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Organizational Structure in Agricultural Production Alliances

ABSTRACT: The manuscript addresses the choice of organizational form in industrialized hog production. The objectives are to review the relevant theoretical literature on organizational form and create conceptual models of two of the major contractual relationships (alliance and integrator) emerging in the hog sector. Actual contracts are proprietary. Consequently, empirical information is scarce; however, we feel that the application of conceptual models of contracts can aid in making performance comparisons. The goal is to give some prescription as to which alternative organizational and contractual forms will perform the best. The models developed in this paper derive optimal contracts and show that an integrator organizational form (one party as residual claimant) may have advantages over an alliance.

This paper explores the recent increase in vertical coordination in the U.S. hog industry (Kliebenstein and Lawrence, 1995; Fulton and Gillespie, 1995; Boehlje, 1995). The industry is evolving significantly with respect to organizational form and function. The percentage of hogs produced nationally under contract arrangements is expected to increase from 11% in 1993 to about 26% in 1998, with hogs produced under packer ownership and/or production contracts roughly tripling (2% to 7%) over the same period (Lawrence, Rhodes, Grimes, and Hayegna, 1997). Growth in contract hog production was especially strong in North Carolina, allowing it to surpass several Midwestern U.S. states in total hog production.

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Contract production, however, is not a uniform development. The contract specifications can differ significantly in terms of risk sharing, incentives, management responsibilities, and asset ownership (Mahoney, 1992a). Because of the proprietary nature of these contracts, little is known about the magnitude of differences in these specifications and about their performance implications. In the absence of this empirical information, employing conceptual models of contract situations can aid in making performance comparisons and in highlighting key decision attributes.

The objectives of this paper are to review the relevant literature on organizational form and create conceptual models of two of the major contractual relationships (alliance and integrator) emerging in the hog sector. The goal is to give some prescriptive idea as to which alternative organizational and contractual forms will perform the best. The paper is organized as follows. Section 1 discusses organizational form and function, followed in Section 2 by a discussion of relevant theories of vertical coordination. Section 3 presents a theoretical analysis of integrator and alliance contracts, which illustrate the emerging organizational forms and contractual specifications. Section 4 summarizes the results and details the policy implications.

1. Organizational Form and Function

An organization is a governance mechanism that keeps workers and work organized (such as production scheduling, input purchases, and hiring). The organization may also serve as an information clearing house, as an instrument to determine strategic resource use, and as a policy setting body which determines production targets, product mix, pace of innovative activity, and the rules that govern how the organization does its job. Organizational form is the internal structure of the firm that largely determines how the firm carries out its various functions. Organizational form can also influence financial performance (Chandler, 1962), dealings with employees and suppliers, how remuneration is paid, and how profits are distributed.

One important facet of organizational change is its relationship to technological change. Langlois and Robertson (1995) distinguish between systemic and autonomous technological change. Systemic technological change involves a fundamental shift in the production process requiring fundamental organizational change. Autonomous change, conversely, affects a part of the production process and can usually be accommodated within existing organizational structures. All-in/all-out pork production for example, is designed to minimize disease transmission among animals; it illustrates a systemic technological change. The all-in/all-out system is designed to move pigs from one production site to another together.[1] This modular, batch-type process seeks to reduce herd health problems and improve performance. It requires substantive changes in the organization, particularly at the

boundaries of the sites/modules. The specialization of modular production requires inter-firm strategic management across the boundaries of the modules. The organizational form may be integration, strategic alliance, or another form that permits joint decision-making.

Mahoney (1992a) suggests that the reasons for vertical integration include: mitigating transactions costs, taking advantage of output or input price differentials of a competitor, and reducing uncertainties in costs and/or prices. Koehler, Lazarus, and Buhr (1996), and Schrader and Boehlje (1996) identify a number of reasons for networking and alliance formation in the pork industry. These include, advancement in technology, market access, higher quality of animals, sharing of information, risk reduction, size economies, and efficiency gains. Organizational choice is clearly tied to various organizational functions. As the functional nature of the firm changes in response to technology and market forces, the governance structure likely must change to enhance efficiency and effectiveness.

