relationships is dominated by the principal-agent framework in agriculture (Otsuka, Chuma and Hayami, 1992). According to this theory, it is well known that when measuring the grower's effort is expensive, an incentive contract can be the second-best contract in addressing underlying moral hazard problems (Stiglitz, 1974): it provides incentives but only by imposing risk on the growers. Thus, the trade-off between the loss from too little incentives and the loss from too heavy risk-bearing defines the optimal share contract (Bell and Zusman, 1976; Stiglitz, 1988).

In this approach, protecting the input quality has been suggested to be a possible motivation for the use of contracts over the spot market alternative, especially in the p-

Abstract

This paper attempts to develop a consistent theory for the choice of performance contracts in agriculture by analyzing the trade-off between quantity and quality and the presence of competence and uncertainty on the basis of the expected utility theory. This theory is able to explain many contract-related issues, such as why the performance contract can be optimal even providing lesser quantity and quality than the spot market and why a trade-off between processors' and consumer' interests about mechanism choice can exist, utilizing a simulation exercise.

Keywords: Spot market, incentive contract, moral hazard.

Résumé

Cet article essaie de mettre au point une théorie cohérente pour le choix de contrats basés sur la performance dans le secteur agricole, en analysant le compromis entre quantité et qualité, la présence de compétence et d'éléments d'incertitude et ce, sur la base de la théorie de l'utilité attendue. Cette théorie est à même d'expliquer bon nombre de questions associées aux différentes formes de contrat: elle révèle par exemple la raison pour laquelle le contrat de performance s'avère optimal tout en donnant origine à quantité et qualité inférieures au marché au comptant, et fraye la voie à l'existence d'un possible compromis entre intérêts des transformateurs et intérêts des consommateurs sur le mécanisme à choisir grâce à un exercice de simulation.

Mots clés: marché au comptant, contrat à clause d'intéressement, aléa moral.

resence of imperfect quality measurement (Hueth and Ligon, 1999a,b, 2001, 2002). In particular, Wolf, Hueth and Ligon (2001) conclude that «contracting can be thought of as an organizational response to an increased demand for quality among increasingly discerning consumers».

Many studies of incentive contracts testing the principal-agent framework found support for the effect of incentive contracts on quality. Among the existing studies, Curtis and McCluskey (2003) analyze a sample of production contracts between potato processors and growers in the

Columbia Basin area of Washington and Oregon. The authors conclude that contracts are effective in increasing potato load quality over the spot market alternative. Carriquiry and Babcock (2004) consider that contracts are actually the only way to induce a risk-averse grower to move away from producing a commodity to producing a high-value product.

In a recent paper, Alexander, Goodhue and Rausser (2007) examine an unusual dataset of 14 tomato growers over 4 years to analyze the effect of incentive contracts on their behaviour. They find that the processor obtains higher quality tomatoes from contracting than from spot purchases because growers respond to price incentives for quality.

Although these contributions have provided empirical support for the prevalence of incentive contracts to encourage growers to produce greater level of quality over the no-contract alternative, it can not be concluded that the processor is better off offering price incentives than not contracting. In fact, Alexander, Goodhue and Rausser (2007) outline that some of their results suggest that offering those in-

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centive contracts does not improve profits. Hence, there would be the possibility that the processor could not be acting optimally, as well as the possibility that their analysis would be mistaken on the basis of their methodology and data.

To identify the solution to this problem, i.e. the objective of this paper, we theoretically develop two models of vertical relationships: the incentive contract and the spot market, to be implemented in the food industry and inspired by previous studies (e.g. Stiglitz, 1974; Holmström, 1979; Shavell, 1979). These models analyze the efficiency of each mechanism by maximizing the total joint certainty equivalent for all processors and producers.

Most of the theoretical models examined in the previous literature suffer from limitations. Although it is well known that agricultural production often presents a trade-off between the quality of a good and the quantity produced, little attention has been paid to their role in the principal-agent models. And in the standard vertical-product-differentiation models in which quantity and quality have been analyzed (for example Gabszewicz and Thisse, 1979, 1980; Shaked and Sutton, 1982, 1983), it is implicitly assumed that these variables are independent choices. That is to say that, as any set level of quality, a grower is free to produce as much as he desires. But in practice, it is more realistic to assume that higher quality comes at the cost of lower yields and vice versa. An exception is McCannon (2008) who pioneered a vertical-product-differentiation model to analyze the trade-off between the quality and the quantity of a product. Likewise, market prices are higher for high-quality than for lower quality product, but they are inversely related with the total market supply. However, often the models do not consider both issues to determine the price market. The reason why models have not included the previous aspects is likely attributable to analytical problems.

To fill these gaps, we develop a more general principal-agent model and then we use it to analyse the effects of the incentive contract and the spot market on quantity and quality. We generalize the models by considering the effect of the quality-quantity trade-off and competition.

