Behavioral Risk: An Explanation of Contracts in the Broiler Industry

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Abstract

While the traditional explanation for the evolution of the contracts in the broiler industry focuses on factors such as access to capital and sharing of price risks this paper explains the evolution of the modern contingency contract on the basis of behavioral risk and the underlying two sided moral hazard problem. A relative performance contract solves the moral hazard problem.
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1. Introduction

Contracts in the broiler industry have changed rapidly since vertical integration began in the early 1960's. Several arguments explain the motivation of integrators and growers individually and mutually to engage in production contracts. Among these arguments, risk sharing has been recognized as the main reason, in particular the sharing of input and output price risk (Knoeber and Thurman).

This paper focuses on another type of risk, behavioral risk. We argue that convergence to modern relative performance contracts was strongly motivated by behavioral risk, which together with information and enforcement limitations, resulted in a moral hazard problem. Furthermore, we claim that the moral hazard problem in the broiler industry is a two sided moral hazard problem. Monitoring and information limitations are faced by both integrators and growers. While the integrator cannot monitor the grower's effort, growers cannot perfectly monitor the integrator's behavior (effort associated with care of chicks and quality of inputs provided).

The paper is organized as follows: Section 2 analyses the current structure of the broiler industry. Section 3 describes the evolution of contracts in the industry. Section 4 provides the traditional explanation for the evolution of vertical integration and contracting. Section 5 explains why we view behavioral risk and the moral hazard problem as a key factor which led to the evolution of modern contracts. Section 6 provides a formal model of the two-sided moral hazard problem in the broiler industry and explains how the modern contingency contract can be viewed as the optimal contract. Section 7 concludes.
2. The structure of the broiler industry

The current structure of the broiler industry incorporates elements of both vertical and horizontal integration (USDA, 1977; Benson and Witzig). The integrator owns a feed mill and processing plant and has contracts with a large number of hatching farmers and chicken growers. The incentive for integrators to supply feed rather than rely on the growers to supply feed can be explained by two factors. First, it reduces the magnitude of the moral hazard problem by decreasing the number of unobservable inputs. Second, it allows the integrator to choose the quality of feed which maximizes his profits. Since the profit maximizing quality of feed does not necessarily coincide with the "best" possible quality of feed there exists an incentive for the grower to increase his effort.

While the production of feed and the processing of broilers is done on a large scale, the actual rearing of chicks is done on a relatively small scale (Benson and Witzig, p.18, p.8). We suggest that the different nature of production in these stages and the associated comparative structural differences explain the need for integration.

The size of a production unit hinges crucially on the returns to scale associated with production. Traditional microeconomic theory suggests that returns to scale are initially constant or increasing, but as production increases, diseconomies of scale set in and eventually decreasing returns to scale are observed. Once this scale is reached, it pays the firm in the long run to replicate its production process rather than to increase the scale of production. We submit that decreasing returns are encountered at a much smaller scale in the case of rearing chickens than in the case of feed production or broiler processing. The reason is that the rearing of chickens has an additional source of diseconomies of scale associated
with the threat of disease. This is why broiler integrators prefer to form contracts with growers whose farms are 'neither too small nor too large'. For chicken growers, the threat of disease multiplies once a certain critical farm size has been reached. In contrast, feed processing and processing and marketing of broilers apparently enjoy considerable economies of scale. Thus, returns to scale can explain the current structure of production in the broiler industry. Apparently, similar principles also apply to the structure of production and processing in other industries (e.g., swine) in which the rearing of animals is combined with the production of inanimate matter.

3. Evolution of Contracts in the Broiler Industry

Prior to the 1960's, the broiler industry was dominated by independent units of production, i.e., hatcheries, feed companies, farms, and processing plants. By the end of the 1960's, however, most of the broiler industry had become vertically integrated. Integrators and growers became partners in raising and producing chickens where each party was assigned specific responsibilities that were formalized in contracts. Integrators supplied growers with chicks, feed, medication, veterinarian supervision, and training. Feed and chicks account for a significant proportion of the production cost of the integrated enterprise (e.g., in 1967 this figure was 82%, USDA, 1971). Growers supplied labor, housing, energy, and water.

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1 Such preference are evident from direct communication with integrators, e.g., the Wampler Company.
2 For a detailed description of broiler contracts see Martin.
3 An integrator is a firm, cooperative, or a person that controls more than one stage in the production of broilers, usually everything from broiler egg production through processing. It owns the broilers. It contracts with farmers-growers to grow them (USDA, 1977).
The evolution of contracts in the broiler industry during the 1950's and 1960's suggests a slow convergence over time. That is, over the years, parameters in contracts have been gradually refined to accommodate both integrators' and growers' interests.

