The Viability of Spot-Market Transactions in the Poultry, Egg, and Pork Industries

This report examines the role of contracting or vertical integration in reducing transaction costs in the poultry, egg, and pork industries and relates transaction characteristics to vertical coordination methods over periods of significant change in vertical coordination. Asset specificity and measurement costs are examined as possible sources of transaction costs that reduce the efficiency of spot-market trading.[15]

Physical Specificities and Small-Number Conditions

Firms that specialize in certain types of output or differentiated products, or those with highly technical production processes, may require investments in specialized assets.[16] Investments in assets that have few alternative uses, coupled with fewer outlets or input suppliers, determine the relationship-specific nature of the transaction. In the broiler, turkey, egg, and hog markets, investments in relationship-specific assets suggest a role for contracts and vertical integration, particularly in geographic regions undergoing industry expansion.

Broilers and turkeys

Following World War II, the poultry industry experienced rapid changes in technology, which induced more specialized production facilities, processing plants, and breeding stock designed for the production of chickens for meat or for eggs. In the broiler industry, most growers invested heavily in chicken housing. As noted by Breimyer, "As a broiler house cannot be converted readily to uses other than poultry, the financial obligation imposes a tight restraint on a grower's freedom of action." Similarly, the U.S. Department of Agriculture, Packers and Stockyards Administration found that "limited alternative uses for existing investments in broiler enterprises and limited off-farm employment, principally in the South, have kept many farmers in broiler production in spite of excess capacity and generally low returns."

Investments in specialized broiler production and processing assets affected the relationship-specific nature of transactions by limiting alternative uses and users of such investments. While broiler houses may be specific in a production sense (that is, specialized to broiler production), they may not represent relationship-specific investments unless there also are few buyers.[17] Scale economies associated with specialized technology adoption resulted in fewer and larger firms, especially in expanding regions of the South.[18] According to Reimund, Martin, and Moore, technological innovations could be adapted more readily in areas with relatively little output because existing capital investments and production methods had less influence in these areas.

The extent of technology adoption and associated scale economies in the South is indicated by changes in the size and number of U.S. broiler firms as the share of production in the South increased (fig. 5) (app. B). In 1964, 201 processing firms operated 320 plants that slaughtered 6.7 billion pounds of broilers. By 1984, 134 firms operated 238 plants that slaughtered 17.8 billion pounds. Larger plants became more prevalent in the South as broiler slaughter capacity became more concentrated in this region. In 1984, pounds slaughtered per plant in the South averaged 99 million pounds, compared with the U.S. average of 73 million pounds. On the production side, from 1959 to 1982, the number of farms selling broilers fell from 42,185 to 30,100. Over the same period, the share of U.S. broiler sales by large broiler farms (100,000 or more birds) increased from 29 to 89 percent (Lasley et al.).

Similarly, in the turkey industry, investments in specialized assets had a significant effect, especially in the South. As confinement and semi-confinement production operations replaced range rearing, increasingly specialized production stages created demand for

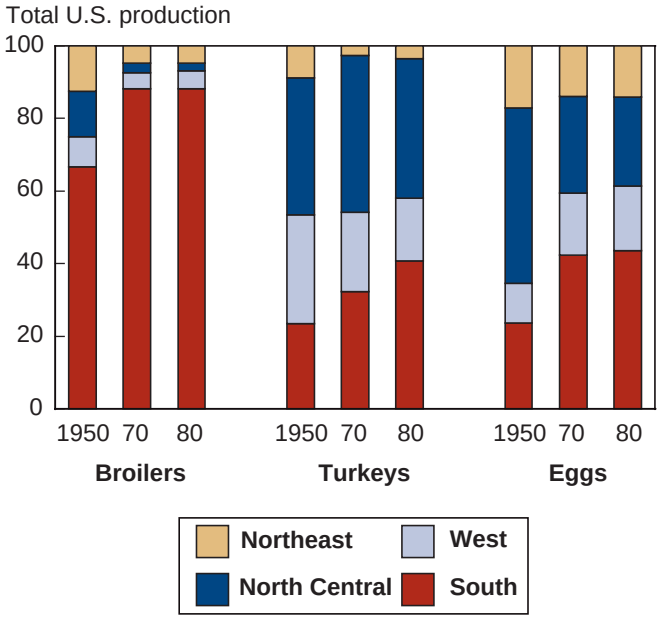
[15]Efficiency of alternative organizational arrangements is typically related to observable characteristics of the transaction because transaction costs are difficult to measure directly (Joskow). Hence, transaction-cost economics requires detailed information on organizational form and attributes of transactions (Williamson and Masten).