2. Theory of Vertical Integration and Alliance Formation

Vertical coordination in agriculture has received considerable attention (King, 1992; Barry, Sonka and Lajili, 1992; Sporleder, 1992; Featherstone and Sherrick, 1992; Babb, 1992), while vertical coordination in the hog industry has been discussed by Kliebenstein and Lawrence (1995), Fulton and Gillespie (1995) and Boehlje (1995). One of the insights from the literature is that the industry's evolution requires novel approaches by industry decision makers in order to give producers an adequate understanding of the new way of doing business. The evolving production systems are dynamic and require learning-by-doing along with traditional modes of inter-firm decision making.

The trend towards increasing vertical coordination reflects: (a) the growing influence of consumers in controlling the agri-food agenda; (b) the increasing marketing power of large food companies; and (c) technological changes that necessitate coordination. Consumers indirectly employ market power through their buying habits and preferences, which are immediately transmitted from the grocer to the food company. Thus, the increasing presence of information technology informs the food company of desirable product characteristics. Food companies also play an important role in the creation of new food products and the cultivation of consumer demand (Barry, 1995). In terms of technological forces, information system development allows retailers to convey market information to manufacturers, processors and ultimately producers which is the key to becoming market responsive. The combination of new genetics, new processes and new control mechanisms is increasing the rate of industrialization.

In order to explain industrialization we can draw on new and emerging theories of the firm. Three relevant theories of the firm will be explored in this section: (1) the property rights theory, sometimes called incomplete contracting theory (Hart,

1993, 1995; Grossman and Hart, 1986, 1987; Hart and Holmstrom, 1987); (2) agency theories—positive agency theory, and principal-agent theory; and (3) the resource based theory (Penrose, 1959; Mahoney, 1992b; Mahoney and Pandian, 1992; Conner, 1991).[2]

2.1. The Property Rights Approach

Alchian and Demsetz (1972) said that the structure of property rights affects transactions costs and agency costs. The nature of property rights determines who are the contractual and residual claimants to the profit stream. The main assumptions of the property rights approach are that individuals are hindered by bounded rationality and that contracts will necessarily be incomplete because it is impossible or prohibitively costly to write a complete contract that will address all contingencies. Grossman and Hart (1986, 1987) build on the earlier framework and show that ownership is determined by the nature of a firm's investment decisions and their importance to the downstream firm.

Property rights theory views the firm as bundle of rights. The objective is to form ownership rights that are most efficient for asset use. Firms can also share rights in asset use. If the rights to a particular asset are divisible, then the rights may be split up among different owners who will affect the asset's rent stream. In terms of an alliance some rights are owned outright by each firm while other rights are shared. Even though the asset may not be divisible the rights can be divided. In some cases it may be optimal to pool assets together or use complementary assets from another firm (related to the resource-based view of alliance formation). According to Ramanathan, Seth, and Thomas (1997) if assets cannot be separated from the owner firm without disrupting production, then control and residual rights remain with the original firm. Otherwise, if assets can be separated, then control will be shared jointly in the alliance. If all assets were separable from the parent firm, then the firm that places the highest value on the assets will own them.

Barzel (1989) discusses the case where one party can affect the income flow between two parties. If the person who can affect the flow bears full responsibility for their actions, then property rights are clear. The person who bears full responsibility for their actions in this case would be called the residual claimant of the income stream. Clearly he or she would own the asset. If, however, both parties can affect the income flow from the asset, then the situation is less clear. According to Barzel (1989): "The central issue underlying an organization is that the greater is the inclination of a transactor to affect the mean outcome, the greater is the claim on the residual the transactor will assume" (p. 61). So, we may have mutual ownership of an asset, but one party may be entitled to more of the income stream than another because of his or her greater influence on the income stream. Regarding moral hazard, Barzel's argument implies a tradeoff in large firms between the ease with which individuals can shirk and the increase in efficiency due to the large scale of operation. He believes the way to attenuate shirking is by

letting individuals become firm owners or residual claimants. Barzel considers vertical integration and sole proprietorship as polarized organizational forms. He believes that moral hazard can be solved through the formation of alliances or a closely related organizational form.

