
The Changing U.S. Pork Industry: A Dilemma for Public Policy

By Alan Barkema and Michael L. Cook

The shape of the U.S. pork industry is changing dramatically, as pork production shifts into the hands of fewer, larger farmers with closer ties to processors and consumers. The changing shape of the pork industry, the nation's second largest meat industry, points to the loss of thousands of small hog farms in the United States. The threat to traditional ways of farming has triggered a public policy debate in Iowa, Kansas, and other leading hog producing states.

Primarily responsible for the changes underway in the U.S. pork industry are today's discriminating consumers. Their more sophisticated tastes challenge the industry to pack improved nutrition into more convenient products. The industry is responding with an arsenal of new technologies. And to keep high-tech pork products on target for today's palates, the industry is abandoning its traditional way of moving pork from the producer's lot to the dinner table.

This article considers the changes underway

in the U.S. pork industry today and what they suggest in the years ahead. The first section reviews the structural changes currently taking place in the industry. The second section describes the causes underlying this structural evolution. The third section considers the industry's future structure. The final section contemplates the dilemma the changing pork industry poses for public policy.

The article concludes that the wave of structural change in the pork industry will continue, resulting in a more integrated industry of fewer, larger farms with closer market ties to pork processors. The industry's emerging structure, however, poses a dilemma for public policy, which must balance the loss of traditional small farms against the economic benefits to consumers of higher quality, lower cost products.

HOW IS THE U.S. PORK INDUSTRY CHANGING?

A wave of concentration and integration is sweeping the U.S. pork industry. Pork production is concentrating in the hands of fewer, larger producers and processors. Meanwhile, hog farmers and pork processors are developing closer ties, forming a more integrated industry from the hog farm to the supermarket.

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A more concentrated industry

In the past, hundreds of thousands of small, independent hog farms were the heart of the U.S. pork industry. Most small hog farms mixed hog production with a wide menu of other farm enterprises, especially the production of corn and soybeans, the main ingredients in hog feed. In the traditional production sequence, hog farmers purchased breeding stock from hundreds of small, independent producers and raised their offspring from birth to market weight on home-grown grains. The genetic makeup of hog herds varied widely from farm to farm, and a wide range of feeding and management systems boosted the variation in the nation's hog herd even more.

Today, the pork industry has a new makeup. The number of hog farms in the United States has plummeted, as the industry consolidates on fewer, larger, more specialized hog farms. During the past two decades, the number of hog farms has dropped from nearly 900,000 to only 250,000.¹ Despite that drop, the total volume of pork production has increased, underscoring the industry's consolidation on larger farms (Chart 1).²

The trend toward bigger hog farms has accelerated in the 1990s, as the latest production technologies have transformed the traditional hog shed into a specialized pork factory. Today, some modern hog farms produce and market more than half a million hogs a year. Multinational companies offer improved breeding stock with the most advanced genetics that enable pigs to grow faster and produce leaner pork with less feed. Climate-controlled buildings ensure top production regardless of weather. Computerized information systems enable well-trained managers to monitor herd performance and health. Diseases are kept in check with a steadily improving collection of health products, some of which are the creations of the latest advances in biotechnology. These specialized hog farms produce pigs that are nearly identical in size, shape, and quality—in sharp contrast to the variation found across the dwindling

ranks of smaller farms. Thus, consumers are provided pork products of more consistent quality.

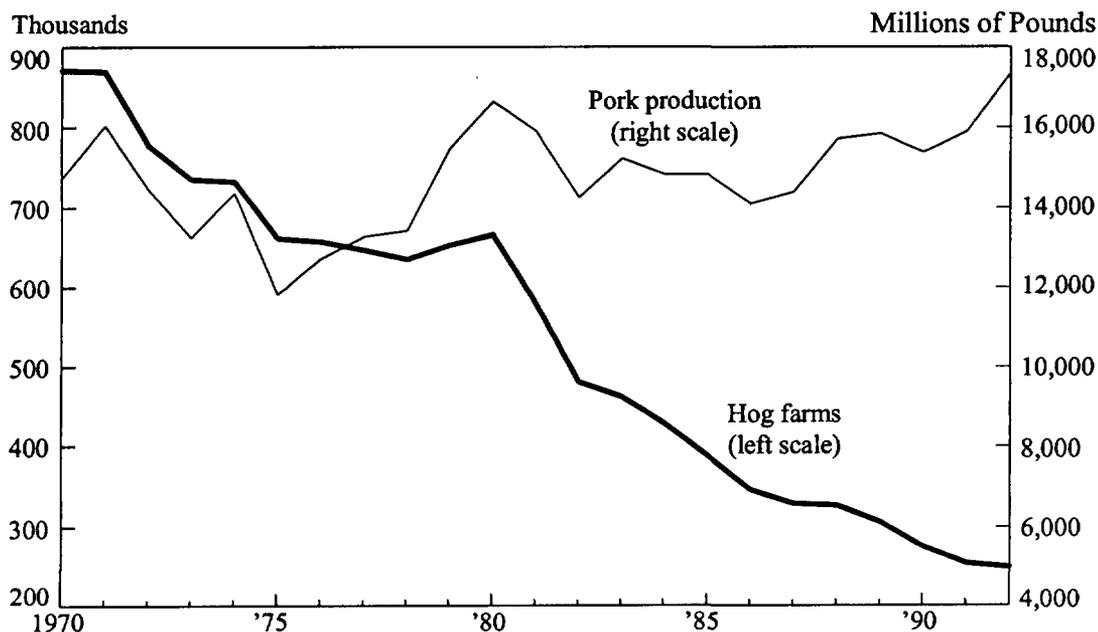
A more integrated industry

A change in marketing arrangements between hog farmers and pork processors has accompanied the industry's shift to fewer, larger farms. An increasing portion of the nation's hogs are produced under contract with pork processors or are owned outright by the processors, a system called vertical integration. As a result, marketing linkages between producers and processors are tighter. From 1980 to 1990, the percentage of the nation's hog production under contract or vertical integration doubled to about 10 percent (Manchester). Other data show that up to 16 percent of the nation's hogs were produced under contract or vertical integration in 1991 (Rhodes and Grimes). Thus, the trend toward a more integrated pork industry appears to be accelerating.