Using this generalized model, we carry out a simulation exercise, and find that the study of the competence and the quality-quantity trade-off is fundamental to understanding the effects of governance mechanisms. Depending on the characteristics of the relationship involved, the incentive contract can provide a greater level of quality than the spot market but with a smaller level of efficiency. Hence, it

would suggest that the actual contracts in use could not be optimal, although they provide greater levels of quality than the spot market. Practically, processors could not act optimally. While such a result is apparent in the intuitions underlying many earlier papers (for example, Alexander, Goodhue and Rausser, 2007), we also formally derive it from the optimizing behaviour of processors and producers.

The paper is structured as follows. In the following section, we set up both alternative models of governance choice (incentive contract and spot market) using this generalized framework. We then carry out a simulation exercise to understand the effects of governance mechanism under a wide variety of circumstances. The results of this exercise are used to explain many governance choice related issues. In the final section of this paper, the linkages between governance structures and agricultural policy are discussed.

2. Models formulation

An important contractual choice question is: do incentives for quality ensure optimality? Agricultural activities are characterized by a substantial degree of uncertainty frequently in the form of hazardous natural environment, price risk and quality measurement errors (Hueth & Ligon, 1999a, b). In this context, the deterministic profit maximization model is inappropriate and another model should be adopted. A widely accepted framework for analyzing decision-making under risk, especially in agriculture, is the mean-variance approach (e.g. Myers & Thomson, 1989; Chavas & Holt, 1990; Pope & Just, 1991; Coyle, 1992; Andersson, 1995; Gaynor & Gertler, 1995; Duvois & Vukina, 2004), which allows concepts of uncertainty and attitude towards risk to enter the theoretical framework. To illustrate the proposed methodology, we assume that both parties, growers and processors, maximize a constant absolute risk aversion (CARA) utility function and the stochastic variables are normally distributed¹.

The grower and the processor's behaviour

It is assumed that n processors and m growers are symmetrically distributed in the village economy. As is it often employed in empirical research in agriculture, growers are modelled as risk-averse while processors are modelled as neutral risk landowners² (Allen and Lueck, 1999).

A quality-differentiated input is produced over a crop cycle which is the period of our analysis. The input depends on the effort levels of the grower, that contribute to its quantity, q , and quality, s , in terms of production efforts in these variables, x and e respectively, according to: $q = x$ and $s = e\mu_s$ where $\mu_s \sim N(1, \sigma_s)$. Quality uncertainty is an increasingly important issue in the agricultural sector (Chambers and King, 2002). Randomness of quality is imputable to risky environment and measurements errors. Symmetry restriction regarding the quality variance for all growers is also implemented. Although the quantity is supposed deterministic, the elimination of this uncertainty only implies

¹ The optimal choice for a decision-maker faced with uncertainty is the maximization of his expected utility where the expected profit and variance are the arguments of utility. As the expected utility derived from variable profits is equal to the utility derived from the certainty equivalent, CE, the maximization problem can be mathematically written as, where the coefficient ($e''(0)$) measures the risk aversion and $\frac{1}{2}\pi$ is the variance of profit (Robinson & Barry, 1987).

² A reason for this assumption is that the cost of bearing risk is generally relatively lower for the processor than for the grower (Milgrom and Roberts, 1992).

under-representing the importance of income risk (Fraser, 2001). However, since the random variable is multiplicative, grower's risk premium is also affected by quantity.

There is a cost associated with effort because it is unpleasant and forgoes the opportunity to undertake other activities. The standard vertical-product-differentiation model assumes that the cost is increasing in both quality and quantity, convex in quality, and the marginal cost of production is independent of quality (McCannon, 2008). To introduce the trade-off between quality and quantity, assume instead that, $C(q,s) = \frac{c}{2} q^2 s^2$ with $c > 0$; see Champsaur and Rochet (1989) and Giraud-Héraud, Soler and Tanguy, (1999) for examples that have used this cost function.

Processors transform the raw material (input) into finished product (output). We assume that there are not losses of quantity and quality in the transformation process, that is, output quantity (Q) and quality (S) are linear functions of the input quantity and quality as follows: $Q=q$; $S=s$. Likewise, we further consider that there are no raw material processing costs. Although these unrealistic assumptions are made for the purpose of analytical simplification, they do not take away from the applicability and implications of the model.

