Cash Market or Contract?
How Technology and Consumer Demand Influence the Decision

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The use of contracts for producing and marketing agricultural commodities has become nearly universal in some sectors. For decades now, broilers and processed vegetables have been produced almost exclusively under contract. More recently, newly developed high value grains, such as high-oil corn, have been produced exclusively under contract. In 1998, according to USDA, 35 percent of the total value of agricultural commodities was produced or marketed under contract; 90 percent of this amount focused on ten commodity groups. Among the many factors mentioned as being responsible for the use of agricultural contracts, two stand out. The first, a demand-side factor, is the development of strong consumer preferences for specific qualities. When this development occurs, manufacturers and other intermediaries will directly contract with growers to ensure that they receive and pass on to consumers exactly the quality and quantity desired (Drabenstott). The second, a supply-side factor, is technological change and resulting economies of scale. Most technological change, the argument goes, has led to larger operations and, thus, a need for greater supply-channel coordination, possible through contracting (see Bieri, De Janvry, and Schmitz, 1972; Parlberg, 1981).

Both benefits and costs accrue to firms offering and producers using contracts. Benefits to contractors include assured supply and uniform product quality while costs include those arising from asymmetric information, including monitoring and contract enforcement. Benefits to farmers may include a reduction in price risk (Hueth and Ligon; Featherstone and Sherrick) and increased financial leverage (Hennessey and Lawrence). Among the greatest disadvantages to farmers is a loss of managerial control (Featherstone and Sherrick, Hennessey and Lawrence). For example, some broiler and potato producers feel exploited (Baltimore Sun, Richards et al.) and some small family livestock farmers complain that they receive lower prices than their larger competitors (Knight-Ridder, 3/4/2000). On the other hand, an Iowa State University survey indicates that many hog contractors were satisfied with contracting (Hennessey and Lawrence).

While the benefits and costs of contracting are well known, the trigger that shifts transactions from the cash market to contracts is not well understood or documented. In this paper, we suggest an analytical framework that sheds light on a firm's decision to use the cash market or contracts by incorporating consumer demand, technology, and transaction costs into the firm's objective function. The starting point for the analytical framework is the interdependency between transaction costs and property rights. When property rights are completely and perfectly specified, for example, it is not possible for someone to have unauthorized access to the good or rents from the good. If the rights are imperfect, however, it is possible for another party to capture some of the rents, forcing the owner to incur transaction costs to protect his rights over the good (Allen, Barzel). Transaction costs include the cost of information, which includes the cost of determining product quality and enforcing an agreement (North). One component of this is contract enforcement, which includes ensuring that all contract terms are satisfied (including quality specification, delivery, and payment). Thus, efforts by seed and life-science companies to prevent "illegal" seed saving can be viewed as transaction costs necessary to maintain the property rights associated with the seed.

This analytical framework supports the idea that the shift from using the cash market to contract transactions is an institutional response to the increased value of property rights associated with a new production, processing, or marketing technology. Property rights increase in value if changing consumer demand or technological innovation increases the technology owner's potential benefits. As the value of property rights increases, more effort will be exerted to maintain and protect them. For example, a technological improvement may lower costs of production, yet require a specific and uniform product quality. This type of technology would be adopted only if the production cost savings more than offset the added transaction costs required to establish uniform quality. Likewise, increased consumer demand for an identity-preserved product may increase the potential benefits associated with technology ownership, yet also require higher costs to monitor product quality. When identity preservation is crucial, such as for organically produced commodities or specialty grains, potential costs also include market disappearance á la the standard lemons market problem. Contracting is one way to prevent specialized commodities from "mixing" with generic commodities; another way, a market based approach, is to rely on elaborate third-party certification, such as that found in organic agriculture. More generally, contracts can be favored over cash market transactions when the increased ability to capture rents from higher-valued property rights outweighs the increased transaction costs associated with contracts.

