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From Farmers to Consumers

Vertical Coordination in the Food Industry

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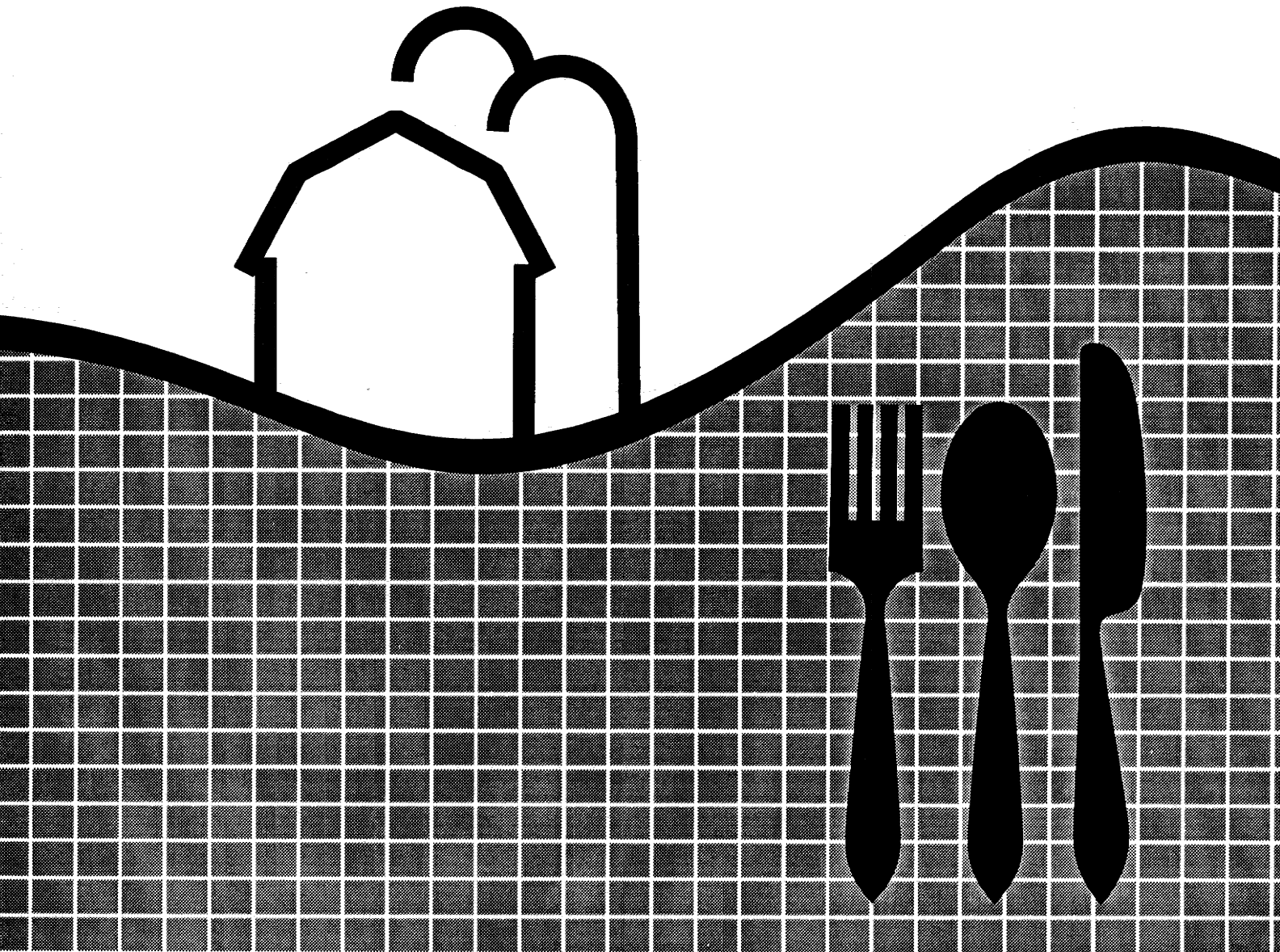

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Abstract

Vertical coordination refers to the allocation of resources across successive stages of a food supply system. Methods of coordination include open production, contract production, and vertical integration. With changes in consumer preferences for food products over the past several decades, open-market exchanges have given way to contract production and vertical integration. These developments may continue in the future as consumers demand specific product attributes and technological advances enable added control over farm product attributes and flows. Changes in methods of vertical coordination raise important policy issues.

