11-2000

A Comparative Analysis of the Evolution of the Three Major U.S. Meat Industries: With Implications for the Future Direction of the U.S Beef Industry (Bulletin #877)

Jeffrey Gillespie

Christopher Davis

Aydin Basarir

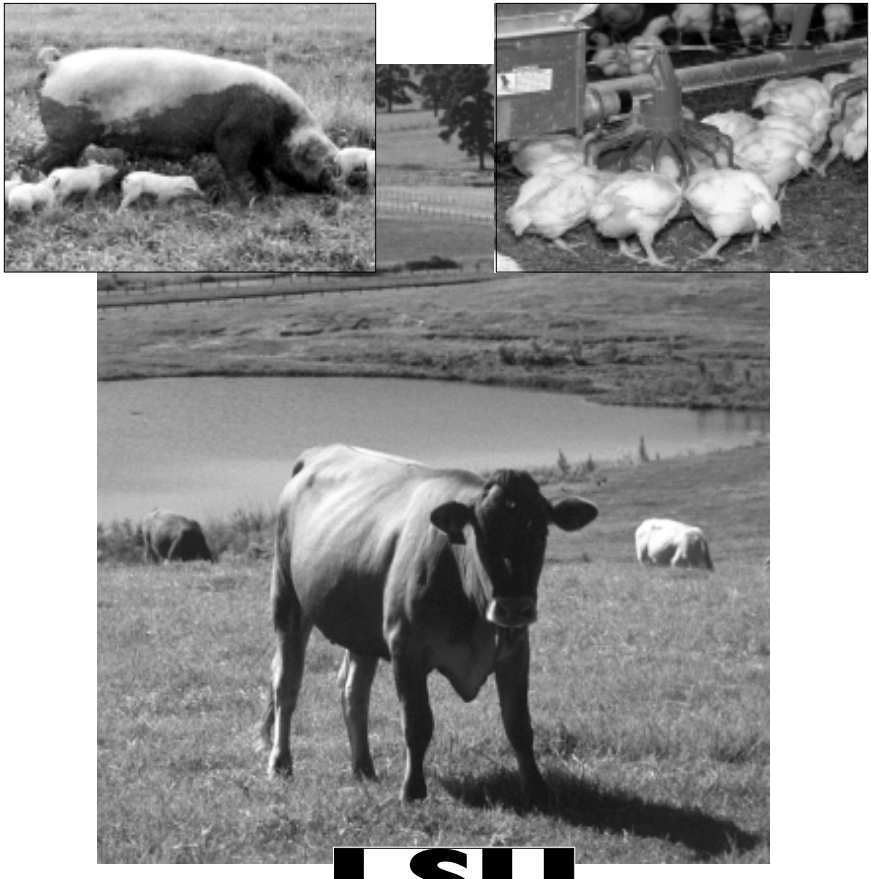
Alvin Schupp

November 2000 Bulletin Number 877

A Comparative Analysis of the Evolution of the Three Major U.S. Meat Industries

With Implications for the Future Direction of the U.S. Beef Industry

Jeffrey Gillespie, Christopher Davis, Aydin Basarir, and Alvin Schupp



LSU AgCenter Research & Extension

Table of Contents

Louisiana State University Agricultural Center
William B. Richardson, Chancellor
Louisiana Agricultural Experiment Station
R. Larry Rogers, Vice Chancellor and Director

A Comparative Analysis of the Evolution of the Three Major U.S. Meat Industries

With Implications for the Future Direction of the U.S. Beef Industry

Jeffrey Gillespie, Christopher Davis, Aydin Basarir, and Alvin Schupp*

1. Introduction

The structures of the U.S. livestock and poultry industries have undergone dramatic change in recent years. While the physical dimensions of structural change are observed in the reduced number and increased size of today's firms, equally interesting are changes in the business arrangements used in these industries. Formal means of vertical coordination have significantly changed the way many producers conduct business with up- and downstream firms.

Major forces influencing structural change in the agricultural sector include shifting consumer demands; new technologies that lead to larger, more specialized production operations; and more environmentally oriented public policy. We examine the evolution of the U.S. hog, broiler, and beef industries, focusing on factors that have influenced structural changes in each industry. While we do not present definitive explanations for all of the forces that have influenced the evolution of these industries, we attempt to

*The authors are, respectively, Associate Professor, Graduate Students, and Martin E. Woodin Professor, Department of Agricultural Economics and Agribusiness, Louisiana Agricultural Experiment Station, LSU Agricultural Center.

provide a better understanding of the forces and to compare and contrast the unique evolutionary paths taken by each industry. The questions “Why have the three industries evolved differently?” and “Do significant incentives exist for the beef industry to vertically coordinate in a manner similar to the broiler and hog industries?” are addressed.

The objectives of this study are to: (1) use an appropriate model of structural change in agricultural industries to critically examine the evolutionary paths of the three major U.S. meat industries to date, and to (2) provide insight as to the future challenges faced by the beef industry in progressing toward a more efficient consumer-oriented industry.

The organization of this paper is reminiscent of Reimund et al. We first examine selected broad industry trends, proceed by examining the existing theory of industry evolution, then provide case studies of the broiler, hog, and beef cattle industries and compare and contrast the evolution to date of the three industries. Finally, we provide our observations on the path the beef industry is likely to take in its future development.

1.1 Trends in the Livestock and Poultry Industries

At least three major trends in the livestock and poultry industries have either influenced or been influenced by the evolution of the industries. These include (1) increased farm sizes, technology, and overall production; (2) changes in consumption patterns of meat; and (3) increased vertical coordination in the livestock and poultry industries. Discussion of each of these trends follows.

1.1.1 Livestock and Poultry Production

A significant trend in each of the major meat industries has been a dramatic increase in firm size over the past 50 years, especially in the hog and broiler industries. Table 1 presents measures of physical structural change in each of the three examined industries (U.S. Agricultural Census). Broiler growers producing 1 to 59,999 broilers accounted for 97 percent of all broiler growers in 1954. By 1997, the percentage had declined to 25 percent. Few growers produced 100,000 or more broilers in 1954; by 1997, 68 percent of growers were in this category. Changes

Table 1. Farms by number of units sold per farm, 1954 to 1997

Year	1954	1959	1964	1969	1974	1978	1982	1987	1992	1997
Broilers										
1 to 59,999	48407	36083	24838	17519	15532	14436	13209	10236	6640	6089
60,000 to 99,999	1687[a]	3848	5890	7195	6561	5284	3677	2936	1801	1536
100,000 or more	N/A	2254	4400	7634	9314	12023	13214	14473	15508	16312
Beef Cattle										
1 to 49	3816850	3055291	1947044	923043	1207107	1157577	837738	930326	829962	808801
50 to 99	79168	102638	122580	149058	127533	139273	150170	119309	108376	107245
100 to 199	47059[b]	45653	54222	68896	58105	64120	58253	54843	51227	51676
200 to 499	N/A	23823[c]	25334	35140	31979	35887	23781	31485	30061	29612
500 or More	N/A	N/A	7999	12392	12377	29972	6205	14560	14563	14475
Hogs										
1 to 99	1755245	101867	575124	287162	259831	237402	163063	109811	76771	43745
100 to 199	111922	161611	105458	113197	59244	67558	44400	32667	23182	9597
200 to 499	42768[c]	81572	54317	102999	47790	73100	55954	44901	35426	15037
500 to 999	N/A	9983	6433	25904	11908	29766	30030	27515	25038	11967
1000 or More	N/A	1542	1136	7089	4058	15752	21648	23925	27750	21760

[a] This figure includes 60,000 or more, since the category 100,000 or more was not collected in 1954.
[b] This figure includes 100 or more, since the categories 200 to 499 and 500 or more were not collected in 1954.
[C] This figure includes 200 or more, since the category 500 or more was not collected in 1959.

have also occurred in beef cattle production: in 1954, farmers having 1 to 49 head accounted for 97 percent of all beef cattle operations, while farmers having 100 or more head of beef cattle accounted for 1 percent. By 1997, 80 percent were in the 1- to 49-head category, and 9 percent were in the 100-or-more-head category. While this shows significant structural change, it is not as dramatic as in the broiler industry. Hog producers producing 1 to 99 hogs in 1954 accounted for 92 percent of all producers. Few producers produced over 500 hogs. By 1997, only 42 percent produced fewer than 100 hogs, while 21 percent produced more than 1,000 hogs.

Along with increased farm size and decreased farm numbers, the U.S. commercial slaughter of broilers, hogs, and cattle also changed over the period 1950 to 1997 (Figure 1). In 1950, 1,945 million pounds of broiler meat were processed in the United States. By 1997, 37,523 million pounds were processed, a 2,107 percent increase. Hog slaughter increased from 16,690 million pounds in 1950 to 25,863 million pounds in 1998, a 55 percent increase. Cattle slaughter increased from 17,704 million pounds in 1950 to 42,806 million in 1996, a 142 percent increase. However, most of the increase in beef slaughter occurred prior to 1976, and it leveled off afterward. Sharp increases in broiler slaughter occurred in the late 1970s, during the late 1980s, and throughout the 1990s. Trends in per capita consumption (Figure 2) are, not surprisingly, similar to commercial slaughter.

Continued technological development in the agricultural sector has been a primary force for change in the structure of agricultural industries. Examples of technological developments in livestock production include genetically improved breeding stock, automated feeders, video marketing, improved disease control, controlled environments, computerized information systems for monitoring herd performance and health, medicated feed, and others. Changing technology has made possible larger production units that benefit from increased economies of size. The use of such technologies has been affordable to only a subset of producers, thereby forcing the exit of those who could not or would not adopt them. Adoption of the newer technology has led to increased herd or flock sizes, and the accompanying increased size economies have led to larger, more specialized operations.

Figure 1. Commercial Slaughter, U.S.

Broilers, Hogs, Cattle, 1950-1996

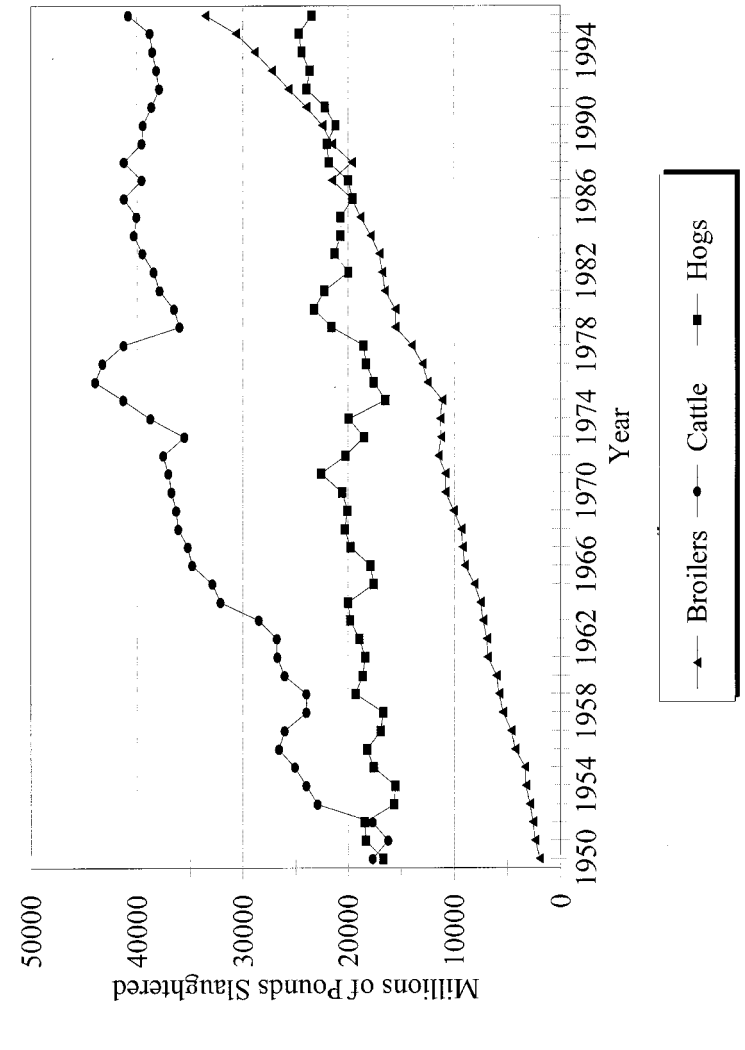
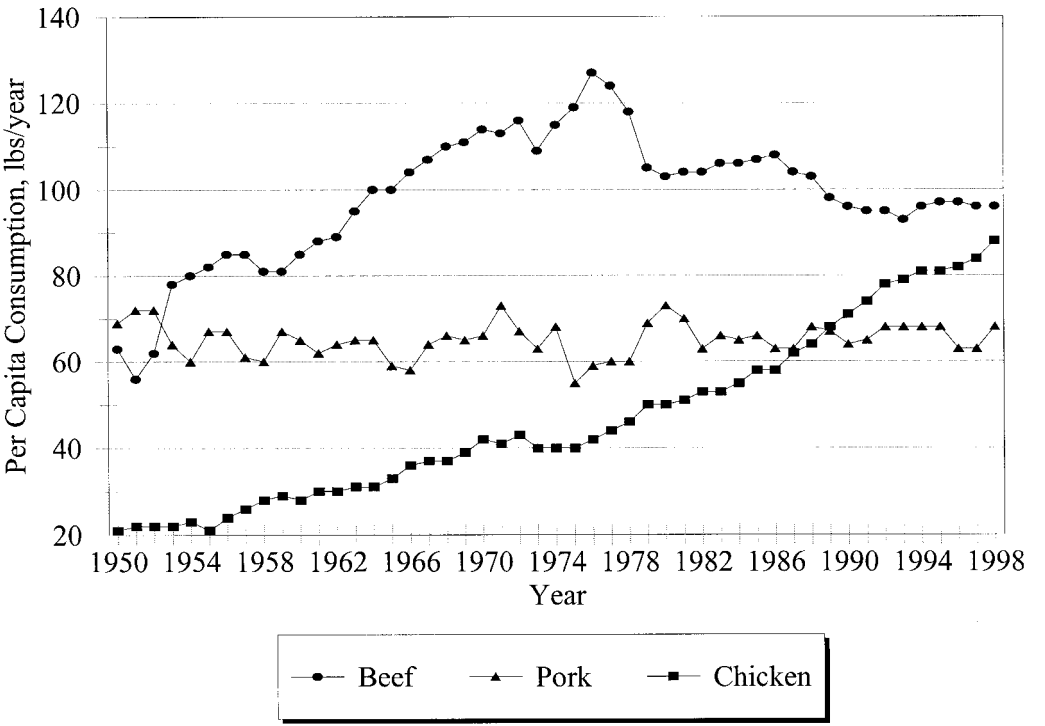