[16]Proxies for physical asset specificity used in the empirical literature include fixed assets to shipments, fixed assets to number of employees, advertising (representing intangible assets, such as brand name and reputation) to shipments, expenditures on research, ratio of research and development expenditures to sales, and the difference between acquisition price and salvage value (Mahoney; Frank and Henderson; MacDonald; Shelanski and Klein; Sporleder; Caves and Bradburd).

[17]I thank Jill Hobbs for emphasizing this point.

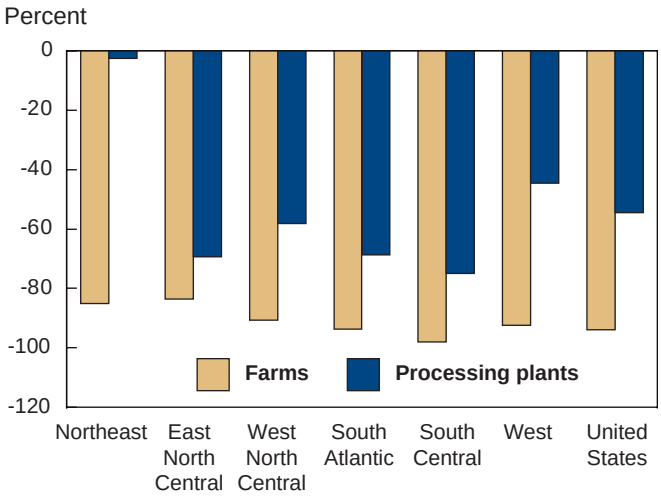
[18]In addition to the relationship-specific nature of these investments, larger operations are associated with larger quasi-rents and, hence, greater benefits from holdup by the other party (Pirrong).

Figure 5
Geographic patterns of poultry and egg production



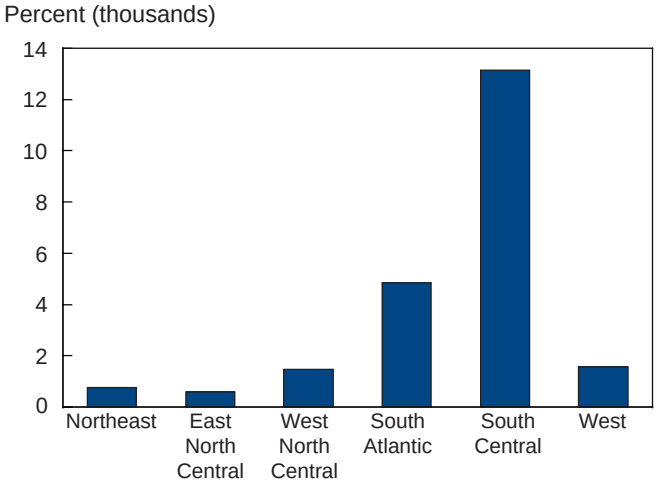
Source: Lasley.

Figure 6
Decrease in number of turkey farms (1959-78) and processing plants (1962-81)



Source: Lasley, Henson, and Jones.

Figure 7
Increase in average number of turkeys per farm, 1959-78



Source: Lasley, Henson, and Jones.

feeds, equipment, and other products and services designed for each stage (Rogers, 1979; Small). By the mid-1980s, large and specialized turkey processing plants replaced plants that slaughtered both broilers and turkeys during the broiler slack season, a common practice in the 1960s (Gallimore and Irvin; Lasley, Henson, and Jones). Regional variations in the adoption of new, specialized production technology were reflected by the rapid decline in number and growth in size of turkey production and processing operations (figs. 6, 7, and 8).