Keywords: Vertical coordination, contract production, vertical integration, captive supplies, industrialization.

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Summary

If recent trends in the U.S. food industry continue, food production may be increasingly dominated by firms exercising control over several stages of food production. Vertical coordination refers to the way products are acquired or traded in a market, and this report examines the various forms of vertical coordination, reviews the recent history of vertical coordination, and looks at its future, including its implications for market control and environmental protection.

There are three basic types of vertical coordination that a firm can exercise:

Open production. A firm purchases a commodity from a producer at a market price determined at the time of purchase.

Contract production. A firm commits to purchase a commodity from a producer at a price formula established in advance of the purchase.

Vertical integration. A single firm controls the flow of the commodity across two or more stages of food production.

The food industry has traditionally operated in an open production system. However, more discriminating consumers, plus new technological developments that allow farm product differentiation, are contributing to a decrease in open production and an increase in contract production and vertical integration.

Also fueling this trend are changing demographics and the increasing value of homemakers' time, both of which have contributed to consumer preferences for a wide variety of safe, nutritious, and convenient food products.

Providing food products with specific characteristics preferred by more discriminating consumers will likely involve increasingly more detailed raw commodity products, such as a frying chicken of a specific weight and size, or a corn kernel with a specific protein content. This effort to carefully tailor raw commodities with processing in mind is already underway in some food industries, accompanied by changes in vertical coordination.

Any trend toward contract production and vertical integration, as opposed to open production, implies that firms at one stage of production exert more control over the quality or quantity of output at other stages.

For example, pasta processors who prefer a specific type of wheat for a specific type of pasta gain control over planting decisions or seed selection that were previously made by farmers who sold their wheat on the spot market. Farmers are compensated for relinquishing control through bonuses for quality and through reduced uncertainty.

Recent changes in vertical coordination have been accompanied by an increase in concentration in the food sector. These developments have raised two primary policy concerns: market power in the processing sector and environmental protection.

Changes in vertical coordination and increased concentration in the food sector can allow a small number of firms to affect prices or other terms of trade. Because of the changing nature of vertical coordination, new methods and data may be needed to accurately monitor food industry concentration. On the environmental front, the growth of massive livestock operations has increased the potential for environmental degradation and the need for technological and policy solutions.

From Farmers to Consumers

Vertical Coordination In The Food Industry

Steve W. Martinez
Al Reed

Introduction

A food supply system is comprised of a set of economic stages of production (fig. 1). The vertical arrangement of economic stages reaches from the upstream farm production stage to the downstream retail stage.[1] Each stage represents an activity that adds value to the final product. A stage is referred to here as an *economic stage* in the sense that it is a process capable of producing a salable product or service under appropriate circumstances (Mighell and Jones, 1963). *Vertical coordination* refers to all possible economic arrangements involved in transferring resources between economic stages. For the most part, firms in different stages of food production coordinate the transfer of inputs and outputs through open production, contract production, or vertical integration. Each method of vertical coordination has an impact on consumers.

Historically, *open production* has been the prominent way in which the food industry has allocated resources between stages. In open production, a producing firm does not commit itself to selling its output before completing production. Cash (spot) prices coordinate resource transfer across stages of production. Farmers selling their wheat to the local elevator at the posted price, or supermarkets selling their goods to customers, are examples of open production. If food industries are perfectly competitive, consumer values are clearly reflected in the resources allocated to food production, in the variety and quality of food produced, and in food prices.[2] Economists refer to this concept as market efficiency. The textbook example of an efficient market is a perfectly competitive, open market. However, perfectly competitive firms can vertically coordinate resources in ways other than open production and the market can remain efficient.