Using this logic, we would expect contracting to take place in sectors where there are highly valued property rights associated with a product and where cash market transactions inadequately protect these rights. Specifically, these instances would include sectors where (a) product quality, or uniformity of quality, is highly valued by processors and/or consumers, (b) product quality is imperfectly reflected in the spot market, (c) opportunistic or risk averting behavior by growers strongly affects transaction costs in the cash market, and (d) individual capital constraints facing growers strongly affect transaction costs in the cash market.

We begin by modeling the choice to market inputs either through contracts or in the cash market, using a stylized principal-agent relationship. The framework embodies the interplay between property rights and transaction costs, and indicates how a firm might be willing to protect the value of its innovation by incurring high transaction costs. We further consider how this decision might change as innovation occurs or demand for specific attributes of quality increases. Evidence from the broiler and high oil corn[1] industries is used to support our discussion.

The Game Set Up and Order of Play:

Using a stylized model, we explore a firm's choice to offer inputs for either private contract or cash market sales. We model the transaction as a principal agent problem, where a principal (henceforth called the processor) owns a specific asset, such as high value seed or specialized technology, and wishes to transact with an agent (henceforth called a grower). We assume that both the processor and grower are risk neutral, and are negotiating a one-time transaction.[2] The game between the two is played in six stages as described below.

Stage 1: Processor owns marketing, processing, and input technologies; processor decides whether to market its input through the cash market or a private contract.
Stage 2: Grower decides whether or not to accept the offered sale.
Stage 3: If the grower accepts the sale, the grower receives inputs and chooses the level of effort to maintain the quality associated with the technology.
Stage 4: Nature moves, determining product quality.
Stage 5: Grower harvests output; quality is revealed through an observed quality indicator; processor pays grower based on observed indicator.
Stage 6: Processor resells output.

[1] High-oil corn is targeted to the livestock industry as feed. The corn has a higher protein and oil content than ordinary feed corn, and substitutes for oil in livestock diets, subsequently reducing feed costs.
[2] We make this assumption so that we can focus on the role of transaction costs, property rights, and consumer demand on contracting decisions, rather than emphasizing how contracts share risk.

In the first stage, an owner of a specialized technology, such as high-oil corn seeds, young broilers, marketing technology, or specialized processing equipment (denoted by t) decides whether to offer inputs for sale to growers through a cash market or a private “care-taking” contract. The specialized technology is exogenous, and influences the potential quality of the final product, and therefore, the available rents. In the second stage, the grower faces either a specific “care-taking” contract or cash market contract and decides whether or not to accept the contract. The care-taking contract specifies how the producer will care for the input throughout all stages of production and marketing, while the cash market contracts contain no care-taking provisions. We make the simplifying assumption that the terms of the care-taking contract are fixed, ex ante, and therefore establishing the transaction costs of the contract.

In the third stage, growers who accept either contract choose how much effort to exert when producing and marketing the crop. In the fourth stage, both contract and cash market producers harvest output of quality z, which is a random function of level of input technology and care taking effort. The distribution, $z(e; t)$, is common knowledge and realized quality, z, is perfectly observable to all parties. In the fifth stage, the technology owner pays the grower. Payment terms are specified in the care-taking or cash market agreement and, in both cases, are based on realized quality. In the sixth stage, the processor resells output at a price that is increasing in observed quality, exogenous, and common knowledge.

In order to characterize the equilibrium, we first examine the care-taking contract and the cash market contract separately. As modeled, each transaction (care-taking and cash market) is a standard moral hazard problem, and each forms a separate subgame.

After solving the contract sale and the cash market sale, we turn to the processor's marketing decision. Equilibrium of the game has three dimensions: the share of inputs sold under contract, prices paid to contract growers, and input prices for cash market sales.

Stages 2 and 3 of the Contract Sale

In this transaction, the processor and grower agree to a private contract, where the producer agrees to adhere to the processor's care-taking provisions. After harvest, the producer turns the commodity over to the processor. The equilibrium of the contracting transaction is a set of prices that depends on the quality of the good the grower returns to the processor. Implicitly, this equilibrium depends on the grower's optimal level of effort, the grower's reservation wage, technology, and consumer demand. To characterize this equilibrium, we first turn to the constraints on the optimal contract.