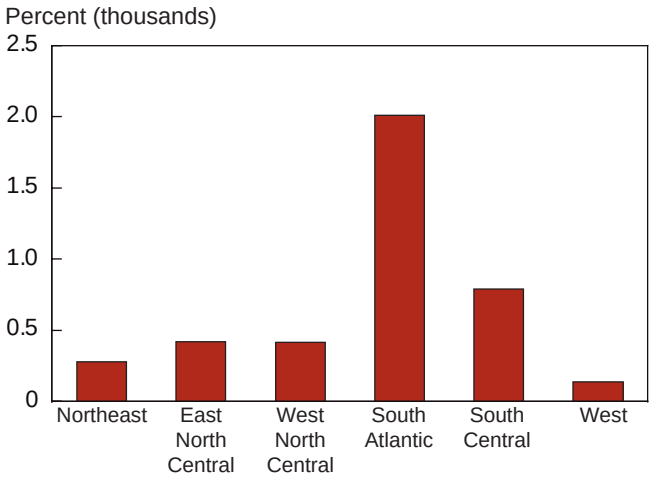
Table eggs

In the table egg industry, specialized production replaced the general farm flock due to improvements in breeding, feeding, disease control, management, and marketing. For example, as in the broiler industry, pullet growing in the table egg industry was dominated by specialized, large-scale operations using mass-production techniques (Roy, 1972). Technological innovations in the 1950s and 1960s, including automated egg washers, blood spot detectors, and automated egg cartoners, encouraged large-scale production and mechanized handling and distribution of a large number of eggs.[19] Large-scale enterprises could implement new, highly mechanized technology more advantageously than smaller operations, which encouraged further

[19]Modern "in-line" operations that mechanically gather, clean, grade, and package the eggs require large capital investments for environmentally controlled housing and computer technology to control egg flow, quality control, and packaging. Typically, eggs on commercial egg-laying farms are never touched until they are handled by the food service operator or consumer (United Egg Producers).

Figure 8

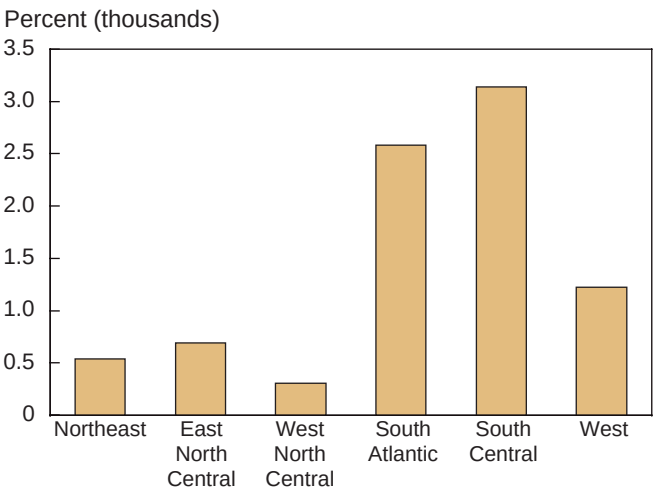
Increase in average number of turkeys per plant, 1962-81



Source: Lasley, Henson, and Jones.

Figure 9

Increase in average number of eggs sold per farm, 1954-68



Source: Rogers, Conlogue, and Irvin.

growth in specialized egg production units (National Commission on Food Marketing; Strausberg).

Regional changes in the size and number of egg operations reflect corresponding differences in the rate of specialized technology adoption. Emerging table egg production areas of the South and West experienced significant increases in the size of flocks (fig. 9). While the number of farms selling eggs fell 72 percent from 1959 to 1978, the rate of decline was highest in States where total output expanded (Lasley; Rogers, Conlogue, and Irvin). Average egg-packing volume also was above average in plants in the South and in areas of the West and below average in the North Central, where plants were less efficient (Rogers, Conlogue, and Irvin).

Hogs

The pork industry has been moving toward more specialized hog production and processing operations for over 60 years, but the trend appeared to accelerate in the 1990s (Hurt). Modern facilities are equipped with state-of-the-art technology dedicated only to pork production (Brewer, Kliebenstein, and Hayenga). These new technologies are more commonly used in the larger hog-production operations (see box on hog production technologies).