In the traditional marketing system—called “open production”—farmers sell market-weight hogs to the highest bidder among local hog processing companies or their agents.³ Hogs arriving at market vary widely in size, shape, and quality characteristics. But the variation in the hogs makes relatively little difference in the price farmers receive because quality grades are broadly defined. In effect, farmers are generally paid for the total live weight of the hogs sent to market, even though quality varies widely.

Prior contractual arrangements between hog farmers and processors are rapidly taking the place of open production in the pork industry. In a typical contractual arrangement, the farmer is paid a flat fee, plus various performance incentives, to feed young pigs to market weight. The farmer provides land, labor, buildings, and equipment, while the contractor provides the young pigs, feed, veterinary supplies, and management advice. Thus, the contractor assumes much more control—and the farmer assumes less control—over

Chart 1

Pork Production and the Number of Hog Farms in the United States

Source: United States Department of Agriculture.

the production process than in traditional open production.

Alternatively, some pork processors now rely on vertical integration to raise their own hogs. The key distinction between vertical integration and contracting is that even more control over the production process is transferred to the processor. Under vertical integration, hog farmers relinquish their independence and simply become employees of the integrated pork firm.

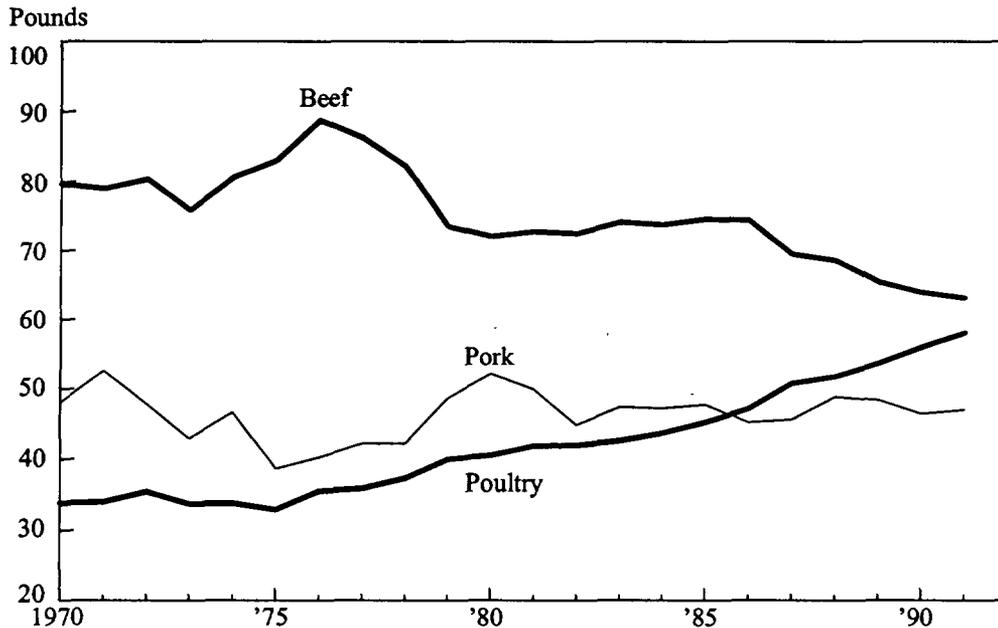
The shift toward a more integrated industry works hand-in-hand with the trend toward fewer and larger hog farms, much to the consternation of smaller producers. Processors who contract with farmers would prefer to manage a few contracts with large producers rather than many contracts with small producers. Integrated pork processing

firms are likely to produce enough hogs to account for a significant portion of their processing capacity. Thus, the trend toward a more concentrated, integrated pork industry has raised concerns that the nation's smaller, independent pork producers could lose access to markets and eventually be crowded out of the industry by much larger, integrated producers.

WHAT IS DRIVING THE PORK INDUSTRY TOWARD MORE CONCENTRATION AND INTEGRATION?

Three closely related factors appear to be driving the pork industry toward a more compact market structure. First, consumers have become

Chart 2

Per Capita Consumption of Beef, Pork, and Poultry

Source: United States Department of Agriculture, "Agricultural Outlook."

more discriminating, requiring the pork industry to design its products more carefully. Second, new technology is overhauling the pork industry, giving it the means to tailor its products for the consumer's more discriminating palate. Third, a more compact market structure has improved the flow of information between consumers and producers, ensuring that pork products are designed with consumer tastes in mind.

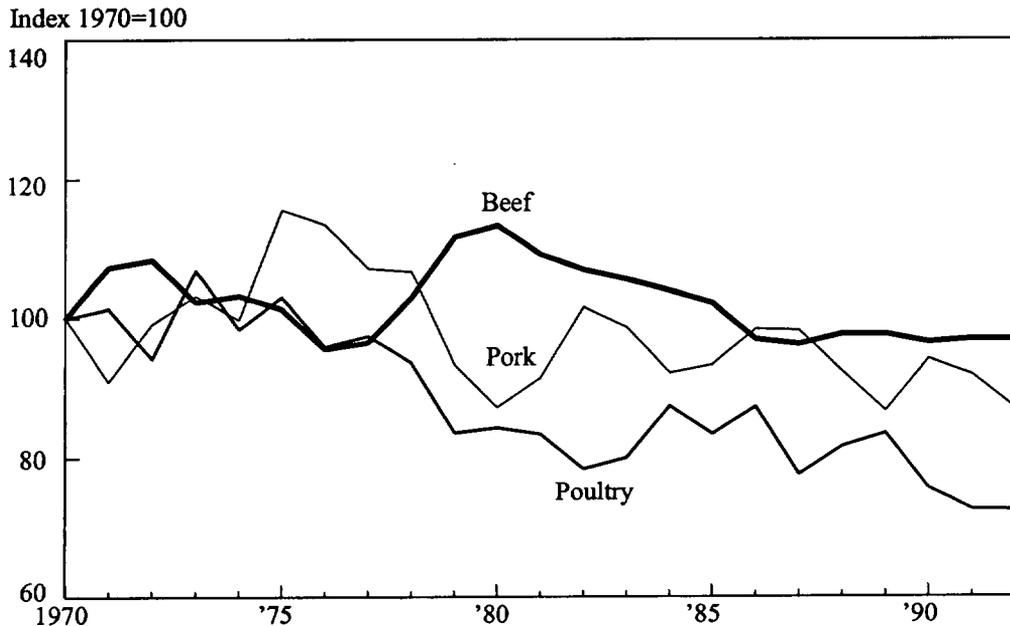
A more discriminating consumer

Consumers have become more discriminating buyers of pork and other food products. Faster paced lifestyles and new concerns about nutrition are dictating changes in American eating habits.

