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Allocation of Authority in Agricultural Production Contracts

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Introduction

The use of agricultural production contracts in agricultural commodity markets has grown rapidly in recent years. In 2003, the share of all agricultural commodities produced under production contracts was 17.5 percent, up from 12 percent in early 1990s. Production contracts are more prevalent in livestock markets than in crop markets. In 2003, the production shares of livestock produced under contracts were 88 percent for poultry and eggs, 50 percent for hogs and 25 percent for cattle. These correspond to a 5 percentage point increase in poultry and eggs, a 20 percentage point increase in hogs and a 10 percentage point increase in cattle production under contract compared to their levels in early 1990s (MacDonald and Korb, 2006).

The growing importance of the agricultural production contracts has led researchers and policy-makers to study the extent and consequences of contracting. Some previous studies have examined the effects of contracting on production chain and distribution of benefits, while others focused on the forces that explain the design of the contracts. This study adds to the latter genre of studies focusing on contractor control of some inputs. Processor (principal, contractor, integrator), henceforth principal, control of inputs is a controversial feature of agricultural production contracts. In a recent article, Hueth et. al. (2007) points out the research needs to better understand this feature: "'Although the farm is often treated as an autonomous decision-making unit, first-level handlers are clearly involved to some extent in decisions that farmers make. What purpose does this involvement serve?"' (p. 1280).

Previous studies on agricultural production contracts have mostly focused on risk–shifting aspects of contracting. In general, these studies have pointed out the tradeoff between risk and expected return in contracts and have concluded that the primary force behind contractual arrangements is risk reduction (e.g. Kliebenstein and Lawrence, 1995; Johnson and Foster, 1994).

Gillespie and Eidman (1998) argued that risk itself does not completely explain why a producer might accept a contract. By assessing the hog production contracts in a multi-attribute (income and autonomy) framework they found that autonomy is a significant aspect of contracts and overlooking autonomy might underestimate the price to attract the independent producers. However, the study does not establish an economic rationale to why farmers desire to maintain autonomy.

While abovementioned studies describe advantages and disadvantages of contracting they do not focus on the forces that form the design of contracts. Goodhue (1999), on the other hand, provides informal discussions of the motivations behind processor control of inputs, suggesting that processors might prefer input control for planning purposes to reduce production costs. For example, control over the timing harvest might be important for scheduling deliveries from many farmers. Another motivation might be controlling input in attempt to preserve intellectual property rights. In some agricultural commodities processors undertake substantial amount of investment in genetic improvements (e.g, soybean seed, chicks). Therefore, instead of selling the input to farmers the processor might contract for production while holding the property rights of the input. Lastly, input control can be effective in achieving the processor's desired quality level of final product. While these motivations explain the implicit tradeoffs for processor and their involvement in input control, they do not explain the incentives for farmers to cede control.

In another study, Goodhue (2000) provides a formal discussion of input controls in broiler industry. The study employs a multi-agent multi-task framework to solve for the combined hidden action and hidden information that the processor faces. Goodhue (2000) finds that the economic rationale in processor control of inputs is the reduced information rents that must be paid to high productivity agents. Implicit in this result is that farmers desire their autonomy in order to maintain their information rents. A significant restriction of this model is that it assumes the decisions are ex ante contractible. However, in actual contracts we observe that it is the decision rights that are contractible but not the decisions. For example, a broiler contract does not specify actual quantity and the quality of the feed that should be used; instead it gives decision right to the processor.

An environment in which decision rights are contractible ex ante but not the decisions can be analyzed by using adaptation theory (Gibbons, 2005; Baker et.al., 2002). The previous studies on agricultural contracts have not employed adaptation theory to explore the forces that govern the contract design. In adaptation theory the central issue is the control and it does not involve ex ante incentives. Conversely, in incentive systems theory the central issue is ex ante incentives and it does not involve control. However actual agricultural production contracts involve aspects of both control and ex ante incentives. Therefore, we developed a hybrid model based on these two frameworks to be able to explain why we observe different levels of farmer's autonomy in production contracts of different agricultural commodities..

