

Application of Vertical Coordination Theories to the Broiler and Pork Industries

As defined in the pioneering effort by Mighell and Jones, vertical coordination includes all the ways that vertical stages of a marketing system are synchronized. Methods of coordination can be classified according to the degree of control over other vertical stages. At one end of the spectrum is *open market coordination*, representing the least control. Open market coordination refers to sales that are made after production has been completed. At the other end of the spectrum is *vertical integration*, representing the most control. Vertical integration refers to ownership and management of two or more successive stages of the marketing system by a single firm. Intermediate forms of coordination, which lie between open market coordination and vertical integration on the spectrum of control, include *quasi-vertical integration and contracting*. Quasi-vertical integration occurs when a firm owns a specific asset that is used by one of its suppliers. Contracting includes market-specification contracts and resource-providing contracts. Market-specification contracts typically specify a market outlet, delivery schedule, and method for determining the price. Resource-providing contracts, in addition to providing for a market outlet, provide for direct participation by both parties in the management of farm production and the provision of important inputs.

There is extensive theoretical literature regarding the motives for contracting and vertical integration. This section applies this theory to the broiler and pork industries. Incentives for contracting and vertical integration include reducing transaction costs, reducing price and quantity risk, and financing production inputs.¹¹ By understanding the motives for such arrangements, one can better understand their potential effects on the quantity, quality, and prices of pork and chicken products.

¹¹Motives related to market power also exist. Discussion of these motives is in the section “Policy Responses to New Methods of Vertical Coordination.”

Transaction Costs

Transaction costs are expenses associated with carrying out a transaction. These include costs related to: insufficient information regarding terms of the transaction; searching for the “best” price; negotiating, monitoring, and enforcing contracts; and costs of relaying information in vertically integrated operations.

Transaction cost economics seeks to explain the variety of organizational arrangements that are used to coordinate resource transfers across stages of production. The central theme underlying transaction cost economics is that the efficiency of alternative organizational arrangements is measured by the costs of trading under each (Masten). Contracting and vertical integration in the broiler and pork industries offer incentives for reducing transaction costs associated with asset specificity, measuring and sorting costs of the traded goods, and assuring supplies and market outlets.

Asset Specificity

An important feature of industrialization in both the broiler and pork industries is the development of new production technology. Advances in feed formulations, production facilities and equipment, nutrition, and disease control result in scale economies for larger operations. Genetically improved breeding stock enable producers to select highly productive animals with traits that producers, processors, and consumers value.

Highly technical production processes may require specific assets—assets whose value is much greater in a particular use than in the next best alternative. Specific assets include physical, site, and temporal forms. An asset’s unique physical characteristics can make it a specific asset. Hatcheries, broiler houses, feed facilities, and processing plants, for example, can be considered specific assets because they have few alternative uses (Reimund, Martin, and Moore; Sawyer; Marion and Arthur). An asset’s location can also make it a specific asset. When one party to a transaction, for example, locates its facilities close to the other party in an attempt to lower transportation costs, the asset may

acquire a site-specific value. Temporal specificity arises when the timing of performance is critical, such as with perishable agricultural commodities (Masten). Many vegetables, for example, require processing soon after harvest to maintain quality (Manchester). After farmers invest in production inputs, processors may delay delivery to extract price discounts.

Specific assets may generate quasi-rents, which measure the value of the asset in excess of its next best alternative use. To illustrate, consider the example provided by Gallick. A horse carriage can be rented to transport tourists for \$180 per day or rented as a museum piece for \$100 per day. In this case, the quasi-rent is \$80 per day.