Pork consumption has been nearly flat for the past three decades, while poultry consumption has surged and beef consumption has fallen (Chart 2). The shift to poultry is partly explained by a sharp drop in the price of poultry products. The real price of poultry products has fallen more than a fourth during the past two decades, while beef and pork prices have been nearly flat (Chart 3). But another cause of the consumer's shift to poultry from red meat is the consumer's new penchant for convenience and healthier eating (Barkema and Drabenstott).

In the past, consumers were willing to do the lion's share of meal preparation themselves, purchasing relatively unprocessed food products at neighborhood grocery stores and butcher shops and transforming them into meals in their own kitchens. Modern consumers spend less time in the

Chart 3

Real Retail Prices of Beef, Pork, and Poultry

Source: United States Department of Agriculture.

kitchen, however, aiming to spend no more than 20 to 30 minutes preparing an average meal (Office of Technology Assessment). Strong demographic trends have shortened the consumer's tolerance for preparing meals. The proportion of women aged 25 to 54 in the work force has climbed steadily during the past two decades to about three-fourths, boosting sharply the number of single-individual and dual-income households. Both types of households are believed to spend less time preparing meals than traditional single-earner families. Thus, today's consumers are increasingly shopping for conveniently prepared food products that fit faster paced lifestyles.⁴

Another key element in the consumer's more discriminating demand for food is an increased concern about nutrition. Consumers increasingly

believe they are what they eat. Consumers are especially intent on reducing saturated fat, cholesterol, and sodium in the diet, perhaps in response to the health recommendations of groups like the American Heart Association (AHA).⁵ Concerns about heart disease and cancer have pushed up consumption of fresh fruits and vegetables and pushed down consumption of foods perceived to be fat-rich, like whole milk and red meat (Barkema and others 1991).

In sum, consumers are challenging the pork industry—and other segments of the food system—to tailor food products for more precisely defined market niches. To find success in today's food market, pork products must be conveniently prepared, while cutting back on saturated fat, cholesterol, sodium, and calories.⁶ The poultry indus-

try remains the leader in the race to win consumer favor with a wide range of new products that promise both convenient preparation and healthy eating. But recent marketing efforts by the pork industry, such as its "other white meat" campaign, appear to be gaining ground. The bottom line for the pork industry is that it must satisfy more discriminating tastes at competitive prices if its products are to win consumer acceptance at the supermarket.

A more capable producer

A happy coincidence for the pork industry is that advances in technology have enabled it to tailor its product for the consumer's increasingly discriminating palate. The product engineering process now begins on the hog farm itself, where the industry uses the latest technology to design hogs that produce the leaner pork consumers want. New measuring devices enable swine breeders to select the leanest, most productive animals. Then new reproductive technologies are used to rapidly multiply superior types of animals. Sophisticated computer software tracks and analyzes the performance of entire breeding herds. Thus, the industry is achieving much more rapid improvement in the industry's overall genetic pool. The result is leaner, faster growing, more efficient pigs than the old-fashioned animals of just a decade or two ago.

Meanwhile, advances in nutrition provide carefully formulated diets that enable the new super pigs to grow lean and fast with a minimum production of fat. One of the newest advances in swine nutrition is the development of the swine growth hormone pST, porcine somatotropin. A product of the latest biotechnology, pST promises to boost daily weight gains 10 to 20 percent, boost feed efficiency 15 to 35 percent, and cut fat by 50 to 80 percent. Thus, pST promises another quantum leap in the industry's ability to produce the leaner pork products that today's consumers demand.⁷

New market channels

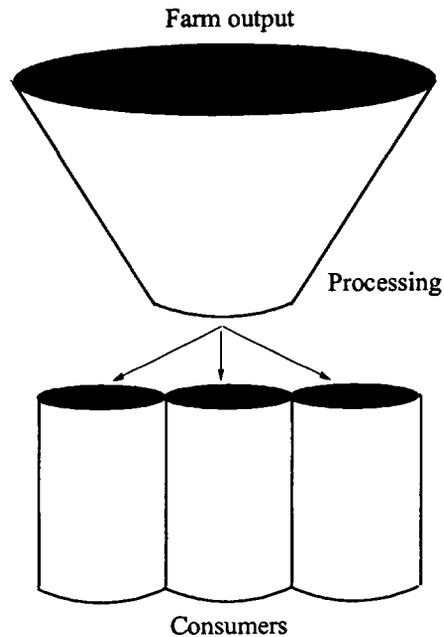
The pork industry has long relied on price signals from commodity markets to guide pork products from farm to grocery. Price signals link consumers to retailers, retailers to wholesalers, wholesalers to processors, and processors to hog farmers. But consumer preferences are becoming more specific than traditional price signals can handle.

Commodity price signals transmit general information well, but they are too fuzzy to transmit the more detailed information required in the modern pork market. For example, the traditional pricing system in the pork industry classifies market-ready hogs into only four quality grades, based on a visual examination of hog carcasses and the expected yield of lean meat. The grades were established decades ago to reward hog farmers for producing leaner hogs. But modern consumers want pork that is even leaner than the leanest of the old grades. Thus, the old grades provide little incentive for hog farmers to produce the kind of pork that today's consumers want.

Thus, new channels of communication are developing to ensure that pork products are properly engineered to meet the modern consumer's tighter specifications. Production contracts and vertical integration are especially effective ways to transmit the consumer's more demanding product specifications to hog farmers. Processors replace fuzzy price signals with crystal-clear contract provisions that specify the genetics, feeding program, and management system to be used on hog farms. Likewise, processors who integrate directly into hog production replace the traditional pricing system with the internal administrative commands of a single firm. Thus, both contracting and vertical integration in the pork industry tighten marketing linkages, ensuring that pork products remain on target for smaller consumer niches.

A sketch of the food system helps illustrate the change in market channels between producers and consumers in the new pork market. In the tradi-

Figure 1
The Traditional Pork Marketing System



tional food system, pork and other bulk farm commodities flowed into the processing sector through traditional commodity markets (Figure 1). The commodity hopper was wide because quality standards were wide. Consumers accepted pork products with broad quality characteristics and then transformed them into meals in their own kitchens.