Figure 2. U.S. Per Capita Consumption
Beef, Pork, and Chicken, 1950-1998



Larger, specialized operations have led producers and processors to search for business arrangements through which risks and/or transaction costs could be reduced.

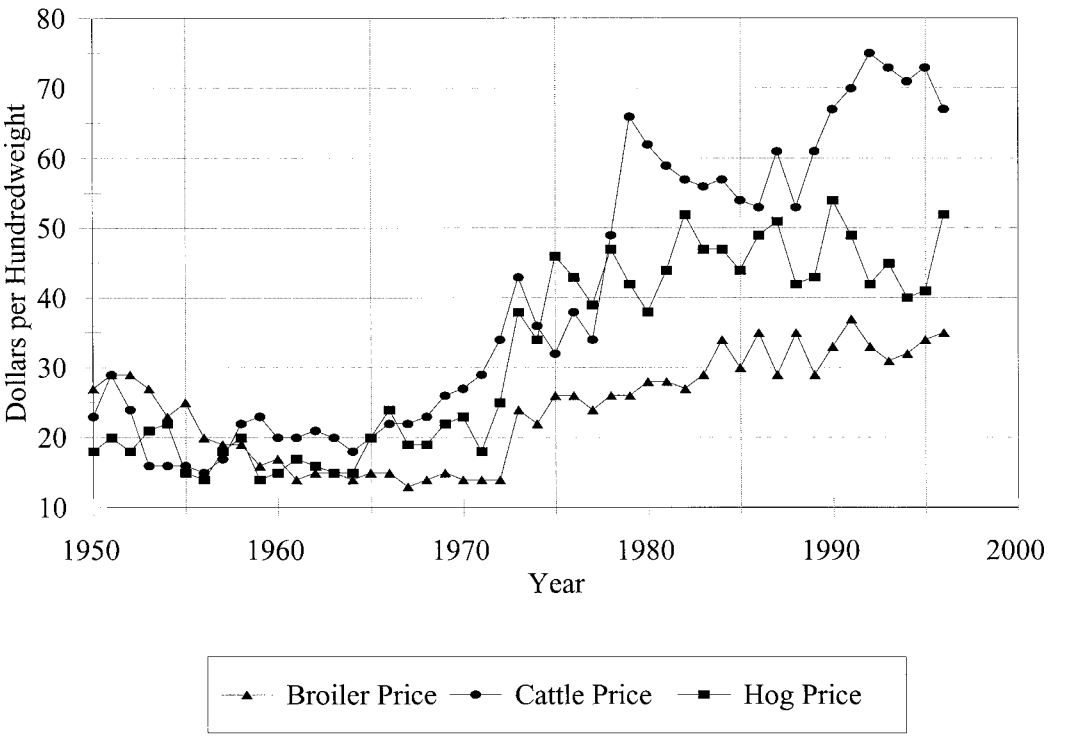
1.1.2 U.S. Consumption of Beef, Pork, and Chicken

A second trend that has influenced the three industry structures has been changing meat consumption patterns. At least three factors have encouraged the significant increase in U.S. per capita broiler consumption relative to other meats. First, health concerns associated with eating red meats have decreased their relative attractiveness to consumers. Second, during the past 50 years, the broiler and, later, the hog industries have become more cost efficient relative to the beef industry in animal production. As a result, hog and broiler prices increased less than beef prices during the mid-1960s and afterward (Figure 3). The consumer price has been highest for beef, thus reducing the quantity of beef consumed. And third, the increase in broiler consumption relative to beef has been partially due to the increase in value-added convenience items for chicken relative to beef. New value-added beef products have been developed very slowly relative to competing meats. Ritchie et al. report that, at the 1996 Meat Marketing Conference in Phoenix, Arizona, a major supermarket chain listed only five pre-packaged, consumer-ready beef products, while more than 70 poultry, 58 pork, 7 veal, and 6 lamb items were listed. Today's consumers increasingly demand tasty, easy-to-prepare, value-added products (Senauer et al.). The uniformity and consistency in the quality of poultry and pork products compared with beef have also increased the demand for poultry and pork relative to beef.

1.1.3 Vertical Coordination in the Livestock and Poultry Industries

Increased vertical coordination has been a major trend in the U.S. meat industries. Vertical coordination, however, has evolved differently in the three sub-sectors. More than 99 percent of U.S. broilers are produced by vertically coordinated firms, while it is reasonable to expect that 20 percent to 30 percent of hogs are produced by vertically coordinated firms. The prevalent form of vertical coordination in the broiler industry evolved during the

Figure 3. Prices Received by Farmers
Cattle, Hogs, and Broilers, 1950-1996



1950s, resulting in the current supply chain structure, in which growers typically contract with a firm integrated from feed mill to processor. This type of structure is frequently referred to as vertical integration, though it may be more appropriate to term it as quasi-vertical integration – while the integrator maintains ownership of birds and feed throughout the production process, growout of these birds is contracted with a separate firm, which prevents the term "vertical integration" from being used in its purest sense. Vertical integration in the strictest sense occurs when one firm owns and operates all segments involved in the coordination effort.

The hog industry continues to vertically coordinate, moving toward a structure similar to the broiler industry. Major moves toward vertical coordination began in the 1970s and 1980s. The beef industry has become more coordinated, though its structure has evolved differently and more slowly than the other two industries. While 17 percent to 23 percent of steer and heifer slaughter consisted of captive supplies during 1988-1994 (Ward et al.), little formal coordination links breeders or cow-calf operations to packers. Retained ownership is among the vertical coordination linkages between cow-calf producers and packers that will be discussed in more detail later in this bulletin.

2. The Theory of Industry Evolution

What factors are responsible for the nature of evolution in an industry? Economists have developed dynamic models to explain the evolution of industries toward formal vertical coordination. Stigler argues that firms tend to conduct all phases of production when an industry is relatively new, or in the first stage of evolution, since the extent of the market does not support specialized firms. Hence, an industry is vertically integrated early in its development. In the second stage, as the market grows, the extent of the market becomes large enough to support specialized firms. In the third stage, as the market shrinks, firms tend to reintegrate and undertake more joint processes.

The structure-conduct-performance paradigm models the laws of motion of an industry (Caves). Structure, including elements such as seller concentration, product differentiation,

barriers to entry of new firms, buyer concentration, height of fixed costs and the resulting barriers to exit, and market demand, affects market conduct. Market conduct refers to how a firm sets policies and reacts to market rivals. Conduct includes three major elements: setting prices, product quality and non-price policies, seeking strategic advantage, and deterring entry. Caves defines market performance as "the appraisal of how far the economic results of an industry's behavior fall short of the best possible contribution it could make to achieve (the industry's) goals." The structure-conduct-performance paradigm models the dynamics of an industry.

Reimund et al. discuss structural change in four stages: (1) change in technology, (2) shift in location of production, (3) industry growth and development, and (4) adjustment to risk. They argue that initial changes are driven by forces external to the industry, such as consumer demand or new technology. These forces lead to the adoption of new production technology. Regions that have comparative advantages in the new technology adopt it. As the new technology is adopted, industry growth and development evolve as firms become more specialized and concentrated, thus increasing risk. Adjustments to risk generally encourage formal vertical coordination.

Gillespie et al. modified the Reimund et al. model to explain structural change in the Quebec hog industry. Transaction costs are included, the role of the structure-conduct-performance paradigm is made explicit, and endogenous and exogenous factors affecting industry structure are formally discussed.

Boehlje summarizes five models of structural change in agriculture: the technology, human capital, financial, institutional, and sociological models. He discusses how each influences firm size, property rights, and coordination in agriculture. He argues that (1) technology gives rise to economies of scale and size in agriculture; (2) human capital enhances managerial skills and increases management's ability to process information and implement new technology; (3) finance allows producers to combine durable and non-durable goods to increase farm size and leverage; (4) the institutional model examines the structure, conduct, and performance of an industry; and (5) the sociological model describes individual and family roles in the firm.

Boehlje and Schrader use a life-cycle theory to analyze structural change in the U.S. hog industry. They argue that rapid industry structural change occurs at the convergence of four cycles: (1) the product life cycle, (2) the investment / replacement life cycle, (3) the manager / producer life cycle, and (4) the technological life cycle. They argue that the transformation of pork products, upgraded facilities, plans for managerial succession, and innovative technology provided windows of opportunity for growth when they occurred simultaneously.

Barkema argues that structural change in the U.S. food system has occurred because of changes in food consumption, food production, and the retail food market. He pinpoints consumers as a driving force for structural change through changing demographics, lifestyles, diets, and emergence of new market niches, placing more emphasis on the importance of consumer demand on structural change than previous studies. He also links technology to industry evolution.

2.1 The Role of Transaction Costs in Industry Evolution

Coase discussed the importance of transaction costs in firm decisions. Transaction costs are those costs that are required to establish and maintain property rights (Allen). A second definition would be that transaction costs are costs associated with inefficient pricing and production behavior (Joskow). Transaction costs arise in business because of communication breakdowns, imperfect information, incomplete contract stipulation, and ambiguous entitlements. Naturally, as the number of transactions that occur during the production and marketing of goods increases, transaction costs increase. Thus, larger producers are likely to incur higher total transaction costs, since they are likely to buy inputs and sell outputs more frequently than smaller producers.

Williamson (1990) identifies dimensions that are critical in characterizing transactions, describes governance structures that are used in transactions, and discusses why certain governance structures are preferred to others, given a particular transaction type. He differentiates between classical contracts, which account for all possible contingencies; neoclassical contracts, which are

dynamic in nature and all possible contingencies cannot be covered; and relational contracts, which are transaction-specific and characterized by the development of a dependent relationship between parties. The type of investment that is required for transactions and the frequency of transactions influence the contract governance that is likely to evolve. If little investment of human or physical capital is required for a transaction, and the frequency of transactions is either occasional or recurrent, then classical contracting (market governance) will likely evolve. Where transactions are occasional, non-recurrent, and the investment in human and physical capital is idiosyncratic or a mixture between idiosyncratic and nonspecific, then trilateral governance, a form of neoclassical contracting, is likely to evolve. With trilateral governance, an arbitrator may be used if a dispute arises between the two parties. With recurrent, frequent transactions, and an associated idiosyncratic investment, a unified governance relational contract will arise (vertical integration). However, if recurrent transactions are coupled with a mixed investment characteristic (both nonspecific and idiosyncratic investments are needed for the transaction) then bilateral governance relational contracts will arise. Clearly, the nature of technology and its investment characteristics influence the type of contract that is likely to evolve in an industry. If technology is highly transaction-specific, such as a $500,000 hog facility useful for no purpose other than hog production, and if the frequency of transactions becomes high, then relational contracting is more likely to arise.