Early broiler contracts can be categorized into seven broad types, which roughly in chronological order of development and use are as follows: (1) open account contracts where loans were provided by a bank, credit association or owner of a feed mill to the grower in return for interest payments, (2) open account - no loss contracts which were similar to (1) but carried an additional clause that ensured that any deficit incurred by the grower after broiler marketing was absorbed by the integrator, (3) guaranteed price contracts which were similar to (2) except for an additional clause that guaranteed a certain price per bird to the grower, (4) flat fee contracts where the integrator provided feed, medicine and chicks as well as marketing facilities and the payment to the grower was either on a per pound or per bird basis, (5) share contracts which stipulated proportions according to which profits were shared between the integrator and the grower with responsibilities of the integrator as in (4), (6) feed conversion contracts which stipulated payments for growers purely on the basis of feed meat conversion ratios, and (7) combination contracts which combined a flat fee with bonuses on the basis of feed efficiency, mortality and other characteristics.

More recently, contracts in the broiler industry have had the following features:

(a) Inputs. The integrator provides the chicks, feed and medication. The grower provides the house, supporting infrastructure, labor facilities, water, and energy.

(b) Payment to growers on a per bird or per pound basis. A per bird payment scheme does not take into account the additional time taken to rear heavy birds. Therefore, some integrators
employing this scheme pay a premium for heavier birds. Similarly, a per pound payment scheme does not take into account the fact that young female birds do not gain as much weight as young male birds. Therefore, some integrators employing this scheme make adjustments according to the gender of the bird.

(c) Penalties and bonuses. Penalties and bonuses depend on the performance of the grower relative to average performance. The criteria used for judging the performance of the grower include the feed conversion ratio, mortality, etc. This system of penalties and bonuses according to relative performance ensures an incentive for the grower to improve production efficiency irrespective of his current level of efficiency.

Modern broiler contracts protect the grower from output price risk and input price risk because integrators provide growers with the major inputs, pay growers on a relative scale and guarantee price per bird or per pound. The provision of major inputs by the integrator also ensures that common production risk is shared jointly between participating agents.

4. Evolution of Modern Contracts: The Role of Behavioral Risk and Moral Hazard

Traditionally, the explanation for the integration of production units in the broiler industry and the appearance of contracts included four arguments: Access to capital, consumer demand for product reputation and uniform quality, R & D financing and innovation dissemination, sharing of price, production, and financial risks.

While price, production and financial risks explain the evolution of integration and early integration contracts, we submit that the further evolution of the modern contingency contract is explained by behavioral risk - a factor as yet unexplored in the integration literature.
Price risks motivate the need to combine growing, processing, and feed milling activities. However, different scale economies at different stages of production explain why individual firms cannot simply combine all these activities but rather must cooperate to fully exploit these economies of scale. Cooperation also facilitates the transfer of some risk from small scale producers (growers) to large scale processors (integrators). Interestingly, cooperation that does not have appropriate incentives can create a moral hazard problem. The moral hazard problem arises when one party to a transaction may undertake certain actions that affect the other party's valuation of the transaction but the second party cannot monitor/enforce perfectly (Kreps). We argue that the evolution of broiler contracts converged to relative performance incentive contracts due to the moral hazard problem embedded in the partnership between integrators and growers. In the case of the broiler industry, the moral hazard problem is two-sided. Neither integrators nor growers will invest sufficient (joint profit-maximizing) effort in the partnership without proper incentives. For example, integrators may not handle the chicks with great care prior to their arrival on the farm and/or he might try to economize on the expenses per chick. On the other hand, growers can neglect feeding schedules and grow low-weight chickens if payment is made strictly on a "per live bird" basis. Both integrators and growers may withhold information, and monitoring and enforcing certain actions and standards may be infeasible due to high costs and practical issues. Both, the integrator and the grower supply factor inputs which have highly imperfect markets. An effective way to gain access to such factors is to offer an incentive mechanism to the owner of the factor. 4

4 For example, in the literature on tenancy contracts, factors which have highly imperfect markets are studied by Bell and Zusman. Such factors are incorporated into a two-sided moral hazard model by Eswaran and Kotwal.
The solution to the moral hazard problem is to provide such an incentive mechanism. Once each individual’s income is tied to the action taken relative to a base action, shirking behavior is avoided. When a grower’s payment is determined by relative rather than absolute performance (as reflected by feed conversion ratios and the incidence of mortality) then risk can be reduced while maintaining incentive for growers to use appropriate effort. Incentives based on relative performance are covered by the tournament literature (see Kreps, pp. 610-11, for a literature review). Increases in effort reduce the magnitude of idiosyncratic production risk because growers more prepared to handle farm specific production risks tend to incur a lower loss. On the other hand, conditioning integrator profits on average performance introduces incentives for integrators to supply joint profit-maximizing quality of chicks, feed, and other services.