Figure 1
Vertical stages of a food supply system

- Farm production
- Processing
- Wholesaling
- Retailing

Contract production is production for a forward market.[3] When a buyer and a seller negotiate a *production contract,* their relationship is closer than in open production. Before completing production, a producer commits to deliver a particular product to a particular buyer. For example, Murphy Family Farms might promise to deliver a specified quantity and quality of hogs per day to Smithfield Foods at, essentially, a spot-market price.

Interstage *vertical integration* refers to combining two or more stages within a single firm. When stages are vertically integrated, the firm administers resources between stages.

Other forms of coordination also exist in the food industry. *Strategic alliances* are informal collaborations between firms based on trust and involve a transfer, or sharing, of assets (Sporleder, 1992). The food service distributor, Martin-Brower,

[1] This differs from *horizontal* arrangements, which refer to arrangements between firms at the same stage of production.

[2] By perfect competition, we mean that each firm is a price taker, and each is free to enter and exit the industry (Lipsey and Steiner, 1978). Firms are perfectly competitive in the sense that a single firm cannot systematically control the market.

[3] In a forward market, transactions relate to goods and services to be delivered sometime in the future.

Ways of Achieving Vertical Coordination

Coordination of two or more stages in a food supply system occurs in three basic ways:

- In *open production*, spot prices coordinate transactions between buyers and sellers at successive stages. Commitments to sell a product to another stage are made only after its production is complete.
- In *contract production*, commitments to sell a product to another stage are made prior to completing its production.
- *Vertical integration* of successive stages allows a firm to administratively coordinate resources between stages.

Movement along the continuum from open markets to integration represents increasing control over another stage of production. Other forms of coordination also exist.

for example, has developed a strategic alliance with McDonalds by establishing an "understanding" that Martin-Brower will be the sole supplier of certain products for McDonalds restaurants in a given geographical area. Evidently, sufficient incentives exist, without a formal contract, for Martin-Brower to maximize its effort and provide quality service to one of the world's largest restaurant chains. Food ingredient suppliers may also forge strategic alliances with processing firms to jointly carry out the firm's research and development of new food products.

The use of contracts and integrated ownership has increased modestly in certain food industries over the past two decades (table 1). However, even modest changes can affect the prices and quality of food products, and new vertical arrangements can lead to market efficiency and increased responsiveness to consumers.

Any trend toward contract production and vertical integration, as opposed to open production, implies that firms at one stage of production exert more control over the quality of output at other stages of production. Decisions made by a firm at an early stage of production might be transferred to a downstream firm. This represents transfer of control. For example, pasta processors may gain control over planting decisions or seed selections that were made by farmers who previously sold wheat on the spot market. Farmers are compensated for relinquishing control through bonuses for quality and through reduced uncertainty. Frank and Henderson (1992) incorporate this concept of control into a vertical coordination index that attempts to measure the closeness of stages within a single food industry. The index increases as control is transferred across stages of production. Specifically, Frank and Henderson treat open production, contract production, and vertical integration as a continuum from least control transferred (open production) to greatest control transferred (vertical integration). For example, as an industry moves from open production to contract production, its index increases.

Evidently, firms choose a level of control by selecting a method of vertical coordination. Pasta processors, for example, may choose to vertically integrate back to the wheat production stage to procure a specific type of wheat for a specific type of pasta. The pasta firm might expect that higher quality pasta, achieved with additional control over wheat quality, would result in positive marginal revenue. By vertically integrating to the farm stage to achieve this control, the processing firm would also incur the costs of wheat production. Alternatively, the firm might achieve almost the same degree of control by negotiating production contracts with independent wheat farmers. Contract production might involve the costs of negotiating and enforcing contracts, but would not involve the costs of wheat production. By matching the additional revenues from higher quality pasta with the additional marginal costs of achieving control over wheat quality, the pasta firm maximizes profits. Economists refer to this as production efficiency. By choosing the appropriate method of vertical coordination, firms maximize profits and produce efficiently.