The price function

As we noted earlier, there is a total number of m growers ($k:1\dots m$) of an input, each of whom differentiated in quality. We will denote the quantity and quality produced by grower k by q_k and s_k , respectively. We denote by q_{ik} the quantity of grower k 's input supplied to processor i , where

$$q_k = \sum_{i=1}^n q_{ik}. \text{ Likewise, there are a total of } n \text{ processors } (i:1\dots n)$$

who acquire growers' input. Let Q_{ik} and S_k be defined as processor i 's output quantity and quality derived from grower k 's input. As there is no loss of yield and quality in input processing, $Q_{ik} = q_{ik}$, $S_k = s_k$. Likewise, let Q_i be defined as the total processor i 's supply, where. Following Lancaster (1979), we distinguish between horizontal and vertical differentiation. Let p_i denote the price at which each processor sells the output derived from the grower i 's raw material. An increase in the output quality improves each consumer's utility (see Mussa and Rosen, 1978). Then, the inverse demand function³ for the processor i 's output derived from grower i 's input is assumed to be linear in his supply, Q_i , and quality, S_k , and symmetrically linear in the supplies of the rest of the competitors as follows:

$$P_k = b_1 S_k - b_2 Q_i - b_3 \sum_{j=1}^n Q_j \quad \forall i=1\dots n \quad k=1\dots m$$

Where b_1 , b_2 and b_3 represent, respectively, the own market specific quality effect (vertical differentiation) and the own and each rival market specific effects (horizontal differentiation) with $b_h > 0 \quad h=1\dots 3$.

We have chosen these specific functional forms for the price and cost functions so that the impact of the quality-quantity can be readily observed. On the one hand, the price of a product is greater when a higher quality product is made, but it is more costly in total cost and marginal cost. On the other hand, the marginal cost of production is assumed to be constant for a given level of quality, but for larger values of the supply the price decreases.

Our formulation of the models⁴ implicitly recognizes the law of supply and demand for both raw material and finished product, i.e. the volume demanded will be equivalent to the volume supplied in the regional area.

2.1. The Spot Market

To model the spot market, we consider that n processors (indexed by $i:1\dots n$) compete on the market for processed products by setting quantities. It is assumed that each processor i takes as given the qualities (s_k) and prices (p_k) of raw materials supplied by the m growers (indexed by $k:1\dots m$). Moreover, each grower competes on the market for raw materials by setting quantities and qualities.

The model is solved by backward induction. The objective function of the i -th processor, assuming that he takes p_k and s_k as given, is defined in equation 1. The processor maximizes his certainty equivalent, which is equivalent to his expected profit, by choosing quantity for each level of quality produced, q_{ik} . A processor's profit is the revenue generated minus the total cost paid:

$$(1) \quad \text{Max}_{Q_{ik}} CE_i^M = E \sum_{k=1}^m (Q_{ik} P_k - q_{ik} p_k)$$

Upon expanding the above expression, the following is obtained:

$$(2) \quad \text{Max}_{Q_{ik}} CE_i^M = E \sum_{k=1}^m \left[Q_{ik} \left(b_1 S_k - b_2 \sum_{i=1}^n Q_i - b_3 \sum_{j=1}^n \sum_{k=1}^m Q_{jk} \right) - q_{ik} p_k \right]$$

Taking the first-order necessary condition for a maximum in (2) yields:

$$(3) \quad p_k = b_1 E(s_k) - 2b_2 \sum_{i=1}^n q_{ik} - b_3 \sum_{j=1}^n \sum_{k=1}^m q_{jk}$$

Aggregation of (3) across the demands for grower k from the processors yields:

$$(4) \quad p_k = b_1 E(s_k) - \frac{2b_2 + b_3(n-1)}{n} \sum_{i=1}^n q_{ik}$$

The grower k 's problem for the derived demand (4) is to choose his effort in quality and quantity to maximize his certainty equivalent:

³ Linear demand systems have been extensively used in models of oligopolies, see (Coughlan, 1985; McGuire & Staelin, 1983; Jaumandreu & Lorences, 2002).

⁴ From now on, the superscripts M and IC will indicate the associated mechanism, i.e. spot market and incentive contract respectively.

$$(5) \text{Max}_{x_k, e_k} CE_k^N = E \left(q_k p_k - \frac{c}{2} x_k e_k^2 \right) - \frac{\rho}{2} \sigma_k^2$$

Upon expanding the above expression, the following is obtained:

$$(6) \text{Max}_{x_k, e_k} CE_k^N = q_k \left(b_1 E(e_k) - \frac{2b_1 + b_1(n-1)}{n} \sum_{i=1}^n q_i \right) - \frac{c}{2} x_k e_k^2 - \frac{\rho}{2} q_k^2 b_1^2 e_k^2 \sigma_k^2$$

Taking into account that $q_k = x_k$ and maximizing (6) with respect to x_k and e_k , a system of two equations with two unknowns is obtained:

$$(7a) \frac{\partial CE_k^N}{\partial x_k} = b_1 e_k - \frac{(2b_1 + b_1(n-1))}{n} \left(\sum_{i=1}^n x_k + x_k \right) - \frac{c}{2} e_k^2 - \rho x_k b_1^2 e_k^2 \sigma_k^2 = 0$$

$$(7b) \frac{\partial CE_k^N}{\partial e_k} = x_k b_1 - c x_k e_k - \rho x_k^2 b_1^2 e_k \sigma_k^2 = 0$$

Since processors and growers face common equations, without loss of generality, in what follows we omit the subscript i and k in the variables. Analyzing equation (7a), we see an inverse relation between quantity and quality.