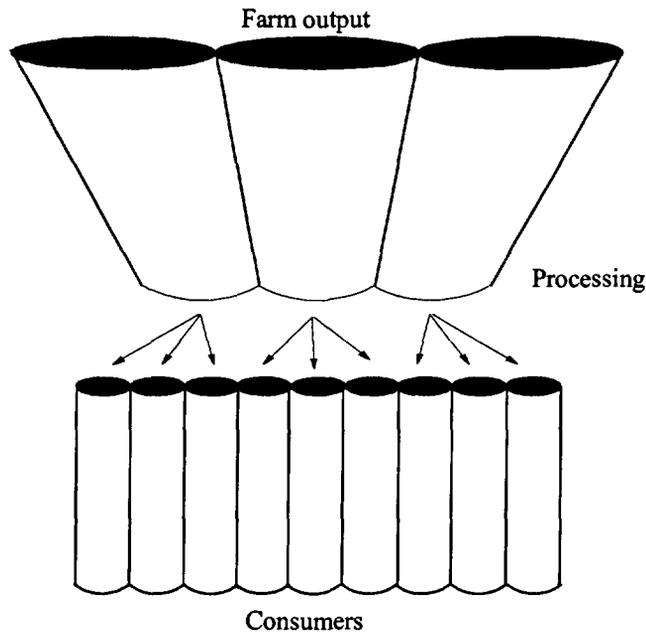
In the new food system, pork and other farm products flow into the processing sector through narrower market channels (Figure 2). The channels are narrower—that is, the diameter of the hoppers is smaller—because the consumers' food specifications are more detailed. Pork products must meet more stringent standards, because today's consumers are willing to spend less time in the kitchen transforming them into the foods they want. Targeting processed foods for smaller con-

sumer hoppers requires that farm products be targeted for smaller processing hoppers.⁸ Thus, the early steps of product development in the new pork market begin on the farm, rather than in the processing plant. For example, the pork industry is learning to trim fat with advances in genetics and nutrition on the hog farm, rather than with knives and cleavers in the butcher shop.

WHAT IS AHEAD FOR THE PORK INDUSTRY?

The U.S. pork industry is headed toward more consolidation and integration. The industry's structural realignment promises further erosion in the number of small hog farms as pork production

Figure 2

The New Pork Marketing System

concentrates in the hands of fewer, larger hog farms with closer ties to pork processors. Powerful economic forces, unleashed by changes in consumer demand and emerging technology, will drive the industry farther down the road toward a more integrated structure. Public policy, however, is geared toward preserving traditional small hog farmers. Thus, the changing pork industry and public policy seem headed for a collision.

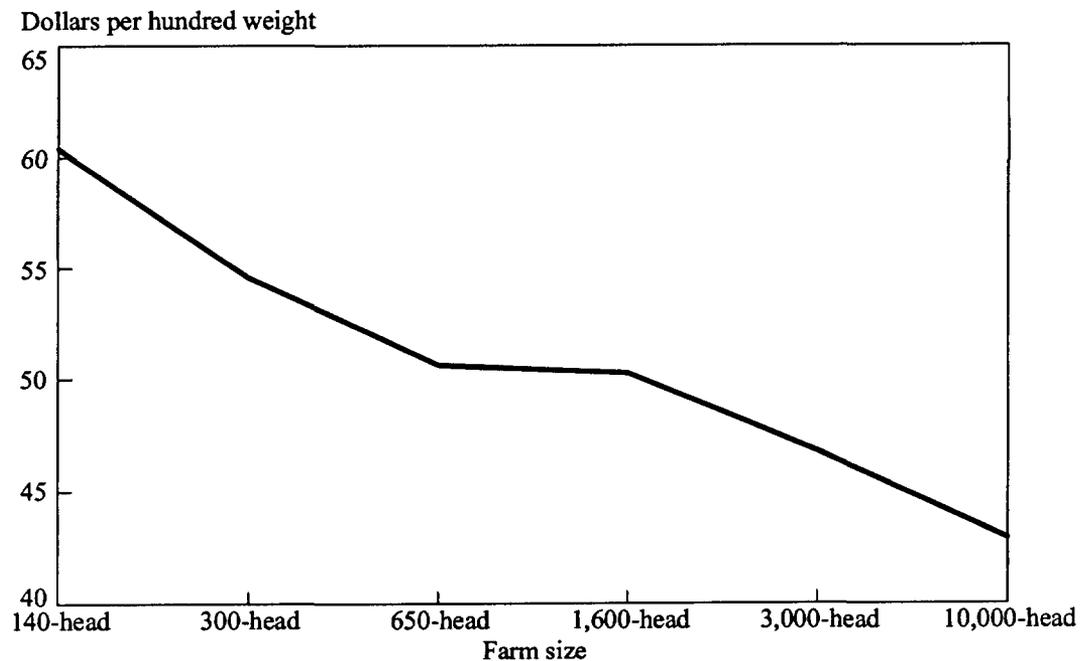
Economic factors behind more consolidation and integration

Two key economic factors will drive the U.S. pork industry toward more consolidation and integration in the years ahead: 1) a drive to cut costs

by capturing economies of scale, and 2) efforts to control the industry's increasing risks. Cutting production costs by shifting production to more efficient, larger farms will fuel further consolidation in the industry. Meanwhile, a further shift toward contracting and integration will reduce the industry's exposure to key sources of risk in the modern pork market.⁹

While both contracting and vertical integration are likely to increase in the years ahead, it is not clear which will be most common. Contract production is likely to be the norm for most large hog producers. But in some regions of scarce hog supplies, processors may ensure a steady supply of hogs for processing lines by integrating vertically into hog production. As more of the industry's processing capacity is met with contract

Chart 4

Average Hog Production Costs in the United States

Source: United States Department of Agriculture "Cost of Production-Livestock and Dairy, 1990."

production and processor-fed hogs, access to markets will shrink for independent hog farmers operating outside the umbrella of production contracts.