Williamson (1971) asks, why vertically integrate? He discusses the properties of a firm that are likely to lead to internal organization as falling into three categories: incentives, controls, and inherent structural advantages. One incentive for vertical integration is that it attenuates potentially aggressive relationships that can arise between parties using arms-length bargaining. Such aggression can arise due to opportunism, where both parties seek personal advantage. Having control over these relationships, as well as available data at both levels to determine the economic efficiency of each segment, are advantages. The vertically integrated firm does not have to “guess” the production efficiency and profits another segment is making; thus, there is less argument among the segments that would arise due to bounded rationality. Some inherent structural advantages of

vertical integration include economies of information exchange and communication.

Williamson (1971) also discusses some market failure considerations in determining whether a firm will vertically integrate: First, in a perfectly static environment, vertical integration holds no advantage over a once-and-for-all contract. Second, vertical integration allows an efficient decision process to be utilized. Third, in cases of strategic misrepresentation (risk) from one or both parties, vertical integration can be advantageous. For instance, moral hazard, externalities, ambiguous property rights, and variable proportions distortions in production can lead to vertical integration. As well, anti-competitive consequences such as price discrimination and barriers to entry provide incentives for vertical integration. Fourth, the firm gains information processing advantages. Fifth, more efficient institutional adaptation may also lead to vertical integration. (Also see Casson for a discussion of the advantages of vertical integration.)

In addition to transaction costs and asset specificity associated with the idiosyncratic investment, Mahoney discusses the choice of organizational form using agency theory, which incorporates the concepts of non-separability and task programmability. Non-separability refers to the inability to observe the final output of team production and, subsequently, define each individual's input contribution to total production. For example, in broiler production, the task of the broiler grower in raising the chickens is well defined. The grower's reward can, thus, be determined according to his or her contribution to the total production process. Task programmability refers to the ability to measure task input and use this as a basis for making rewards. An example of high task programmability would be the contribution of labor on an assembly line. In such a case, productivity is directly related to effort and, thus, wages based upon productivity are likely to reward effort. An example of a low task programmability process would be crop production, where great effort may be expended, yet crop yield may be low due to uncontrollable factors, such as weather, diseases, and pests. With low task programmability, monitoring is costly in determining a fair reward. Thus, in segments with low task programmability, contracts that require monitoring will not be chosen.

3. A Model of Structural Change in Agricultural Industries

The model adopted for examining industry evolution in this paper was used by Gillespie et al., who modified the Reimund et al. model. Figure 4 diagrams the model.

3.1 Stage 1: Development and Adoption of New Technology

The initial stage of structural change is the development and adoption of new technology that leads to increases in productivity and economies of size. Adoption of technology often requires investment in idiosyncratic assets and often is accompanied by an increase in task programmability. Some producers are more capable of adopting technology than others, often depending upon availability of financial and human capital resources. Early adopters benefit if the new technology proves to be profitable. Depending upon regional production characteristics, new regions may emerge with a comparative advantage. Producers who initially cannot adopt the new technology search for sources of capital through which they may adopt it.

Exogenous factors influence the primary production stage. Consumer demand can influence the processor's product mix, altering demand for the primary product and stimulating the development and adoption of new technology. Suppose a fast-food restaurant demands larger chicken parts. This derived demand is communicated upstream to growers, who must produce larger birds. Growers demand technology that yields more efficient bird production and offsets the associated higher death rates suffered at higher broiler weights. Thus, consumer demand can influence the development and adoption of new technology throughout the production chain.

Public policy also influences the type of research that is conducted at both public and private research institutions and, thus, the development of technology. For instance, the land grant university system receives public funds for research and development of new technology for all stages of the livestock and poultry industries. Farm income subsidies reduce the incentive for eligible

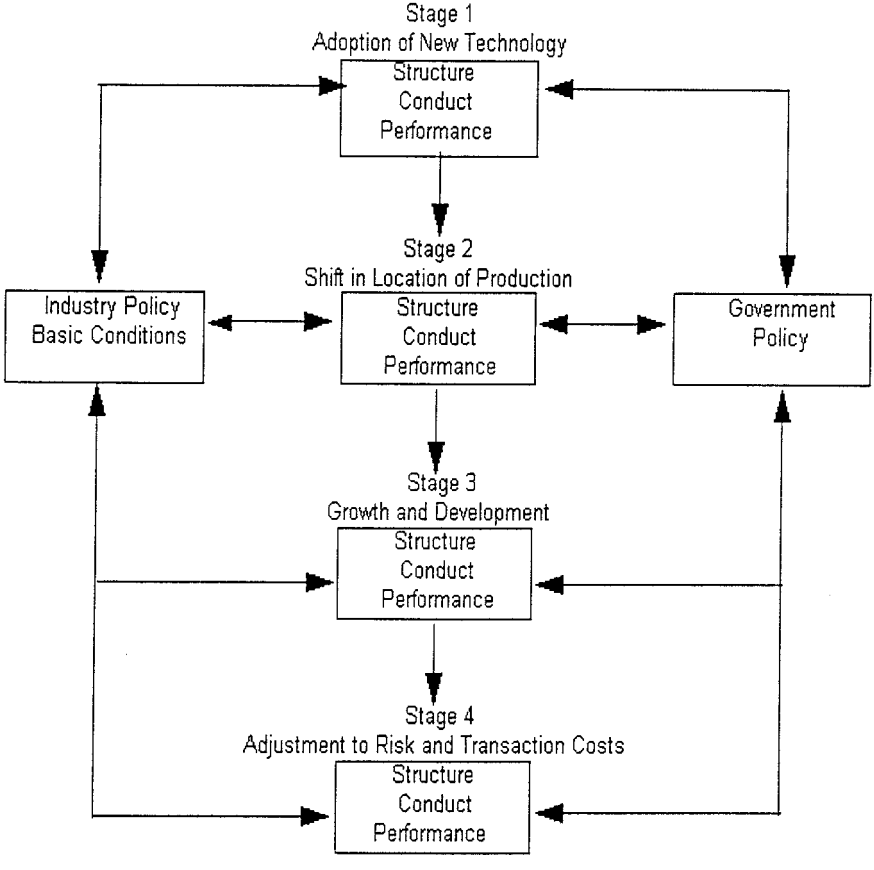


Figure 4. Life Cycle Model of Agicultural Industry Evolution

growers to adopt technology that reduces production costs. In addition, commodity groups can provide research funding, often using check-off monies, for the development of new technology.

3.2 Stage 2: Shift in Location of Production

The adoption of new technology occurs in areas that have a competitive advantage in using the new technology. Conduct at Stage Two consists of new firms locating in the new production region, while traditional production technology continues to be used in the established production regions. Performance in the traditional region suffers because the region no longer holds a competitive advantage. If the traditional region cannot regain a comparative or competitive advantage, it will be difficult for it to expand, and industry survival in the region may be at risk. However, if the established region's competitive disadvantage results primarily from exogenous public policies that discourage adoption of the new technology, a change in public policy may be initiated so that the region can remain competitive. For instance, in traditional hog production states with anti-corporate farming laws, the repeal of such laws could change competitive advantage.

Consumer demand is an exogenous factor that can affect the location of production. If population is growing more rapidly in one region than another, the location of production may be adjusted to reduce distribution costs.

3.3 Stage 3: Growth and Development of the Industry

In this stage, the industry's infrastructure grows and develops as entrepreneurs expand. While this growth and development may be occurring in the industry as a whole, it is particularly prevalent in the new region of production. Larger, more specialized firms with superior information systems develop. These new firms are generally characterized by greater risk associated with being larger and less diversified. Agglomeration economies develop in the new region and a more efficient industry evolves. However, transaction costs increase as input suppliers, firms, and buyers compete for higher qualities and quantities of inputs and products.

3.4 Stage 4: Adjustment to Risk and Transaction Costs

Stage 4 begins with high risk associated with large, specialized operations and high transaction costs associated with producers' idiosyncratic investments. The relationships between industry segments may become adversarial, especially if one segment is perceived to hold market power and to be more profitable. Risks and transaction costs are reduced via increased vertical coordination among the firms. In the case of potential adversarial relationships, vertical integration is likely to result. The collective performance of all levels of the industry becomes more industrialized and efficient.

3.5 Non-Mutual Exclusivity of Stages and Exogenous Factors

The four stages in the evolution process are not mutually exclusive. Each may be occurring simultaneously, though each may be thought of as a necessary condition for the subsequent stage. For instance, in the hog industry, the growth and development of the industry in a new production region, North Carolina, occurred simultaneously with increased vertical coordination. Firms that wished to expand using new technology, or new firms, realized that increased vertical coordination would be advantageous and that a new location would be required to adopt and use the new technology efficiently.

Exogenous and endogenous factors that may influence the industry at any or all stages include public policy and basic supply and demand conditions. Public policy may accelerate or decelerate the evolution process, depending upon the nature of the policy – is the policy intended to advance a region's development in a particular industry or hinder it? For example, increasing state tax rates, anti-corporate farming laws, and environmental policies may influence the shift in location of agribusiness as well as its growth and development. Exogenous demand factors that may affect any or all stages of industry evolution include shifts in population, changing tastes, substitutability of competing goods, a changing balance of trade, and others. Exogenous supply factors might include the availability of newly developed technology or a change in business attitude. An endogenous factor is

industry policy. Steps may be taken by the industry itself to influence its evolution, such as the establishment of a trade organization or check-off program.

4. Case Study: The U.S. Broiler Industry

4.1 The Current Structure of the U.S. Broiler Industry

The U.S. broiler industry is characterized by relatively few large, vertically integrated firms that coordinate more than 95 percent of U.S. broiler production. Thornton lists 46 firms that were involved in broiler production in 1997, with the smallest, College Hill Poultry, Inc., slaughtering one million pounds per week, and the largest, Tyson Foods, Inc., slaughtering 152 million pounds. The second largest company, Gold Kist, Inc., slaughtered 70 million pounds per week. The largest five firms each slaughtered more than 40 million pounds per week, 49 percent of total broiler slaughter. Twenty-five firms slaughtered less than 10 million pounds each per week.

The vast majority of U.S. broilers are raised under contract. Under a typical contract, the broiler grower provides housing, equipment, labor, and litter to raise contractor-owned broilers to a specified weight, typically between 4 and 6 pounds, using contractor specifications and contractor-owned feed, veterinary services, and supplies. Broiler contracts reduce price risk relative to that which would be faced by growers in the market (Knoeber and Thurman). The contractor typically owns feed mills, hatcheries, and slaughter and processing facilities. The contracted portion of the firm is in the grow-out of broilers and, perhaps, the production of eggs used in the production of chicks.

Poultry breeding is carried out by a small number of companies producing hybrid chicks and selling them under contract to the large broiler integrators (Johnson and Ruttan). These companies use intensive genetic selection and testing with the intent of producing birds that meet consumer and producer demands. All major producers use hybrid chicks from these companies.

The following four sections relate the current structure of the broiler industry to its evolution through the four stages of its life cycle.

4.2 Stage 1: Adoption of Technology in Broiler Production

Prior to World War II, broiler production was a sideline operation for most producers. Marion and Arthur (p. 38) identify technology as a force for change, stating that "advances in broiler breeding, feeding, disease and health control, housing, processing, shipping, and management procedures have provided fundamental forces to transform the broiler complex from an assemblage of loosely organized, small volume industries to the present highly industrialized vertical system."

Knoeber also discusses the importance of technology in the industry's evolution, noting disease control, breed development, development of chickens particularly suited to meat rather than egg production, and improvement in feed rations as important innovations. Technical efficiency has increased. In 1950, 3.8 pounds of feed were required to produce one pound of broiler, and 10 to 12 weeks were required to grow the bird to four pounds. Today, 1.8 pounds of feed are required to produce one pound of broiler, and it takes six weeks to grow the bird to 4.5 pounds. The industry performed with dramatically increased technical efficiency. The stage was set for a shift to regions that could best adopt the new technology.

4.3 Stage 2: Change in Location of Broiler Production

From 1945 to 1995, U.S. broiler production increased 3,278 percent. Only two of the top 25 producing states decreased in production over that period: New York and Michigan. Each of the top 10 broiler-producing states in 1995 -- Georgia, Arkansas, Alabama, North Carolina, Mississippi, Texas, Delaware, Maryland, Virginia, and California -- had also been among the top 10 states in 1945, with the exception of Mississippi, which replaced West Virginia. However, examination of the top three states shows a shift from Delaware, Maryland, and Virginia to Georgia, Arkansas, and Alabama. Thus, large increases in production in

the southeastern states occurred relative to the Middle Atlantic states. The industry also became more spatially concentrated: the top 10 states in 1945 accounted for 74 percent of production, while the top 10 in 1995 accounted for 81 percent. States that gained the least included Delaware, Iowa, Maryland, Ohio, West Virginia, and Virginia, while those that gained the most were Arkansas, Mississippi, Oklahoma, Tennessee, Missouri, and Alabama. The industry has slowly shifted southward.