Opportunistic behavior (self-interested behavior unconstrained by morality) may reallocate quasi-rents from the owner of the specific assets to the trading partner. Once the owner has invested in the specific assets, the other party may offer a lower price than specified before the investment. However, whether the quasi-rent is appropriable depends on a small-numbers condition (small number of bidders in the market) (Williamson, 1975).¹² Continuing the example, if there is only one bidder for the horse carriage to transport tourists, then the entire quasi-rent could potentially be appropriated by that bidder. That is, the bidder could decide to pay less than \$180. As long as the offer exceeds the value of the carriage as a museum piece (\$100), the owner of the carriage is better off renting it to transport tourists. However, if there are several bidders for the carriage to transport tourists at \$180 per day, then the \$80 in quasi-rents would not be appropriable. As asset specificity increases, parties become more susceptible to opportunism in the presence of few bidders (Williamson, 1975).

The threat of opportunistic behavior may result in welfare losses because mutually-advantageous trades do not occur (Milgrom and Roberts). For example, investment in a large-scale production operation that benefits producers, processors, and consumers may not be made for fear of opportunism.

¹²This point was contributed by Jim MacDonald, ERS.

The use of specific assets to produce intermediate goods may serve as an incentive to vertically contract or integrate to protect the asset owner from opportunistic behavior (Klein, Crawford, and Alchian). Contracts can help to place limits on acceptable behavior. Vertical integration can alleviate adversarial relationships.

Asset specificity in the broiler industry is significant, which may influence the types of coordinating arrangements used. Broiler housing facilities, processing plants, and breeding stock have a low value outside of their intended purpose (physical asset specificity).¹³ Broiler growers tend to be located close to feed mills and processing facilities because broilers are perishable commodities (temporal specificity) and transportation costs of feed, chicks, and grown broilers are high (site specificity) (Lajili; Marion and Arthur).¹⁴ Because processing must occur soon after production has been finished, broilers are considered to be perishable. Delays at this stage may elicit price concessions from the producer who would be hard pressed to find alternative markets on short notice. Following the broiler depression in the early 1960's, feed suppliers integrated with processors to assure themselves of a market for their broilers. (Hog producers, however, may have more time to find suitable market outlets. Temporal specificity may partially explain why the broiler industry has integrated its production and processing stages, while the pork industry is coordinated through marketing contracts.) Another form of asset specificity in the broiler industry is site specificity. Spatial concentration of processor-integrators may reduce the number of alternative trading partners for the broiler growers because the processor-integrators prefer to obtain broilers within a 20-mile radius (Rogers, 1992). Contracts between growers and an integrator reduce the likelihood of opportunistic behavior on the part of the integrator.

Investments necessary to take advantage of economies of size in hog production and processing may also be considered as site-specific assets (Martinez, Smith, and

¹³In addition, when feed mills entered the South, they were specialized facilities designed for serving the broiler industry (Sawyer).

¹⁴Processing plants tended to locate closer to broiler production areas as advances in transportation allowed dressed broilers to be transported greater distances (Rogers, 1992).

Zering). These substantial investments are highly specific to both parties and neither can survive in the long term by transporting hogs long distances. Producers located near one or a few processors may be subjected to opportunistic behavior by the processor. Once the producer's facilities are built, the processor may attempt to gain some of the quasi-rents accruing to the producer by offering lower prices for hogs. Similarly, a processor that locates in an area with few producers would be subject to opportunistic behavior by the producer. In this case, quasi-rents are the difference between the local price and the price of more distantly located hogs.

Multiyear marketing contracts between hog producers and processors may reduce the likelihood of opportunistic behavior related to site-specific assets. Asset specificity, together with the small-numbers condition, may account for the disparity in procurement methods used by the two largest pork packers, Smithfield Foods and IBP. Smithfield owns approximately 10 percent of the hogs that it slaughters and obtains 52 percent from multiyear marketing contracts with several large hog producers (Smithfield Foods, Form 10K, filed with Securities and Exchange Commission July 25, 1997). It also possesses 72 percent of packing capacity in the South Atlantic region (North Carolina, Virginia, South Carolina, Georgia, and Tennessee). On the other hand, IBP's main supply of hogs is purchased daily on the open market by buying agents (IBP, Form 10K, filed with Securities and Exchange Commission March 26, 1998). IBP is located in the North Central region (Illinois, Iowa, Minnesota, Missouri, Kansas, Indiana, Nebraska, South Dakota, and Kentucky), where no one packer possesses more than 25 percent of available packing capacity. Hog producers also tend to be smaller and more numerous in the North Central region than in the South Atlantic region.