The processor, in order to induce the grower to participate in the contract, offers the grower expected profits at least equal to her next-best alternative. The producer's expected benefits satisfy the following individual rationality constraint:

(4) $E\{w(z(e^*;t\ ))- c(e^*) \geq \pi_1,$

where π_1 is the grower's reservation wage, *w(.)* is the offered wage schedule, and *c(e)* is the producer's cost of effort. Intuition suggests that expected contract wages are bounded from below by expected cash market prices. Alternatively, when no cash market exists, contract wages are bounded from below by expected cash market prices for a different crop. For example, high-oil corn contracts specify some (per bushel) premium schedule, using the Chicago Board of Trade price for No. 2 yellow corn as the base price.

Given the offered wage schedule, a risk-neutral grower picks her own effort level to maximize her expected net benefit:[3]

$$(1)\ \ \max_{e}\ (E\{w(z(e;\ t))\}) - c(e),$$

Her expected revenues, the first term in (1), depend on realized quality, which is determined by the stochastic relationship between effort and technology. This decision leads to the following first-order condition, often called the "incentive-compatibility" constraint:

$$(2)\ \ E\{w'(z(e^*;\ t)\,\partial(z(e^*;t))/\partial e^*\} = c'(e^*),$$

where e^* is the level of effort that maximizes (2). Another interpretation is that the principal offers the proper incentives (in this case, wage schedule) to induce the agent to exert the level of effort desired by the principal.

With the above constraints in mind, then, the processor chooses the wage schedule to maximize expected profits. The processor (technology owner) maximizes expected profits:

$$(3)\ \ \max_{w}\ \ E\pi = E\{B(z(e;\ t);\eta,t)\} - E\{w(z(e;\ t))\} - C_1^{TX},$$

The first term in the equation is the processor's expected benefit from the sale of processed output, which depends on output quality (z), technology (t), and an exogenous demand shifter (η). We assume that expected benefits increase when the exogenous demand shifter increases consumer demand, and when there is innovation in input, processing, and marketing technology. Increases in effort are expected to increase the

[3] A risk-averse agent would maximize expected utility. Under the assumption of no wealth effects, expected utility could be approximated by subtracting the risk premium associated with the expected income.

quality outcome and, in turn, the processor's proceeds. The second term, $E\{w(z(e;\ t))\}$, represents the expected wage schedule from the processor to the grower, given output quality $z(e;\ t)$. The third term, $C_{1,}^{TX}$ is the transaction costs of the sale between the grower and processor. These costs, fixed in the short run, are all the ex ante and ex post costs of the transaction, including costs of writing and enforcement, and could potentially include recruiting and training costs.

Stages 2 and 3 of the Cash Market Sale

In the cash market sale, the processor offers the input for sale to growers at a price v. The equilibrium price depends on all parameters, including technology, consumer demand, and the producer's reservation wage. After harvest, the processor repurchases the grower's output according to a market price schedule, $p(z(e;\ t))$, which is exogenous and known ex ante to the processor and grower, and increasing in quality.

As in the contract subgame, the grower chooses her effort by maximizing expected net benefits: $\max_{e} E\{\ p(\ z(e;\ t)) - c(e)\}$. For a risk-neutral grower, this decision leads to the following first-order condition:

(4) $E\{\ p'(\ z(e^{**};\ t))\dfrac{\partial z(e^{**};t\ \ )}{\partial e^{**}}\ \} = c'(e^{**})$.

In other words, in equilibrium, the producer exerts effort until the point where expected marginal benefit from increased effort equals the marginal cost of effort. The processor, to guarantee grower participation, ensures that prices satisfy:

(5) $E = \{\ p(\ z(e;\ t)) - v) - c(e) \geq \pi_0$,

where π_0 is the reservation wage.[4]

In the cash market sale, the processor selects v, the input price, to maximize expected profits subject to the producer's participation and incentive constraints:

(6) $$\max_{v} \; E\pi = E\{B(z(e;\, t));\, \eta, t)\} \; - [E\{\, p(\, z(e;\, t))\} - v)] - C_0^{TX},$$

where C_0^{TX} are the costs associated with transacting in the cash market.