Cutting production costs on bigger farms. A steady stream of new production technologies will lead to further economies of scale in hog farming, spurring the current trend toward fewer, larger farms. Many industry observers believe the widening cost disadvantage of small farms points to a swift decline in the number of hog farms, from about 250,000 today to only 100,000 by the year 2000 (Hurt and others). The erosion in hog farms will be fastest among small farms, which are at the greatest cost disadvantage. As small farms leave the industry, hog production will concentrate further on bigger farms.¹⁰

Technology will drive the shift to fewer, larger hog farms. New production technologies are pushing down production costs on the nation's hog farms. But the industry's cost savings are achieved primarily by capturing economies of scale on big farms, where average production costs fall rapidly as the volume of production rises (Chart 4). For example, average production costs on farms producing 10,000 hogs annually, the largest size tracked by the U.S. Department of Agriculture, are nearly 30 percent lower than costs on small farms producing only 140 hogs a year. The steady, downward slope of the cost curve in Chart 4 suggests that even larger production units—like the new mammoth farms producing half a million or more hogs a year—have an even bigger cost advantage over smaller farms.

The newest technologies coming on stream are likely to push down production costs even more, especially on large farms. Some of the new technologies—like pST—are said to be “size neutral,” indicating they could lower production costs on both small and large farms. But these technologies are likely to be used more effectively on large farms where sophisticated production and management systems are already in place.¹¹

The economies of scale that are driving the industry’s consolidation should improve pork’s competitiveness with other meats—especially budget-priced poultry. The sharp drop in the price of poultry relative to beef and pork in the last two decades boosts its appeal to budget-conscious consumers. To remain competitive at the supermarket, the pork industry must hold down its costs—while simultaneously satisfying more discriminating tastes. Thus, further consolidation in the pork industry will be driven by the consumer’s demand for convenient and nutritious pork products in a highly competitive food market.

Reducing risk with contracting and integration. The pork industry is also driven toward more contracting and integration by its growing business risks. Ever larger capital investments expose the industry to bigger losses in risky markets. But hog producers and pork processors are learning to control market risks with contracting and vertical integration.

The industry’s further consolidation on bigger hog farms is making hog production a much riskier business than before. The highly specialized equipment used on big hog farms has little value in uses other than hog production. These modern pig factories have less flexibility than small farms to cut back production or liquidate assets altogether if hog prices fall or if a market cannot be found for market-ready hogs. Thus, uncertain marketing arrangements expose investors in modern hog farms to large losses.¹²

Uncertain marketing arrangements expose pork processors to similar risks. Operating costs in modern processing plants rise sharply if processing lines are not operated at optimal speed.

Thus, processors are exposed to large losses if a steady supply of market-ready hogs is unavailable. Moreover, pork processors must also ensure that the hogs entering their plants are of top quality. Otherwise they run the risk that the pork products they manufacture will be rejected by today’s more demanding consumers.¹³

Ensuring a steady supply of top-quality hogs for modern processing plants is likely to be of increasing importance to processors as pork production consolidates on fewer farms. Processors will have fewer sources of hogs, increasing the importance of continuing marketing relationships with large producers. Thus, the cost-driven consolidation in hog production will work hand-in-hand with the supply risks faced by processors to drive the industry toward a more integrated market structure.

Contracts between hog producers and pork processors are one way of reducing the risk of loss on large investments in specialized assets for both parties. Producers are ensured access to a market for their hogs at a guaranteed price, and processors are ensured a steady supply of hogs to keep processing lines running at optimal speed. Similarly, producers can expect compensation for hogs of exceptional quality—which the traditional pricing system might ignore—and processors can expect that hogs entering their plants will meet the more stringent quality specifications dictated by more demanding consumers.

Vertical integration goes a step farther than contracting in reducing the market risks associated with investments in specialized hog production and processing facilities. By locking together hog farms and processing plants under common management, the integrated firm can ensure a steady supply of high-quality hogs into its processing plants. As a result, production and processing facilities are used at optimum capacity, cutting the risk of loss on big capital investments.¹⁴

The trade-off for cutting marketing risks with contracting and vertical integration, however, is higher management costs. For example, proces-

sors who skirt traditional markets and contract directly with hog farmers face the cost of negotiating and managing numerous production contracts. Likewise, the vertically integrated pork firm faces the bigger burden of managing both hog production and pork processing instead of one or the other. But overall, an accelerating trend toward more contracting and integration in the U.S. pork industry suggests the economic advantages of contracting and integration outweigh any increase in management costs.

THE CLASH BETWEEN PUBLIC POLICY AND THE NEW PORK INDUSTRY

The continued structural realignment of the pork industry portends a new public policy challenge for rural America. Many rural communities will face a decline in local economic activity as the number of small, independent hog farmers erodes. But new, large-scale hog farms will boost economic activity in some other communities. The structural shift in the pork industry, therefore, promises the further concentration of rural economic activity in fewer pockets. Thus, policymakers are challenged to balance the impact of the industry's structural change on rural America with the economic benefits consumers derive from a more efficient industry that delivers higher quality products at lower cost.

Consumers have much to gain from the changes taking place in the pork industry. With stiff competition in the overall food market, the pork industry will pass along to consumers its new efficiency gains in the form of higher product quality and lower prices. Pork products compete directly with other protein foods including beef, poultry, fish, and even new products made from soybeans and other sources of vegetable protein. Thus, the risk is slim that a more concentrated pork industry could exercise monopoly power, which could constrain pork supplies and drive up prices for consumers.

While the structural evolution underway in the pork industry promises significant gains for consumers, it also promises to concentrate a significant source of rural economic activity in fewer pockets. Many rural communities will watch local economic activity dwindle as the number of small hog farmers erodes further. But large-scale production facilities will be a boon to economic activity in some other communities.¹⁵ Thus, the structural shift in the pork industry promises to create a new patchwork of a few rural winners and many losers.

Most public policy concerning farmers is made in Washington, D.C. Price supports for farm commodities, subsidies for farm exports, and other measures designed to boost farm incomes are legislated at the federal level. But the impact on farmers of a more compact pork industry is being debated in state capitals across the farm belt.

Public policy is generally designed to protect the interests of traditional small farmers. As the changing pork industry threatens the livelihood of smaller farmers, it is falling out of step with a host of public rules and regulations. Some of these rules restrict corporate farming in general, others restrict or regulate contracting and vertical integration in livestock production in particular, and still others seek to minimize the impact of concentrated livestock production on the rural environment. Thus, tension is building between public policy designed to protect the traditional pork industry and the new pork industry that is rapidly taking its place.