Expanding hog-production regions (for example, the South Atlantic region, led by North Carolina, and the South Central region, led by Oklahoma) used the newer, specialized technologies nearly a decade before the traditional hog-production areas of the North Central region (Brewer, Kliebenstein and Hayenga; Hurt; Hurt, Boehlje, and Hale) (fig. 10). The North Central region, which had its last major capitalization in the late 1970s and early 1980s, was characterized by smaller, more diversified farming operations and older hog-production technology (Foster, Hurt, and Hale). Much of the newer technologies could not be fully implemented by these operations given their existing physical and human capital.

Regional differences in the adoption of the newer technologies, and associated scale economies, are reflected by differences in the size of operations. In 1997, units marketing 7,500 or more hogs and pigs accounted for nearly all production in North Carolina and Oklahoma, compared with less than 40 percent of production in Iowa and Illinois (Martinez, 2000). Lower production costs for large operations resulted from the application of specialized technology, large capital expenditures, bulk purchasing, and other strategies to achieve economies of scale (Brewer, Kliebenstein, and Hayenga).

Small-number conditions also were apparent in regions of hog-industry expansion. A limited number of processors accounted for a large share of slaughter capacity in the expanding-production regions, South Atlantic and South Central, compared with the North

Large-Scale Hog Production Technologies

Since the 1980s, and especially since 1989, U.S. hog production has been shifting to highly specialized, large-scale farms. Large-scale hog production technology differs from small-scale production technology in several ways. Newer buildings, three-site production, and the use of all-in/all-out and isoweaning, split-sex/phase feeding, and artificial insemination typically characterize large-scale operations.

In the 1970s and 1980s, farrow-to-finish operations with fewer than 1,000 hogs and pigs were the most common method of producing hogs. In these small-scale operations, hogs are raised from birth to market. In larger scale, commercial hog operations, specialization occurs in the three phases of production: farrowing, nursing, and finishing. Many hogs are produced on three sites (that is, one for each phase of production) while having one owner. The facilities at each site may be owned by the owner of the hogs or by another producer who raises the hogs under a production contract. From 1978 to 1995, farrow-to-finish operations fell from 78 percent of all U.S. hog farms to 35 percent.

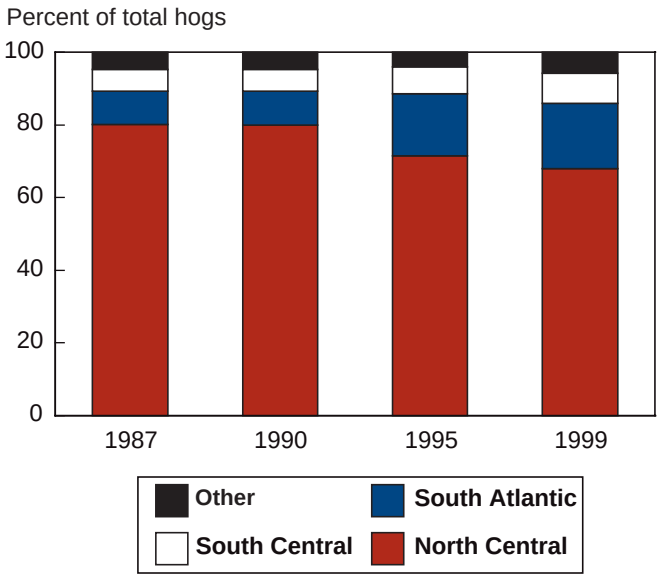
Disease transmission throughout the various production stages, which reduces growth rates, lean tissue deposition, and feed conversion efficiency, is more difficult to control in larger operations. Mixing groups or ages of hogs compromises the animals' health because pathogens can enter through breeding stock, feeder pigs, and other sources. Larger operations use high tech methods, such as all-in/all-out production and isoweaning, to prevent the spread of disease. With all-in/all-out production, all animals are replaced at the same time, and buildings are cleaned and disinfected before another group of animals arrives. With isoweaning, weaning piglets (that is, young pigs separating from the sow) are placed in isolated accommodations to eliminate infectious agents. Precautionary measures ensure that each group of isoweaned pigs is not contaminated by pigs of other ages. In traditional farrow-to-finish operations, younger pigs are placed in direct contact with older pigs.