But do changes in vertical coordination translate into increases in market power? If changes in vertical coordination impart market power to a few firms, market efficiency is lost—the quality and variety of food produced and the prices paid for food do not reflect consumer values. On the other hand, if changes in vertical coordination occur within an efficient market (i.e., marginal costs of attracting resources into food production match the value consumers place on food), food supply and prices reflect consumer values. It is important, therefore, to view changes in vertical coordination within a context of changing food consumption patterns and the changing structure of food industries.

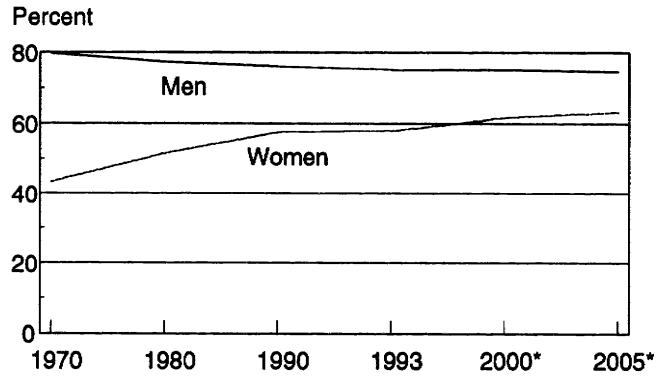
Consumers Are Changing as Vertical Coordination Is Changing

Compared with consumers 40 years ago, present-day consumers demand a wider variety of safe, nutritious, and convenient food products. The food system has responded by offering a wider variety of food products of consistently higher quality. Food products sold over the last 40 years have "changed from a basket of goods with a limited service component to a basket of services with a limited goods component" (O'Brien, 1994). Considerably more value is added to food products at the processing and distribution stages, which has resulted in a wider range of differentiated food products.

Several factors are responsible for changes in U.S. consumer trends. One factor is the increased value of households' time. Labor force participation rates of men and women in the United States are converging (fig. 2). Over the past two decades, the number of married women working outside of the home has increased dramatically. Almost 70 percent of American married women of prime childbearing age are in the labor force (Kinsey, 1994), and women currently account for about 46 percent of the employed civilian labor force (U.S. Bureau of the Census, 1994). The entry of women into the paid labor force has meant that the value of time has increased. To reduce the amount of time spent in the kitchen, consumers have placed greater value on the convenience of processed food products. As time has become more valuable, the opportunity cost of becoming ill from food-borne pathogens has increased, as has the increased opportunity cost of gathering information about food content. Hence, consumers place a higher value on food-quality assurance and on public regulation of food products (Kinsey, 1994).

Demographic factors have also affected consumer trends. The U.S. population is more ethnically diverse than in the past. For example, half of the corn products manufactured by Quaker Oats are purchased by ethnic minorities (Kinsey, 1994). Ethnic diversity contributes to more numerous market niches like Mediterranean, Thai, and Indian cuisines. To produce specialized, culture-specific products, firms must often procure specialized farm commodities. Other demographic factors, such as the later incidence of marriage and the reduction in household size, have also affected trends in food consumption. Single people and members of small households tend to consume more food away from home than married people and members of large households (Kinsey,

Figure 2
Civilian labor force participation rates of U.S. workers, 1970-2005



*Projected
Source: Compiled by Economic Research Service from Statistical Abstract of the U.S.: 1994. Bureau of the Census.

1994). An increased concern with health and nutrition has fostered growth in animal product alternatives, such as vegetarian burgers, soy and rice milk, cheese alternatives, and nondairy deserts that did not exist 40 years ago (*Supermarket News*, 1995).

The food industry is responding by supplying more safe, nutritious, and convenient processed food products than in the past. Improvements in quality and reliability have permitted store-brand products to compete with traditionally more reliable national brands. Warehouse clubs are competing with the more traditional supermarkets (*The Economist*, 1993). Furthermore, growth in domestic food consumption is projected to be slow. As consumers grow more discerning, leading firms may transfer greater control across stages of production than in the past.

