Production Contracts as a Means of Vertical Coordination With Application to the Wheat Industry

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Introduction

Vertical coordination refers to the economic arrangements involved in synchronizing the transfer of outputs from upstream stages of production to downstream stages, which rely on such resources as inputs into production processes that end with consumers. Many such input/output linkages between individual firms form interconnected food production, marketing, and distribution channels linking chains of producers with consumers. Vertical coordination of such a complex and interconnected system may be accomplished by a combination of several methods throughout its length. The focus of this paper is production contracts as a vertical coordination mechanism between the farm production stage and the next downstream stage within food marketing channels.

The following section of the paper provides an overview of the spectrum of alternative methods of vertical coordination with particular attention to various types of contracts. A third section discusses the major trends and factors that are moving food marketing channels toward tighter means of vertical coordination mechanisms, including contracting. The fourth section presents and discusses a model of contracting based on agency theory. Lastly, a hypothetical application of contracting to achieve coordination in an identity-preserved wheat-marketing channel is offered.

Overview of Vertical Coordination Methods

Vertical coordination includes a spectrum of methods used to synchronize the vertical stages of a marketing system (Figure 1). Vertical coordination arrangements can be classified on a continuum, based upon the degree of control exerted by one firm over firms in adjacent stages.

Open spot markets anchor one end of the continuum while closed ownership arrangements occupy the opposite end (Martinez and Reed, 1996). Open market coordination is accomplished through sales on spot markets subsequent to completion of a firm's production process. An example of such an open market transaction is a grain producer delivering and selling grain to an elevator at the spot price without negotiating a prior contract of any kind. Outright ownership is control—which combines adjacent stages into one firm—at the extreme other end of the spectrum. For example, a wheat producer purchases a specialty flourmill to grind his/her wheat into flour (Brester, 1999). This is also common in integrated livestock operations that produce feed in owned mills solely for their own livestock. Between these two extremes lie several other forms of vertical coordination, including strategic alliances, joint ventures, and contracts of various types (Sporleder, 1993).

Strategic alliances are relatively informal agreements between two firms to cooperate in the vertical marketing chain by sharing information while maintaining their formal separate identities. The relationship between parties is largely based on trust while varying degrees of autonomy and flexibility are preserved for the participating firms. A joint venture is formed between two firms when they share an ownership stake in a third firm while maintaining their own formal identity. Control of a joint venture operation is shared and is fully spelled out in the formal legal terms between the firms involved in the joint venture; this arrangement is one step removed from ownership integration (Sporleder, 1992).

Contract Types

There are three general classes of contracts identified in previous literature (USDA, 1996). These are marketing contracts, production management contracts, and production contracts with specified resources provided. Respectively, each of these contracts represents increasing degrees of control by the contractor. Marketing contracts refer to agreements between a contractor and a grower that sets a price or an agreed upon pricing mechanism and an outlet for marketing the product before harvest or marketing livestock. Marketing contracts provide the contractor the least degree of control over the producer since full

Selected Characteristic	Interfirm Alliance	Vertical Contract	Ownership Integration	Joint Venture
Parties to agreement keep formal identity	Yes	Yes	No, one firm maintains identity	Yes
Nature of asset transfer or sharing	Usual to have "hostage" assets committed, each firm a stake-holder	None, a non-equity arrangement, each firm a stakeholder in outcome of agreement	Always actual investment dollars, one firm is shareholder and stakeholder	Each firm is a shareholder and stakeholder
Shareholder in object of cooperation	May be, but not, a key feature	No	Key feature	Usually, investment identified carefully
Nature of control and/or breach and relative vertical control over object of cooperation	Based on trust, exit from agreement relatively easy, least relative control, fuzzy prerogatives and obligations for both parties, maximum flexibility	Presumes opportunistic behavior by each firm, specific obligations, control tends to be ex ante in nature, legal recourse in case of breach, breach expensive	Executive flat replaces contractual control and legal recourse, maximum relative control	Similar to vertical contract
Measurable outcome and length-of-run anticipated	Perhaps, but may only be to "learn" and/or exchange technology or tacit information, usually long-term anticipated	Yes, usually specified in detail in the contract, agreement is usually short-term in nature	Yes, usually in terms of return on investment, usually of long-term nature	Measurable outcome similar to contract, long-term length-of-run anticipated
Relative exit costs	Low	Usually time-related, relatively moderate to high exit cost prior to expiration	High, mistakes expensive	Moderate
Asset synergy expected	Yes	No	Yes	Usually

Figure 1. Characteristics of Selected Vertical Coordination Methods.