Because nutrient requirements vary as pigs age, and male and female pigs develop differently after reaching a certain weight, different levels of nutrients are required in a pig's diet to optimize lean growth. To obtain the most efficient feed conversion, market hogs may be separated by sex by the time they reach 70 pounds and fed different diets (split-sex feeding). Changing a hog's diet several times in a hog's life also improves feed efficiency (phase feeding). Splitting the tube that distributes feed to the hogs and using additional feeding equipment (for example, feed bins and sort boxes) enables hogs to be fed different diets at different locations in the building. Furthermore, the types of feeds flowing through the feed distribution tubes can be switched. While many smaller operations use these techniques, they are more commonly used in large operations.

Attempts to improve leanness and other traits in hogs require changes in the hogs' genetic makeup. With artificial insemination (AI), the genetic makeup of hogs can be quickly controlled and changed, and new genetics can be easily sampled. An AI program also can be tailored to the needs and goals of each farm. The use of artificial insemination increased from less than 1 percent of U.S. sows in the early 1990s to approximately 40 percent in 1998.

Sources: Brewer, Kliebenstein, and Hayenga; Marbery; Cline et al.; Singleton and Schinckel; Harris and Harris; Hayenga et al.; Schrader; Hodson; Martinez, Smith, and Zering.

Figure 10
Share of hog inventory accounted for by regions



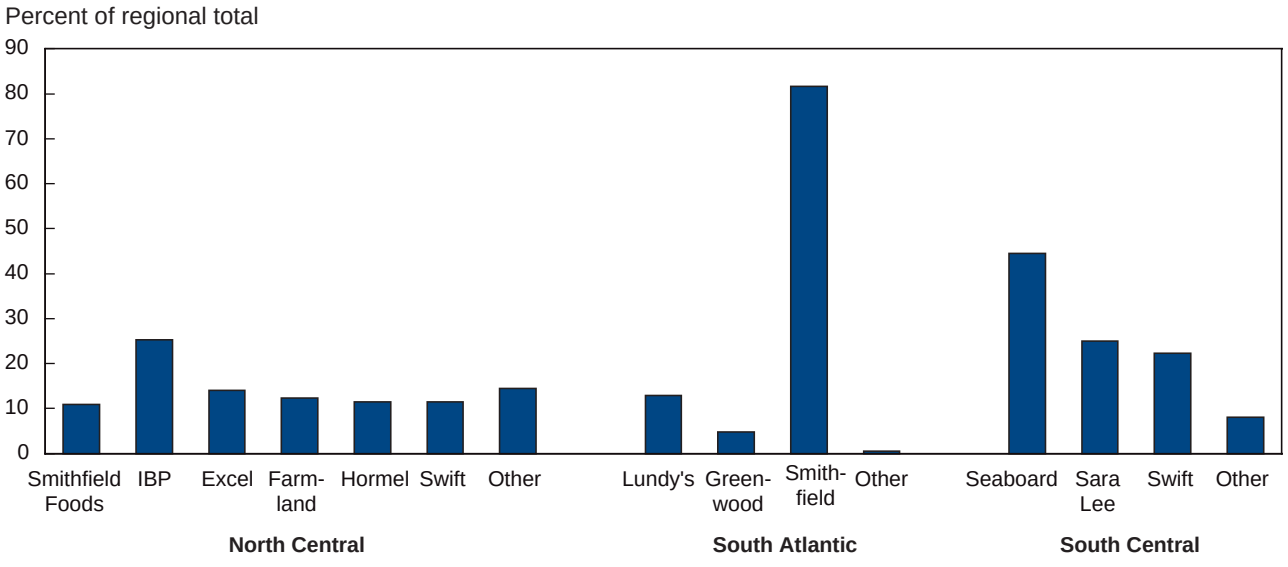
Note: Inventories as of December 1.
Source: Compiled by ERS/USDA from USDA[a].