Current consumer trends and a slowly growing economy are expected to continue, which exposes firms to additional risk and uncertainty. One way to reduce or allocate additional risk or uncertainty is to forge closer relationships with firms in other stages of production. Reorganized relationships within a more industrialized food industry may be driving changes in vertical coordination.

Changes in Vertical Coordination Reflect a Reorganized Industry

By 1990, almost all the output of broilers, turkeys, processed vegetables, citrus, and potatoes was coordinated either through production contracts or through integrated ownership (see table 1). Contract

production and vertical integration have grown significantly in the potato, fresh vegetable, and some fresh fruit industries. While the percentage of transactions coordinated by vertical integration has increased in the sheep and lamb industry, the majority of transactions continue to be through open production.

Firms have historically engaged in contract production to ensure timely sales of perishable products. Today, contract production and vertical integration represent the most prevalent means of vertical coordination for perishable products (O'Brien, 1994).

However, for industries undergoing reorganization or industrialization, vertical coordination is changing. Firms in these industries may use special inputs in production, may invest heavily in production facilities or biotechnology, or may specialize in fewer stages of production. These firms are choosing levels of control consistent with efficient production by changing their method of vertical coordination.[4]

The North Carolina hog industry illustrates how changes in vertical coordination support industrialization. Before constructing one of the world's most technically efficient plants in Tar Heel, NC, Smithfield Packing Company sought reliable and sufficient supplies of specially bred and raised animals. By negotiating *market-specific* production contracts[5] with producers such as Murphy Family Farms and Carroll's Foods, Smithfield gained control over the variability of delivery schedules and over carcass size and quality that could not be attained on the spot market. By reducing variability, Smithfield lowers its operating costs, and obtains premium prices for products of consistently high quality.[6] The producers, or integrators, receive premiums above the spot-market price. Prior to construction of the Tar Heel plant, producers mastered a system of raising a large number of hogs in confined environments. The producers offered growers *resource-providing* production contracts to implement this system. Specifically, these contracts enforce a system in which producers retain ownership of the animals while they are raised by a grower, and specify that producers provide growers with feed, medication, and managerial support. Although growers provide land, buildings, labor, and waste disposal, their production and price risk under production contracts is reduced. As a result, the industry remained financially sound despite low hog prices in 1994-95. The changes in the North Carolina hog industry reflect some of the changes taking place across the food sector today and in the past (see box, "Changing Vertical Coordination in the Broiler Industry: An Example From the Past").

Changes in vertical coordination are also evident in grain-based industries. Consumer health concerns have pushed growth in pasta demand past growth in demand for other grain-based products. Pasta demand has brought notable changes in the milling of flour and the production of pasta in Arizona and in the Upper Midwest. Almost all of Arizona's durum wheat is grown under contract either with Borden or with Arizona Grain. Borden is one of the world's largest pasta manufacturers and arranges for (perhaps with contracts) a nearby Bay-State milling plant to mill wheat grown under the Borden contract. On the other hand, Arizona Grain mills the wheat it has under contract and negotiates contracts for the flour with two Italian firms. Evidently, the introduction of production contracts in Arizona has induced a higher quality of durum wheat than in the past.

In the Upper Midwest, the pasta industry has combined vertical integration and production contracts to coordinate durum wheat and pasta production. The Dakota Growers Pasta Company owns a modern mill and pasta plant and farmers from three Upper Midwest States own the Dakota Growers Pasta Company. Each farm member purchases a share of the company and enters into a *market-specific* contract with the company to deliver a predetermined quantity and quality of wheat on a certain date. If the 4-month average open-market price exceeds the contract price, the company adjusts the grower's check upward. If the average falls below the contract price, the company covers the difference. Premiums are paid for wheat of exceptional quality, and if a producer fails to meet the terms of the contract, he can purchase wheat from company-held stocks. The vertical integration of the farm production and processing stages, and the negotiation of production

[4] The following examples represent changes underway in several food industries. Based on available evidence in 1990, contracting for specialized products, such as canola, high-lysine corn, and pasta, does not represent a significant portion of total production and should not be considered as indicative of farm products as a whole.