2.2. The Agency Approach

Agency theory has two branches: principal-agent literature (Holmstrom, 1979, 1982; Rasmusen, 1987) and positive agency theory (Jensen and Meckling, 1976; Fama and Jensen, 1983). In the principal agent model the principal (usually the business owner) would like to offer a contract that will cause the agent (employee) to perform in the owner's best interest (work hard). The principal-agent model assumes that the agent will act in his own self-interest (shirk) unless his incentive compatibility constraint is met; the contract thus, must be lucrative enough to make the agent work diligently. If the agent is risk neutral, the principal should offer him an incentive based contract. If he is risk averse, the problem becomes one of risk sharing and often it is best to pay the worker a flat wage (because he is willing to forego extra income in order to receive insurance from the principal in case of a bad outcome). According to Mahoney (1992b) principal-agent theory does not "fit" with property rights theory, nor does it offer any predictions about organizational form. Rather the aim is to design optimal contracts, with organizational form as exogenous.

Positive agency theory on the other hand, views the firm as a nexus of contracts. One of the firm's purposes is to design efficient monitoring and bonding devices to minimize agency costs. Another insight is that capital structure of the firm matters (its debt-equity position) because of the presence of agency and transactions costs (which contradicts the Modigliani-Miller, 1958, theorem). According to the theory, integration should remove barriers to the transfer of valuable private information. Eccles (1991) examines transfer pricing within a vertically integrated firm. He believes that the problem should center on more than one agent as is common in the principal-agent literature. He says that incentives must be designed to encourage cooperation between two agents who transact with each other—for example, a corporation would like its divisions to cooperate with each other and set transfer prices in an equitable non-antagonistic manner. He asserts that little is known about transfer pricing policies, and that the transfer pricing decision should be based primarily on strategy not profit maximization. A vertical integration strategy makes sense in terms of low cost inputs, a certain supply of inputs, and gaining technological knowledge about the production process and the product itself.[3]

Positive agency theory would characterize alliance formation as a team effort where the residual rents are shared among the participants. Team production occurs among two or more firms because each firm brings unique assets or resources to the alliance. According to Ramanathan et al. (1997), equity-based alliances promote cooperation among the participants. They also assert that the

smaller the alliance, the easier it is for mutual monitoring and self-enforced action against moral hazard.

2.3. The Resource-Based Approach

The resource-based view emphasizes the firm's continual search for rents and the gains from holding unique resource portfolios, which can create sustainable competitive advantage. According to Mahoney and Pandian (1992) strategy is the search for rents. Rents can be defined as: owning a scarce or valuable resource (a Ricardian rent) that can be locational or a unique physical resource, quasi-rents from co-specialized assets, entrepreneurial or Schumpeterian rents that are the result of risk-taking entrepreneurial behavior in an uncertain and complex environment, and quasi-rents from firm specific resources. Time is a critical element of the resource-based view because of path dependencies and the sequential nature of decision making.

The sources of rent to the firm are endogenous because the firm selects a strategy to generate rents based on its resource capabilities. Differences among firms in information, luck, and inherent capabilities enable the firm to generate rents. A firm may achieve rents not because it has better resources but because it makes better use of its resources. Furthermore, the resources of the firm limit its choice of markets and expected profits. Some key resource constraints are the shortage of labor or physical inputs, the shortage of finance, a lack of investment opportunities and a lack of sufficient managerial capacity.

The theory maintains that certain resources within a firm can lead to sustainable competitive advantage because some resources are inimitable due to isolating mechanisms internal or external to the firm. The resource based approach to vertical integration (Westgren, 1994) emphasizes the pooled asset holdings of firms and the resulting expected rent streams. Initially two firms have their own idiosyncratic asset portfolios consisting of human resources, financial resources, physical assets and organizational resources. In order for vertical integration to occur the returns from the newly pooled portfolio must exceed the returns from the original portfolios. Penrose (1959) asserts that backward integration occurs not just to secure supplies, but because efficient management is scarce. It may cost less in terms of controlling the firm and planning for future investment by integrating backwards. The resource based view can be easily modified to account for alliance formation behavior (Westgren, 1994). Instead of one firm valuing the joint portfolio more than the other firm, both firms may find it advantageous to pool part of their resources to form an alliance. In order for the firms to form an alliance the returns from the joint venture must exceed the firm's individual returns prior to joining the alliance.