5. A Stylized Model Demonstrating Optimality of the Modern Contingency Contract

To analyze the static two sided moral hazard problem, or partnership model in the integrated broiler industry, we deviate from the standard analysis of the many sided moral hazard problem (Dutta and Radner). Specifically, in the standard analysis, players are assigned the label of 'agent' and there is no principal. For simplicity, assume one principal (or integrator) and two agents (or grower). The integrator can choose from two qualities of feed, high (H) and low (L). Similarly, each grower can choose between two effort levels H and L. Each grower has two possible output levels, 1 and 2. The following matrix shows a potential probability distribution over output levels for different combinations of qualities of feed and effort.

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5 For an extensive review of recent literature on incentive problems see Dutta and Radner.
Note that the first (second) entry in each cell gives the probability with which output quantity = 1 (= 2) occurs. We consider the following class of compensation functions for representative growers:

\[ P_i = aG_i - b(G_1 + G_2) \quad \text{for } i = 1, 2. \]

This compensation function corresponds to a relative performance contract if \( b > 0 \). If \( b = 0 \) and \( a > 0 \), then the function corresponds to an absolute performance contract. The integrator's payoff function is given by

\[ I = G_1 + G_2 - (P_1 + P_2). \]

The payoff function for grower \( i \) is given by \( P_i - A_i \), where \( A_i \) represents the effort level of grower \( i \). The payoff matrix for different combinations of actions by the integrator and growers 1 and 2 is given by the following representation.
Integrator - H

Grower 1

Grower 2

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
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<tbody>
<tr>
<td>L</td>
<td>4/3a-8/3b</td>
<td>4/3a-103b</td>
</tr>
<tr>
<td></td>
<td>4/3a-8/3b</td>
<td>2a-10/3b-1</td>
</tr>
<tr>
<td></td>
<td>8/3-8/3a+16/3b</td>
<td>10/3-10/3a+20/3b</td>
</tr>
<tr>
<td>L</td>
<td>2a-10/3b-1</td>
<td>2a-4b-1</td>
</tr>
<tr>
<td>H</td>
<td>4/3a-10/3b</td>
<td>2a-4b-1</td>
</tr>
<tr>
<td></td>
<td>10/3-10/3a+20/3b</td>
<td>4-4a+8b</td>
</tr>
</tbody>
</table>

Integrator - L

Grower 1

Grower 2

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>a-2b</td>
<td>a-7/3 b</td>
</tr>
<tr>
<td></td>
<td>a-2b</td>
<td>4/3a-7/3 b-1</td>
</tr>
<tr>
<td></td>
<td>2-2a+4b</td>
<td>7/3-7/3 a+14/3 b</td>
</tr>
<tr>
<td>H</td>
<td>4/3a-7/3 b-1</td>
<td>4/3 a-8/3 b-1</td>
</tr>
<tr>
<td></td>
<td>a-7/3 b</td>
<td>4/3 a-8/3 b-1</td>
</tr>
<tr>
<td></td>
<td>7/3-7/3 a+14/3 b</td>
<td>8/3-8/3 a+16/3 b</td>
</tr>
</tbody>
</table>

The first, second, and third elements in each cell give the payoffs of grower 1, grower 2, and the integrator, respectively. Note that the triple \{H, H, H\} results in the highest aggregate payoff and so is the best outcome. Any cooperative outcome with less aggregate payoff would necessarily entail shirking and evidence moral hazard. Suppose \( b = 0 \) as in an absolute performance contract. Note that no positive value of \( a < 1 \) (which is necessary for positive profits of the integrators) results in \{H, H, H\} being the Nash equilibrium. However, if both \( a > 0 \) and \( b > 0 \) as in a relative performance contract, then suitably chosen values of \( a \) and \( b \)
result in \{H, H, H\} as a Nash equilibrium, e.g., \(b = \frac{2}{3}\) and \(13/6 < b < 14/6\). Thus, a relative performance contract is necessary to establish \{H, H, H\} as a Nash equilibrium and thereby resolve the two-sided moral hazard problem.

7. Conclusions

The initial motivation for contracting in the broiler industry can be explained by differing economies of scale in the different stages of production and significant price and financial risks that exist in absence of contracts. Perhaps as a result, the traditional explanation for the evolution of contracts in the broiler industry has remained focused on factors such as access to capital and sharing of input and output price risks. In contrast, we believe contracting itself introduced behavioral risk due to a two-sided moral hazard problem and that it is the solution of this problem that has led to specific characteristics of the modern contingency contract. Specifically, the relative performance feature of modern contingency contracts in the broiler industry is demonstrated to solve the problem of moral hazard compared to traditional absolute contingency contracts in a simple stylized model. Clearly, further and more sophisticated modeling is needed to determine whether these results can be developed more generally and empirically verified in the context of broiler industry data. Nevertheless, the results of this paper help to chart a course for further needed research.
References