Source: Sporleder (1993).

ownership of the product remains with the grower and the grower retains complete management control of the production process. A supplier continues to assume all production risks although he transfers some price risk to the contractor. Marketing contracts are commonly used in the grain industry for future sale of wheat and other grains to a particular buyer. Various pricing terms are commonly incorporated into these types of contracts including fixed price; pooling price as in the apple industry; minimum price and price based on grade and yield as in the pork industry; and delayed price agreements in the grain industry. A major advantage of using a marketing contract is that an outlet for production is established ahead of time for the producer while the purchaser is assured of certain volumes of product to handle or process.

The class of formal agreements referred to as production management contracts represents an intermediate level of control and risk sharing. These contracts include all the significant features

of marketing contracts with additional provisions for the participation of the contracting company regarding management decisions during the course of the production process. This type of contract is prevalent in processed vegetable production where varieties seeded, cultural practices, and planting and harvesting schedules are specified in the contract. Contractors, such as vegetable processors, prefer this type of contract as a means to control the flow of raw products to their processing plants over an extended seasonal production schedule. High oil corn contractors use this type of contract to control the quantity and quality of extra oil containing hybrids planted and the timing and place of delivery of the crop. Premium payments for performance or meeting product specifications are generally provided by these contracts in addition to a base price. These contracts transfer more control and share a greater degree of risk between the parties than marketing contracts do.

Resource-providing production contracts offer the greatest degree of control and simultaneously transfer the greatest risk to the contractor. The contractor retains ownership of a key input into the production process in a resource-providing contract. This contract is most widely used throughout the broiler and turkey industries, where the contractor supplies baby chicks and turkeys, feed, veterinary supplies, and other services to contract growers. The contractor gains a high degree of control in exchange for accepting the price risk associated with processing and marketing the products. Input control may also aid in mitigating the effects of a moral hazard problem, which results in a more efficient outcome but redistributes returns from the producer to the contractor relative to the case when the producer controls inputs (Goodhue, 1999).

Several factors, in addition to the extent of control desired and the degree of risk incurred among the alternative methods, influence the choice of vertical coordination method. Trade customs unique to a marketing channel or product, extent of perishability, the nature of the end use market, and the need to influence the production process for inputs so as to minimize internal costs of production also influence the choice of vertical coordination (Sporleder, 1993). However, risk is most pivotal to the choice of vertical coordination method. In commodity marketing channels, such as grains, the major sources of risk include price, production (quantity and quality), and timing of delivery, including storage and inventory. Agricultural commodity channels exhibit such risks partly as a consequence of seasonal output, weather effects, and the biological nature of production.

In comparison to spot market transactions, a formal vertical linkage from an upstream firm to a downstream firm within the production/marketing/distribution channel can be an important determinant of the absolute risk that a firm experiences in addition to the distribution of risk between the firms. The choice of a particular vertical linkage also influences the amount of control that a firm possesses over factors underlying each type of risk. The choice among exchange arrangements can provide a competitive advantage or disadvantage over rival firms.

Production contracts are most widely used in the broiler and turkey industries. Although the use of contracting is not widespread in the crops industries, there are signs that the use of contracts will become more common in the future, especially in achieving identity-preserved marketing of grains. For example, contracts for high oil corn, waxy corn, and white corn have recently become available in the Midwestern Corn Belt. Production contracts have been used for a long time in the processed vegetable industry for crops such as tomatoes, sweet corn, green peas, and snap beans.