There appears to be little intellectual conversation between the adherents of different theories of the firm. One example that integrates two theories comes from Mahoney (1992a). Mahoney blends agency theory and transactions cost theory in

Table 1. How Theories of the Firm Explain and/or Predict Integration and Alliance Formation

Theory	*Assumptions*	*Integration*	*Alliance'*
Property Rights	•firm as bundle of rights •contracts are incomplete due to bounded rationality	•party who can most affect income flow owns the asset	•can have mutual asset ownership, and income sharing •one party may get more income because it can affect income stream more
Positive Agency	•firm is bundle of contracts •firm designs efficient monitoring and bonding arrangemenets to minimize agency costs	•integration will mitigate agency costs, increase access to knowledge, and secure input supplies	•alliance may promote cooperation (equity-based) and mitigate agency costs
Principal Agent	•organizational form is exogenous •firm can design an efficient contract to minimize moral hazard (perfect foresight on part of the firm's owner)	•theory not predictive in terms of organizational form	•thoery not predictive in terms of organizational form
Resource-Based	•firms continually search for rents •resource portolios are source of rents due to uniqueness and inimitability •path dependencies due to time dimension	•pooled asset holdings yield higher rents than if held separately	•joint asset portfolio yields higher rents than if held separately

order to explain vertical integration/vertical contracting (which he says are the same organizational form). The five determinants of organizational structure under the blended theory include task programmability, nonseparability, demand uncertainty, technological uncertainty and asset specificity. Integrating theories in the way that Mahoney does often provides the richest theoretical lens to help view economic phenomena.

Table 1 summarizes the main arguments for integration and alliance formation from the three theories of the firm just presented. The table shows that positive agency theory can explain why vertical integration and alliances may occur, yet it is not predictive. Property rights theory and resource-based theory can explain why the two organizational forms might be observed, and can also predict which organizational form will obtain in equilibrium. The resource-based theory both predicts and explains integration and alliance formation on efficiency grounds.

3. Organizational Form and Contracting

Because of the uniqueness of hog contracting and the different contractual arrangements, no one theory of the firm best fits the situation. Rather, applicable elements

of the theories discussed above must be blended together. Such elements might include identification of the contracting parties, the nature of their claims, and their degree of influence; the compatibility of their incentives; informational asymmetries; risk sharing, monitoring and bonding arrangements; and the influence of the parties' resource capabilities on rent seeking. The integrator and alliance contract models demonstrated in Case 1 and Case 2 draw upon these elements of theory. They serve as conceptual devices for analyzing the hog contracting process; for endogenous determination of the contract specifications; and for determining which organizational forms are best suited to high technology production methods.

Besides the theories of the firm, a theory of franchising developed by Maness (1996) is also applicable to hog production. The author uses some aspects of Grossman and Hart's (1986) incomplete contracting model combined with Mathewson and Winter's (1985) principal-agent contracting model.[4] While Maness' model is directed specifically at franchising (such as the fast food industry), it applies to hog production because some contractual arrangements (such as the contracts designed by Farmland Industries, 1996; and Alliance Farms, 1995) resemble a franchise system. For example, some contracts require the hog producer to buy into the parent firm by paying a membership fee or by buying a share of the parent firm, which is equivalent to a franchise fee. Second, such contracts may require the producer to follow very strict guidelines as to the design and construction of the hog units, the feeding regimen, and care of the animals. The specificity of the physical assets to the franchisor's specifications acts as a bonding device between the two parties. Some contracts require the producer to purchase the feeder pigs (feeder pigs would be from superior genetic lines) and then re-sell them to the parent company once they are at market weight. Other contracts have the franchisor maintain ownership of the feeder pigs. The hogs are usually sold through the franchisor and the franchisee may get annual "patronage dividends" (Alliance Farms) which are a form of profit sharing. Maness (1996) reviewed franchise contracts and found that the franchisee typically receives a share of total revenue. The franchisor gets a share in total revenue generated by the franchise as well. Under vertical integration the local outlet is owned outright by the franchisor and the manager is paid a fixed wage plus a bonus (a proportion of revenue).