It cannot be obtained a explicitly closed-form solution for the values of x and e from the previous equations. Thus, a numerical simulation exercise will be carried out as a solution to this model.

2.2. The Incentive Contract

We develop here a generalized moral hazard model for analyzing a general linear contract for sharing an uncertain outcome between a processor and a grower. We assume that in absence of transaction costs⁵ each processor offers each grower an individual contract and that the growers choose their efforts levels no cooperatively. We do not consider the optimal allocation of land ownership between the growers who work with land directly, and their intermediaries who process and sell the growers' output in some downstream market because it does not affect the total joint certainty equivalent.

According to Holmström & Milgrom (1987), when contracting is repeated many times and the agent has discretion in actions, the optimal contract offered to each agent is linear, consisting of (i) a fixed rent, α , which is independent of the observed outcome, and (ii) a share, β , of the observed outcome. Hence, risk-sharing is combined with the incentive effect in this contract. A lower output share exposes the grower to less risk while a higher share gives him greater incentives to supply his effort adequately.

We do not consider the optimal allocation of land ownership between the grower who works with land directly and his intermediary who processes and sells the growers' output in some downstream market because it does not affect the total joint certainty equivalent.

Within this multi-period framework, reputation plays a significant role in contractual enforcement. As growers and processors consider long-term relationships, the fear of loss of contracting will prevent them from failing to take actions prescribed by the contract (Otsuka, Chuma and Hayami, 1992).

With regard to the performance indicator, the grower's contribution to revenue in the downstream market will be chosen because it provides a more valuable signal regarding the grower's action than the input quality, which is imperfectly measured (Holmström, 1979; Hueth and Ligon, 1999a). This performance measure is frequently found in fresh fruits and vegetables (Hueth and Ligon, 2001). Then, the optimal contract by processor i offered to grower k is:

$$(8) w_{ik} = \alpha_i + \beta_{ik} Q_{ik} P_{ik}$$

Next, building on prior research by Holmström & Milgrom (1987), we model the processor i 's behaviour given the grower's optimal response. The processor i chooses the parameters of the linear contract, α_{ik} and β_{ik} , that maximize the expected profit net of growers' compensation, CE_i^C , subject to the constraints that each grower chooses his efforts in quantity, x_{ik} and quality e_k , to maximize his expected utility CE_k^C (incentive constraint), and that each grower attains with each contract at least his reservation utility U_{ik}^{\min} (participation constraint). These constraints ensure individual and incentive compatibility in form of a Nash equilibrium, where agents choose their respective efforts levels individually and no cooperatively. Then, the maximization problem for a representative processor i becomes:

$$(9) \text{Max}_{\alpha_i, \beta_i} CE_i^C = E \sum_{k=1}^n (Q_{ik} P_{ik} - w_{ik})$$

Subject to:

$$(10) \text{Max}_{x_k, e_k} CE_k^C = E \sum_{i=1}^n \left(w_{ik} - \frac{c}{2} x_k e_k^2 \right) - \sum_{i=1}^n \frac{\rho}{2} \sigma_k^2$$

$$(11) E \left(w_{ik} - \frac{c}{2} x_k e_k^2 \right) - \frac{\rho}{2} \sigma_k^2 \geq U_{ik}^{\min} \quad \forall k = 1 \dots n$$

The optimization problem in equations (9)-(11) can be sequentially solved. First, the optimal solutions to the grower's decision on efforts in quantity and quality in equation (10) are obtained:

$$\text{Max}_{x_k, e_k} CE_k^C = E \sum_{i=1}^n \left(\alpha_i + \beta_i Q_{ik} \left(b_1 S_k - b_1 \sum_{j=1}^n Q_{jk} - b_1 \sum_{j=1}^n \sum_{k=1}^n Q_{jk} \right) - \frac{c}{2} x_k e_k^2 \right) - \sum_{i=1}^n \frac{\rho}{2} \beta_i^2 Q_{ik}^2 b_1^2 e_k^2 \sigma_k^2$$

Optimizing and substituting the values of Q_{ik} and $E(S_k)$, we obtain:

$$(12) \frac{\partial CE_k^C}{\partial x_k} = \beta \left(b_1 \alpha_k - b_1 \left(x_k + \sum_{i=1}^n x_i \right) - b_1 \sum_{j=1}^n \sum_{k=1}^n x_{jk} \right) - b_1 \sum_{j=1}^n \beta_j x_{jk} - \frac{c}{2} e_k^2 - \rho \beta_k x_k b_1^2 e_k^2 \sigma_k^2 = 0$$

$$(13) \frac{\partial CE_k^C}{\partial e_k} = \sum_{i=1}^n \left(\beta_i x_{ik} b_1 - c x_{ik} e_k - \rho \beta_i^2 x_{ik}^2 b_1^2 e_k \sigma_k^2 \right) = 0$$

⁵ The assumption of absence of transaction costs is restrictive in the sense that transaction costs of offering contracts are never equal to zero in practice, and offering individualized contracts will generate higher transaction costs. However, the reason for this restrictiveness is to focus on competitive motivations instead.