Optimal Level of Effort for Cash Market and Contract Sales

Given the differences between the endogenous wage schedule *w(.)* and the exogenous price schedule, *p(.)*, logic suggests the contract sale can induce a level of grower effort at least as high as the cash market sale can, or that $e^* \geq e^{**}$. The expected marginal benefit that a grower receives from expending extra effort is $E\{w'(z(e;\, t)\,)\partial\,(z(e^*;t\,))/\partial\,{}^*e\}$ for contract sales, and $E\{\, p'(\, z(e^{**};\, t))\, \frac{\partial z(e;t\,)}{\partial e}\}$ from cash market sales. In each case, expected marginal benefits depend on how responsive the price or wage schedule is to quality. Processors cannot directly influence effort in cash market sales because the market price schedule is exogenous. Processors can, however, manipulate the grower's decision to participate through the choice of the input price, v. Alternatively, contract provisions are under the direct control of the processor. Hence, the processor has control over expected quality and, to lesser degree, realized quality in a contract sale. The processor could, in fact, force producer effort in the contract sale to exactly duplicate producer effort in the cash market sale by setting *Ew*(.) equal to *Ep*(.). Whether a risk-neutral producer would accept such a contract would depend on the cost

[4] It may simplify the analysis to think of π_1 and π_0 as equal reservation expected net income levels. However, because the reservation wage may depend on the presence of an functioning cash market, they may be different for each subgame.

of effort in the care-taking contract relative to cash sale. Ultimately, in our risk-neutral world, the processor can entice higher effort by offering a higher expected wage in the contract sale.

The Principal's Marketing Decision

After solving the two subgames, our attention returns to the processor's decision, in which the processor maximizes expected profits by choosing either a specific contract or cash market transaction. Here, the processor chooses the share of contract or cash market sales, denoted by δ, to:

(7) $\max_{\delta} E\pi = E\{B(z(e;\ t);\ \eta, t_P)\} - \delta\, E\{w(\ z(e;\ t))\} - (1-\delta)[\ E\{p(z(e;\ t))\} - v] - C_{\delta}^{TX}$,

where
$\delta = (0,1)$ is an indicator of a cash market ($\delta = 0$) or contract ($\delta = 1$) transaction; and
C_{δ}^{TX} = the fixed transaction cost to the processor, which depends on the choice of δ.

The problem, given its current structure, has a corner solution, so that in equilibrium, all transactions will take place under contract or in the cash market.[5] Solving for the optimal marketing choice, cash market or contract, involves comparing expected profits under the two possibilities. One finds contracting to be optimal, $\delta = 1$, when expected net benefits from contracting exceed the expected net benefits from cash market sales:

(8) $E\{B(z(e^*;t);\ \eta, t)\} - E\{w(\ z(e^*;\ t))\} - C_1^{TX}) \geq$

$E\{B(z(e^{**};t);\ \eta, t)\} - [\ E\{p(z(e^{**};t))\} - v] - C_0^{TX}$,

[5] Given that growers are homogenous and risk neutral, and that only one caretaking contract is offered, in equilibrium processors will offer only cash market sales or contract transactions. Introducing different levels of contracts or allowing growers to vary by type (and risk preference might define types) would enable processors to offer both cash market and contract transactions in equilibrium.

where e^* and e^{**} are the equilibrium levels of effort from the contract and cash market sales. Alternatively, selling in the cash market is optimal when the inequality in (8) is reversed. Note that each side of the inequality in (8) has three similar terms: the expected benefit from the sale of the harvested commodity, the net expected payment to growers, and the transaction costs associated with each type of sale. Collecting terms allows us to discuss the nature of the inequality more clearly:

$$(8') \quad [E\{B(z(e^*;t); \eta, t)\} - E\{B(z(e^{**};t); \eta, t)\}] \geq$$

$$[C_1^{TX} - C_0^{TX}] + [\, E\{w(z(e^*;t))\} - [E\{p(z(e^{**};t))\} - v]\,].$$

The left-hand-side term is the difference in expected benefit from contract and cash market sales, while the right-hand-side terms are the difference between transaction costs and the growers' increased expected wage under the two scenarios. Therefore if the inequality in (8') holds, the processor's expected net benefit from contracting exceeds the processors additional costs of contracting, and contracting is preferred.