Why did production shift south? Reimund et al. discuss the structural factors: (1) New technology required a different type of housing and capital investment from the previous technology. "Producers in the new areas were not hampered by capital investment based on prior production methods or existing institutions governing the production, financing, and marketing of broilers." (2) There were many underemployed farmers and a favorable climate in the southern United States. The region had a comparative advantage in getting growers to invest significant labor in large-scale broiler production. (3) Most broiler-processing plants in traditional regions required significant modifications to meet new standards for sanitation and waste disposal. Therefore, many were closed. New plants opened in areas with a comparative advantage in both processing and production. Industry conduct was to move to a new location where the industry could perform more efficiently.

4.4 Stage 3: Growth and Development of the Broiler Industry

Growth and development of the broiler industry occurred as integrators continued to move to and expand in the southern United States. The most significant changes in industry structure appear to have occurred during the 1950s and 1960s as formal vertical coordination became the industry standard. In 1950, 42 percent of chicken produced on a ready-to-cook basis originated from commercial broilers, while 58 percent was from other chickens (Reimund et al.). These percentages had switched to 92 and 8 percent, respectively, by 1972. From 1950 to 1997, commercial broiler production increased from 2.0 billion pounds to 34.2 billion pounds. The industry rapidly developed from a loosely structured, relatively small industry to one that closely monitored

consumer demand and instituted mechanisms (contracts) that efficiently transferred consumer signals upstream to primary production. The resulting products were those demanded by an increasingly health-conscious, convenience-food oriented population. Declining real prices of broiler meat relative to competing meats also spurred consumption.

4.5 Stage 4: Adjustment to Risk and Transaction Costs in the Broiler Industry

Changes in industry structure called for new, alternative business arrangements that reduced risks and transaction costs. The industry performed such that marketing and production efficiencies increased. Marion and Arthur provide insight as to how contracts arose in the broiler industry, discussing several companies that originated the contracting process. In the 1930s, Swift and Company, a large meat packer, entered into agreements with growers to purchase birds at market prices after selling them chicks from company-owned hatcheries. By the 1950s, growers asked Swift and Company for contracts that reduced the risks associated with declining prices. Swift offered the contracts to maintain a reliable supply of broilers for its packing plant. The original contracts contained floor prices below which losses were shared by both Swift and the grower. Price recessions of 1959 and 1961 caused growers to demand contracts that separated their returns from the market price. Thus, Swift began to retain ownership of the birds.

Tyson Foods evolved from a 1930s trucker of live broilers to its current vertically integrated structure (Marion and Arthur). Upon learning of growers' difficulties in obtaining chicks, Mr. Tyson bought a hatchery and sold chicks to growers whose broilers he transported. This helped him coordinate transportation because he knew when the birds would need to be transported given the chick delivery date. He started his feed business during World War II, when farmers began to experience difficulty obtaining feed. Upon closures of a number of small poultry processing plants in the 1950s due to mandatory federal inspection of processing plants, Tyson opened a processing plant. Shortly thereafter, Tyson began to retain ownership of the birds via grower contracts.

Ralston Purina, a feed company, also became involved in contracting in the late 1950s, as growers became less able to handle market risks. Their contracts guaranteed growers a minimum return. Later, processors were brought into the vertically coordinated structure (Marion and Arthur).

The integration of Holly Farms essentially created one multifirm company. The company arose through the consolidation of 16 separate companies: “three hatcheries, a feed mill with grain purchasing and hauling subsidiaries, five broiler contractors, one breeder-flock company, a poultry processing plant, and three related companies” (Marion and Arthur, p. 41). The forces causing this decision were economic in nature. Successful firms that had previously conducted business with one another became more successful as transaction costs were reduced and competition among them was eliminated.

While each of these cases is unique, several common forces encouraged increased formal coordination. In adopting new technology and expanding the size of their operations, broiler growers faced increased market risk. Contracting could reduce this risk. Whether the integrator was an input producer or a processor, the need to secure markets for inputs or output and reduce transaction costs associated with repeated market transactions was common to all. Contracts evolved from market governance to neoclassical contracting with mixed investment characteristics and occasional frequency. Eventually, as investments became more idiosyncratic and transactions more recurrent, relational contracts with unified governance evolved. Technology drove the movement to this type of contract, given that the new technologies used by both growers and processors were highly idiosyncratic and shorter grow-out periods resulted in increased market frequency.

Grower risk increased due to the larger size and capital requirements of broiler grower operations. Though larger growers faced the same prices as smaller ones, they faced greater risk as they sold in greater volumes. In addition, these growers were more likely to be specialized in broiler production than the backyard growers. No other enterprise offset the increased price risk faced by growers. A guaranteed or formula price offered by the contractor allowed for a reduction in price risk.

The environment in which broilers were raised became more controlled due to climate controlled housing and increased biosecurity, changing the nature of production risk. While the potential for loss due to outside factors had decreased and a higher degree of task programmability had resulted, potential losses from an unfavorable event had graver consequences, given the greater number of birds in each house. Thus, the downside potential of the larger operations was potentially disastrous. Growers searched for ways to decrease their risk.

Grower contracts decreased revenue risk, since most contracts set a fee or margin floor, providing growers with certainty that they would receive at least a minimum revenue per pound. In addition to reducing revenue risk, tournament contracts also reduced certain production risks (Knoeber). In a tournament contract, growers compete with other growers delivering broilers during the same week. A base (average) margin or fee per pound is set. However, the grower with the highest (lowest) production efficiency receives the highest (lowest) fee. Much of the environment faced by growers in the tournament is common; all use the same feed, chicks, and field support and face similar climatic conditions. An average fee to be received per pound is set.

Suppose feed provided to growers during a particular week is substandard. All of the competing growers use the same feed. While the overall distribution of technical efficiency is likely to be lower for that week, the least (most) efficient grower will likely receive the same fee per pound that he or she would have received during a “normal feed” week. Thus, the grower is not penalized as greatly for common production risks that are not within his or her control. (Of course, if all growers have fewer birds to sell, then their total returns will be lower, so the tournament contract does not fully transfer common risks to the contractor.)

The presence of common risk shows that the highest degree of task programmability had not been reached, though the feasibility of a resource-providing contract with little monitoring cost lends evidence that task programmability had increased. Idiosyncratic risks, such as the risk of a disease infecting birds in a particular flock, are not decreased via contract, except to the extent that the contract specifies the use of certain technologies that reduce such risks.

Another important risk component to the broiler grow-out phase was the increased risk associated with an idiosyncratic investment. There are few alternative uses for a broiler house and associated equipment. With tight operating margins in production, the grower must keep facilities at full capacity to cover payments on the investment. Transaction costs associated with negotiating repeated, timely purchases of feed and selling of birds were large. Suppose a feed dealer had an inadequate supply of feed to sell a grower on the day it was needed; multiple transactions with different feed dealers would be required to meet feed demand. Suppose the processor were running at full capacity for the week and there were no capacity for the grower's birds; the grower would be required to feed the birds longer, perhaps past their optimal weight. These transaction and associated costs are eliminated with a resource-providing contract.

An additional incentive for growers to accept contracts is the reduced initial investment involved. Most potential growers do not command the resources needed to enter broiler production without a loan. This became an increasing concern as operational sizes grew. Contracts reduced the total initial investment required since the grower did not purchase feed, other variable inputs, and broilers. Lenders were more likely to lend to growers under contract. Growing under contract signaled that proven management practices would be used, markets would be available, and lenders would face decreased risks.

What were the incentives for feed mills and processors to coordinate with broiler growers? Both types of firms involve idiosyncratic investments. To maintain the full capacity needed to pay off their investments, processors need to schedule deliveries ahead of time, which can be conducted via contract. Bird characteristics are also important. Some markets require 4.5-pound birds, while others require 6.0-pound birds. If purchasing through spot markets, it would be difficult for the processor to consistently obtain the type of bird needed. Information costs would be high as buyers searched for birds of the correct weight and quality. Feed dealers contracted with growers to form a steady market for their products, thus reducing informational transaction costs associated with market search. Monitoring and enforcement costs are also reduced under the contract. Growers had economic incentives to use specific inputs and management practices.

Why has the broiler industry evolved toward quasi-vertical integration via contracts with growers rather than vertical integration in its strictest sense? A number of studies have addressed this question (e.g., Knoeber, and, more recently from an agency theory perspective, Goodhue). Economies of size in production are not as large for broilers as some other agricultural commodities, such as turkeys and eggs. Through financing, growers can become involved in production; therefore, broiler companies do not have to invest in the buildings, equipment, and land needed to raise them. Also, with an average of 67 growers per poultry complex, there are enough growers to fill a tournament (Knoeber). The incentive for the grower to produce efficiently is also high, given the possibility of losing a contract and having no or few other sources of birds. Task programmability had increased such that, with minimal monitoring using tournaments, the efficient growers could be rewarded for good management. In like fashion, the incentive exists for the less efficient grower to improve his or her management.

5. Case Study: The U.S. Hog Industry

5.1 The Current Structure of the U.S. Hog Industry

The percentage of hogs marketed from U.S. farms with 2,000 or more hogs increased from 17 percent in 1978 to 67 percent in 1994 (Plain); hog farm size also increased. In addition to this physical structural change, all segments of the industry have experienced changes in their ownership, management, and labor functions. Traditionally, independent producers secured all inputs and made all marketing and production decisions. The typical producer operated a farrow-to-finish unit, breeding sows and raising the offspring to slaughter weight. Others specialized in farrow-to-nursery or finishing operations. Most traditional Midwestern hog farms have been vertically integrated with feed production, as producers also raise feed grains. These firms have not been vertically coordinated with a packer. Today, independent production remains a common business arrangement for producing hogs.

However, new forms of vertical coordination have evolved in the hog industry. In many cases, operations that were vertically integrated from farrowing through finishing have separated into firms linked via vertical coordination. Some systems link primary production to both the feed and packer segments via contract. Most contracting has been driven by feed companies and packers. By vertically coordinating with hog production, these firms secure markets for their products and/or services. An example of a vertically coordinated hog production firm is Smithfield Foods, which contracts with hog producers and owns processing facilities, as well. Smithfield Foods recently acquired Murphy Family Farms, the second-largest U.S. hog production firm.

Commonly used contracts in the hog finishing industry are the flat-fee, incentive payment, and tournament contracts. All three are typically resource-providing: the contractor supplies the feed, feeder pigs, veterinary care, medication, transportation, and a market for the hogs. Initially, a minimum payment is made to producers, usually on a per hog basis. With incentive-based contracts, bonuses are awarded based on technical efficiency. With tournaments, bonuses are based on the technical efficiency of each producer compared with other producers within the tournament.

Production contracts exist for farrow-to-nursery, finishing, and farrow-to-finish operations. Grimes and Rhodes estimate that finishing contracts are twice as common as either farrow-to-nursery or farrow-to-finish contracts in the United States. Approximately 10 percent of the nation's hogs were produced under contract in 1989 (Rhodes); by 1994, 16 percent were under contract. Contracting has continued to increase since then.

Besides independent production and contract farming, other business arrangements used by hog firms include various forms of cooperatives, vertical coordination and vertical integration. Some new cooperatives have arisen to provide independent producers with some of the benefits of large-scale production, while allowing them to maintain autonomy. (See Fulton and Gillespie, and Reilly and Reynolds (a) and (b) for more information on the role of cooperatives.)

U.S. swine breeding stock is provided primarily by independent purebred breeders and breeding companies (Johnson and

Ruttan). Purebred breeders are typically small producers who serve small local markets. Breeding companies are large, international corporations that produce crossbred pigs, involving fewer but more carefully selected breeds. Many large, vertically coordinated hog production firms are customers of breeding companies.

One exogenous factor that has influenced the structure of the hog industry is consumer demand. Consumers have become more discriminating buyers of pork. Vertical coordination has served as an efficient vehicle for transmitting changing consumers' product specifications to hog farmers (Barkema and Cook). Other exogenous factors have included public policies, such as environmental laws and anti-corporate farming legislation, discussed under Stage Two.

The following four sections relate the current structure of the hog industry and its evolution through the four stages of its life cycle.

5.2 Stage 1: Adoption of New Technology in the Hog Industry

By the 1940s, the stage was set for technological breakthroughs in hog production. Rural electrification gave rise to confinement as power ventilation and lighting became available (Baxter). Indoor facilities promoted improved economic efficiency via slatted floors; improved means of storing, digesting, and distributing animal wastes; farrowing crates; automated feed and watering equipment; climate-controlled buildings; and computerized information systems for monitoring herd performance and health. Conduct has been to adopt all-in/all-out production, segregated early pig weaning, split-sex feeding, and other technology.