Here, we should substitute equations (12) and (13) into equations (9) and (11) and maximizing with respect to β , the optimal share for the grower would be obtained⁶. Finally, substituting x^* , e^* and β^* into equation (11), we would obtain the optimal fixed rent α^* . But similarly than in the previous model, these equations can not be solved analytically and a numerical simulation exercise is obtained instead.

3. Simulation and discussion

As we mentioned before, the mean-variance approach has been used to analyze various contractual issues. However, it is usually very difficult to explicitly solve the first-order conditions that define the values of the decision variables in the optimal contract. Quantitative applications of mean-variance models require numerical simulations (Robe, 2001).

Theoretically, growers respond to incentives in contracts obtaining greater levels of quality than in the spot market. And in practice, some authors have obtained conclusive support empirically (for example, Curtis and McCluskey 2003, Alexander, Goodhue and Rausser, 2007). However, given the often present trade-off between the quality of a good and the quality produced, it cannot be assumed that a greater level of quality always leads to a greater level of expected profit.

In this section, we undertake some comparative statistics in order to see how changes in the number of operators, uncertainty and/or grower's risk aversion can explain that the processor could be not acting optimally with an incentive contract. Our models allow two sets of results. First, there are implications about the consequences of contractual choice in grower's decision variables. Second, the models developed above are used to show the optimality of these contractual mechanisms.

We carry out a simulation exercise with a wide range of scenarios and select the examples below as being representative of the behaviour we found. We use Mathematica⁷ to solve the model and Excel to draw the graphs using the data produced by Mathematica. We initially choose the following parameters: $b_1 = 1$, $b_2 = 0,00001$, $b_3 = 0,001$ and $c = 0,4$. It should be noted that these initial values are used for convenience and have no special significance here, and that simulation results do not substantially change if different values for b_1 , b_2 , b_3 and c are used.

It will be seen below that this exercise is able to provide a consistent explanation for many issues relating to governance mechanisms. However, before proceeding, we should note the caveat that this simulation exercise uses restrictive assumptions about the shapes of price and cost functions. Although these seem highly plausible to us for most situations, there may be situations that are not covered by our simulations.

Then, we have three free parameters in our model: the number of growers, n , the number of processors, m , the primary producer's coefficient of absolute risk aversion, ρ , and the variance of input quality, σ_s^2 . It may be worth noting here that the risk premium can be higher for a grower than for another either because he is more risk averse or because he faces higher variance in his income. Hence, these latter two parameters can be jointly identified, $\rho\sigma_s^2$, as both act on the producer's risk premium in a similar way.

For the purposes of the simulation, we consider an identical number of processors and growers, varying from 1 to 40, in steps of 5. Likewise, we assume that $\rho\sigma_s^2$ takes values 0, 0.000001, 0.00001 and 0.0001⁸. Still larger values for $\rho\sigma_s^2$ do not substantially affect the results of simulation exercise reported in this section. Using the equations explained in the models, we calculate the grower's effort in quantity in each contractual mechanism for each of possible combinations, which is illustrated in Figure 1. This process has been repeated for the grower's effort in quality and the total certainty equivalent (see Figures 2 and 3, respectively).

Figure 1 shows that the effect of the spot market on quantity is greater than that of the incidence contract only in scenarios characterized by relevant competition and low levels of growers' risk premium. On the contrary, in situations with imperfect competition, the contract is more likely to provide incentive for growers to provide a level of quantity higher than the spot market. In particular, for an important level of risk premium, independent from the number of operators, the quantity obtained with the incentive contract is greater than the one obtained with spot market.

Figure 2 shows the values of quality for both mechanisms for all values of risk premium and number of operators.

Figure 2 shows that in the absence of grower's risk premium, the spot market obtains an effort in quality greater than the one of the incentive contract, with the exception of successive monopoly ($n=m=1$), in which the level of quality is similar in both mechanisms. As the grower's risk premium increases, the level of quality in both mechanisms decreases, being this effect much more intense in the spot market than in the incentive contract. This result would support the role of risk-sharing inherent in the incentive contract suggested by some authors (for example, Newberry, 1977; Newberry and Stiglitz, 1979). Hence, as the grower's risk premium increases, the incentive contract is more likely to provide greater levels of quality than the spot market.

It may seem contradictory that with a few operators, the spot market obtains a greater level of quality than the incentive contract for all the values of risk premium considered in this simulation. However, it can be explained with the trade-off between quantity and quality. With high levels of grower's risk premium and small number of operators, the spot market obtains a very low level of quantity (see Figure 1). Given the inverse relation between quantity and

⁶ Let the Nash equilibrium values be denoted as $*$.