Motives for Entering Contracting

Theoretically, there are mutual incentives—including the reduction of transactions cost, price risk, quantity and quality risks, and financing inputs—for firms to enter into contracts (Martinez, 1999). Contracts can be used to align the producer's incentives with the contractor in order to ensure that the producer takes care to produce high-quality products. The reasons that farmers enter into contracts include income stability, market security, access to specialized capital, and improved efficiency. The grower may want to enter into a contract to avoid the exercise of market power by the buyer of his/her product. The producer may have to invest in production assets that do not have alternative uses (the asset specificity problem), and there may not be alternative buyers (Hennessy and Lawrence, 1999). Most contracts transfer risk from the farmer to the contractor to varying degrees in comparison to open spot mar-

ket production. A contracting farmer can expect a more stable income over time although that income may not necessarily average as high a level as might be otherwise attained. This reflects the mean-variance tradeoff that is an underpinning of economic theory. When a firm bears risk, the opportunity for profit (and loss) exists. As risk is lessened for one firm via transfer of risk to someone else in the marketing chain, the resulting potential profit is reduced. This risk/reward tradeoff varies for each firm depending on management's attitude to risk and expectations concerning potential returns from alternative contracting or non-contract marketing arrangements.

In the case of production management and resource-providing contracts, producers can be motivated to enter into contracts to gain benefits from the relationship with the contracting firm. Technical advice, managerial expertise, market knowledge, and access to technologically advanced crop seeds or breeds of animals may be available only through a contract. This is the case in broiler production, where specialized breeds, feeds, and markets are only available through contracts with other firms. Improved market security is typically conveyed through a set of contract specifications regarding product attributes that are intended to best meet consumer demands. The grower knows that the buyer will purchase his output if contract specifications are met. Resource-providing production contracts eliminate much of the need for growers to obtain production credit on their own because the contractor provides many of the inputs. In some instances, the contractor retains title to the product, and thereby, advances of such resources are not characterized as liabilities on the grower's financial statements. Contracts also provide a means for a farmer to increase the volume of business with relatively limited capital available. Income stability associated with contract arrangements may allow a more favorable credit rating for the borrower, thus enhancing access to credit.

Not all aspects of contract arrangements are viewed positively by farmers. The loss of entrepreneurial capacity and independent control of one's own farming operation is viewed as a disadvantage by many farmers (Skully, 1998). Under contracts, many practices are specified in order to streamline and bring uniformity to the production process across many individual operations. Specified practices may include schedules of chemical applications, planting dates, feeding schedules, and type of inputs used. In essence, farmers become providers of land, resources, and management services for a fee under the most binding of these arrangements. They must judge for themselves whether the tradeoff—of risk and independence in exchange for income stability and confirmed market access—is in their best interest.

Processor Motivations for Contracting

Motivations for processors and other downstream firms to enter into contracts include the control of input supply, improved response to consumer demand, and expansion and diversification of operations. Many agricultural processing activities involve extensive investments in buildings, equipment, and human resources. Processors want to ensure that an orderly flow of raw products are available as inputs into their production process through contracts with suppliers. This allows them tighter control of operating costs while maintaining enhanced quality control of their production.

As processors respond to consumer demand, there may be a need to adjust product attributes, standards, or product form. The life science companies have recently become increasingly powerful in the food system through the development of new output attributes in grains and oilseeds. These firms show tendencies to achieve control over the entire length of the value chain to ensure that their expensive, developed strains of seeds do not get mixed in with conventionally produced seeds. Identity preservation of specific attribute grains via contracts allow more direct and quicker production and allow for orderly adjustments as dictated by the consumer market. This system also allows the life science companies a way to achieve a return on their huge investment outlays to bring enhanced attribute crops to market via genetically altered seeds. The broiler industry has long been especially adept at offering many new products to meet consumer preferences for variety, convenience, and health via innovation throughout their production systems.

Contracting can allow processors to strengthen their competitive position in a market by increasing efficiencies associated with larger volumes of business. Even though this is likely accompanied by increased price risks at one level, large integrated firms may recapture returns in another downstream stage of the marketing channel where prices tend to be less volatile. Financial

strength allows large firms, which tend to be well-aligned with purchasers, to weather periods of low returns longer than those processors that are more dependent upon open markets.