Pork production in the Tenth District. The tension between tradition-bound policy and a rapidly evolving pork industry is now evident in the Tenth Federal Reserve District.¹⁶ Pork production in the district has always taken a back seat to its northern neighbors in the Corn Belt, where pork production reigns supreme. But restrictions on the industry elsewhere are pushing pork production into parts of the district where it has seldom been seen.

Pork production has traditionally been an important part of agriculture in three district states,

Kansas, Missouri, and Nebraska. Nebraska ranks among the top five hog producing states in the nation, and Missouri and Kansas rank among the top ten. These three states account for the lion's share of pork production in the district and about a seventh of pork production in the nation.

But now pork production is beginning to migrate into other district states—Colorado, Oklahoma, and Wyoming—where the industry was almost nonexistent before. The share of the nation's pork production in these district states is still tiny, but a number of large pork firms, including Seaboard Corporation, DeKalb Swine, Cimarron Pork, Tyson, Pig Improvement Company, and National Farms, have recently chosen these non-traditional states for expansion.

Restrictions on the pork industry's activities in some traditional hog states are guiding the industry into these new production regions. For example, nine midwestern states (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin), including six of the top ten pork producing states, have enacted some form of corporate farming law. The provisions of these laws vary widely, but generally they place restrictions on the farming or land holding activities of large, publicly traded corporations.¹⁷

A recent legislative battle in Iowa—by far the nation's leading hog producing state—and another currently raging in Kansas highlight the policy debate triggered by the pork industry's structural change. Since 1975, Iowa has prohibited processors from contract feeding of hogs. But in 1988, the state passed an exemption to the law that allows cooperatives who own processing facilities to engage in contract hog production with their members. Last year after an intensive debate, an attempt to repeal or add restrictions to the cooperatives' exemption was unsuccessful.¹⁸ Similarly, a 1988 Kansas law prohibits processors from contract feeding of hogs or from owning hogs directly. But a proposal to ease the law's restrictions is a topic of intense debate in the current session of the Kansas legislature.

Meanwhile, the pork industry is skirting the policy debate by moving into new production regions in nontraditional district states. The industry's geographic shift suggests the dividends paid by a new industry structure outweigh the possible drawbacks from moving into uncharted territory. How much of the industry the district gains will depend at least in part on the outcome of the public policy debate. Some states may attempt to preserve the pork industry's traditional structure, only to see the industry migrate to states where the regulatory environment is more accepting of its new structure. Overall, the Tenth District could capture a bigger share of the nation's pork industry, if the industry continues its shift into new production areas.

SUMMARY

The structural realignment underway in the U.S. pork industry will ultimately result in fewer, larger hog farms with closer marketing ties to pork processors and consumers. The industry's new structure promises consumers higher quality pork products at lower cost. But the industry's structural shift will also create winners and losers among traditional hog farms and rural communities, opening a public policy dilemma. Hog farms with a big enough scale of operations and the technical know-how to meet rigorous product requirements will thrive in the new pork market. Many smaller farms will be crowded out. Economic activity will rise in some rural communities and fall in others, as the industry concentrates in fewer pockets. Thus, a clear challenge emerges for public policy. Policymakers must balance the costs of a changing pork industry in rural America with the benefits to consumers of a more efficient industry that promises higher quality products at lower cost.

APPENDIX

HOW DOES THE MARKETING SCHEME AFFECT INDUSTRY COSTS?

The shift toward contracting and vertical integration in the U.S. pork market points to a key question: Under what conditions are these marketing arrangements favored over the traditional system of open production? Coase suggests that the fundamental reason for performing a variety of tasks in a single firm is that entrepreneurs find it cheaper to manage those tasks or services internally than to purchase some or all of them from others.¹⁹

The infant industry

Stigler's description of the industry life cycle is a good starting point for considering how the choice of a marketing structure can affect firm costs. In Stigler's view, the firm is an agglomeration of various processes, such as purchasing inputs, transforming inputs to outputs, and marketing final products. Panel A of Figure A1 depicts the cost structure for a pioneering firm (Firm 1) in a new or infant industry. The firm performs two functions or processes, process A and process B, described by average cost curves AC_A and AC_B , which sum to the firm's average total costs AC_F . The firm has no choice but to manage processes A and B internally, because the firm is virtually the only firm in the new industry.

As the industry grows, however, additional firms enter and the industrywide volume of both process A and process B increases. Eventually, industry volume is large enough to support a firm (Firm 2) which specializes in process B, exploiting economies of scale unavailable to the original pioneering firm. Thus, Firm 1 can lower its total production costs by relying on Firm 2 for process B, which it can buy at a price lower than its own

production costs regardless of volume (Panel B, Figure A1). This simple example suggests open production should become more common and vertical integration less common as a new industry grows, a trend which is opposite that occurring in the U.S. pork industry.

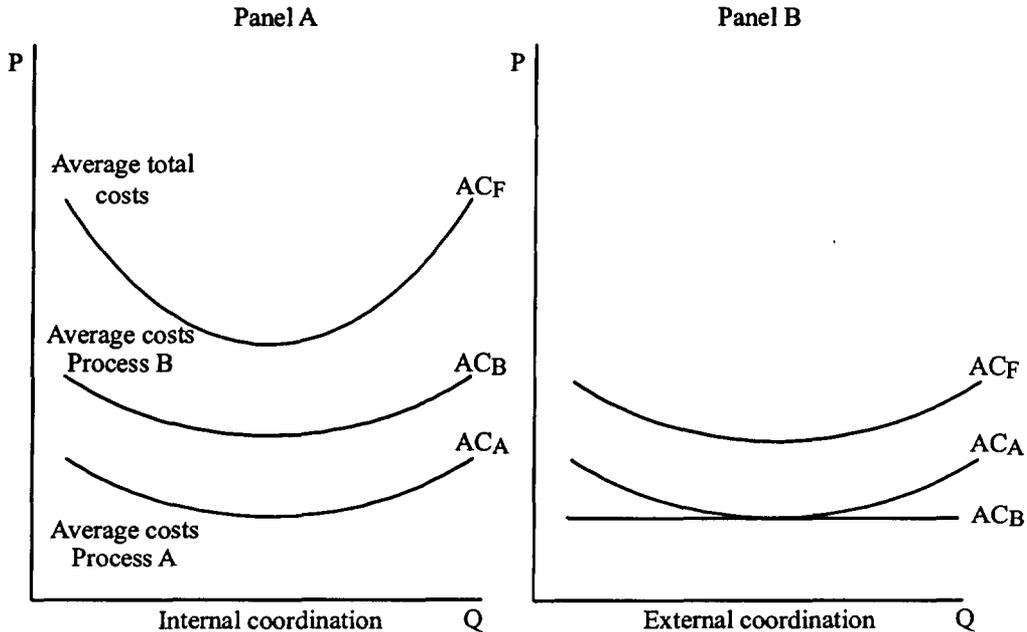
Adding transaction costs

The discussion so far has focused on production costs and ignored transaction costs, the costs of managing marketing relationships, which can change the picture markedly. Williamson's extensive work (1979, 1986) in the area has extended and refined Coase's original argument, attributing the choice of a marketing structure to the firm's cost minimizing decision. Williamson suggests that firms weigh the effects of different marketing schemes on production and transaction costs, with an eye to minimizing their sum.