⁷ The Mathematica commands are available from the authors on request.

⁸ With $=0.0001$ the value of the certainty equivalent per processor is very small.

Figure 1 – Comparing grower’s effort in quantity with incentive contract and spot market.

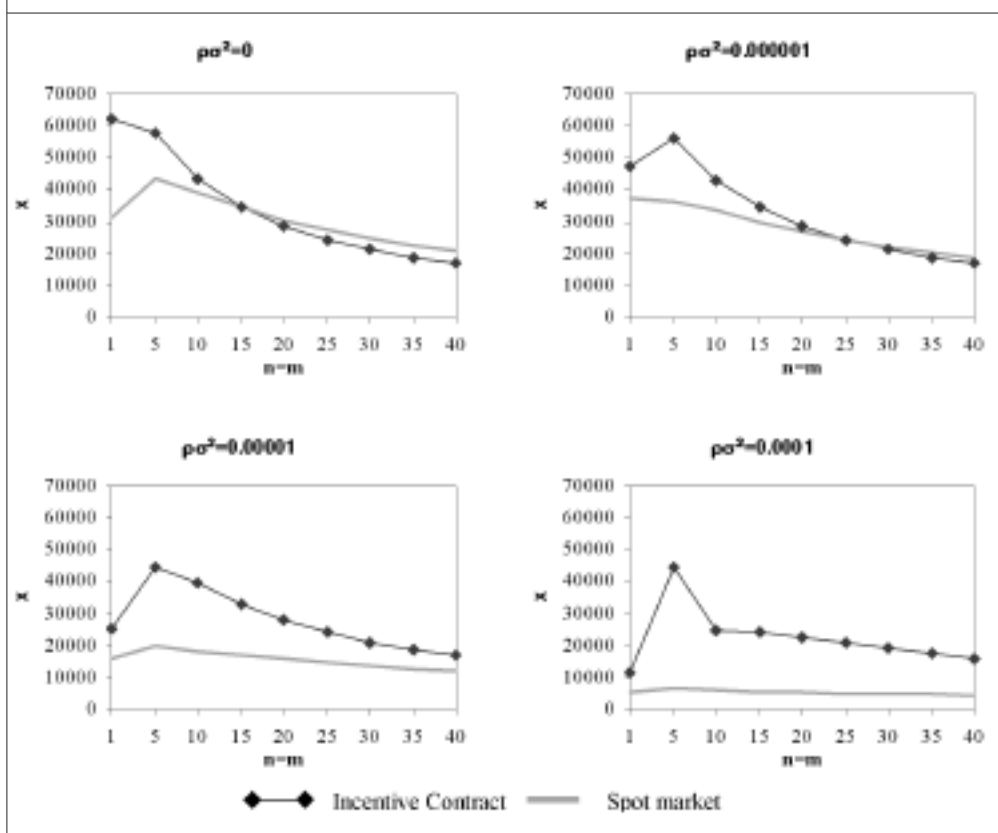
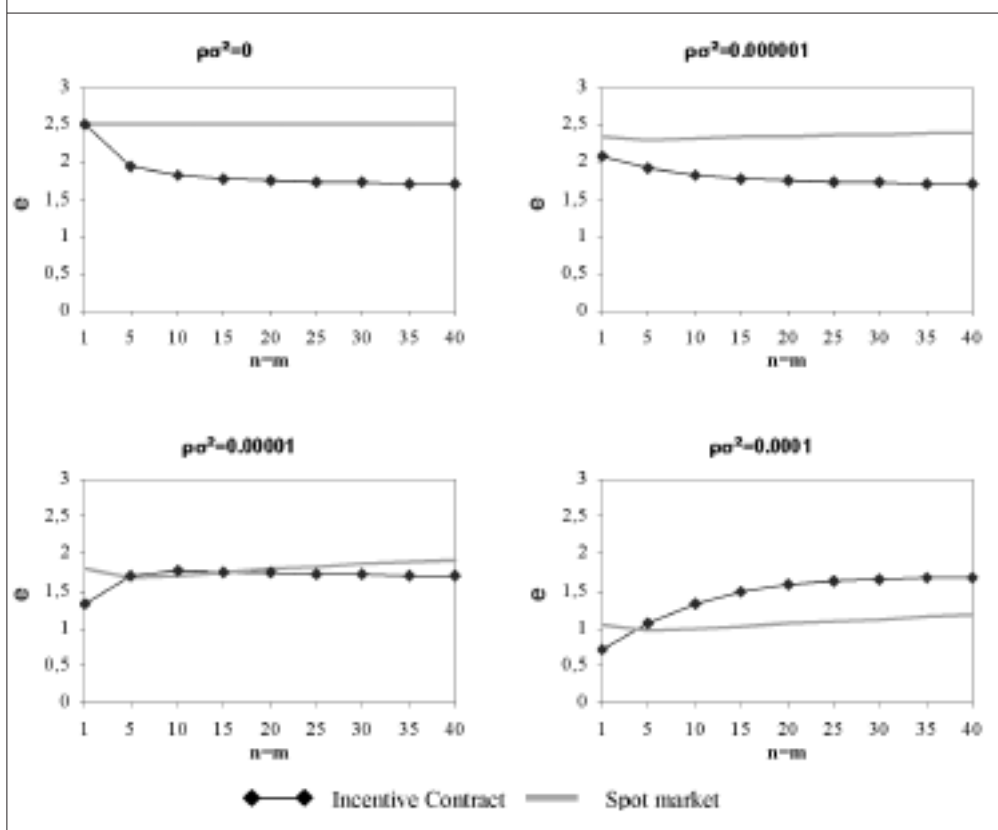