Drivers Toward More Closed Forms of Vertical Coordination

Major trends will likely make the use of the more closed methods of vertical coordination more widespread (Boehlje, 1996). These trends are largely concentrated at the ends of the food production, processing, and marketing system. Trends in consumer tastes and preferences anchor one end, and technological change in inputs, especially through biotechnology developments, anchor the other. These powerful changes at both ends will require adjustments in coordination throughout the middle section of supply chains. The concept of consumer sovereignty holds that consumers ultimately determine what the balance of the chain will supply via the messages that they send regarding their preferences as revealed by their purchases. Food retailers are increasingly exercising the power contained in their scanner data to affect the balance of the food system. Wal-Mart provides an example of how this information on consumer purchases can be transmitted back upstream through the supply chain to automatically signal the replenishment of those items that consumers are purchasing. Consumers are more widely aware and concerned with purchasing healthy, nutritious, safe, convenient foods in an expanded number of forms and flavors. Consumer groups demanding different food attributes are more identifiable with the advent of scanner technology at the grocery checkout. The introduction and widespread use of customer loyalty or club cards has further enabled specific chains and even individual stores within a chain to identify more accurately the needs and purchase preferences of their customers. This translates into identifiable target groups of consumers that the balance of the system should satisfy with desirable attributes. Upstream suppliers increasingly want to become part of supply chains that provide access to information and innovation. Supply chains will have to continuously adapt because consumer preferences, in general, and especially specific consumer niches are dynamic. It will become increasingly imperative for successful firms to be part of chains that constantly innovate as consumers and technology change.

Another major set of forces is referred to as industrialization and is focused on the other end of the food system (Barkema, Drabsenstott, and Welch, 1991). Industrialization implicitly refers to a mentality of manufacturing and process control that is being increasingly applied to food production. Farms are using methods that have long been used in industrial plants. Precision agriculture involves closer monitoring, measuring, and information analysis on an ongoing basis to produce a more uniform quality output. These advances permit the monitoring and control of product attributes—such as starch, protein, and oil content—demanded by food processors, and the technology on the farms now has the ability to supply them and to keep their identity preserved as they move downstream in the food channels.

Biotechnology is also a major force within agricultural industrialization. Genetic engineering allows actual manipulation of seeds and breeds to achieve the desired attributes. This new technology will allow for entirely new attributes and for reduction in the variation in products that has been accepted up to now due to the biologic nature of production. Biotechnology holds the promise of developing nutraceuticals, new strains of crops, and livestock that will contain desirable healthy and nutrition attributes for consumers. Specialized markets for such attributes will call for closely coordinated production and marketing chains to ensure that the products reach the target consumers. Attributes in agricultural products will be increasingly demanded by food processors as they produce differentiated foods for a more health and nutritionally aware consumer.

What may be referred to as intervention technology is closely associated with these technologies. In other words, the ability to intervene and make adjustment in the growing process to overcome problems detected through a production-monitoring process. Soil sensors, plant sensors, weather stations, and environmental control in livestock building are all examples of such ever-advancing intervention technologies.

Food supply chains in the future will need to be more responsive to consumers; this can be accomplished by implementing improved scheduling of product flows and improved quality control through the control of inputs. The power for innovation will reside at the ends of advanced food supply chains. Consumers are sovereign and will be the driving force on one end while the life sci-

ence companies using biotechnology continuously supply more tailored attribute foods from the other end. This power at both ends will enlist participants in the middle of the chain to complete the bridge while maintaining a high degree of control over the entire chain. Being part of chains that progress as consumers and technology change will become increasingly important for business survival in the future. Food supply chains lead to discussion of the issue of contracts and alliances and whether they provide freedom or whether they constrain and confine the choices that firms make.

Theoretical Considerations in Contracts

As contracts become more widely used, a need to deepen the understanding of the relationship between parties involved in such contracts arises. Principal-agent theory offers a framework for examining the economics underlying contracts offered by a principal (the integrating business entity, such as a food processing firm) to another economic agent (another business entity, most likely a farm in the current context).

An illustrative example of such an agency problem is the compensation for legal services. The attorney is the agent, and the client is the principal. What is the best way to align an attorney's incentives with the client's incentives? With a fixed fee, there is no incentive for effort. With an hourly wage, there is an incentive for effort if the attorney's actions are verifiable. Finally, with a payoff based on the sharing of monetary rewards or a contingency-fee basis of compensation, the attorney has an incentive to work diligently in the client's interest, and it is not necessary for the principal to verify the attorney's actions.