Central region (fig. 11). This scenario leaves producers with fewer alternative outlets and, hence, makes them more vulnerable to opportunistic behavior by existing processors. The number of alternative hog suppliers to packing plants also was especially limited in the expanding regions (fig. 12).[20] Traditionally, hog-packing plants were concentrated in the North Central region because of the abundant supply of hogs within a reasonable distance of the region's packing plants (Zering, 1995). More packing capacity generated more hog production, which generated more packing capacity, and so on. In 1992, this pattern of regional concentration growth was broken when Smithfield Foods opened the world's largest pork-packing plant in Tar Heel, North Carolina.[21] Smithfield's plant was twice as large as any plant in the North Central region (Hurt, Boehlje, and Hale). The plant also was built to Japanese and European standards, featuring optical probes to measure backfat and loin eye depth and magnetic resonance imaging to measure fat content in hams (Miller, May 2000). The opening of this facility occurred at a time when the North Carolina/Virginia region already had excess processing capacity, a limited share of U.S. hog inventory, and few other hogs and processors within reasonable trucking distance.

[20]From 1981 to 2000, the number of U.S. hog farms fell from 579,000 to 86,000 (USDA[a]).

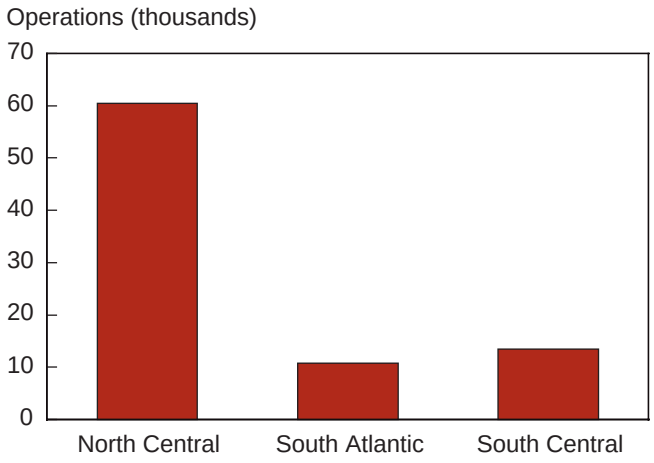
[21]Later, in 1995, Seaboard opened a large state-of-the-art processing plant in Guymon, Oklahoma.

Figure 11
Hog-packing capacity by firm and region, 1999



Note: Excel is a subsidiary of Cargill, and Swift is a subsidiary of ConAgra.
Source: Compiled by ERS/USDA from *Pork Facts*, National Pork Producers Council, 2000.

Figure 12
Number of U.S. hog and pig operations, December 1, 1999



Source: Compiled by ERS/USDA from USDA[a].

Changing methods of vertical coordination in regions of industry expansion[22]

In light of investments made in new specialized assets and small-number conditions in expanding poultry, egg, and hog markets, transaction-cost considerations suggest that the spot market was an inefficient means of vertical coordination in regions of industry expansion. At the same time, contracting in the broiler and turkey industries became more prevalent in the South. Similarly, table egg contracting increased in the South as well (table 1). In the late 1950s, egg production contracts existed mostly in the Southern States, where contracting and large-scale flocks were common because of the region's sizeable broiler industry. By the mid-1960s, egg production contracts had spread to the West, where contract systems and large, vertically integrated egg complexes that require huge investments developed together.

In the pork industry, expanding production in nontraditional regions also was accompanied by marketing contracts and packer-owned hogs produced under production contracts. A 1994 survey of large hog producers found that large producers in the North Central region marketed 26 percent of hogs through the spot market and 63 percent using marketing contracts. In

Table 1—Table egg production and contracting in the South

State	Change in production, 1959-65	Production under contract, 1964
	Percent	
Alabama	71	45
Georgia	72	33
Arkansas	159	50

Source: Gallimore and Vertrees.