Marketing contracts can also reduce the incidence of opportunistic behavior associated with investments to improve hog quality (physical asset specificity). Once a producer makes the investment, the premium for the higher quality hogs becomes a quasi-rent that can be appropriated to the packer (Martinez, Smith, and Zering). The producer can either accept the lower premium or sell the hogs on the open market and receive no premium. For example, carcass value pricing, which refers to carcass weighing and inspection after slaughter

to determine price premiums and discounts, has become the chief method for pricing hogs.¹⁵ Packers currently pay premiums to producers of large and lean hogs. Selection of breeding stock to produce leaner hogs, however, has led to increased incidence of the stress gene, which is associated with pale, soft, exudative (PSE) pork (tough, dry, and lean pork).¹⁶ Investments in breeding stock to reduce the incidence of PSE pork may be considered a specific asset. Once the investment is made, the premium for PSE pork over the open market price offered by the packer becomes a quasi-rent that can be appropriated to the packer. Because open markets do not include premiums for hogs bred from genetic lines that are free of the stress gene, the packer can lower the premium initially offered. The producer can either accept the lower premium or sell the specially bred hogs on the open market for no premium. Marketing contracts that specify payment of quality premiums reduce the likelihood of this type of opportunistic behavior.

Furthermore, premiums can vary substantially among packers because they have different processing equipment and may serve different markets. They may also use different methods to determine carcass premiums and discounts. For example, because consumers prefer consistency in the products they purchase, packers discount their prices for carcasses that do not provide the size of cuts desired. An analysis of carcass value pricing schemes used by 10 large packers found that 2 packers paid no premiums for lean, when carcasses were below 160 pounds, while other packers paid a range of premiums (Kenyon, McKissick, and Lawrence). Seven packers used backfat and loin depth to compute percent lean, while three packers used backfat measurement only. Differences among pricing schemes, which make it difficult for producers to compare prices, increase the potential for opportunistic behavior by the packer after the producer has invested

¹⁵Historically, hog prices were negotiated on the basis of live weight.

¹⁶Pale, soft, exudative pork occurs when the muscle from the pork carcass is pale in color, has a soft texture, and is watery (exudative). Because PSE pork is more susceptible to moisture loss, processors and retailers can experience significant costs due to reduced processing and storage yields. Panel scores suggest that pale-colored pork is less acceptable to consumers (McKeith, Ellis, and Carr). PSE pork is also less tender because of increased cooking losses.

in specific breeding stock. Long-term marketing contracts can reduce the likelihood of opportunism in the production of pork with unique quality characteristics.

Measuring and Sorting Costs

Quality attributes of the raw product may have an important influence on processing costs and value of the final product. For example, processors may reduce their costs by processing leaner hogs because of lower handling costs and more salable meat. In addition, consumers may be willing to pay a premium for leaner pork. In the pork industry, important quality factors for processors and consumers include hog size, leanness, uniformity, and PSE. Important quality attributes for processors and consumers in the broiler industry include size of the birds, uniformity, and yield of high-value breast meat.