The hog industry has improved breeding stock, rations, equipment and facilities, and disease control. Genetic improvements have resulted in leaner, faster-growing pigs. In 1954, the average litter size per sow was 5.3 pigs; by 1997, this figure had increased to 8.7 pigs (Census of Agriculture; USDA-National Agricultural Statistics Service). Top producers were weaning 25 pigs per sow per year.

5.3 Stage 2: Shift in Location of Production in the Hog Industry

Significant shifts in location of production have occurred in the hog industry in recent years. From 1987 to 1992, Iowa and Illinois, the two largest hog-producing states in 1987, increased production by 14 percent and 5 percent, respectively, to sales of approximately 26.8 million and 10.3 million hogs, respectively. However, North Carolina's sales increased by 108 percent, to 10.8 million hogs, replacing Illinois as the second-largest producer. Exogenous public policies, such as environmental regulations and anti-corporate farming laws, are believed to be two reasons why hog production has shifted in location (Hubbell and Welsh). As growth and development occurred, rural communities protested the negative environmental externalities generated by large hog operations (Wang, Chen, and Asuming-Brempong), citing water pollution, foul odors, and aesthetic degradation. To resolve these problems, limitations were placed on manure disbursement, thus constraining operations in traditional areas. Large firms searched for alternative locations for growth.

In the early 1980s, anti-corporate farming legislation was passed in Iowa, restricting corporate involvement in agricultural production. This legislation was amended in 1988 to prohibit contracting by packers (Johnson and Foster). Today, anti-corporate farming laws are effective barriers to entry in Iowa, Nebraska, Oklahoma, Kansas, North Dakota, South Dakota, Wisconsin, and Minnesota (Johnson and Foster, Hamilton and Andrews), providing incentives for large-scale corporate farms to locate in other states. Producers in many states have pushed for anti-corporate farming legislation. The fear that contractors would exploit contractees (producers) through market power and the associated loss of managerial control by producers are two factors that have led to resistance to contracts and vertical integration. Gillespie and Fulton found that anti-corporate farming laws had significantly decreased the net new entry of large hog operations in states with such laws, relative to states without them.

Existing institutions have also affected production location. In the traditional production regions, markets have been available and ample expertise and capital have been devoted to hog production. Contract production has been viewed by some as a threat

rather than an opportunity, as farmers value autonomy (Gillespie and Eidman). Many potential producers in non-traditional hog production regions viewed contracting as an opportunity. Neither North Carolina nor Arkansas was a major hog-producing state prior to widespread contracting. Both were, however, major broiler-producing states, where contracting was common. Both generally accepted hog industry expansion initially, though environmental concerns associated with large confined animal feeding units arose, and increased regulation soon followed.

Regions experiencing the greatest change in hog production are the Southeast and West. North Carolina has been the fastest growing state, increasing 489 percent from 1.9 million hogs in 1975 to 9.3 million in 1996 (Hubbell and Welsh). Arkansas grew from 285,000 head in 1974 to 850,000 head in 1993. Oklahoma's hog production increased from 240,000 head to 1.32 million head from 1993 to 1996 (Hubbell and Welsh). Western states, such as Colorado, Utah, and Arizona, have also experienced significant increases in hog production. This growth has been attributed to producers' willingness to accept vertically coordinated production since little existing industry was threatened by the introduction of new business arrangements. It is likely that hog production in these areas results in fewer externalities because population density is lower. While these regions may have competitive advantages in the new production modes, it is doubtful that they hold natural comparative advantages due to their higher input costs, mainly feed.

5.4 Stage 3: Growth and Development of the Hog Industry

The hog industry has grown over the past 10 years, though not as extensively as did the broiler industry over the same period. Figure 3 indicates modest growth in commercial slaughter since the 1970s. Much of the growth has been in exports, which remained relatively stable prior to 1981, then decreased through 1986. Exports increased steadily thereafter to 714 million pounds in 1997 (National Pork Producers Council).

While hog slaughter has not increased to the extent of the broiler industry, one must consider several factors. First, the slight growth in pork slaughter is contrasted with the decrease in beef

slaughter, a competitor red meat. The pork industry has been attuned to consumer preferences and has introduced new products that meet consumer demand. The pork industry is in the early phases of vertical coordination, with most producers remaining independent. It remains to be seen whether future hog industry growth will occur primarily through vertical coordination (i.e., contracts).

5.5 Stage 4: Adjustments to Risk and Transaction Costs in the Hog Industry

Among the first U.S. hog production contracts were those offered by Murphy Farms in North Carolina in the late 1960s and Tyson Foods in Arkansas in the early 1970s (Futrell). Over time, other firms, such as Cargill, Carroll Foods, and Prestage Farms, began contracting with producers.

Fulton and Gillespie discuss the 1994 establishment of Alliance Farms, a hog production cooperative formed via a joint venture between Farmland Industries and Yuma M and M Cooperative in Colorado. A 2,400-sow farrow-to-nursery operation and contracted finishing facilities were established. Farmland entered the business to lower the risks and transaction costs associated with securing an adequate quality and quantity of hogs for its packing facilities. Yuma M and M Cooperative wanted to add value to locally raised feed grains via hog production. Colorado had little previous history in hog production. Without a contract, few producers would likely have received loans to build facilities, given their lack of experience. Fulton and Gillespie discuss the potential competitive advantage held by Colorado over its neighboring anti-corporate- farming-law states, Kansas and Nebraska. Alliance Farms represents the experience of a number of large, vertically coordinated hog firms. The need of packers to obtain consistent quality and quantities of hogs and the need of feed dealers to secure feed markets drove the industry to formal vertical coordination. Producers with insufficient equity capital to fund the required idiosyncratic investment entered into an agreement whereby part of the initial investment was funded by the integrator, producer income risk was reduced, and the total risk associated with maintaining a market for hogs was reduced.

Risk has influenced producer decisions to adopt contracts. A number of studies have shown the effect of risk on the contracting

decision (e.g., Gillespie and Eidman, Johnson and Foster). According to Martin, price risk accounts for approximately 94 percent of the risk that leads to income variability in hog production. If independent hog producers face 100 percent price risk, contract holders with or without tournaments face only 6.5 percent and 9.5 percent price risk, respectively (Martin). Thus, over 90 percent of the price risk is shifted to the contractor.

Contracts also affect the production risk faced by producers. Most contracts require state-of-the-art, bio-secure hog production facilities. Production risk associated with events that affect all producers in a particular area (common risk) can be reduced via tournament contracts, as discussed with respect to the broiler industry. A higher degree of task programmability has allowed success of such contracts with minimal supervision. Producers' efforts are rewarded based on feed efficiency and other efficiency criteria.

Transaction costs are lower for contract producers than independent producers. As herd size has increased and transactions have become more recurrent, independent producers have incurred higher information search costs involving the quality, prices, and availability of inputs and the existence of hog markets. Large-scale independent producers who sell hogs weekly must routinely collect and analyze price information. Negotiation costs may also be significant. Arranging for transportation can be costly. Timely delivery of the quantity and quality of feed needed may pose a challenge for some independent producers. Most contracts eliminate these costs, as feed and other inputs are furnished by the contractor, and hogs are collected and shipped to market by the contractor.

Business arrangements that have evolved in the hog industry are heterogeneous across producers and contractors, relative to the broiler industry. Contract provisions vary widely. Some producers have entered into cooperative agreements, often to benefit from many of the advantages of contracting while maintaining a higher level of autonomy. The vertical organization that will eventually evolve as an industry standard in the hog industry is uncertain at this time.

The variation in business arrangements could be due to the ability to cover cash expenses using a variety of business arrange-

ments. While significant economies of size exist in the industry, smaller, independent farrow-to-finish operations (i.e., 100 sow) have survived in recent years, though rapid exit among this group continues. Market governance has continued in small operations because transaction frequency is more occasional for the producer – these producers may sell only twice per year, and their facilities are older and fully depreciated. Trilateral governance using neoclassical contracts exists with some medium and large farms. Transportation, administrative, and monitoring costs for the contractor would also be higher with more small producers. However, these contracts exist primarily where the contract is with a local producer and trust has developed over time. Most contracts offered by large integrators are relational contracts; the contractor is a quasi-vertical integrator. These producers have highly recurrent transactions, and their relatively new facilities are highly idiosyncratic in nature. Some analysis has been conducted examining the profits accruing to the primary production segment. For example, Cozzarin and Westgren compared profits of a contract with a quasi-vertical integrator with those of a strategic alliance, concluding that "it would seem that some changes would be necessary in order for an alliance to compete over the long term with a franchise" (or contract). Thus, we expect to see greater use of contracts with vertical coordinators.

Many of the incentives for broiler integrators' involvement in contracts also hold for the hog industry. Hennessy and Lawrence discuss large contractors' assessments of the advantages and disadvantages of contracting, finding that increasing financial leverage, reducing environmental and regulatory problems and accessing motivated labor are among the most important advantages to contracting. They then discuss the influence of factors such as asset specificity, opportunism, property rights, and risk on the contractor's incentive to contract. Like the broiler industry, the need to reduce search and negotiation costs associated with operating the packing plant at full capacity drives the integration decision. Monitoring costs associated with making certain that hogs are raised to the required specifications are reduced. Enforcement costs are lower because producers must raise hogs under company specifications. Under contracts, producers must strive for higher technical efficiency or face contract discontinuance.

6. Case Study: The U.S. Beef Industry

6.1 The Current Structure of the U.S. Beef Industry

Though the U.S. beef industry has become more vertically coordinated, the nature and extent of the coordination differs significantly from the hog and broiler industries. The cow-calf segment is present in every U.S. state, with a wide array of herd sizes. Calves sold by this segment range from 400 to 650 pounds, depending upon region and producer. The stocker (backgrounding) segment, where calves are prepared for the feedlot, is present in some cases as a firm separate from the cow-calf segment. It occurs mainly in regions with quality winter pasture (e.g., ryegrass in the Southeast and wheat in the Southern Plains). In some regions, stockers may be retained through summer to take advantage of quality forages. The feedlot segment is located mostly in the High Plains but is also in the West and Midwest regions. Animals remain in the feedlot from 90 to 240 days prior to slaughter. Substantial economies of size exist with feedlots. Of 50,000 U.S. feedlots, the 390 largest account for 65 percent of U.S.-marketed fed cattle (Ritchie et al.). Moreover, a steer or heifer may be owned by three or more separate firms during its relatively short lifetime.

Some vertical coordination exists between the three segments, though the degree of coordination varies greatly among firms. No single coordination mechanism can be considered an industry standard. The majority of calves and stockers are sold via local conventional auctions; others are sold via video auction or direct order to the buyer. Producers selling via video auction or direct order to the buyer on the farm or ranch benefit from economies of size associated with assembling large lots of cattle and receiving higher prices. Few firms are vertically integrated through all three segments. It is more common for the cow-calf segment to vertically integrate only with the stocker segment.

Retained ownership is used by some cow-calf and stocker producers whereby they maintain ownership of cattle through the feedlot. A contract between the feedlot and producer specifies that the producer is paid when the animals are marketed and slaughtered. Retained ownership in custom feedlots was introduced in

response to economies of size that left small, individually owned feedlots less competitive than large, commercial lots. Custom feeding allowed smaller producers to continue to be involved in the feeding segment, while taking advantage of cheaper feed and other inputs available to larger feedlots (White and Chesnick). A number of retained ownership arrangements exist, reflecting the array of grazing and feeding alternatives available. Retained ownership offers cow-calf or stocker producers an opportunity to increase average returns, though the most profitable alternative varies from year to year, depending upon the market (Peel). Use of retained ownership remains limited.

The packing industry is characterized by a few firms that buy most cattle via private treaty. The four-firm concentration ratio for the beef packing industry was 82 percent in 1994 (USDA, Agricultural Statistical Abstracts). Some vertical coordination in the form of captive supplies exists between feedlots and packers (Outlaw et al.). Captive supplies include packer feeding, basis forward contracts, and exclusive marketing/purchasing agreements (Ward et al.). Packer feeding is a form of vertical integration whereby a packer purchases feeder cattle and places them in packer-owned or commercial feedlots. When finished, the cattle are transferred to the packer. With basis forward contracts, the feedlot and packer enter into a forward contract. For example, for the month that cattle are to be slaughtered, the packer bids a futures market basis. The feedlot determines when to select a futures market price, from which a cash selling price is computed at an agreed-upon basis. With exclusive marketing/purchasing agreements, producers agree to supply packers with specified numbers of cattle at a future date. Pricing agreements vary. Captive supplies accounted for 17 percent to 23 percent of steer and heifer slaughter from 1988 to 1994 (Ward et al.).