[5] The similarities and differences among market-specific, production-management, and resource-providing contracts will be discussed in the next section.

[6] Efficient plant utilization with respect to meat quality characteristics is difficult to determine. However, quality control through contracting does help to minimize measurement and sorting costs, so that packing costs are lowered.

Table 1—Farm production coordinated by contract production and vertical integration

Commodity	Contract production[1]		Vertical integration		Total	
	1970	1990	1970	1990	1970	1990
			Percent			
Livestock:						
Broilers	92	92	7	8	99	100
Turkeys	60	65	12	28	72	93
Hogs[1]	1	11	1	6	2	17
Sheep/lamb	7	7	12	28	19	35
Field crops:						
Food grains	2	7	1	1	3	8
Feed grains	1	7	1	1	2	8
Specialty crops:						
Processed vegetables	85	88	10	9	95	97
Fresh vegetables	21	25	30	40	51	65
Potatoes	45	55	25	40	70	95
Citrus	84	70	9	8	93	78
Other fruit & nuts	20	35	20	25	40	60
Total farm output	28.2	30.5	5.3	7.6	33.5	38.1

[1] Combines contracts entered into before production begins and contracts entered into after production begins.
Source: Compiled by Economic Research Service from *Transition in the Farm and Food System*, Manchester, 1992, and updates.

contracts, has supported the industrialization of the durum wheat-based pasta industry in the Upper Midwest.

Vertical coordination provides some pasta firms with greater control over the color, gluten content, sprout damage, or granulation of milled flour. Production contracts and vertical integration ensure premium prices for wheat of specified quality. The reorganization enables the pasta industry to differentiate a variety of high-quality pasta products preferred by health-conscious consumers.

In the rice-based cereal industry, contract production enables firms to better control the variability of the size of rice kernels. The large variability of kernel sizes of rice purchased on spot markets sometimes causes batches of rice cereal to be undercooked or overcooked. Cereal manufacturers negotiate *production-management* contracts with rice growers, who agree to grow strains of rice with more homogeneous kernel sizes, thereby improving the quality of rice-based cereal.

Contract Production Leads to Economies as Firms Specialize and Shift Risk

Production contracts are used to coordinate an increasing amount of commerce in U.S. agriculture. Once confined primarily to poultry and processed vegetables, production contracts today help coordinate growing proportions of hog production and food and feed grain transactions.

Production contracts are well suited to today's industrialized food markets. Clearly written contracts define the amount of control one party at one stage of production purchases from another party at another stage. Contract production may provide firms with enough product control to forego costly vertical integration. The party relinquishing control, on the other hand, is compensated with premiums or by reduced market risk.

Not only do production contracts allocate control, risk, and uncertainty across existing stages, but they sometimes define new economic stages. Contracts between farmers and growers in the North Carolina hog industry, for example, have vertically disintegrated the farm production stage into a breeding and a growing stage. The extent to which

Changing Vertical Coordination in the Broiler Industry: An Example From the Past

While changes in the vertical coordination of the North Carolina pork industry seem unique, similar changes began in the U.S. poultry industry in the 1950's. Like the more recent changes in pork, changes in vertical coordination of poultry apparently supported industrialization.

For many decades, chicken meat was produced as a byproduct of the raising of laying flock replacements and old hens no longer useful for laying purposes. Winter broiler production began in the late 1920's, but it was not until 1950 that commercial broiler sales exceeded that of young and mature farm chickens.

In the early 1950's, production began to move to the South Central and South Atlantic regions of the United States. Because of depressed farming conditions, producers in these regions were more open to new ideas about farm enterprises. However, even though technical and biotechnical innovations were available to reduce mortality rates and reduce the time and feed required to raise broilers, producers would not adopt these changes until vertical coordination changed.

Traditional suppliers of credit considered large-scale broiler producers in these regions high- risk ventures, and refused to extend them credit. In an effort to expand feed markets, however, feed dealers supplied credit to these producers. Feed dealers, serving as suppliers of credit to broiler producers, marked the beginning of a series of changes in the coordination of poultry industry.