Measuring and sorting costs associated with quality attributes of the raw product can be reduced by contracts between the producer and processor or by vertical integration. Producers and processors may have different information for determining whether the terms of a transaction are acceptable or whether they are being met. This situation is referred to as *asymmetric information*. For example, producers may have more accurate information regarding the quality of their product. If this information is freely available, then equally valued products will sell at an equal price. When quality information is costly to obtain, however, producers may attempt to sell high- and low-quality products at the same price. Hence, buyers may demand costly measurement of raw product attributes to determine its value, and inaccuracies could result in wealth transfers (Barzel). In addition, if quality attributes of the raw product vary, then costly sorting may be required to determine its value. If the quality of the intermediate or final product can be controlled by the producer, however, then the processor can reduce the cost of presale measuring and sorting by changing the method of coordination. Long-term contracts that specify quality attributes, and direct control through vertical integration, may reduce the need for costly measuring.¹⁷ Contracting or vertical integration becomes more likely as the value of

¹⁷Hennessy develops a theoretical model that demonstrates incentives to vertically integrate because testing for quality is costly and subject to error.

the good becomes more uncertain because the opportunity for exploiting errors in measurement increases.

To illustrate, consider the following example paraphrased from Barzel. While the weight of an orange can be measured at virtually no cost, weight provides little information as to the true value of the orange. The skin of the orange hides information regarding its taste and juiciness, and direct measurement of these attributes by peeling and squeezing at the time of purchase is costly. Hence, the quality attributes of the orange are subject to measurement error. The producer may attempt to exploit errors in measurement by charging equivalent prices for both low- and high-quality oranges. To prevent such opportunistic behavior, the purchaser may incur expenditures to measure the value of the oranges. New methods of coordination, however, may limit expenditures for this purpose: 1. If a seller agrees to deliver a certain quality of oranges under a contractual agreement, the purchaser's need for presale testing of quality declines: 2. By combining both the production and processing of the oranges in a single firm (vertical integration), the need for costly measuring is lessened.

On the open market, several buying agents may be required to purchase hogs that conform to the specifications of the packer. Attributes that are difficult to measure at the time of grading, such as PSE, may require costly testing that is prone to errors. Because the value of hogs is largely determined by genetics and weight, the use of long-term contracts between producers and packers that specify quality characteristics may reduce measuring and sorting costs. Large packers favored long-term contracts chiefly as a means of assuring the quality and consistency of hogs (Hayenga and others). Half of the large packers surveyed required minimum quantity and quality specifications or specific genetic requirements. Direct control through vertical integration can also reduce measuring and sorting costs.

The broiler industry uses production contracts and vertical integration to control size, aesthetics, and uniformity for meeting the quality requirements of slaughter plants and the specifications of retail customers. Because many contract growers supply one processing facility, replication of growing conditions, such as the

use of high-quality inputs, and proper management, are very important for producing high-quality, uniform birds. The specific requirements of production contracts reduce variations in birds across grower flocks and over time. The contracts generally provide management services and may require each facility to have the same equipment. Growers are trained in proper management practices. Water and feed placement, for example, can have an important effect on broiler quality as chickens may suffer scratches on their skin from crowding around an inadequate number of feeders (Stillwell). Feed ingredients and genetics also have an important influence on broiler quality. By vertically integrating into breeding, most of the major processors directly control the genetics of the breeder chicks (Rogers, 1992). Feed from processor-owned feed mills also helps to ensure that each grower obtains similar, customized feed ingredients.

With uniformity of birds resulting from control over production inputs and management services, mechanized processing and handling became possible (Bugos; Rogers, 1992). This is illustrated by the procedure used to slaughter birds. Live broilers are hung by their feet on shackles that roll by on a chain. As they move through the plant, they are electrically stunned, bled, plucked, and eviscerated, emerging as dressed broilers. Throughout the entire process they are seldom touched by human hands. Such automation would not be possible with varied body shapes. In 1961, Holly Farms became an integrated company by adding hatcheries, feed mills, a breeder flock, and a processing plant, and contracting for broiler growing. By 1964, Holly Farms was the first to commercially market broilers that were prepackaged at the processing plant, which required close quality control at all stages (Marion and Arthur).