Figure 2 – Comparing grower’s effort in quality with incentive contract and spot market.



quality, the level of quality is relevant in comparison with that of the incentive contract.

Finally, in the Figure 3 we have evaluated the total certain equivalent for all values of risk premium and number of operators considered in the simulation exercise.

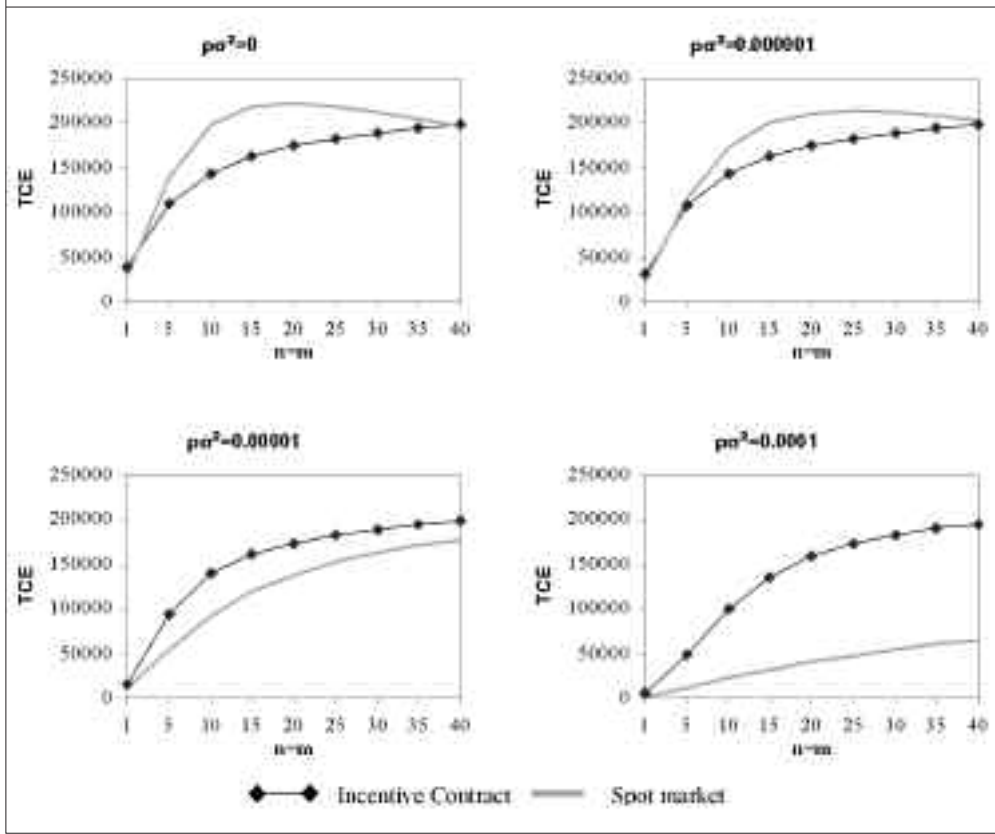
Observing the Figure 3, we see the processors may be either better or worse using the incentive contract compared to the spot market depending on the characteristics of the relationship involved. As agency theory predicts, an increase in the magnitude of grower’s risk premium increases the appealing of the incentive contract while decreasing the appealing of the spot market, considering the total certain equivalent (see Figure 3).

In the first best world with risk-neutral agents and/or absence of uncertainty ($\rho\sigma^2_s=0$), the incentive contract is rarely efficient, only when the number of operators is reduced, nearly successive monopoly. However, in the second best world with risk-averse growers, the spot market becomes less attractive due to the high risk premium supported by the growers in this mechanism.

Then, as grower’s risk premium (i.e. risk aversion or output variance) increases, relative preference for incentive contract is likely to increase over spot market. This result is supported by other studies, for example Cheung (1969), Bardhan (1984) and Parthasarthy and Prasad (1974).

Comparing the three figures, we can see cases in which the incentive contract provides a smaller level of quality but a greater level of total certain equivalent than the spot market (see for example, $n=m<5$ and $\rho\sigma^2_s=0.00001$). Hence, it cannot be concluded that the governance mechanism that provides a greater level of quality is the optimal mechanism considering the total certain equivalent.