The first hog contracting model discussed below is the integrator organizational form. The integrator controls breeding-gestation and farrowing. He owns the animals and supplies some contractually based inputs such as feed and medications to the nursery operator and the finishing operator. The contractual inputs are paid for by the integrator and are called contractual costs in the model. Non-contractual costs such as capital costs and the remaining variable costs are paid for by the growers. The growers of both the nursery and finishing unit receive a fixed wage for their labor (effort) and they also receive a proportion of net revenue from the integrator as bonus payments. Optimal effort implies that animals reach the proper weight, and maintain good health while in the grower's care. The model involves

a two stage game: stage one involves the choice of organizational form, the sharing rule, and the wage, while in the second stage the agents perform work and the firm receives revenue and pays its costs.[5] The private marginal cost of effort is constant and normalized to one for the three parties.[6]

CASE 1: The Integrator Contract

$R(e_1, e_2, e_3)+ \varepsilon$	revenue of the integrator
e_1	effort of firm 1 (the integrator)
e_2	effort of firm 2 (the nursery operator)
e_3	effort of firm 3 (the finisher)
ε	random disturbance with mean of zero, and variance of σ_ε^2
$R(e_1, e_2, e_3)$	increasing and concave in e_1, e_2, e_3, if e_1 or e_2 or $e_3 = 0$ then $R(e_1, e_2, e_3) = 0$
$C_1(e_1, e_2, e_3) + \theta_1$	cost of firm 1
θ_1	cost disturbance term with mean of zero and variance of $\sigma_{\theta_1}^2$
$C_j^u(e_1, e_2, e_3) + \theta_j$	non-contractible cost of firm 2 and firm 3, j = (2,3)
θ_j	cost disturbance term with mean of zero and variance of $\sigma_{\theta j}^2$
$C_j^c(e_1, e_2, e_3) + \rho_j$	contractible cost of firm 2 and firm 3
ρ_j	cost disturbance term with mean of zero and variance of $\sigma_{\rho j}^2$
C^u and C^c	decreasing and convex in the level of effort of firm 2 and firm 3
s_1, s_2, s_3	share of net revenue paid to each firm and $s_1=1 - s_2 - s_3$
W	integrator pays the managers a fixed wage, assume both wages are the same for simplicity

The goal is to:

$$\underset{s_1,s_2,W}{Max}\ (1-s_2-s_3)\{R(e_1, e_2, e_3) - \sum_{j=2}^{3} C_j^c(e_1, e_2, e_3) - C_1(e_1, e_2, e_3)\} - 2W - e_1 \tag{1}$$

subject to:

$$s_2\{R(e_1, e_2, e_3) - \sum_{j=2}^{3} C_j^c(e_1, e_2, e_3) - C_1(e_1, e_2, e_3)\} - C_2^u(e_1, e_2, e_3) + W - e_2 = 0 \tag{2}$$

$$s_2\left[\frac{\partial R}{\partial e_2} - \frac{\partial \sum_{j=2}^{3} C_j^c}{\partial e_2} - \frac{\partial C_1}{\partial e_2}\right] - \frac{\partial C_2^u}{\partial e_2} - 1 = 0 \tag{3}$$

$$s_3 \{ R(e_1, e_2, e_3) - \sum_{j=2}^{3} C_j^c (e_1, e_2, e_3) - C_1(e_1, e_2, e_3) - C_3^u (e_1, e_2, e_3) + W - e_3 = 0 \quad (4)$$

$$s_3 \left[\frac{\partial R}{\partial e_3} - \frac{\partial \sum_{j=2}^{3} C_j^c}{\partial e_3} - \frac{\partial C_1}{\partial e_3} \right] - \frac{\partial C_3^u}{\partial e_3} - 1 = 0 \quad (5)$$

$$(1 - s_2 - s_3) \left[\frac{\partial R}{\partial e_1} - \frac{\partial \sum_{j=2}^{3} C_j^c}{\partial e_1} - \frac{\partial C_1}{\partial e_1} \right] - 1 = 0 \quad (6)$$

Equation 1 is the objective function of integrator who chooses the sharing rule and the wage.[7] Equation 2 is the participation constraint for the manager of firm two (nursery unit).[8] The participation constraint must be satisfied in order for the manager to want to remain under contract. Equation 3 is manager two's incentive compatibility constraint (where the level of e_2 is chosen by manger two) which must be satisfied if he is to supply optimal effort. Equations 4 and 5 are the participation constraint and incentive compatibility constraint of firm three's manager (the finishing unit). Equation 6 is the incentive compatibility constraint of the integrator (the farrowing unit). In order for the integrator to supply optimal effort the net revenue sharing rule must be large enough so that he can recoup all his costs. The first-order-conditions show that the integrator uses s and W to align incentives so long as the managers are left with enough revenue to meet the participation constraint. Let the solution to the model be W*, (e_1^I, e_2^I, e_3^I), and (s_1^I, s_2^I, s_3^I), , which we will compare to the solution of the following alliance case.