Production contracts with growers can also reduce measuring and sorting costs related to pathogen content by allowing the processor to implement quality controls quickly and thoroughly. Stricter food safety performance standards place a greater burden on the slaughter plant, which in turn, places greater pressure on live production to help meet the stricter regulations (Stillwell). As additional research into pathogen control proliferates and new management practices are identified, these practices can be quickly implemented

through production contracts. Furthermore, production contracts provide a means of tracing the animals back to the farm of origin.

Supply and Demand Assurance

By contracting or vertically integrating, firms may increase the likelihood of obtaining a given flow of live animals to avoid costly overuse or underuse of processing facilities. Modern, efficient processing plants can lower unit processing costs, as well as retail meat prices, compared with older and smaller plants (fig. 7). Large fixed costs associated with processing, however, suggest that deviating from the optimal utilization level can lead to substantial increases in costs. In modern processing plants designed to operate efficiently at a stable output level, costs rise quickly when output is highly variable (Barkema and Drabenstot). This is illustrated in figure 7 by the more sharply sloped shortrun average cost curve for modern plants (SRAC'). When the flow of raw inputs is highly variable, variations in output lead to larger increases in per unit costs than with the older plants. Hence, it becomes more important to control the quantity and scheduling of live animal inputs.

Contractual arrangements have been used in both the broiler and pork industries to assure supplies of live animals. Large packers indicate that "increased volume" of hogs delivered to the slaughter plant is an important reason for multiyear marketing contracts (Hayenga and others). Marketing contracts may specify the number of hogs per day or week to be delivered.

Contracting and integration can also reduce uncertainties related to market outlets. Feed suppliers found that by establishing production contracts with broiler growers, they were assured of a potentially large market for their feed supplies. Large hog producers ranked "assured market outlet" for their hogs as the most important reason for contracting (Hayenga and others).

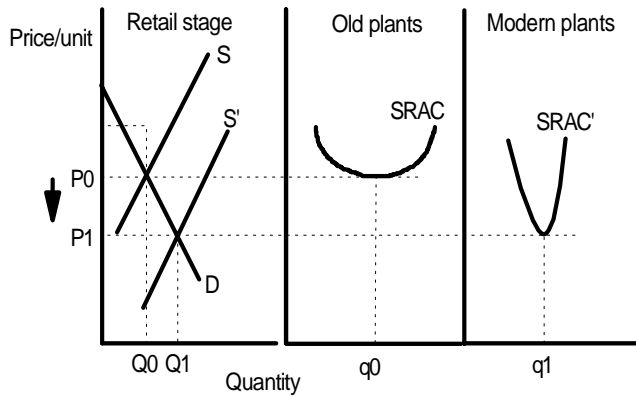
Price and Production Risk

Price and production risks in agricultural industries can lead to highly variable incomes. The relationship between inputs and output is subject to many uncertainties, such as weather, disease, and accidents. A portion of this production risk is specific to the particular

Figure 7

Effect on the retail stage of operating processing plants at optimum capacity

Modern processing plants are more efficient, but that efficiency comes at a price; the steeper curve in the modern plant means that its costs rise quickly if the volume of production varies much from the optimal level



Note: S and S' are the aggregate retail supply curves associated with production in old and modern plants, respectively. D is aggregate demand at retail. P0 and Q0 are the equilibrium retail price and quantity, respectively, associated with production in old plants. P1 and Q1 are the equilibrium retail price and quantity, respectively, associated with production in modern plants. SRAC and SRAC' are the short-run average cost curves associated with old and modern plants, respectively. q0 and q1 are production levels associated with the minimum of the short-run average cost curve for the old and modern plants, respectively.

Source: Compiled by ERS, USDA from Barkema and Drabensstott, 1990.

producer, such as equipment problems, while other risks are common to many producers, such as weather conditions. Producers also face risk related to market prices of inputs and output.