A processor's expected proceeds are likely to be higher from contracting than from cash market sales if three conditions are met: (i) if contracting can induce a higher effort from the grower than does a cash market transaction, (ii) if proceeds are highly responsive to quality and, hence, effort, and (iii) if market proceeds are adversely affected by quality deterioration (a lemons problem). In a sense, each of these three conditions describes a separate stage in the marketing chain. Condition (i) applies to the production stage; condition (ii) applies to the marketing stage; and condition (iii) applies to the consumption or final demand stage.

Contracting Responses to Innovation and Demand Shifts

Our main concern is the processor response to technological innovations and shifts in consumer demand; our thesis is that under certain conditions, the processor's optimal response is a shift from cash market sales to contracts. Hence, our goal is to examine how (8') responds to changes in technology and changes in consumer demand, η, to gauge whether these shifts will make contracting more or less likely. To evaluate changes in (8'), we examine how changes in technology and consumer demand alter the processor's expected net benefits from contracting by examining processor expected benefits, expected grower compensation, and transaction costs. In doing so, we rely on evidence from the broiler and high oil corn industries.

Technological Innovation

We first turn to technological innovation, and examine the impact of changes in technology on the processor's marketing decision by rewriting (8') as follows, where $t^?$ represents a higher technology level:

(9) $E\{B(z(e^*;t^?); \eta,t)- w(z(e^*;t^?))\} - E\{B(z(e^{**};t^?); \eta,t) - p(z(e^{**};t^?))\} <,>,=$

$[C_1^{TX} - C_0^{TX}]$

The first two terms represent the expected net benefits from contracting and cash market sales, respectively. The right side represents the difference in transaction costs between the two contracts, which, for notational simplicity, is henceforth referred to as $? C^{TX}$. Restating an earlier conclusion, contracting is optimal when the left side of (8') exceeds the right side.

Technological innovation enters the processor's marketing decision in several ways. First, based on our assumptions, there will be higher expected quality for each level of effort, which will indirectly increase expected benefits. Technology has a direct effect on processor expected benefits, too, through reduced production costs, more efficient marketing, or other efficiency gains from the new technology. Finally, the optimal contract wage and cash market price schedules will respond to the new technology, changing the optimal effort levels in the two cases. Just how the processor's expected payment to the producer changes depends on the responsiveness of the grower's net payment to an increased maximum quality. Whether the higher technology ultimately leads to a switch from cash to contract sales depends on the net effect of all these factors.

To gain insight, we turn first to the broiler industry and next to the high oil corn industry. Technological advances set the stage for a switch in the broiler industry, from small, independent production to an industry dominated by contracts. Technological advance brought new feed formulations, automatic feeding, and breeding increased the size of flocks, subsequently increasing capital requirements (Martinez). In general, as production costs fell in the broiler industry, producers and integrators were willing to incur higher transaction costs to protect the now more valuable property rights associated with larger flocks and more expensive capital and feed formulations. Larger feed companies soon offered and established production contracts with growers, offering growers inexpensive risk mitigation while maintaining or protecting the property rights by assuring a market for their feed formulations. Further technological change in the industry resulted in chicken processors replacing feed suppliers as primary integrators.

Turning next to high-oil corn, we first note that virtually high-oil corn all has been produced under contract since DuPont introduced the product to the market in 1992, when less than 50,000 acres were planted. Around 1996, a relatively inexpensive (less than $30,000) portable piece of equipment able to measure oil content became available, making it inexpensive to write and enforce contracts that pay growers based on oil content. Acres of high-oil corn planted doubled after the equipment became available. In 1996, 370,000 acres were planted, in 1997, 750,000 acres, and about 1 million acres in 1999.