Authority Model of Input Controls

We develop a theoretical model of agricultural production contracts that provides an economic explanation of input control by blending some features of both incentive systems and adaptation theories. The developed hybrid model depicts the complex nature of agricultural production contracts that specifies authority for some input decisions while provides incentives for other inputs. Authority is specified for inputs that are difficult to contract on ex ante [1] (e.g. quality of feed). Whereas, incentive schemes are used for some other inputs that are not observable but contractible through a performance measure such as output (e.g. grower effort).

Another feature of the model is that it allows for different degrees of heterogeneity of production environments across farm industries. A higher the degree of heterogeneity in production environment implies higher variations in productivity and type of inputs used. For example, wheat producers might face different soil conditions and/or might use different so that they have higher variations in type and productivity of inputs like seed and fertilizer. On the other hand, swine producers are likely to have similar type of housing or breed of livestock so that they might have less variation in type and productivity of inputs such as feed. In this model we assume that farmers within an industry are homogeneous in ability and relate the observed differences in their performance to the heterogeneity of production environment.

The production function is specified as:

$$y_i = f(e, Q(\alpha_i)) \tag{1}$$

where i indexes on farm industries (i.e. Cattle, broiler, wheat), y is output, e is effort and Q is a composite non-effort input. Non–contractability of Q might arise, for example, from innovation. Since innovation is continuous in time, whereas contracts are discrete, at the time of the negotiation parties might be uncertain of the best type of input to be used in production. Therefore, they would prefer to assign decision rights rather than to administer the input directly in the contract. We introduce a technology parameter α_i which is related to Q but not e. α_i is a random variable and composed of

[1] It is assumed that decision rights are not negotiable ex post.

a constant, β_i, that is common to all agents and an idiosyncratic part, ϵ_{il}, that varies across agents, $l = 1, ..., m$, within industry i:

$$(2) \qquad \alpha_i = \delta_i\beta_i + (1 - \delta_i)\epsilon_{il} \quad \forall\delta_i \in [0, 1]$$

where δ_i measures the degree of homogeneity of production across agents within industry i that is known to both parties.

Composite input is not contractible and its ex ante total cost is unknown to both parties. However, both parties can gather information on α_i to find out the optimal Q. Cost of information on constant β_i is same for both parties and denoted by constant c_i. However, the principal is assumed to have the advantage of splitting the cost across m agents with whom she has a contract. Information on ϵ_{il}, on the other hand, is assumed to be less costly for the agent due to his advantage in learning his site-specific production characteristics. These costs are also assumed to be constants and denoted as s_i^a and s_i^p for agent and principal, respectively, where $s_i^a < s_i^p \; \forall \; i \in (1, ..., n)$.

The payoffs for the agent and principal, respectively, without considering who bears the cost of composite input and search are given by $U^a(y_i, d) = w(y_i) - c(e)$ and $U^p(y_i, d) = y_i - w(y_i)$. Where $w(y_i)$ is transfer function, $c(e)$ is a convex cost function of effort and d denotes the decision on composite input use. The timing of the model is as following:

- Parties negotiate governance structure: both control and contract.
- Parties exert effort and gather information on production technology.
- the controlling party makes a chooses the non–effort input.
- production occurs and payoffs are realized.

The optimal contract can be solved by using backward induction. Accordingly, in the third stage the party who has the control makes a decision that maximizes his/her expected utility:

$$(3) \qquad max_d E_{y_i}(U^j(y_i, d^j(y_i))) \quad \forall j \in (a, p).$$

Then the payoff to the party without control is given by $E_{y_i}(U^k(y_i, d^j(y_i)))\; j \neq k$. The decision right in negotiation stage is then given to the party whose decision provides the highest expected total surplus.

$$TS^j = E_{y_i}(U^p(y_i, d^j(y_i)) + U^a(y_i, d^j(y_i))) \quad \forall j \in (a, p). \tag{4}$$