areas outside the North Central region, the difference was greater; 14 percent of hogs were sold through spot markets, and 81 percent were sold through marketing contracts. For example, Smithfield Foods, which has most of its slaughter plant capacity in the South Atlantic region, obtains 50 percent of its slaughter requirements from company-owned hogs, and an additional 14 percent are obtained from marketing contracts (Smithfield Foods, 10K, filed July 28, 2000). Seaboard Farms has most of its slaughter capacity in the South Central region and owns about 75 percent of the hogs that it slaughters (Marbery). On the other hand, in 1999, IBP, which has slaughter plants in the North Central region and is the Nation's second-largest pork processor, did not own sows (Freese). The company's main supply of hogs is purchased daily by IBP buyers, a few days before processing (IBP, 10K, filed March 23, 2000).[23]

Investments in specialized genetics for producing pork with unique quality attributes also have increased. For example, in the early 1990s, Smithfield Foods introduced Lean Generation Pork in response to diet and health concerns related to fat content of foods. Lean Generation Pork is produced from National Pig Development (NPD) hogs, the leanest hogs in U.S. large-scale production. In this case, specialized genetics represents a relationship-specific asset, regardless of small-number conditions, because it is tied to a specific brand. Smithfield obtained uniform genetics for the pork through a partnership with a leading hog producer, Carroll Foods, involving long-term marketing agreements and joint ownership of hog-production operations.

[22]In this section, information on regional differences in methods of vertical coordination is obtained from Roy (1963; 1972); Gallimore; Rogers, Conlogue, and Irvin.; Rogers (1979); and Lawrence et al.

[23] In each of the next 5 years, IBP is committed to purchasing about 21 percent of its annual hog production capacity, using marketing contracts with payments based on market-derived prices (IBP, 8-K, filed November 7, 2000).

Site and Temporal Specificities[24]

Limited procurement distances also created relationship-specific transactions in the poultry and egg industries. Parties can move chickens only about 30 miles and still remain profitable because live birds lose weight if transported over lengthy distances. Consequently, as advances in distribution technology made it more efficient to transport processed poultry products, site specificities were created when large processing plants moved closer to the flocks. Production density was more critical than optimal processing plant size in determining the competitive position of processors. As processors sought high-production density to reduce the span of their broiler supply sources, many contract growers had essentially no alternative trading partners. Vertically integrated operations, in which the integrator owns both the production and processing facilities, were more common with larger-than-average broiler houses located closer to the processing plants.

Timing factors create temporal specificities in the poultry, egg, and pork markets.[25] Poultry and eggs are considered to be perishable products. Poultry requires a withdrawal period, whereby growers withdraw feed before the birds are processed to limit intestinal contents and protect against fecal contamination of poultry carcasses. Processing delays can result in deterioration of the birds' intestines, which increases susceptibility to rupture and contamination. Furthermore, the pressure required to remove the crop in older birds can rupture the crop, spill its contents, and lead to salmonella contamination, which suggests that poultry must be sent to the processor within a narrow age range.[26] In addition, large investments by poultry processing plants in the late 1950s, in response to mandatory inspection requirements, increased the importance of timely bird supplies. Table eggs undergo weight loss and albumen deterioration immediately after lay, so eggs must reach the supermarkets within a few days of leaving the laying house to ensure a fresh and safe product.

In the pork industry, timely delivery of hogs to the processing plant affects processing costs. Modern pork processing plants are designed to operate efficiently at a particular utilization level, and operating costs rise rapidly at other levels of production.

Measurement Costs

While consumers gain by understanding the value of a good, measuring the good at the point of sale may be costly to the consumer. Some meat attributes, such as taste and product safety, are costly to verify before the meat is consumed. In addition, consumers incur a cost sorting through heterogeneous packages of equal price to affect the distribution of gains but do not alter the overall quality of the products. As household leisure time becomes more valuable, such sorting becomes even more costly.

Many product attributes that can influence consumers' eating experiences depend on the characteristics of animals supplied for processing. These characteristics may be difficult to measure when the animals are sold, but production inputs, such as genetics, feed and nutrition, and management practices, may affect certain product attributes. For example, the pale, soft, exudative (PSE) condition in hogs, which is associated with tough, dry, and lean pork, is difficult to measure when hogs are sold but is highly heritable (K.E. Smith). Measuring pathogen content also may be difficult. Furthermore, it is costly to measure and sort animals of varying size, shapes, and quality within and across flocks and herds.