A few minor adjustments to the sketch of Stigler's growing infant industry illustrate Williamson's ideas. Panel A of Figure A2 again shows the cost structure of the original pioneering firm (Firm 1) after its decision to rely on Firm 2 for process B. But Figure A2 also accounts for Firm 1's transaction costs (ACT)—the costs of managing its relationship with Firm 2.

Figure A2 also provides a useful framework for understanding the structural change underway in the U.S. pork industry by assuming that Firm 1 is a pork processor and Firm 2 is a hog producer. The pork processor's transactions costs might reflect both the cost of searching the countryside for a large enough supply of hogs to keep its processing lines running and the risk that market-weight hogs could be in short supply or of inferior quality. The addi-

Figure A1

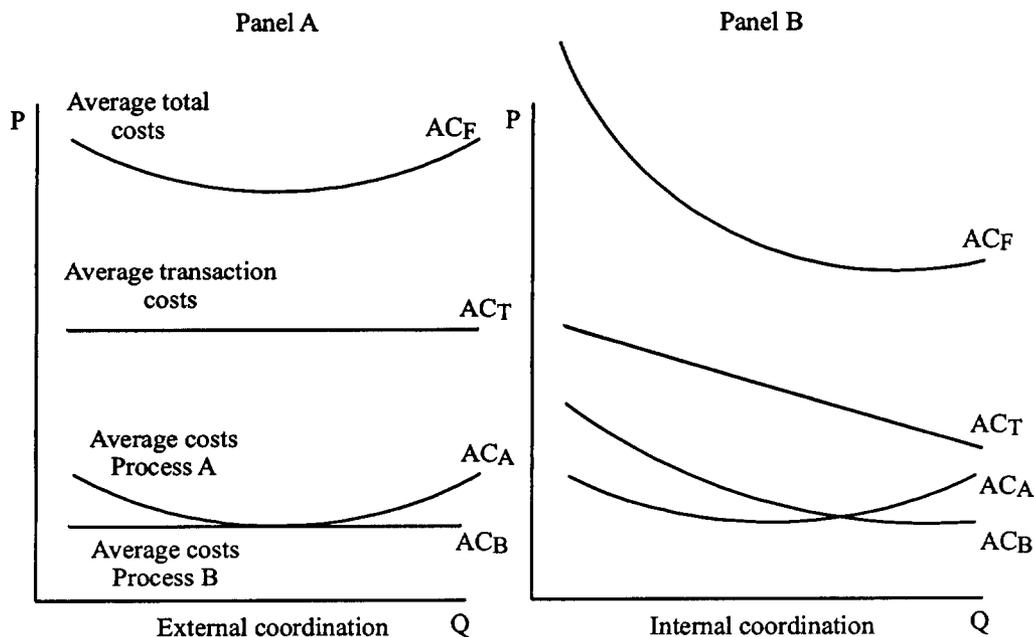
Growth of the Infant Industry

tion of these transaction costs significantly pushes up the pork processor's total average costs (ACF).

As an alternative to using the traditional marketplace, the pork processor and the hog producer may consider a contractual agreement, or the processor may integrate directly into hog production (Panel B, Figure A2). The production contract guarantees the hog producer a ready market at a sure price. And both contracting and integration ensure the processor a steady supply of top-quality hogs to keep processing lines running at optimal speed. Thus, market risks are reduced for both producer and processor. In the absence of contracting or vertical integration, on the other hand, market uncertainties could constrain both the producer and the processor from making large fixed investments in their businesses.

Lower marketing risks could embolden the vertically integrated pork processor to make large investments in hog production, driving down production costs by capturing economies of scale. The processor would probably have to add additional staff to manage the firm's new hog production activities. But the unit cost of the larger management load (ACT) would probably decline as hog production volume rose. Thus, the hog processor could find that transaction costs are smaller under vertical integration than under open production, when production volume is large enough to support the bigger management burden. As a result, at large production volumes, vertical integration enables the processor to maintain low production costs (the sum of ACA and ACB), reduce transaction costs (ACT), and thereby reduce total costs ACF .

Figure A2

Growth of the Infant Industry with Transactions Costs**ENDNOTES**

¹ In 1992, less than a third of the nation's hogs were found in small farm herds of fewer than 500 hogs; in 1970, roughly half the nation's hogs resided in such small herds.

² A trend toward more concentration is also evident in pork processing, although not as pronounced as in pork production. In 1992, the largest four pork slaughter firms accounted for about 42 percent of the nation's pork slaughter, up from 32 percent in 1972 (Hayenga and Kimle).

³ This classification scheme for different kinds of market structure is drawn from Mighell and Jones. See the appendix to this article for a more complete discussion of market structure.

⁴ According to Senaur and others (p. 310), "The history of food and agriculture is a story of gradually shifting roles. First food production, then processing, and now, increasingly,

food preparation have shifted out of the household."

⁵ The AHA advises consumers to limit total intake of meat, seafood, and poultry to no more than 6 ounces per day, use chicken or turkey (without the skin) or fish in most main meals, and to substitute meatless main dishes for regular entrees (American Heart Association 1985).

⁶ Senaur and others (p. 311) summarize the basic nature of food demand stating, "Over time, the fundamental human concerns regarding food remain largely unchanged. People desire a food supply that is reliable and affordable, furnishes the nourishment to sustain life and health, and provides satisfaction and pleasure when consumed."