CASE 2: The Alliance Contract

In this case assume one individual (called a farrower) owns a breeding-gestation-farrowing unit and wishes to initiate an alliance agreement with two other firm owners. The reason for forming an alliance is to create sustainable competitive advantage from the combination of a unique and potentially inimitable set of resources. The newly formed and jointly held portfolio of resources includes the human, physical, financial, and organizational capital of the three member firms. Firm owners will enter an alliance if they believe that the value of the combined

resources is greater than their sum individually. The terms of the alliance are that each member's costs are deducted from total revenue before the disbursement of net revenues. The farrower must design a contract that splits the alliance's net revenues on an optimal basis, so that the downstream firms supply optimal effort. Animals are jointly owned, but each member is responsible for his or her production specific costs (feed, medications, capital costs, labor and management costs, and other variable inputs). Hence, each firm has its own cost function and disturbance term given by: $C_i(e_1, e_2, e_3) + \theta_i$ and $i = (1, 2, 3)$. As in the first case optimal effort implies that animals reach the proper weight, and maintain good health while in the grower's care. The model involves a two stage game: stage one involves the choice of organizational form and the sharing rule. In stage two the individuals perform work and the alliance receives revenue, and disburses it amongst the members. The alliance members therefore share the profits and losses of the enterprise. The private marginal cost of effort is constant and normalized to one for the three parties.

$$\underset{s_1,s_2,W}{Max}\ (1-s_2-s_3)\{R(e_1, e_2, e_3) - \sum_{i=1}^{3} C_i\ (e_1, e_2, e_3)\} - e_1 \tag{7}$$

subject to:

$$s_2\ \{R(e_1, e_2, e_3) - \sum_{i=1}^{3} C_i\ (e_1, e_2, e_3)\} - e_2 = 0 \tag{8}$$

$$s_2\left[\frac{\partial R}{\partial e_2} - \frac{\partial \sum_{i=1}^{3} C_i}{\partial e_2}\right] - 1 = 0 \tag{9}$$

$$s_3\ \{R(e_1, e_2, e_3) - \sum_{i=1}^{3} C_i\ (e_1, e_2, e_3)\} - e_3 = 0 \tag{10}$$

$$s_3\left[\frac{\partial R}{\partial e_3} - \frac{\partial \sum_{i=1}^{3} C_i}{\partial e_3}\right] - 1 = 0 \tag{11}$$

$$(1-s_2-s_3)\left[\frac{\partial R}{\partial e_1} - \frac{\partial \sum_{i=1}^{3} C_i}{\partial e_1}\right] - 1 = 0 \tag{12}$$

Equation 7 is the farrower's objective function and Equation 12 is his incentive compatibility constraint. The participation constraint and incentive compatibility constraint for the nursery operator are Equations 8 and 9, respectively. Equations 10 and 11 are the finisher's participation constraint and his incentive compatibility constraint. Let the solution to the model be (e_1^A, e_2^A, e_3^A) and (s_1^A, s_2^A, s_3^A).