The cattle breeding segment differs greatly from the broiler and hog breeding segments. A number of purebred breed associations exist, each consisting of large numbers of independent operators. Crossbreeding is common among cattle producers due to the benefits of hybrid vigor and complementarity among sire and dam breeds. Few cow-calf producers use improved breeding technologies. Only 15 to 20 percent of U.S. beef cattle are the result of artificial insemination (Keeton). Johnson and Ruttan

discuss the reasons why commercial cattle producers have been reluctant to adopt new breeding technologies. While cattle breeders are often guided by the objective of producing animals that perform well in the show-ring, commercial production often occurs under harsh environments. The latter often requires traits not employed in the show-ring and, therefore, not accounted for by the breeder.

An additional reason for the low rate of artificial insemination in beef cows is that the animals are not confined, making assembly of animals for artificial insemination more difficult and costly. Currently, improvements in genetic seedstock in the beef industry arise primarily via (1) feedback from purchasers of the breeding stock (cow-calf producers), (2) signals from judging at breed and other livestock shows and, more recently, (3) expected progeny differences (epd) data on breeding stock. With some exceptions, these sources do not have immediate or meaningful contact with consumers or the packer segment of the beef industry, thus superceding the signals from these two sources.

While retained ownership, vertical integration, and captive supplies have increased the extent of vertical coordination, the beef cattle market remains relatively inefficient at transferring consumer preferences to cattle producers via the pricing system. Each industry segment has different goals. Each pays relatively different prices for various cattle characteristics, clouding and confusing market signals, especially at the cow-calf level.

Outlaw et al. discuss the following goals and incentives of the different segments: cow-calf producers are paid on pounds of calves produced; thus they emphasize calving rate, weaning weight, birth weight, cow milk production, and calving ease. Stocker operators are much less concerned with characteristics of the mother cow. Rate of gain, feed conversion, breed, condition, and animal color are of more importance. Cattle feeders are concerned with cattle and feed prices, feed conversion, quality grades, and rate of gain. Cattle continue to be sold to packers in pens. Packers usually buy all cattle in a pen; thus, cattle are sold on an average price basis. A problem arises in that individual animals are not priced according to their traits (however, value-based marketing has increased, reducing this problem). Consumers also have differing preferences, further clouding the market

signals. The result is potentially confusing price signals at various levels of the production / marketing channel.

The following three sections discuss the evolution of the U.S. beef industry to its current structure.

6.2 Stage 1: Adoption of New Technology in the Beef Industry

Technological change has increased beef cattle economic efficiency. Ritchie et al. discuss some technological advances, including, but not limited to, artificial insemination (1936), bovine embryo transfers, growth promotants (1954), and, more recently, further breeding technology, such as development of epds. Despite these advances, cattle productivity has not increased as rapidly as hog or poultry productivity. For instance, dressed beef production per cow increased 25 percent from 1980 to 1995, while dressed pork production per sow increased 90 percent over the period (Brester et al.).

Part of the reason for the slower rate of increase for dressed beef production per cow could be attributed to the longer generation interval for cattle compared with pigs and poultry. However, relatively few advanced breeding technologies are widely used. At least 15 breeds are used in Louisiana (Schupp), while many others are used in other parts of the United States. due largely to different environmental conditions. By comparison, both the hog and poultry industries have concentrated on improving the production efficiencies of a few lines of genetics. In the beef industry, while animals with certain traits command higher prices than others, little industry coordination has emerged to encourage product uniformity at the packer level.

6.3 Stage 2: Shift in Location of Production in the Beef Industry

The major shift in beef cattle production has been with the feedlot segment from the Midwest to the Southern High Plains states (Reimund et al.). The High Plains emerged as a major grain production region during the early 1970s, with sorghum being grown under irrigation, making it a grain surplus region. With growing economies of size in the feedlot segment, the relative

sparseness of human population in the High Plains was attractive for cattle feeding. However, this expansion was not associated with a reduction of cattle feeding in the traditional production region. Expansion in the High Plains accounted for most of the expansion in U.S. cattle feeding. Industry conduct was to expand in the new region. Eventually, custom feeding and captive supplies emerged as economies of size increased in the feedlot and packer segments.

6.4 Stages 3 and 4: Growth and Development and Adjustments to Risk and Transaction Costs in the Beef Industry

Limited vertical coordination has evolved in the beef industry. A recently developed vertically coordinated organization is the Farmland Supreme Beef Alliance, through Farmland Industries (Farmland Cooperative System), which is organized as a cooperative. The goal is to secure high quality animals for which producers are paid premium prices. All animals must be at least 50 percent Black Angus. All English and selected Continental crossbreeds are allowed; dairy and Brahman crossbreeds are not. Cattle are finished at Supreme Cattle Feeders, Inc., and sold via value-based marketing to Farmland National Beef Packing Company. Producers receive incentives for carcasses that quality grade higher than USDA Select. Producers may retain ownership, partnership or direct-sale feeder calves. Higher premiums are gained by producers retaining at least 50 percent ownership. In such cases, producers receive information for decision making. By targeting a specific branded end product, such as Farmland Black Angus Beef and Certified Angus Beef, producers receive consumer feedback, feedlot performance, and carcass information.

Other beef alliances include Bradley Natural Beef, with 100 producers in 18 states who supply feeders and calves to three feedlots (Davis). Bradley uses a grid pricing system based on carcass weight, marbling scores, yield grades, and brand location. No implants or added growth hormones are allowed. Precision Beef Alliance, Certified Uniform Beef, and Pfizer Select Supplier programs are other examples of beef alliances through which cattle producers can receive premium prices. These strategic alliances reflect efforts to meet consumer demand. Packers recog-

nize the need to provide consistent, uniform quality products for sale at the retail level.

In addition to strategic alliances, captive supplies have a number of advantages. Packers are guaranteed a certain quantity of fed cattle to be delivered at a specified future date. The price is determined ahead of time, reducing price risk to feeders. Short-run search costs associated with identifying cattle markets are reduced, and financing may be more available to feedlots under these agreements.

While certain segments of the beef industry have moved toward vertical coordination, formal coordination continues to be limited. There is very little coordination from packers to the breeding stock segment. While the Farmland Beef Alliance contract specifies Angus breeding, up to 50 percent of another breed may be present. Participation by cow-calf producers in retained ownership programs is often loosely organized, so that a producer can be involved whenever he or she deems it advantageous. This producer choice differs greatly from the control exercised by the packer over breeding, gestation, and birth or hatching in the hog and broiler industries, where a producer typically contracts either all or none of his or her production. Use of captive supplies is limited. It appears that incentives are lacking for the beef industry to vertically coordinate on a large scale. Why is this so?

The relatively small idiosyncratic capital investment in buildings and equipment in the cow-calf and stocker segments does not provide incentive for contracting in the beef industry. The major capital expenditure other than land in both segments is fencing (Boucher and Gillespie), which may not be identified as idiosyncratic since many farmers use fencing for purposes of maintaining property boundaries. In short, the cow-calf and stocker industries are contestable industries, where firms can enter or exit with minimum loss of investment capital.

Related to the specific asset argument is the fact that economies of size for cow-calf and stocker operations essentially peak at relatively small volumes (Lamb and Beshear). Numerous 20-cow cow-calf operations exist. The lack of a substantial, leveraged fixed investment with low opportunity cost contributes to the relatively small economies of size. Coupled with the small econo-

mies of size is the apparent willingness of some small cow-calf producers to produce calves at prices that fail to cover full economic costs (Boucher and Gillespie). In short, cattle are not the primary source of income for the smaller-volume producers. Thus, the incentive to coordinate with an up- or downstream firm is almost nonexistent.

Related to the absence of size economies is the fact that cattle operations are likely to sell calves and stockers infrequently, many only once per year. Many producers utilize a limited breeding season. This, coupled with the biological capacity of a cow to produce only one offspring per year, leads to infrequent sales. Thus, transaction costs associated with search for and negotiations with buyers are relatively low for these producers. Most cattle producers have access to local auctions for selling animals. Thus, there is little cost associated with identifying and securing a market. Unlike broiler and hog producers, small cow-calf and stocker producers have little incentive to accept contracts that assure market availability or reduction of market transaction costs.

The low level of task programmability in beef cattle production also limits vertical coordination. Cattle production is primarily land-based, with heterogeneous forage as a major input. Vastly different production climates call for different breed types. Exogenous factors, such as weather, highly influence productivity. It would be difficult for a vertical coordinator (up- or downstream from cow-calf production) to accurately assess a cow-calf producer's efforts and provide a fair reward without significant monitoring. Without monitoring, incentive exists for the producer to use an alternative, lower-cost resource, hoping for the prospect of a high level of technical efficiency. Using the model proposed by Mahoney, the characteristic low task programmability, low asset specificity, and low non-separability of cow-calf production, is likely to lead to use of a spot market.

For the packer, the use of captive supplies can reduce short-run search costs, enabling the schedule of slaughter in advance. Programs such as the Farmland Supreme Beef Alliance help packers to ensure supplies of uniform quality cattle, rather than heterogeneous lots. However, the incentives have not been strong enough to entice packers to either widespread vertically coordi-

nate or force value-based marketing. Some of the disincentives include: (1) packers have been successful in pricing pens of cattle based on average value; (2) the overall consumer market for beef has been sufficiently diverse; the carcass from almost any animal has a market. Packers can often alter less-than-desirable carcasses so that they can be sold as boxed beef; (3) consumers have increasingly accepted fresh beef in ground form, which does not require a uniform quality carcass. Beef packer branding, which would require consistent quality cattle, has been limited. Fresh beef is not a strong candidate for branding. Beef is USDA quality graded, and the grade serves as a limited proxy for brand; and (4) cow-calf producers have shown a willingness to provide weaned calves at residual prices without exiting the industry.

Overall, coordination between packers and feedlots remains limited but is consistent with the lack of being highly attuned to consumer preferences. According to Lamb and Beshear, the lack of coordination is ". . .surprising, since concentration in the packing industry could facilitate greater coordination." While a number of factors explain the beef industry's relative lack of progress toward vertical coordination, there appears to be a lack of clear direction envisioned by the industry. Industry policy, an endogenous factor that could accelerate movement through the four stages of evolution, has generally been lacking. Lamb and Beshear state that, "In short, the beef industry currently has no clear path toward vertical coordination."

7. Comparing and Contrasting the Evolution of the Three Industries

7.1 Stages 1, 2, and 3: Technology Adoption, Location of Production, and Industry Growth

Each of the three meat industries has advanced significantly through the four stages of industry evolution. Significant public funding has been devoted to develop technology for the industries, with new technology resulting. Examining U.S. 1862 land grant university research funding for the three industries from 1975 to 1995, beef had consistently higher funding than poultry and swine (USDA-CSREES). In 1975, $44 million, $23 million, and

$18 million were appropriated to beef, poultry, and swine research, respectively, in land grant universities. Similar proportions were funded in 1995, when $110 million, $56 million, and $57 million were funded for the three industries, respectively. Swine research funding increased relative to the others. While these figures include industry-funded university research, they do not include private research, which is likely to be relatively greater for integrated industries, such as poultry.

Three factors have been particularly important in increasing the economic efficiency of broiler and hog production: (1) advances in nutrition, (2) confinement housing, allowing for environmental control and clear production standards, and (3) the biological capability of hogs and broilers to dramatically increase the number of offspring within a specified time frame. The land-based nature of cow-calf and stocker production and relatively low profitability have been associated with production conducted in heterogeneous environments using assets not specific to cattle. Task programmability for beef production has been low compared with broilers and hogs.

All three industries have experienced shifts in location of production as new production technology has become available. Locational shifts have been southward for the hog and broiler industries due to lower cost labor and other inputs and a favorable business environment. The cattle industry shifted location during the 1970s as cattle feeding shifted to the grain-producing High Plains. Substantial industry growth has occurred in all three industries, especially the vertically coordinated broiler industry.