⁷ While pST promises significant gains in pork quality and production efficiency, the jury is still out on its commercial use. The hormone is currently under review by the

Food and Drug Administration. Consumer acceptance of pork produced with pST is another important question. But survey data suggest consumers' desire to reduce fat outweighs consumers' concerns about any adverse impact of pST on food safety (U.S. Congress, Office of Technology Assessment).

⁸ Another way of describing the fragmentation of the pork market and other segments of the U.S. food market into smaller "hoppers" is to say that the number of unique transactions has increased. The characteristics and frequency of market transactions are key factors determining how markets are structured. See the appendix for a more detailed discussion of factors affecting market structure.

⁹ See the appendix for a more complete discussion of the role of economies of scale and risk in determining the structure of the pork industry.

¹⁰ In 1992, for example, less than 5 percent of the nation's hog farms held inventories of more than 1,000 head, the biggest size tracked by the U.S. Department of Agriculture. But those relatively few large farms accounted for nearly half of the nation's hog inventory.

¹¹ One recent study showed that pST could boost average net income per sow by \$110 to \$134 a year, with the biggest gain attained on the biggest farm in the study. Total net income increased about \$80,000 a year when pST was adopted on the biggest farm, compared with an increase of only \$8,000 a year on the smallest farm. Thus, pST is likely to widen the economic advantage of big farms over little farms (Office of Technology Assessment).

¹² A relatively high capital-labor ratio points to the critical role of large investments in specialized technology on big hog farms. Average production expenses on the 10,000-head farms shown in Chart 3 are lower than on the 140-head farms in every expense category. But the biggest difference is in labor expense, which is nearly two-thirds less on the big farms than on the small farms. As a result, the capital-labor

ratio on the larger farms averages more than half again as large as on the small farms.

¹³ To the authors' knowledge no data on the operating costs of pork processing plants are available. However, most industry observers believe that the shape of cost curves in pork processing plants would be similar to that of beef processing plants. See Barkema and Drabenstott for a more thorough discussion of operating costs in beef processing plants.

¹⁴ Cost reductions gained by locking together previously separate functions like hog production and pork processing are usually called economies of scope.

¹⁵ One Iowa study, for example, notes that the production of 40,000 hogs adds more than \$3 million to the value of the state's home-grown grains and boosts economic activity in nearby communities by more than \$6 million (Kliebenstein and Ryan).

¹⁶ The Tenth Federal Reserve District includes all or part of the states of Colorado, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, and Wyoming.

¹⁷ Some corporate farming laws can also be interpreted as prohibiting the contract production of livestock "either as 'indirectly' engaging in farming or as the control of agricultural land" (Hamilton and Andrews, p. 2).

¹⁸ The Iowa Senate passed a bill that would have required cooperatives to receive the approval of 60 percent of its membership before it could engage in contract feeding of hogs. But the bill was amended in the Iowa House to establish a committee to study the issue further (Hamilton and Andrews).

¹⁹ Coase succinctly states the issue, "It is surely important to enquire why co-ordination is the work of the price mechanism in one case and of the entrepreneur in another" (p. 335).

REFERENCES

- American Heart Association. 1985. "The American Heart Diet, An Eating Plan for Healthy Americans."
- Barkema, Alan, and Mark Drabenstott. 1990. "A Crossroads for the Cattle Industry," Federal Reserve Bank of Kansas City *Economic Review*, November/December, pp. 47-64.
- Barkema, Alan, Mark Drabenstott, and K. Welch. 1991. "The Quiet Revolution in the U.S. Food Market," Federal Reserve Bank of Kansas City *Economic Review*, May/June, pp. 25-39.
- Barkema, Alan, Mark Drabenstott, and M. L. Cook. 1993. "The Industrialization of the U.S. Food System," Proceedings of the First Annual Meeting of the Agricultural and Food Marketing Consortium, Orlando, Fla.
- Coase, R.H. 1937. "The Nature of the Firm," *Economica*, vol. 4, pp. 386-405. Reprinted in Stigler and Boulding, eds. *Readings in Price Theory*. Chicago: Richard D. Irwin, Inc., 1952.

- Hamilton, Neil D., and Greg Andrews. 1992. "State Regulation of Contract Feeding and Packer Integration in the Swine Industry," Des Moines, Iowa: Agricultural Law Center, Drake University Law School.
- Hayenga, Marvin, and Kevin Kimle. 1992. "Packing Industry Competitive Structure and Pork Slaughter Capacity," Department of Economics, Iowa State University, Ames.
- Hurt, Chris, Kenneth A. Foster, John E. Kadlec, and George F. Patrick. 1992. "Industry Evolution." *Feedstuffs*, August 24, pp. 1, 18-19.
- Kliebenstein, J.B., and V.D. Ryan. 1991. "Integrating Livestock Industry and Community Development Strategies," conference proceedings of the Livestock Industry and the Environment, sponsored by Iowa State University, Ames, Ia., pp. 113-30.
- Manchester, Alden C. 1992. *Transition in the Farm and Food System*, U. S. Department of Agriculture, Economic Research Service.
- Mighell, Ronald L., and Lawrence A. Jones. 1963. "Vertical Coordination in Agriculture," U.S. Department of Agriculture, Economic Research Service, Farm Economics Division, Agricultural Economic Report No. 19.
- Office of Technology Assessment. 1992. "A New Technological Era for American Agriculture," Washington: U.S. Government Printing Office.
- Rhodes, V. James, and Glenn Grimes. 1992. "U. S. Contract Production of Hogs: A 1992 Survey," Report 1992-2, Department of Agricultural Economics, University of Missouri—Columbia.
- Senaur, Ben, Elaine Asp, and Jean Kinsey. 1991. *Food Trends and the Changing Consumer*, St. Paul: Eagan Press.
- Stigler, George J. 1951. "The Division of Labor Is Limited by the Extent of the Market," *Journal of Political Economy*, vol. 59, pp. 185-93.
- Williamson, O. E. 1979. "Transaction-Cost Economics: The Governance of Contractual Relations," *The Journal of Law and Economics*, vol. 22, pp. 233-61.
- Williamson, O. E. 1986. "Vertical Integration and Related Variations on a Transaction-Cost Economics Theme," in Joseph E. Stiglitz and G. Frank Mathewson, eds., *New Developments in the Analysis of Market Structure*, Cambridge, Mass.: MIT Press.