Now compare the solutions for the alliance and integrator models. First, compare the level of costs in the objective function, which must be paid by the integrator to that of the alliance. The contractible costs of firms two and three plus the integrator's own costs of effort are less than the sum of firm one, two and three's production costs in the alliance model using the following reasoning: $C_1(e_1, e_2, e_3) + C_2^u(e_1, e_2, e_3) + C_3^u(e_1, e_2, e_3) + C_2^c(e_1, e_2, e_3) + C_3^c(e_1, e_2, e_3)$ for the integrator case is equal to $C_1(e_1, e_2, e_3) + C_2(e_1, e_2, e_3) + C_3(e_1, e_2, e_3)$ for the alliance case. It is evident then that: $C_1(e_1, e_2, e_3) + C_2^c(e_1, e_2, e_3) + C_3^c(e_1, e_2, e_3) < C_1(e_1, e_2, e_3) + C_2(e_1, e_2, e_3) + C_3(e_1, e_2, e_3)$. This condition means that the net returns in the integrator case will be higher than in the alliance case; however, firm two and firm three must cover their own non-contractible costs of production. Because the integrator pays firms two and three a fixed wage the sharing rule for the two managers can be small. In fact it is not hard to imagine that the sharing rules for the two managers under the integrator will be much smaller than the sharing rules in the alliance. Furthermore, if the incentive compatibility constraints of firm one in both models are equated, it can be shown that: $\frac{\partial R^1}{\partial e_1} > \frac{\partial R^A}{\partial e_1}$ and this implies that $e_1^I > e_1^A$.[9] In other words the effort level of the integrator is higher than the farrower's effort in the alliance. The result implies that the integrator organizational form will produce higher quality animals (and will ultimately have higher revenues) than the alliance will. Therefore, the integrator form is superior to the alliance.

Table 2. Plausible Governance Mechanisms

Case	*Residual Claimant*	*Solves Optimal Contract*	*Control Over Production*	*Pricing Arrangement*
1	•integrator	•yes	•to some degree	•owner/operators of firm two and three paid fixed wage -profits are split according to sharing rules
2	•alliance •each firm is a residual claimant	•yes	•no	•profits are split according to sharing rules

The model may predict that the integrator form is superior to the alliance; however, one issue to resolve depends on whether the breeding-gestation-farrowing firm is the most critical production stage in terms of cost control. Some would argue that excellent breeding, gestation and farrowing practices ensure optimum animal performance later (low incidence of disease and stress, proper nutrition and weaning weights). In terms of cost reduction, firm one is in the best position to be innovative on the cost side (due to the adoption of technology, for example). The integrator model allows the owner of firm one to capture most of the rents from cost reducing or revenue enhancing innovations. Having the finisher act as the integrator makes little sense if his effort level has little effect on the costs of the upstream firms. Furthermore, firm one determines whether capacity levels of the downstream firms are met or not. Filling barns to capacity depends on high farrowing rates, low mortality of piglets, maintaining herd health, and ensuring that weaned pigs meet target weights. Barzel's criterion for ownership of the residual rent stream is that the firm that can affect the outcome the most should be entitled to the rents. Based on the prediction of property rights theory and the primary importance of firm one, it should be the residual claimant.

4. IMPLICATIONS

The solutions from the models are summarized in Table 3. By comparing the solutions from Case 1 to Case 2 the integrator model is preferable to an alliance. The reason is that the integrator pays less to the managers and, therefore, achieves a higher return on his effort than in the alliance. The integrator also has an incentive to reduce contractible costs because they are deducted from total revenue. Cost saving effort could also occur in an alliance but the innovator would have to split the benefits three ways.

It is difficult to put the results from the analysis into perspective because little theoretical work on the issue of hog contracting has occurred. Maness (1996) found that the incentive contract for a franchise with partially contractible costs was more efficient than first, a straight franchise contract and second, vertical integration with non-contractible costs. The increase in efficiency is attributable to contractible costs easing the participation constraint for the franchisee, and allowing the sharing rule to be larger in favor of the franchisor. Also, because the fran-

Table 3. Model Solutions

Case	*Organizational Form*	*Outcome*	*Optimal Organizational Form*
1	•integrator (farrower) is residual claimant	W^*, (e_1^I, e_2^I, e_3^I) and (s_1^I, s_2^I, s_3^I)	•integrator predicted as optimal organizational form
2	•alliance	(e_1^A, e_2^A, e_3^A) and (s_1^A, s_2^A, s_3^A)	•alliance has lower farrower effort than integrator

chisor is responsible for some costs he is more likely to engage in cost-reducing behavior.