Similarly, the theoretical basis of contracting between firms in a food supply chain can be formalized by considering a two-action/two-outcome principal-agent model. The principal is the firm offering a contract to the agent. The two possible actions to be taken by the agent are a and b. The possible production outcomes are x_1 and x_2, with x_2 specified as superior to x_1. The probabilities of outcome x_2 occurring are Prob $(x_2 \mid a) \equiv \pi_a$ and Prob $(x_2 \mid b) \equiv \pi_b$, given actions a and b, respectively, with $\pi_b > \pi_a$. The costs to the agent of performing actions a and b are c_a and c_b, respectively, with $c_a < c_b$. The key assumption is that there is asymmetric information between parties to the contract because the principal cannot observe action taken by the agent. The payoff to the principal is $(x_i - s_i)$ where x_i is the realized outcome and s_i, $i = 1, 2$ is the amount of the payment to the agent. The payoff to the agent is $v(s_i) - \underset{\alpha=a \text{ or } b}{c_\alpha}$ for the realized outcome x_i, $i = 1, 2$.

The principal makes the decision whether s/he should induce the agent to take action a or action b within the constructs of the contract. If the principal wants to induce the lower effort and cost action a, he should compensate the agent only enough so that the agent is indifferent about participating in the contract. Since taking action b is more costly to the agent than taking action a, the principal does not have to worry about structuring the contract so that the agent will choose action a because the agent will naturally choose to take action a, the lower cost alternative.

Now, assume that the principal wants to induce action b, the higher effort and cost action for the agent. Then the principal faces the following maximization problem:

$$(1) \quad \max_{s_1, s_2} \underbrace{\pi_b(x_2 - s_2) + (1 - \pi_b)(x_1 - s_1)}_{\text{expected payoff for action } b}$$

s.t. a participation constraint (PC)

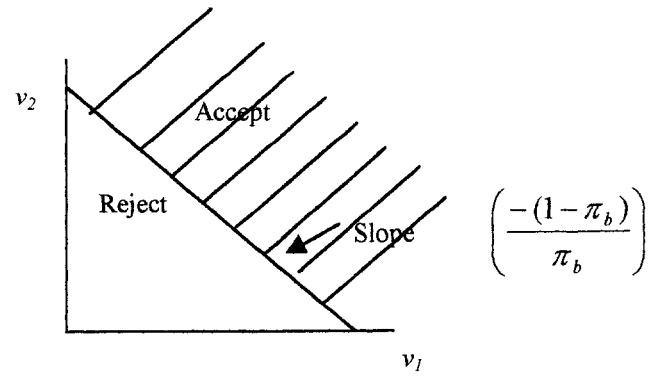
$$\pi_b[v(s_2) - c_b] + (1 - \pi_b)(v(s_1) - c_b) \geq \bar{u}$$

and an incentive compatibility constraint (ICC)

$$\pi_b[v(s_2) - c_b] + (1 - \pi_b)(v(s_1) - c_b) \geq$$
$$\pi_a(v(s_2) - c_a) + (1 - \pi_a)(v(s_1) - c_a)$$

Where $\bar{u}$ is the agent's reservation utility, both constraints will be binding for the optimal contract terms.

In order to illustrate this graphically, let $v_1 \equiv v(s_1)$ and $v_2 \equiv v(s_2)$. The PC can then be expressed as $\pi_b(v_2 - c_b) + (1 - \pi_b)(v_1 - c_b) \geq \bar{u}$. Solving for v_2, we get $v_2 \geq \frac{\bar{u} + c_b}{\pi_b} - \frac{(1 - \pi_b)}{\pi_b} v_1$, which graphically shows the accept and reject regions in v_1- v_2 space.



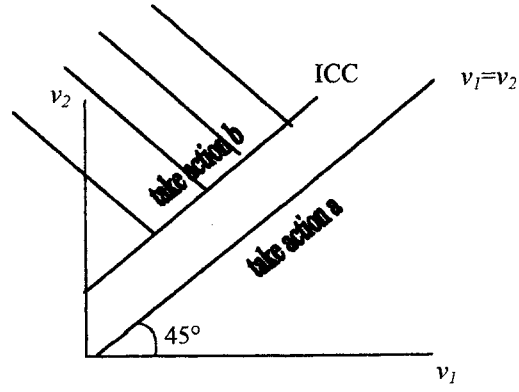
If π_b is small, then the slope will be very steep. Larger payoff will be required for v_2. The IC can be expressed as