New methods for organizing the industry made large-scale production attractive to both feed dealers and potential producers. Through the use of production contracts, feed dealers coordinated several stages of poultry production. The success of large-scale production accelerated the demand for new technology. Producers were able to obtain production capital by financing from feed dealers, and at the same time were reducing their exposure to risk.

Vertical coordination changed as feed dealers became more interested in the production and marketing of broilers. By negotiating contracts with growers, dealers gained virtually complete control over the growout stage. At the same time, feed dealers developed closer relationships with processors so that eventually almost all broilers processed were grown under contract. Independent processors could not obtain sufficient supplies on the open market, and so either worked with feed dealers or provided their own contracts to growers. Today, processors hatch chicks, supply feed, and retain ownership of birds as they are grown.

The technical advances and the changes in vertical coordination from 1945 to 1972 reduced feed consumption by about 50 percent, and resulted in a more concentrated industry responding rapidly to consumer demand. In the 1970's, processors added more value by creating new products. By 1987, the production of cut-up parts accounted for over 50 percent of total processed broilers. Today, patties, fillets, and nuggets provide continually expanding outlets for broilers.

The technical advances and the changes in vertical coordination since the 1940's have resulted in lower, less variable consumer prices. The industry continues to grow as health concerns about red meat serve to expand domestic markets. Furthermore, production and marketing economies have facilitated the growth of the export market.

Sources: Barkema, et al. (1991) and Reimund, Martin, and Moore (1981), and Rogers (1979).

production contracts allocate control, risk, and uncertainty across stages forms a basis for classifying them. This classification is by no means unique, but provides a general framework for classifying contract terminology used by others.[7]

Market-specific production contracts are negotiated between a buyer at one economic stage of production and a seller at another. For example, a North Carolina hog farmer agrees to deliver animals to the packer on a specific date. Increasingly, fresh vegetable packers negotiate market-specific contracts with distributors (Powers, 1994). A buyer in such a contract benefits mainly because delivery schedules are specified. The hog packer, for example, receives uniform animals on a consistent schedule, which may help to lower processing costs. The buyer, in a sense, purchases control over deliveries by reducing the seller's risk of finding a market. The seller usually receives premiums above a spot-market price. Consumers may

[7] This classification scheme is taken from the discussion of Mighell and Jones (1963).

Types of Production Contracts

Three types of production contracts between a producer and a contractor or buyer allocate control, risk, and uncertainty across stages.

- In a *market-specific contract,* the contractor usually reduces the producer's uncertainty of locating a market for harvest. The contractor engages in very few of the producer's decisions.
- In a *production-management contract,* the contractor usually takes on some of the price and income uncertainty of the producer. The contractor engages in some of the producer's decisions.
- In a *resource-providing contract,* the contractor usually takes on most of the income uncertainty of the producers. The contractor engages in many of a producer's decisions.

benefit because of reduced price variability. The market-specific contract usually transfers minimal control across stages.

Production-management contracts typically transfer more control and risk across stages than market-specific contracts. Production-management contracts typically emerge when decisions at either the upstream or seller's stage directly affect an attribute considered valuable to either the downstream or buyer's stage. In these contracts, buyers gain additional control over decisions that were once made by a seller in open production, such as planting schedules or strain of seed. Premium schedules are also specified (Powers, 1994). By assuming control beyond that assumed in a market-specific contract, the contractor takes on some of the producer's price risk. In the case of processed vegetables, for example, the processor would enter into a production-management contract to extend the processing and growing season beyond the typical season (Powers, 1994). Production-management contracts probably benefit consumers by reducing price variability for a variety of differentiated products.