7.2 Stage Four: Adjustment to Risk and Transaction Costs

7.2.1 Risk

Price and production risks have influenced the industries' movements toward vertical coordination. Broiler growers became less willing to accept risks due to their increased operational sizes and associated higher risk. Income risk reduction is also a major incentive for hog producers to accept contracts. Price risk reduction for feeders is a factor leading to captive supply arrangements in the beef cattle industry. A common thread is that increased size

economies have led to larger operations that have, in turn, increased risk. Vertical coordination has allowed up- and downstream firms to share risk, so that one firm is not forced to bear all of the risk. Relatively small cow-calf and stocker operations have experienced little change in risk due to slower increases in firm size, thus resulting in relatively less incentive for these segments to vertically coordinate.[1]

7.2.2 The Sources of Transaction Costs

Williamson (1990) discusses the importance of asset specificity and opportunism in influencing the evolution of industries. Asset specificity may lead to greater opportunism: as a firm's alternative uses for its assets decrease, an incentive exists for up- or downstream firms holding market power to exploit the firm. Today's state-of-the-art hog and broiler production facilities are specific assets that involve idiosyncratic investments. In many areas where contracted broiler and hog production is prevalent, one or at most a few potential live markets exist. An incentive exists for buyers to collude and exploit growers. While the use of resource-providing contracts does not completely prevent such opportunism, the buyer's ownership of variable and some fixed inputs may help curb exploitation, given that the buyer is, in a sense, a partner in the business. Moreover, the final move to full vertical integration is curbed as the integrator prefers not to make the large investment in these facilities, utilities, and fuel. Contractual terms provide producers the incentive to give an adequate level of management since they are paid based upon productivity and ownership of an idiosyncratic investment. Contracts are effective in these industries because their provisions provide the basis for these idiosyncratic investments to cashflow. Less idiosyncratic investment is involved in grazing cattle; thus, there is less incentive for cattle producers to follow strict specifications set by a vertically integrated firm.

7.2.3 Transaction Costs

A number of transaction costs have led to the current structure of the three industries. Information and search costs incurred by packers have increased as packers have worked to procure animals that meet their specifications. More transactions are obvi-

ously needed to fill larger capacity plants. The increasing number of transactions and the scrutiny involved in acquiring quality animals has led to contracting in both the hog and broiler industries. In the cattle industry, captive supplies have allowed packers to reduce short-run search costs associated with acquiring consistent quantities of uniform quality cattle (though they have also increased search costs associated with securing feeder cattle inputs). Related to the search and information transaction costs in this case is asset fixity. With a fixed investment, the packer needs to utilize facilities at a volume that minimizes cost. Contracting is among the most efficient means of ensuring timely availability of needed throughput for the plant. Not only have search costs been important for packers, but also for feed suppliers. In all three industries, feed mills have coordinated with animal feeders to lower costs associated with searching for customers -- most cattle feedlots own their own feed mills. With broilers and hogs, coordination via contract has allowed feed mills to sell previously agreed-upon quantities of feed to producers, thus lowering long-run search and storage costs.

With increased firm sizes, more negotiation costs for buying inputs and selling products have been required. By signing a contract, the number of negotiations is reduced to only when a contract is signed, once every two to three years in the broiler and hog industries. These costs are significantly reduced for all parties to the contract. The beef feedlot sector conducts large numbers of transactions and has become more vertically coordinated with packers. However, fewer annual transactions are needed in most cow-calf operations, where many producers sell calves once per year. Thus, negotiation costs have not led to greater vertical coordination in the cow-calf segment. There has been little need for cow-calf and stocker producers to vertically coordinate with the feed segment since these segments are primarily forage-based.

7.3 Is the Beef Industry Poised to Move to a More Vertically Coordinated Structure?

Before addressing this question, it is worthwhile to discuss the benefits to the beef industry of moving toward a more vertically coordinated structure, using lessons learned from the poultry and

hog industries. One of the benefits would be the production of more consistent and uniform quality beef cuts. Due partially to the increased availability of consistent quality meats in the poultry and pork industries, consumers have come to expect meats that are of consistent and uniform quality, especially in flavor and tenderness. Within the USDA beef grades, the only proxy for quality currently available in the beef industry, quality varies significantly. In addition to consistent quality, consumers increasingly demand convenient, value-added products. For these products to be produced efficiently by packers, beef carcasses need to be of uniform and consistent size, composition, and quality, enabling the efficient transformation of carcasses to specific value-added retail products. The consumer's demand for beef must be efficiently communicated to all segments of the industry so that derived demands for feeders, calves, and ultimately replacement breeding stock are based almost exclusively upon primary demand. Appropriately structured vertical coordination could help achieve this goal.

To achieve greater consistency in carcass size, quality, and composition, a reduction in the number of breeds and increased concentration on improved genetics within the reduced set of breeds are needed. This reduction in breeds would not only result in increased product consistency but also allow more concentrated effort within this narrow set of breeds on developing genetic stock with higher reproductive efficiencies and more efficient performance in the feedlot. Feed-to-gain ratios could be significantly reduced, as has occurred through breeding efforts in the poultry and hog industries. Thus, increased vertical coordination could not only serve to increase beef demand through the provision of more consistent quality products, but in the long run, it could also provide for more efficient animals, reducing production costs and allowing retail beef prices to decrease relative to competing meats.

Strides toward increased industry vertical coordination, including packer captive supplies, packer use of grade and yield pricing, retained ownership, and alternative marketing techniques, have been limited. Moreover, members of the Louisiana beef industry do "not anticipate large changes in the organization of firms in the industry," and "with minor exceptions, . . .(do) not

feel that integration or contracting (will) increase measurably within the Louisiana beef industry" (Schupp). However, unless pricing and technical efficiency in all segments increases significantly and product consistency increases, prices are likely to remain high for beef relative to its competing products, and beef demand will continue to wane. Previous discussion in this publication examines the impediments to a supply chain structure (i.e., task programmability, the nature of risk, economies of size, etc.) for the beef industry. Indeed, Lamb and Beshear do not predict that the supply chain structure of the broiler and hog industries will evolve in the beef industry. Thus, it appears that the beef industry is not poised to move toward a vertically coordinated structure that resembles the hog and broiler industries.

It is not essential that an industry move to a vertically integrated, supply chain structure to increase operational and/or pricing efficiency. If markets between up- and downstream segments operate efficiently and information is transferred effectively, the added net benefits of integration in that industry may be negligible. If feedlots can transfer price signals to cow-calf producers that reveal packer and consumer preferences, many of the inefficiencies currently existing in the industry can be eliminated. In such a case, the pricing mechanism serves as the coordinator. However, today's calf prices reflect the preferences of hundreds of order buyers and dealers who have limited knowledge of what consumers demand and of how calves will meet these preferences after feedlot finishing.

What type of industry structure can begin to correct the problems faced by the current beef industry? In the authors' opinion, the packer must be the primary instigator of a new, more efficient industry structure. The packer segment is the closest segment to the consumer that deals with live animals. Increased or forced use of value-based pricing by packers would be an important first step in achieving this end. While value-based pricing has had limited success, refinement and widespread adoption would provide incentives for feedlots to produce animals (i.e., carcasses) with consumer-desired traits.[2] With greater incentive to produce consistently high quality cattle, feedlots would have significant incentive to offer prices for calves and stockers that reflect their needs. One way to get cow-calf and

stocker producers to provide these animals would be via cooperatives and strategic alliances that provide large quantities of consistently high quality animals.[3] With the availability of more uniform animals, packers could begin to specialize in the types of meat products they handle. Those deciding to produce high quality cuts could use captive supplies to procure consistently high quality animals.

Upon the increase of value-based marketing, beef breed associations and state cattlemen's associations could serve as facilitators for a more efficient industry by inviting packer buyers to their meetings to discuss the types of animals they prefer. These preferences would be expressed in terms of the type of calf that is likely to command a premium price. This would help in identifying a subset of beef breeds or combination of beef breeds whose offspring offer high feedlot performance and produce meat desired by consumers. Strategic alliances could be formed based upon this knowledge.

The beef industry needs to be proactive in helping to identify the smaller subset of breeds that can provide the types of products that consumers prefer. After this subset of breeds is identified, comprehensive research is needed to significantly improve the efficiencies of each of these breeds under feedlot conditions so that feed costs and, thus, retail prices can be reduced. However, in order for such incentives to be provided for increased efficiency, packers must send clear price signals to producers. Continued purchase of calves in lots where all calves command the same price will not achieve this end.

8. Summary and Further Considerations

A number of studies have examined the evolution of agricultural industries. In this paper, a modified Reimund et al. model is used to examine the evolution of the U.S. broiler, hog, and cattle industries. In addition, transaction cost and agency theory are used to explain why the evolutionary paths of the three industries have differed.

While this paper discusses the evolution of the industries toward vertical coordination as moving toward more efficient

industries, we acknowledge the negative consequences associated with many vertically coordinated systems. Some of these systems result in less producer autonomy than can be achieved through a non-vertically coordinated system. While broiler growers have gained some benefits through contracting, as discussed earlier in the publication, they have foregone the independence associated with making one's own short-run production and marketing decisions. They have also become dependent on the contractor to deal with them in a manner that is deemed "fair" by both parties.

Other topics concerning vertical coordination and vertical integration include the following questions. (1) Can independent producers in all segments of the industries respond to new government regulations, such as those issued by USDA, FDA, and EPA, as effectively as vertically integrated or coordinated firms? (2) What would be the effect of unionization of producers on economic efficiency in a vertically coordinated system? The prospect of unionization is gaining popularity in the broiler industry. (3) How does the inclusion of only one vertically coordinated firm in an area affect producer bargaining power? Each of these topics are issues for consideration and research in determining the direction an industry should proceed.

Perhaps the most important point that can be taken from this discussion is the importance of technology and an industry's associated unique production processes in moving an industry to a vertically coordinated system. Without a unique technology to control the production process, little vertical coordination is likely to evolve. Substantial idiosyncratic investment in technology provides the incentive for producers to vertically coordinate or integrate with an upstream or downstream segment to ensure market access. Without idiosyncratic investments that are used to increase efficiency, producers are unlikely to have the incentive to relinquish autonomy to reduce their risk and transaction costs. Task programmability is also a key ingredient for an industry to evolve to more controlled forms of vertical coordination. If extensive monitoring is needed for an up- or downstream firm to ensure that the primary production firm is not shirking on the agreement, attempts at relational contracting are likely to fail.

Given the relatively high prices for beef and fewer beef value-added products, the industry needs to increase its production and market efficiencies. The achievement of higher technical efficiency will pose a challenge, given that one offspring per year is a biological constraint and different regions of land-based production call for different breed types. However, increased coordination in the form of price incentives for production uniformity could help the industry achieve these efficiencies.

9. Endnotes

1. Though the above argument suggests that cattle producers have experienced less risk relative to larger producers in their competitor industries due to the relatively smaller size of the operations, we must acknowledge that the steadily increasing demand for chicken over the past 50 years has led to relative stability in broiler prices, compared with cyclic and declining beef prices. The beef industry's significant decrease in per capita consumption, along with higher carcass weights, has led to continued downward pressures on beef prices.
2. Value-based marketing forces the packer to assess a value for individual animals, a task not needed when pens of cattle are purchased based on averages. The current system, where pens of cattle are purchased at an average price, results in both inferior and superior animals not being revealed, masking any means of correct price signaling to the cow-calf producer segment.
3. Getting small-scale cow-calf producers, whose primary income source is not cattle, to enter into cooperatives and strategic alliances could provide a significant challenge. However, in the long run, as superior breeds command higher prices that reflect their quality, the incentive to participate will increase.

10. Glossary

Agglomeration Economies – Gillespie et al. state that, "Agglomeration economies arise as an industry develops in a region, reducing the costs that industry players must expend to conduct business. As more firms enter, input suppliers and markets increase in number, providing more competition, lower transportation costs, and thus creating a more efficient industry."

Arms-Length Bargaining – Arbitrage that must occur when using spot markets, as opposed to an internal coordination mechanism.

Asset Specificity – An asset is said to be specific to a particular production process if it is useless or substantially less valuable in the production process of any other product.

Bounded Rationality – Rationality is "a style of behavior that is appropriate to the achievement of given goals, within the limits imposed by given conditions and constraints." (Simon) Rationality may be bounded if the decision maker has incomplete information or has alternative goals to "classical goals."

Comparative Advantage – In this publication, comparative advantage refers to a region's natural relative advantage in production.

Competitive Advantage – In this publication, competitive advantage refers to a region's relative advantage in production due not solely to "natural" conditions but also to outside forces such as political conditions.

Downstream Firm – A firm that is part of the downstream industry segment. The downstream segment acquires inputs that are produced by upstream segments of an industry.

Economies of Size – Refers to the reduction in the cost per unit of output that occurs as a firm produces more units of output.

Four-Firm Concentration Ratio – The proportion of total sales made by the four largest firms in an industry.

Idiosyncratic Investment – An investment that is made in inputs such as capital, labor, machinery, or buildings that are useful only for the production of a specific item. An example would be the investment in a milk tank, which is useful only in production of milk in a dairy operation. The opposite of a non-specific investment.

Moral Hazard – Moral hazard arises when there is a conjoining of inharmonious incentives with uncertainty. Arrow discusses moral hazard as the "confounding of risks and decisions."