$$\pi_b v_2 + (1-\pi_b)v_1 - c_b > \pi_a v_2 + (1-\pi_a)v_1 - c_a .$$

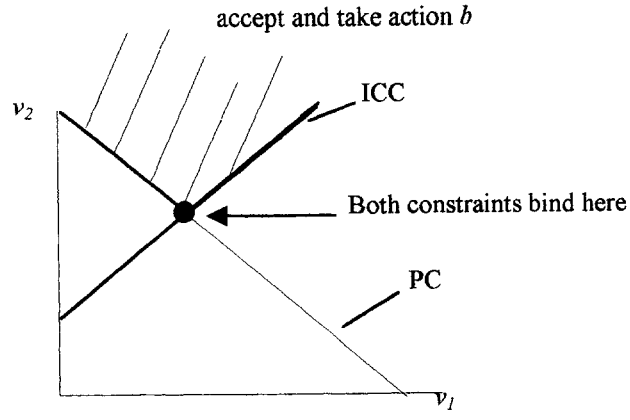
Solving for v_2, we obtain

$$v_2 \geq \frac{(c_b - c_a)}{(\pi_b - \pi_a)} + v_1 ,$$

which is graphically expressed below.



Combining the two graphs (and constraints), we obtain the graph below.



In order to solve this problem mathematically, we will assume that $v(s_i)$ is invertable so that

$$v_i \equiv v(s_i) \text{ implies that } s_i = f(v_i).$$

The problem can be solved mathematically with the following:

$$\begin{aligned}
\mathcal{L} &= \pi_b(x_2 - f(v_2)) + (1-\pi_b)(x_1 - f(v_1)) \\
&\quad + \lambda(\pi_b v_2 + (1-\pi_b)v_1 - c_b - \bar{u}) \\
&\quad + \mu(\pi_b v_2 + (1-\pi_b)v_1 - c_b - \pi_a v_2 - (1-\pi_a)v_1 + c_a) \\
\frac{\partial \mathcal{L}}{\partial v_1} &= -(1-\pi_b)f'(v_1) + \lambda(1-\pi_b) + \mu[(1-\pi_b) - (1-\pi_a)] = 0 \\
\frac{\partial \mathcal{L}}{\partial v_2} &= -\pi_b f'(v_2) + \lambda(\pi_b) + \mu[\pi_b - \pi_a] = 0 \\
f'(v_2) &= \lambda + \mu\frac{(\pi_b - \pi_a)}{\pi_b} \\
\frac{1}{v'(s_2)} &= \lambda + \mu\left(1 - \frac{\pi_a}{\pi_b}\right)
\end{aligned}$$

The term $\frac{\pi_a}{\pi_b}$ is a likelihood ratio. If this likelihood ratio is small, then s_2 must be large. Therefore, the payment to the agent, s_i, is inversely related to the likelihood ratio. Given the expected payoff from each action, the principal must decide which action, s/he would like to induce.

Marketing Identity-Preserved Wheat by Using Contracts

Although identity-preserved supply chains for wheat are currently in their infancy, there are limited cases in which a specific variety, or sub-class, is preserved separately from commodity wheat supplies. There is a strong likelihood that many such chains will be more widely developed and implemented in the future. The use of contracts to maintain the identity preservation (IP) of specifically identifiable wheat, based on enhanced attributes, will be based on contract terms negotiated within the bounded space demonstrated by the forgoing principal agent theory. Offers to growers by contracting firms will have to meet or exceed the participation constraint by providing growers with a level of expected utility that is at least as large as that provided by non-participation in the contract. For example, assume that a new variety of wheat is to be grown under contract for a user of that particular wheat. The grower will have to be offered an expected payoff (as measured by indirect utility) to gain his participation in the contract that is at least as large as that expected by using his resources in the production of commodity wheat. If the contracting firm is unwilling to at least match the expectation of the grower under his ordinary production and marketing program, there will be a lack of participation on the part of growers, and the contractor will be unsuccessful in generating the necessary supply that he requires to meet his customers' needs.