The optimization program retains the basic assumption from principal-agent theory that moral hazard is endemic. It is expected that since owner-operated firms retain more of the residual claims they will exhibit less moral hazard than the manager of a franchise outlet will. The need for the firm to guard against moral hazard continuously may be too harsh if we consider that the contract may be long-term. It would be expected that as an organizational form progresses through time the relationship specific resources (and/or investments) should become more efficient and hence valuable. The question remains whether qualitative factors such as altruism and loyalty (that we would expect to build up in a tightly knit three firm alliance) would more than offset the cost and efficiency gains in the integrator case. The answer to the question is certainly not obvious nor would a general result be likely. It would depend on the interaction between the idiosyncratic resources of each alliance to create Schumpterian rents in a dynamic business environment.

Industrialization in the hog industry is a complicated process. The industry is in the formative stage of choosing new organizational forms for hog production units. No one theory of the firm can precisely capture all facets of current hog contracting arrangements. The models developed in this paper derive optimal contracts and show that an integrator organizational form (one party as residual claimant) may have important efficiency advantages over an alliance.

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NOTES

1. For a more complete discussion of all-in/all-out production and segregated early weaning see Hurt, Brehlje, and Hale (1995).
2. Other relevant theories of the firm not discussed here are the behavioral theory (Cyert and March, 1963), transactions costs theory (Coase, 1937, 1960; Klein, Crawford and Alchian, 1978; Williamson, 1975, 1985, 1986), and evolutionary theory (Nelson and Winter, 1982). Behavioral theory has the following assumptions: bounded rationality, uncertainty, the firm is a searching, information processing, satisficing organization. The choice of organizational form is made to minimize bounded rationality and uncertainty. However, the theory is not predictive. Transactions cost theory has the following assumptions: asset specifity, opportunism, bounded rationality, uncertainty and idiosyncratic knowledge. If asset specifity is somewhat important the contractual parties may form an alliance (knowing that the alliance will mitigate opportunism and transaction costs. If asset specifity is somewhat important the contractual parties may form an alliance (knowing that the assumptions; bounded rationality, the firm face a dynamic Markovian world, the optimal organizational form can never be achieved due to dynamics, the capabilities and decision rules of the firm are similar to genes, and routines are the skills of the organization. The firm will integrate or form alliance when profit seeking search routines identify the organizational form that is near optimal. However, the theory is not predictive.

3. Eccles says that the principal should address three points in the contract. Firstly, the contract should set out the responsibility of agents and the boundaries of their control – their decision set. Secondly, it should set up performance measurement and evaluation standards, and thirdly, it should set up rewards for good performance and punishment for substandard performance.
4. Rhodes (1995) discusses franchising as a model for explaining horizontal contracting. Most of the research relating to franchise contracts has been empirical (Brickley and Dark, 1987; Martin, 1988; Norton, 1988; Krueger, 1991; Dnes, 1992; Lafontaine, 1992). Rubin (1978) investigated franchise contracts from a theoretical and legal perspective.
5. Maness does not state explicitly that both parties are risk neutral but it is implicit in the model. The assumption simplifies the contract significantly and will be used here as well.
6. Assume that direct observation of effort is not possible. Distributions are additive and separable so they do not affect the first-order-conditions of the model. All equations are expressed in expected form and the expectations operator is dropped.
7. The integrator model developed here extends Maness' analysis to three players instead of two.
8. The participation constraints and the incentive compatibility constraints are typically inequalities. Setting the equations equal to zero is a simplification.
9. In order for the inequality to hold the sum of rate of change in contractible costs must be less than the sum of the rate of change in all costs of firms two and three with respect to effort. Mathematically: $\frac{\partial C_2^c}{\partial e_1} + \frac{\partial C_3^c}{\partial e_1} < \frac{\partial C_2}{\partial e_1} + \frac{\partial C_3}{\partial e_1}$ The assumption is that the cost function is additively separable in contractible and non-contractible costs and it is of the following form: $C(e_1) = C^c(e_1) + C^u(e_1)$, differentiating with respect to e_1 we have: $\frac{\partial C^c}{\partial e_1} = \frac{\partial C}{\partial e_1} - \frac{\partial C^u}{\partial e_1}$ and using the fact that: $\frac{\partial C}{\partial e_1} < 0$, $\frac{\partial C^u}{\partial e_1} < 0$, and $\frac{\partial C^c}{\partial e_1} < 0$, it is therefore the case that $\frac{\partial C}{\partial e_1} > \frac{\partial C^c}{\partial e_1}$.

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