Non-Specific Investment – An investment that is made in inputs such as capital, labor, machinery, or buildings that is useful for the production of more than one item. An example would be the investment in a medium-sized tractor, which is a useful input for many agricultural enterprises. The opposite of an idiosyncratic investment.

Opportunism – The incentive of one firm to exploit another, as in the case of a monopoly that sells to a downstream firm in a purely competitive market.

Retained Ownership – Retained ownership occurs when an input supplier continues to own the input as it moves through the downstream production segment. An example would be the case where a cow-calf producer retains ownership of the calf during its growth in the downstream feedlot segment.

Strategic Misrepresentation Risk – Prior to entering a contract between two firms, risk is faced by both sides that the contract is incomplete, that is does not fully specify all possible contingencies. The risk associated with the other firm not specifying a specific contingency for strategic reasons is termed as strategic misrepresentation risk.

Task Programmability – A task is said to be "programmable" and, thus, have a high level of "task programmability" if the use of specific inputs and technology at prescribed levels leads to a predictable level of output. In cases where specific levels of input lead to less predictable output levels, the task is said to have a low level of "task programmability."

Technical Efficiency – Refers to the capacity of producing the maximum level of output for a given quantity of inputs and technology.

Up-Stream Firm – A firm that is part of the upstream industry segment. The upstream segment produces inputs that are used by downstream segments of an industry.

Variable Proportions Distortions – Variable proportions refers to the ability of a production firm to freely substitute one input for another in a production process, thus allowing for varying proportions of inputs. Variable proportions distortion is defined in the context of a monopoly input supplier and the resultant incentive of the downstream production firms to vertically integrate with the supplier.

Vertical Coordination – The link of up- and downstream firms into a single entity.

Vertical Integration – The link of up- and downstream firms through ownership in a single firm.

Video Auction – A video auction is an auction that is conducted via audio-video equipment, usually in multiple geographic locations.

11. References

Allen, Douglas W. "What Are Transaction Costs?" Research in Law and Economics. 14: (1991): 1-18.

Arrow, K.J. "The Organization of Economic Activity: Issues Pertinent to the Choice of Market versus Non-Market Allocation." In The Analysis and Evaluation of Public Expenditures: The PPB System. Vol. 1, Joint Economic Committee, Washington, D.C., 1969: 47-64.

Barkema, A. "The Changing Structure of the U.S. Food System." Canadian Journal of Agricultural Economics. 42: (1996) 541-547.

Barkema, A. and M. Cook. "The Changing U.S. Pork Industry: A Dilemma for Public Policy." Economic Review. (2nd Quarter 1993): 50-65.

Baxter, S. Intensive Pig Production: Environmental Management and Design. London: Granada Publishing, 1984.

Boehlje, M. “Alternative Models of Structural Change in Agriculture and Related Industries.” Agribusiness: An International Journal. 8, 3(1992): 219-231.

Boehlje, M. and L.F. Schrader. “The Industrialization of the Food System: Questions of Coordination.” Paper presented at NE-165 conference on Vertical Coordination in the Food System, Washington DC, 5-6 June 1995.

Boucher, R.W. and J.M. Gillespie. “Projected Costs and Returns for Beef Cattle, Dairy Production, Swine Production, and Forage Crops in Louisiana – 1998.” A.E.A. Info Series No. 161, Dept. of Agric. Econ. and Agribus., Louisiana State Univ. Agric. Center, Jan 1998.

Brester, G.W., T.C. Schroeder, and J. Mintert. “Challenges to the Beef Industry.” Choices. (Fourth Quarter 1997): 20-25.

Casson, M. “The Theory of Vertical Integration: A Survey and Synthesis.” Journal of Economic Studies. 11,2(1984): 3-43.

Caves, R. American Industry: Structure, Conduct, Performance. Sixth Edition, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1987.

Census of Agriculture (1930 - 1965). by United States Department of Agriculture.

Coase, R.H. “The Nature of the Firm.” Economica. 4(1937): 386-405.

Cozzarin, B.P. and R.E. Westgren. “Rent Sharing in Multi-Site Hog Production.” American Journal of Agricultural Economics. 82(February 2000): 25-37.

Davis, E.E. “Are You a Member of a Beef Alliance ... Yet?” Mimeo, Texas Agricultural Extension Service, College Station, Texas, 1999.

Farmland Cooperative System – Farmland Livestock Production System. http://www.farmland.com/agoperat/livestock.html.

Fulton, J. and J. Gillespie. “Emerging Business Organizations in a Rapidly Changing Pork Industry.” American Journal of Agricultural Economics. 77(December 1995): 1219-1224.

Futrell, G. “Contract Production of Hogs in Iowa”. Mimeo, Iowa State University Extension Service, May 1989.

Gillespie, J.M. and V.R. Eidman. “The Effect of Risk and Autonomy on Independent Hog Producers’ Contracting Decisions.” Journal of Agricultural and Applied Economics. 30,1(July 1998): 175-188.

Gillespie, J.M. and J.R. Fulton. “Entry, Exit and Changes in the Size of Hog Production Firms in the U.S.: A Markov Chain Analysis.” Staff Paper 97-12, Dept. of Agricultural Economics, Purdue University, July 1997.

Gillespie, J.M., K. Karantininis, and G.G. Storey. “The Expansion and Evolution of Vertical Coordination in Quebec Hog Industry.” Review of Agricultural Economics. 19, 2: (Fall - Winter, 1998).

Goodhue, R.E. “Broiler Production Contracts as a Multi-Agent Problem: Common Risk, Incentives and Heterogeneity.” American Journal of Agricultural Economics. 82(August 2000): 606-622.

Grimes, G. and J.V. Rhodes. “U.S. Contract Production of Hogs: A 1992 Survey.” Dept. of Agricultural Economics University of Missouri. Report 1994 - 2. Pages 1 - 48.

Hamilton, N.D. and G. Andrews. “State Regulation of Contract Feeding and Packer Integration in the Swine Industry.” Drake University Law School White Paper 92-4, November 1992.

Hennessy, D.A. and J.D. Lawrence. “Contractual Relations, Control, and Quality in the Hog Sector” Review of Agricultural Economics. 21,1(Spring/Summer 1999): 52-67.

Hubbell, B.J. and R. Welsh. “An Examination of Trends in Geographic Concentration in U.S. Hog Production 1974-96.” Journal of Agricultural and Applied Economics. 30, 2 (December 1998): 285-299.

Johnson, C.S. and K.A. Foster. “Risk Preference and Contracting in the U.S. Hog Industry.” Journal of Agricultural and Applied Economics. 26, 2 (December 1994):393-405.

Johnson, N.L. and V.W. Ruttan. “The Diffusion of Livestock Breeding Technology in the U.S.: Observations on the Relationship between Technical Change and Industry Structure.” Journal of Agribusiness. 15,1(Spring 1997): 19-35.

Joskow, Paul L. “Vertical Integration and Long-Term Contracts: The Case of Coal-Burning Electric Generating Plants.” Journal of Law, Economics, and Organization. 1,1(Fall 1985): 33-77.

Keeton, L.E. “Cattle Ranching in the 1990s Is an Office Job.” Wall Street Journal, October 4, 1995, p. B1.

Knoeber, C.R. “A Real Game of Chicken: Contracts, Tournaments, and the Production of Broilers.” Journal of Law, Economics, and Organization. 5,2(Fall 1989): 271-292.

Knoeber, C.R. and W.N. Thurman. “Don’t Count Your Chickens...”: Risk and Risk Shifting in the Broiler Industry.” American Journal of Agricultural Economics. 77(August 1995): 486-496.

Lamb, R.L. and M. Beshear. “From the Plains to the Plate: Can the Beef Industry Regain Market Share?” Economic Review. 83,4(Fourth Quarter 1998): 49-66.

Mahoney, J.T. “The Choice of Organizational Form: Vertical Financial Ownership Versus Other Methods of Vertical Integration.” Strategic Management Journal. 13(1992): 559-584.

Marion, B.W. and H.B. Arthur. “Dynamic Factors in Vertical Commodity Systems: A Case Study of the Broiler System.” Research Bulletin 1065, Ohio Agricultural Research and Development Center, Wooster, Ohio, November 1973.

Martin, L.L. “Production Contracts, Risk Shifting, and Relative Performance Payments in the Pork Industry.” Journal of Agricultural and Applied Economics. 29,2 (December 1997): 267-278.

National Pork Producers Council. “1998-99 Pork Facts,” 2000.

Outlaw, J.L., D.P. Anderson, and D.I. Padberg. “Relationships between Market Price Signals and Production Management: The Case of Fed Beef.” Journal of Agricultural and Applied Economics. 29,1(July 1997): 37-44.

Peel, D.S. “Retained Ownership Opportunities for Oklahoma Cattle Producers.” Oklahoma Current Farm Economics. 67,3(September 1994): 14-34.

Plain, R.L., "Changing Structure of the Hog Industry – U.S. and Abroad." University of Missouri - Columbia. February 1997.

Reilly, J. and B. Reynolds (a). "Integrator Innovators: How Cooperatives are Responding to a Changing Hog Industry." Farmer-Cooperative. Washington, D.C.: USDA Agricultural Cooperative Service. March 1994. V. 60 (12) p. 10-14.

Reilly, J. and B. Reynolds (b). "Furrow to Farrow: New Hog Technology Helps Local Cooperatives Add Value to Corn." Farmer-Cooperative. Washington, D.C.: USDA Agricultural Cooperative Service. April 1994. V. 61 (1) p. 4-8.

Reimund, D.A., J.R. Martin, and C.V. Moore. "Structural Change in Agriculture: The Experience for Broilers, Fed Cattle, and Processing Vegetables." USDA Economics and Statistics Service, Technical Bulletin No. 1648, 1981.

Rhodes, V.J. "Cooperatives' Role in Hog Contract Production." USDA Agricultural Cooperative Service. ACS Research Report 116.

Ritchie, H.D., J.L. Orth, J.N. Ferns, T.R. Pierson, J.H. Hilker, and J.R. Black. "Time Is Now for Beef Industry to Consider Change." Feedstuffs. 69,5(February 3, 1997): 1, 25-26.

Schupp, A. "Factors Influencing the Early 21st Century Louisiana Beef Industry." D.A.E. Research Report No. 712, Dept. of Agricultural Economics and Agribusiness, Louisiana State University Agricultural Center, July 1998.

Senauer, B., E. Asp, and J. Kinsey. Food Trends and the Changing Consumer. Eagan Press, St. Paul, Minnesota, 1991.

Simon, H.A. "Theories of Bounded Rationality." Second Edition, Decision and Organization. C.B. McGuire and R. Radner, eds. Minneapolis: University of Minnesota Press, 1986.

Stigler, G.J. "The Division of Labor is Limited by the Extent of the Market." Journal of Political Economy. 59(1951): 185-93.

Thornton, G. "U.S. Broiler Companies: A to Z Profiles." Broiler Industry. Jan 1998: 27-52.

United States Department of Agriculture. Agricultural Statistical Abstracts (1997).

United States Department of Agriculture, Cooperative State Research, Education, and Extension Service. "Inventory of Agricultural Research," Washington D.C., 1975, 1995.

Wang, H., J. Chen, and S. Asuming-Brempong. "Location Decisions of Polluting Firms Under Alternative State Environmental Regulations: The Case of the Hog Industry." Department of Agricultural Economics. Washington State University, 1997.

Ward, C.E., T.C. Schroeder, A.P. Barkley, and S.R. Koontz. "Role of Captive Supplies in Beef Packing." Report GIPSA-RR 96-3 prepared for the Grain Inspection, Packers and Stockyards Administration, USDA, May 1996.

White, T.F. and D. Chesnick. "Holding On: Retained Ownership Helps Beef Co-Ops Adjust to Rapidly Changing Industry." Farmer Cooperatives. (July 1993): 10-12.

Williamson, O.E. "Transaction Cost Economics: The Governance of Contractual Relations." In Industrial Organization. Edward Elgar Publishing, Limited, Brookfield, Vermont, 1990: 233-261.

Williamson, O.E. "The Vertical Integration of Production: Market Failure Considerations." American Economic Review. 61(1971): 112-23.

Jeffrey Gillespie
Associate Professor
Department of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, LA 70803

Christopher Davis
Graduate Student
Department of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, LA 70803

Aydin Basarir
Graduate Student
Department of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, LA 70803

Alvin Schupp
Martin E. Woodin Professor
Department of Agricultural Economics and Agribusiness
Louisiana State University Agricultural Center
Baton Rouge, LA 70803

Louisiana Agricultural Experiment Station
LSU Agricultural Center
P.O. Box 25055
Baton Rouge, LA 70894-5055

Non-profit Org.
U.S. Postage
PAID
Permit No. 733
Baton Rouge, LA