Assuming that the wheat grower participates, the incentives within the contract terms must then be structured in such a way that the grower takes those actions desired by the contractor to actually realize the quality specificity that he desires. For example, in order to accomplish IP, it may be necessary for growers to supply on-farm storage for the specialty attribute wheat as opposed to delivery to a local commercial elevator. This on-farm storage activity for the specialty wheat may be more expensive for the grower than is usual for commodity wheat. Reasons for this may be extra handling, use of smaller-capacity storage bins, and or extra monitoring and aeration equipment to maintain quality. Therefore, he will need an in-

crement of extra compensation built into the contract terms to reward him for taking the necessary actions to keep the grain in sound condition while providing the necessary storage services. The incentive for storage management must be large enough to ensure that the grower will expect it to be worth the extra cost of performing these extra tasks on behalf of the contractor.

An unspecified, although crucial, part of the acceptance/rejection decision of alternative contracts by growers will be based on their individual assessments of the degree of control versus reward tradeoffs. A contracting firm that desires more control will have to be willing to accept greater risk and to provide a more stable payment to the grower. The arrangement may result in lower expected total returns for the grower, yet s/he will expect to achieve more stability over his/her returns in the long run, which may fit his/her strategy for risk management and business survival.

Negotiations over contract terms in the grain industry are really nothing new, in general, although most grain is produced first and then marketed even if it does involve a contract. Most grain is currently marketed via some form of contract although these contracts tend to cover only price and delivery arrangements for a specified quantity of grain subject to standard U.S. grade specifications. Production contracts with the purpose of preserving the identity of specified end-use attributes will be a new method of arranging a market for grain prior to the initiation of production. In many ways there may be efficiency gains because resources can be more accurately deployed to produce those grains desired by specific consumer markets.

Summary and Conclusions

A wide array of vertical coordination methods is used throughout the food system to synchronize the demands of consumers with the suppliers of products. These methods range from traditional open-spot markets, where price is the main coordination mechanism, on one extreme to outright ownership of related activities in fully vertically integrated firms. Although various food industries are at different stages of moving toward the more closed forms of vertical coordination, there can be little doubt that all food supply chains are moving toward more closely managed systems. Contractual arrangements were the focus of this paper, especially production contracts in which a producer agrees to a market prior to actually producing. Production contracts shift risk, and in some cases, allow for the transfer of responsibility for supplying some inputs in the case of resource-providing contracts. Principal agent theory serves as an underlying theoretical basis for understanding contract design and acceptance. The use of identity-preserved supply chains to achieve a better match between the traits desired by consumers is in its infancy in the grain industry. Contracts used to achieve identity preservation are subject to the same constraints demonstrated by the theoretical model, namely participation and incentive compatibility.

Implications of more closed vertical coordination relate to the degree of control that is transferred from agricultural producers to the downstream contracting firm and/or the input-supplying firms. In some cases, these firms may have alliances whereby the contracting farmer uses specific inputs and then delivers to a firm that is aligned with the input supply firm. Some have posited that, in the extreme, farmers will become little more than providers of land and operators of agricultural equipment. This possibility is unsubstantiated and, in the long run, is difficult to justify because farmers will remain in a position to produce and market outside the control of supply chains for the foreseeable future. As long as alternatives to joining the chain via contract exist, there will be constraints on the power of supply chain managers as suggested by agency theory. New opportunity may await producers who carefully consider their necessary role in supply chains and spend considerable time in cultivating and negotiating an equitable arrangement with the principal. This may allow progressive farmers to stay on the cutting edge of new technology and actually thrive as a result of their willingness to apply new technologies in their operations.

Supply chain management and contract specification has implications in the environmental and food safety areas. This is one of the driving forces behind the management of entire supply chains. Food processors and distributors are most sensitive to the reduction of risk achieved through the reduction of the number of firms and other entities that they rely upon to supply them with wholesome, safe foods. As supply chains become more integrated and managed, there may be real benefits achieved in meeting the heightened expectations of

consumers and society for a safe, nutritious, healthful food supply. This may be accomplished by enforcing strict product specifications and production practices that are not harmful to the environment or detrimental to health. If the promises of biotechnology—in terms of improved health and nutrition via food products—can be realized and maintained via supply chain coordination, they may lead to a cleaner environment and a more healthy populace in the long run.

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