By paying producers according to a relative measure of performance, contracts can serve to shift price and production risk from producers to integrators.¹⁸ Price risk for live broilers is not borne by the growers because their payment is independent of feed prices and broiler market prices. In addition, growers receive a payment that depends on their performance *relative* to others. When each grower's performance is affected, the payment remains unchanged. This reduces production risk that is common to each grower, such as unfavorable

¹⁸Many producers are willing to accept lower payments for reductions in uncertainties about prices and production (Mighell and Jones).

weather. Growers still bear that portion of production risk that affects only the performance of their flock.

Broiler industry production contracts evolved to transfer more price and output risk from the grower to the integrator.¹⁹ Disease and heavy mortality were originally the main sources of uncertainty. As disease losses decreased, prices became a relatively more important source of uncertainty. By contracting with several flocks, feed suppliers were in a better position to manage uncertainties, while supplying necessary resources, because the feed supplier was concerned with *average* mortality and prices for several flocks over the entire year. These averages could be predicted with greater certainty because they varied less than the mortality rates and prices faced by an individual grower. Consequently, the feed supplier transformed a high degree of uncertainty faced by an individual grower into a smaller calculated risk (Mighell and Jones). Income uncertainty entails a cost to producers that would reduce the supply of broilers, if producers are risk averse (Knoeber and Thurman). This suggests that reductions in the cost of managing risk contributed to continual increases in broiler supplies.

Shifts in price risk and common production risk from the grower to the integrator have two basic purposes (Knoeber and Thurman). First, incentives are improved if risk is borne by the party with the greatest control over outcomes (that is, the integrator). Second, the cost of risk is reduced when borne by the party that can manage it most cheaply. Shareholders of publicly held integrators hold diversified portfolios of income-producing assets, thereby reducing the cost of risk bearing. Private companies, like Cargill, by producing a variety of products, can reduce their costs of risk bearing. Of 54 integrated broiler companies, 10 were publicly held in 1990 (Knoeber and Thurman). These 10, accounting for 53 percent of broiler production, included Tyson Foods, ConAgra, Hudson Foods, and Seaboard Corporation.

¹⁹Uncertainty becomes even more important as asset specificity increases (Williamson; Shelanski and Klein). Increasing asset specificity related to buildings and equipment likely exacerbated the role of volatile markets in the rapid growth of production contracting and vertical integration.

Production contracts also help to reduce production uncertainties by improving technology and supervision. By providing some inputs into the production process, the integrator has stronger incentives to supervise production closely, which contributes to substantially lower mortality rates among contracted broilers (Mighell and Jones). Production contracts also facilitate the rapid adoption of new production practices because the integrator controls and supervises production on a large scale (Martin).

Vertical integration may also provide an effective means for managing market risks. Price uncertainties in hatching egg production contributed to integration of the hatchery and feed stages, as feed dealers assumed additional risk and gained greater control over production decisions.

Unlike production contracts in the broiler industry, most marketing contracts between large hog producers and processors play little role in transferring price and output risk. The packer typically provides no production inputs, and pricing formulas are typically tied to a market price, adjusted for quality. Only 4 of 27 large producers surveyed in 1994 had contracts that attempted to share or limit price risks or to link prices to hog production costs (Hayenga and others). As several of the large hog-producer integrators and large packers are publicly held or diversified, they may be proficient at managing risks.²⁰

Financing Production Inputs

By reducing and shifting price and production risk, contracting can increase the flow of resources into agriculture when resource needs are significant (Mighell and Jones). Individual producers may lack the managerial ability to carry out investment opportunities, may not wish to take a chance on losing the equity in their farms, or may be unable to obtain credit from traditional sources. Production contracts often overcome these obstacles to capital investment by pro-

²⁰In the pork industry, production contracts shift risk from the smaller growers to the large producers. Like broiler integrators, several of the large hog producers are either publicly held or are diversified into other commodities (for example, Tyson, Continental Grain, Cargill, and Dekalb, recently acquired by Monsanto), which reduces their costs of bearing risk.

viding guidance and management to producers, as well as market and price guarantees. Consequently, producers are more willing to invest their own capital and labor. In addition, because their risks are reduced, they are more likely to obtain loans from lenders for buildings, equipment, and operating expenses. By reducing broiler production uncertainty through improved technology and supervision, feed supplier-integrators reduced the likelihood of major production losses. Inexperienced growers, therefore, or those with low net worth, found it easier to obtain capital from traditional lenders for buildings and equipment (Mighell and Jones).