As these two industries indicate, technological innovation (input, marketing and processing, or contract enforcement) is likely to make contracting more attractive for three reasons. First, a contract arrangement can induce a higher effort level from the grower, which is now potentially more advantageous with the technological innovation. For example, high-oil corn contracts use a premium schedule, rewarding the grower for producing higher quality, which suggests that a grower's management practices have a large impact on final quality. Broiler contracts, which use relative performance compensation schemes, have strong incentive components to induce high levels of effort. A broiler grower's incentive payment is based on relative feed efficiency, an incentive measure that induces both quality-enhancing and yield-increasing effort. Second, a contract protects the processor from an increased potential of quality mixing, a costly externality that exists primarily due to cash market transactions. For example, broiler processors required uniform quality, which was and still is ensured through common genetics and proper management. Because many contract growers supply a single processing facility, the processor requires each grower to adopt similar management practices to assure uniform quality. High-oil corn contracts similarly require growers to produce an identity-preserved crop, and specify specific production, harvest, and storing techniques to ensure that the crop's identity is preserved. Finally, lower contract enforcement costs make contracting profitable at lower expected benefit differentials. For example, contracting for high-oil corn rapidly increased after an inexpensive method of detecting oil content became available.

If, at the higher level of input technology, the net expected benefits exceed the difference in transaction costs between contract and cash market sales, the processor will offer contract sales. Thus, if sales were previously made in the cash market, the processor will choose to offer contracts if the net expected benefits are large enough to compensate for the higher transaction costs. In a more complicated world where a spectrum of contracts exists, innovation can lead to choosing a contract with higher transaction costs to protect property rights more effectively. For example, the processor might be willing to spend more time or money to train and recruit growers. Additionally, a technological change may induce a processor to write a more complex contract, for example, that places greater constraints on the producer's behavior.[6] Thus, technological change in inputs, which generally increases the property rights, might induce a processor to willingly incur higher transaction costs to protect the property rights. The idea of adapting contracting arrangements accompanying technology innovation is clearly demonstrated in the broiler industry. Initially, feed suppliers were the primary integrators. As processing and marketing innovations increased the value of particular breeding lines and processing technologies, processors stood to gain more by protecting and maintaining the property rights associated with the final product than did the feed companies by protecting and maintaining the property rights associated with the feed. As a result, today, most major chicken processors control all the vertical stages, and breed the parent stock, produce the hatching eggs, and provide baby chicks, feed, veterinary services, and technical advice to growers under contract. Put another way, the processor incurs substantial transaction costs to guarantee that uniform-quality birds enter its processing plants.

At the same time, high oil corn contracts are designed to protect DuPont's property rights over the high value seed. Virtually every contract requires a grower to (i) produce and deliver an identity-preserved crop, (ii) deliver the entire crop to DuPont's marketing agent, Optimum, or an agent of Optimum, (iii) purchase seed from specified companies, and (iv) provide Optimum with free access to her fields. Moreover, minimum quality standards are explicit, and include thresholds for acceptable levels of moisture content, weight, aflatoxin, and damage. In our property rights framework, these provisions work to secure DuPont's property rights over the seed innovation. For example, the four common provisions maintain crop integrity and thus its value. By limiting delivery to certain agents (usually grain elevators, end users, or exporters) and requiring that growers purchase seed from specific companies, the seed innovator is able to monitor specialty grain crop quality and, again, its value.

In sum, then, increases in technology are likely go along with higher transaction cost contracts, made possible by an increase in property rights value and potential processor benefits. In other words, a technology increase expands the feasibility of a whole range of contracts, some of which carry high transaction costs. Prior to the technology increase (that is, at a lower level of processor expected benefits), many of these contracts were not economically feasible. This finding suggests that industry-

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[6] An exception might occur if the innovation reduces the cost of observing quality. That is not the case

specific parameters crucially affect the relative size of benefits and transaction costs, and have an impact on the processor's optimal marketing strategy: in our case, cash market or contract sales.