Contracts and vertical integration, together with branding of retail meat products, can reduce total measurement costs within the food system. Branded products tend to reduce consumer concerns about purchasing a deficient product. Such a product could tarnish the brand name and saddle the producer with potentially critical losses. For this reason, the quality of branded products is expected to be less variable. Quality assurances inherent in branded products are especially important for those product attributes that are difficult for the consumer to measure at the point of purchase. Instead of consumers incurring the cost of attribute measurement at the time of purchase, processors can measure product characteristics more cheaply further upstream, or earlier in the process.[27] For those quality

[24]This section is based on information contained in Henry, Chappell, and Seagraves; Rogers (1976); Marion and Arthur; Roy (1972); *Pork '99* Staff; Byrd; Martinez (1999); Van Leusen and Ceton; and United Egg Producers.

[25]Rapid structural changes in the production of poultry, eggs, and pork that resulted in thin markets, particularly in regions of industry expansion, may have increased the severity of temporal specificities.

[26]The crop stores undigested feed and is removed at processing.

[27]"Upstream" refers to stages of the marketing system closest to the beginning of the production process. "Downstream" refers to those stages closest to the consumer. Value is added as product moves downstream through successive stages to consumers.

attributes of a live animal or carcass that are costly to measure, processors can reduce measurement costs by controlling farm inputs through contracts or vertical integration.[28] Substituting measurement by consumers with earlier, less costly measurement further upstream reduces total measurement costs in the food system, leaving more gains to be distributed among buyers and sellers.[29] As sellers bear some of the cost of buyer presale measurement, sellers would also benefit (Barzel).

Branding has been an integral part of the poultry industry for over 20 years. For example, Tyson Foods, the Nation's leading broiler producer, maintains a strong national brand. Tyson's broiler contracts specify that growers use only company-supplied birds, which come from genetic stock supplied by Tyson's breeding stock company, Cobb-Vantress. Tyson invests in breeding stock research and development to produce birds with the most desirable natural characteristics. In the turkey industry, Jennie-O Foods, the world's leading turkey processor, emphasizes branded, packaged consumer items, such as the company's rotisserie turkey. The company owns turkey production facilities and supplements output from these operations with grower contracts that specify the breed to be used, in addition to weight and pricing formula (Hormel Foods, 10-K, January 23, 1998).

Leading egg companies also emphasize branding. Cal-Maine Foods, the Nation's largest egg company, produces branded egg products for health-conscious consumers under the Egg·Land's Best and Farmhouse labels. Egg·Land's Best eggs (with "EB" stamped on each egg) come from hens that are fed all-natural, vegetarian diets, with no animal by-products, and contain less saturated fats than regular eggs. Farmhouse eggs are produced from free-range hens that feed on natural grains. Attributes of these branded products, which depend on special feeds and production practices, would be difficult to measure by consumers and processors in a spot market.

As in the poultry industry, contracts and vertical integration in the pork industry may lower measurement costs and facilitate branding programs for fresh pork (chops, tenderloins, ribs, and roasts). Companies that have recently introduced branded fresh pork products include Hormel Foods and Seaboard. Hormel obtains 50 percent of its hog supplies from 5- to 10-year marketing contracts (Egerstrom). These contracts specify that producers use Hormel-approved facilities and genetics that can produce lean, uniform-sorted hogs. Seaboard controls genetics and nutrition for its Prairie Fresh label through integrated, environmentally controlled operations. The Pig Improvement Co. provides the genetic base for producing uniform products with fewer PSE-related meat attributes, resulting in less moisture loss and juicier meat after cooking (Marbery, June 5, 2000).

[28]Furthermore, tournament production contracts used in the broiler industry also reduce measurement costs by basing grower payments on a grower's performance relative to other growers (a tournament). This feature reduces measurement costs because relative performance is cheaper to measure than absolute performance associated with weight and other factors, such as feed efficiency and mortality rates (Knoeber).

[29]The opposite is true for consumer warranties. According to Barzel, warranty contracts on finished products, such as household appliances and other durables, reduce measuring costs because it is cheaper for consumers to determine output quality as the product is used than for manufacturers to test every product.