Contracting can reduce the financial burden of each trading partner. In the broiler industry, contracting created the impetus for growers to continue production. Because of significant price and production risk, broiler growers hesitated to undertake production if they had to assemble all of the productive resources.²¹ Through production contracts, larger and financially stronger feed companies reduced the growers' capital requirements by providing most of the variable inputs (chicks, feed, and medicine). At the same time, production contracts typically require the grower to make some of the investments for producing broilers (land, labor, facilities). As a result, the integrator's capital costs for plant and equipment are cut in half because the value of investments necessary for broiler processing is equivalent to the investment required for growing the birds (Westgren). This practice creates a business arrangement with mutual interests because both the integrator and growers have invested in specific fixed capital.

Costs Associated with Contracting and Integration

Milgrom and Roberts describe two types of transaction costs; those related to coordination and those related to motivation. Coordination costs include determining details of the transaction, such as prices, making buyers and sellers known to each other, and bringing buyers and sellers together to transact. Examples include

²¹In some cases, even when broiler producers had the resources to produce independently, they did not wish to accept the hazards (Mighell and Jones).

costs of determining consumers' tastes and preferences, advertising, and time spent searching for suppliers offering the best prices. Motivation costs include those associated with incomplete and asymmetric information. These costs occur when there is insufficient information to determine whether terms of the transaction are acceptable and whether the terms are being met.

While contracts may be used to reduce coordination costs in open markets, there are motivation costs associated with contracting. Contracts are often incomplete because individuals are subject to unobservable outcomes or *bounded rationality*. Bounded rationality refers to an individual's limited ability to foresee all future possibilities. Contracts that account for the full range of contingencies are extremely expensive to write.

Contracts between broiler growers and integrators can create motivation costs associated with *moral hazard*. Moral hazard refers to opportunistic behavior once the contract has been entered into because actions required under the terms of the contract are not easily observable. Contracts that required the feed supplier to provide feed to the broiler grower encouraged shirking on the part of the grower. This is because the grower did not pay for the feed, and payments received by the grower did not depend on the quantity of feed used or feed efficiency. However, production contracts evolved to lower costs of moral hazard. Incentive clauses were later added that based the grower's payment on feed efficiency. Hence, the contracts controlled moral hazard and, at the same time, shifted and reduced the costs of managing price and production risk.

Contract payment methods based on relative performance were formulated to reduce costs of renegotiating contract terms in response to new technology. The rapid pace of technological advances in the broiler industry created uncertainty regarding absolute measures of efficiency that were initially specified in broiler contracts. For example, changes in technology led to unstable feed conversion ratios, which made constant absolute performance measures inefficient (Martin). Because of the integrator's bounded rationality, it became more difficult to update contract specifications to account for improvements in technology. Contract payments based on relative performance automatically adjust to technological gains. This is because the calculation of the bonus or discount would not be affected by outcomes common to all growers, such as advances in technology.²² The reduction in the cost of revising contracts explains, in part, why broiler production remains coordinated by production contracts instead of vertical integration, despite the extreme uncertainty created by rapid changes in technology. In addition, vertical integration could lock in employee growers, whereas contracts can be established with growers who are best able to deal with changing technology.

²²For example, contracts analyzed by Knoeber and Thurman included a settlement cost formula that was used to measure grower performance. An average settlement cost for flocks harvested at the same time was first calculated. The settlement cost would fall as feed efficiency improves, mortality rates decline, and bird weight increases. Relative performance was then measured as the difference between an individual grower's settlement cost and the average. The base payment to the grower was adjusted up (down) if the settlement cost was below (above) average.