Figure 1 – Comparing grower's effort in quantity with incentive contract and spot market.



Likewise, there are situations in which not only the spot market does provide a greater level of quality, but also a greater total certain equivalent than the incentive contract (for example in absence of uncertainty, $\rho\sigma_s^2=0$). This result would suggest that the spot market could be preferred over the incentive contract under several conditions.

Taken together, processors should choose the governance mechanism that maximizes their wealth, not product yield or quality properties. The reason is that it can be concluded that neither a greater level of quality always leads to a greater level of total certain equivalent nor the incentive contract is always more efficient than the spot market.

On balance, from the point of view of efficiency, a processor can be better using the spot market than with an incentive contract depending on the scenario in which he participates. Likewise, our results show that a greater level of quality is not always associated with a greater level of efficiency.

This simulation exercise could also provide a consistent explanation for some results obtained by Alexander, Goodhue and Rausser (2007). They cannot conclude that the benefit of higher quality outweighs the costs of providing the processor with price incentives. Although the offer of these incentives by the processor might appear to be *prima facie* evidence that the processor increases profits by offering price incentives for quality, the results of their analysis do not completely support this inference.

4. Conclusions

The use of contracts to induce growers to provide desired quality attributes has become common practice in many agricultural sectors. To solve the apparent asymmetric information problems between processors and independent growers that universally plague these relationships, the majority of contracts use high-powered incentive schemes to compensate growers (Curtis and McCluskey, 2003; Dubois and Vukina, 2004; Alexander Goodhue and Rausser, 2007). While economists have shown increased interest in the effects on quality of these contracts, surprisingly little attention has been paid to the question whether processors are acting optimally.

To fill this gap, we have developed and applied a model of contractual choice in agriculture by analysing the optimality of the incentive contract and the spot market in the framework of a general-

ized moral hazard model, considering the quantity-quality trade-off and competition.

Specifically, there is a trade-off between yield and quality of many agrarian inputs; higher quality comes at the cost of lower yields and vice versa. Likewise, market prices are higher for high quality than for lower quality products, but exact price levels are determined by market factors such as the relative supply for each good. Thus, prices and yields appear to be inversely related in the aggregated market. However, the literature on contractual choice has long dealt separately with quality and yield probably because they are inaccessible to be analytically solved.

Our analysis illustrates the effects of the incentive contract and spot market on product properties, quality and quantity, on the basis of a simulation exercise. In particular, we analyzed a plausible range of number of operators (growers and processors) and risk premium and carried out a simulation exercise to understand the effects of each mechanism under a wide variety of circumstances.

The exercise throws some light on the relative importance of analysing the quantity/quality trade-off and competition in the analysis of the optimality in governance choice. We cannot conclude from our results that the mechanism that provides a greater level of quality is the most efficient mechanism. Likewise, we cannot conclude that the processor is always better by offering incentive contracts than trading in the spot market.

On balance, the models developed here provide a satisfactory explanation of why processors should choose the mechanism that maximizes their wealth and not the levels of quality. It could explain some of the results obtained by Alexander Goodhue and Rausser (2007), which suggested that offering price incentives does not improve processors' profits.

The simulation exercise presented here leaves unanswered many interesting questions in contracting. One important aspect of the problem, which we have not considered, is that many contracts are based on monitoring. We assumed that the processor can not directly observe grower's effort or infer it from knowledge of the output. However, by monitoring him, they can obtain a reasonable estimate of the grower's effort level, and thereby dissuade him from shirking. Some monitoring of growers is often undertaken by processors (Agrawal, 1999).

Another limitation is that all processors and growers are assumed to be identical. On the basis of previous works, for example Hendrikse (2007), it seems reasonable to conjecture that the possibility of including heterogeneous participants would not influence our qualitative results. However, the analytical difficulties associated with this issue would considerably increase. A similar remark holds for relaxing the assumption that growers are risk-neutral.

This paper provides some interesting implications from an agricultural policy perspective.

It is obvious that each grower faces a trade-off between offering high levels of quantity (and low quality) versus high levels quality (and low yield) of his agricultural inputs. Since these attributes are assumed to have an influence on the price received by the growers, the optimal choice is obviously contingent upon the relationship between the quantity/quality trade-off and the received price.

In the event that agricultural policy is geared towards increasing the quality in the agrarian markets, the policy makers could strive to push growers to produce quality by regulating the specified maximum yield per acre. However, the situation is complicated by the fact that in order to induce growers to produce quality, they must be offered a compensation for the increase in cost associated with it. And if this compensation for cost increases is not associated with higher spot prices, growers can hardly receive it. The alternative, and more realistic, strategy for growers and processors is to think about how to make consumers perceive the quality and pay more for it. Creating a Quality Certified Brand could be a possibility given that it provides consumers with a better understanding of input quality.

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