Changes in Consumer Demand

Analyzing the effects of an increase in consumer demand is slightly easier because consumer demand directly impacts only one term, the expected benefits to the processor. Consumer demand, however, has an indirect effect on equilibrium effort. The direct and indirect effects enter the processor's profits as follows:

$$\text{(10)} \quad \mathrm{E}\{B(z(e^{*};t);\eta^{?},t) - w(z(e^{*};t))\} - \mathrm{E}\{B(z(e^{**};t);\eta^{?},t) - p(z(e^{**};t))\} <,>,= [C_1^{TX} - C_0^{TX}]$$

Increased consumer demand increases the value of the processor's property rights, which manifests as an increase in the processor's expected benefits. The higher expected benefit increases the likelihood of contracting, as processors are willing to incur transaction costs to preserve the more valuable property rights. For example, as the market for the maximum quality product (e.g., high-oil corn) gets stronger, the potential losses from identity deterioration increase. The processor would be expected to induce extra effort and reap additional benefits in the final product market by requiring the grower to take steps to preserve product identity. Another example is increased consumer demand for particular attributes, such as "pesticide free" and "non-GMO". Nearly all fruit and vegetable contracts between producers and baby food manufacturers include provisions for ensuring that the final product is pesticide free. In the same vein, some manufacturers of chips and candy are adding contract provisions requiring producers to use only nonGMO products. In both cases, processors are willing to incur

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modeled here.

the higher contracting costs in order to meet consumer demand, because the cash market is unlikely to provide the same attribute assurances.

Conclusion

In this paper we have attempted to show how the decision to contract can be framed as an institutional response to changing industry and market conditions. More specifically, we have argued that when innovations increase available rents to technology owners, contracts can replace cash market transactions even though contracts carry higher transaction costs. In the broiler industry, for example, technological innovations gave processors and their agents the ability to produce a steady, assured supply of near-uniform quality birds and, in turn, the ability to capture rents in the processing and marketing channels. One of the costs of capturing these rents, however, was the high costs incurred to recruit, train, and monitor broiler growers and enforce contracts. Likewise, in the high-oil corn industry, genetic improvements, new seed formulations, and inexpensive monitoring equipment gave seed manufactures and their agents the ability to produce a highly valued, identity-preserved product. Again, the cost of capturing the rents associated with these improvements was the high transaction cost associated with contracting. At the root of both these stories is the notion that innovation increased the value of the technology owner's property rights and higher costs are likely to be incurred to maintain and protect these rights.

We have also argued that changing consumer preferences can similarly increase the value of property rights, and thus stimulate higher transaction costs. In the broiler industry, increased demand for packaged poultry coincided with technology innovations; and in the high-oil corn industry, a preference for the new corn has developed among feed companies. In both these cases, processors and consumers require a high-quality, a uniform-quality, and/or an identity-preserved product. Quality or identity maintenance, however, lead to higher transaction costs between processors and growers.

Using a stylistic model, we have tried to examine the market conditions that would favor contracting over cash market transactions. The model compartmentalizes the problem into two subgames within a larger processor-grower game. We find that the contracting decision is dependent on several exogenously determined factors, including (i) the responsiveness of processor benefits to quality, (ii) the responsiveness of the market price to quality, (iii) the level of transaction costs associated with contracting, (iv) the differential between the improved input and a conventional input, (v) the level of consumer demand, and (vi) the grower's reservation wage. In broilers, for example, contracting emerged quickly because, among other reasons, processor benefits were highly responsive to quality, consumer demand increased steadily, and growers had low reservation wages. Contracting in high-oil corn likewise has been swift because processor benefits were highly responsive to quality, there was a larger differential between the improved and conventional inputs, and demand for the identity-preserved product is strong.

That these results and arguments are intuitive is not surprising. What is promising, however, is how easily they fall out of a very simple model based on a very simple processor-grower game. Useful next steps will include elaborating on the model to fully account for production and price risk, allowing a broader spectrum of contract types – each with different transaction costs, and allowing for multiple processors – each owning technology of different quality.

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