Optimal contract when effort is observable

Under symmetric information principal can observe effort. First consider the case where the control is given to the agent. The payoffs of agent and principal under agent's authority are given by:

$$\begin{aligned} EU^a(y_i(d_a^*), d_a^*) &= EU(w(y_i(d_a^*)) - c(e) - rQ_a^* - c - s_i^a) \\ EU^p(y_i(d_a^*), d_a^*) &= EU(y_i(d_a^*) - w(y_i(d_a^*))) \end{aligned}$$

where Q_a^* is the optimal quality of composite input for agent and r is the constant cost of the composite input. The agent determines Q_a^* according to the following program:

$$max_Q EU^a(w(y_i) - c(e) - rQ - c - s_i^a).$$

Therefore, unlike conventional principal-agent problems under symmetric information, the first stage problem for the principal is constrained by the agent's maximization problem. This constraint is much like a conventional incentive compatibility constraint, (IC), under moral hazard. In moral hazard models principal provides incentives to the agent to achieve optimal effort. However, in this case principal provides incentives to achieve optimal search of information on Q. In the following, we refer to this constraint as IC bearing in mind its difference from conventional IC. Therefore, the program for the principal's problem that consists of IC and participation constraint, PC, is given by:

$$\begin{aligned} max_{e,Q,w} \; EU^p(y_i - w(y_i)) \\ s.t \\ EU^a(w(y_i) - c(e) - rQ - c - s_i^a) \geq \bar{u^a} \qquad (PC) \\ Q \in argmax_Q EU^a(w(y_i) - c(e) - rQ - c - s_i^a) \qquad (IC). \end{aligned}$$

The lagrangian is:

$$L_{Q,e,w} = EU^p(.) + \lambda(EU^a - \bar{u^a}) + \mu(\partial EU^a/\partial Q).$$

The first order conditions are:

$$\begin{aligned} (5) \qquad L_Q &= \partial EU^p/\partial Q + \lambda \partial EU^a/\partial Q + \mu(\partial^2 EU^a/\partial Q^2) \\ (6) \qquad L_e &= \partial EU^p/\partial e + \lambda \partial EU^a/\partial e + \mu(\partial^2 EU^a/\partial Q \partial e) \\ (7) \qquad L_w &= \partial EU^p/\partial w + \lambda \partial EU^a/\partial w + \mu(\partial^2 EU^a/\partial Q \partial w). \end{aligned}$$

Note that the second term in equation (5) drops out due to the FOC condition of the IC constraint. Similarly, the second term in equation (6) drops out since principal can restrict e to its optimum such that $RTS_{eQ} = c'(e)/r$. This results in an input combination that minimizes production costs, however the principal pays information costs associated with eliciting the optimum amount of search costs needed for the employment of efficient amount of composite input. Since the participation constraint holds with equality, the information costs are equal to the disutility of search costs to the agent.

Now consider the case where the control is given to principal. The payoffs for the agent and the principal under the principal's authority are given by:

$$\begin{aligned} EU^a(y_i(d_a^*), d_a^*) &= EU(w(y_i(d_a^*)) - c(e)) \\ EU^p(y_i(d_a^*), d_a^*) &= EU(y_i(d_a^*) - w(y_i(d_a^*)) - rQ_p^* - c/m - s_i^p) \end{aligned}$$

where Q_p^* is the optimal quality of composite input for principal. The principal determines Q_p^* according to the following program:

$$max_Q EU^p(y_i - w(y_i) - rQ - c/m - s_i^p).$$

Then the optimum contract is the solution to the following program:

$$max_{e,Q,w} \;\; EU^p(y_i - w(y_i) - rQ - c/m - s_i^p)$$

$$s.t$$

$$EU^a(w(y_i) - c(e)) \geq \bar{u^a} \qquad (PC)$$

$$Q \in argmax_Q EU^p(y_i - w(y_i) - rQ - c/m - s_i^p).$$

Note that the principal's third stage problem serves as an IC constraint in the first stage. Assuming that the production functions are identical for both parties[2], the solution for this program is the input combination of (e, Q) that are identical to the previous case. However, in this case, the principal incurs his disutility of search for information instead of paying information rents that compensates the disutility of the agent's search of information. Assuming identical utility functions for both parties, the party that incurs lower search costs provides higher total surplus by holding the authority.

Proposition 1: In the benchmark case (symmetric information) learning costs of production technology is the sole determinant of the allocation of authority.

Corollary: In highly homogeneous (heterogeneous) production environments the principal (agent) is able to increase the total surplus by controlling the input.

[2]This requires that both parties find out identical density function $z(Q)$ after their search.

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