Resource-providing contracts can be thought of as production-management contracts in which the contractor, at one stage of production, retains ownership of a key input as it is transferred to another stage. For example, a poultry processor retains ownership of the chicks as they are raised by a farmer. Resource-providing contracts usually emerge when both special inputs and specialized management practices are required to incorporate attributes into the final product. It is the ownership aspect that motivates a contractor to manage the practices of another stage of production. By using specially bred pigs and special management practices during the growing stage, the North Carolina industry produces hogs with less visible fat. Resource-providing contracts usually offer contractors the most control over another stage without completely integrating the stage. The contractor effectively purchases this control from the seller by taking on the seller's market risk. Recent empirical analysis, for example, suggests that resource-providing contracts in poultry relieve the grower of significant price risk (Knoeber and Thurman, 1995).

Vertical Coordination Will Continue To Change

Changes in vertical coordination in several food industries over the past two decades have been accompanied by slow growth in domestic food markets, increases in consumer demand for processed food with specific attributes, and the proliferation of niche markets. These trends have been accompanied by demand for more control across stages of production in these food industries, and a decline in the importance of open production and spot markets as a means of vertical coordination. To the extent that these trends continue, changes in vertical coordination may also continue.

With sluggish population growth expected, the domestic food sector will likely continue to grow slowly. Nevertheless, consumption patterns will affect the growth of the various industries within the sector. Forces that contributed to the higher premium placed on time appear to be with us for the long term, as women represent a large portion of the labor force and outnumber men enrolled in college (Kinsey, 1992). The demand for safe and convenient food products is likely to continue. Consumers will also continue to place a high value on nutritious food. To produce foods that are convenient, safe, healthy, and nutritious, firms in some sectors will likely demand more control over stages of production than is provided by open production.

Continued ethnic diversity will contribute to continued demand for variety (Kinsey, 1992, 1994). For example, by the end of the century, Hispanics and African Americans will constitute more than one quarter of the U.S. population. Growing ethnic

diversity will continue to support niche markets for food products that require unique ingredients or services. The continued demand for variety will likely diminish the importance of open production as a means of vertical coordination in some food sectors.

Vertical Coordination and Concentration Raise Important Policy Issues

Over the last two decades, vertical coordination of several U.S. food industries might be described less as a series of stages that are coordinated by atomistic producers selling output on spot markets, and more as large-scale, capital-intensive manufacturing firms more directly controlling the decisions of producers. This change has been accompanied by an increase in concentration. It is the increase in concentration accompanying changes in vertical coordination that has raised two primary concerns.

The first concern is market power.[8] Currently, the concern is whether manufacturing firms exert monopsonistic power over firms in the farm sector. For example, the Secretary of Agriculture has recently decided to address a concern that cattle packers use production contracts to obtain "captive" supplies of cattle. The feeders' concern is that production contracts restrict the entry of packers, and thereby restrict their choice of outlets for cattle. They view production contracts as a way in which existing packers control supplies of feeders. If market power is created, market efficiency is lost, and consumer welfare suffers from a reduced variety of products, or higher or more variable price increases.

Statistical measures of concentration alone are not always reliable indicators of market power. If trade agreements or other policies encourage competition from abroad, concentration rates will be misleading measures of market power. If one of the roles of the public sector is to monitor the competitiveness of industries, what types of information can be used to gauge competitiveness as vertical coordination changes?

Monitoring the competitiveness of the food system may require new paradigms and better data (Paul, 1974; O'Brien, 1994). Observed patterns in spot prices, compared against patterns predicted by economic theory and perfect competition, have been used to test for perfectly competitive markets (Wohlgenant and Haidacher, 1989). Spot prices at the farm and manufacturing levels are relevant, however, only to the extent they reflect the value of transactions of economic agents. As stages of food production are being coordinated more by contract production and less by open production, spot prices may not be reliable measures of competitiveness. Information regarding differences among terms of contracts, used in conjunction with paradigms other than the textbook economic models of atomistic producers, may be more appropriate measures of competition.

The second concern regarding an increase in concentration is environmental protection, especially in areas near massive livestock operations. At a complex owned by Premium Standard Farms, a swine herd will generate about half a billion gallons of waste a year, enough to fill the Pentagon (*Wall Street Journal*, 1994). It seems likely that if large, industrialized livestock operations are to continue to grow, firms will be forced to adopt technologies to effectively manage waste. Failure to do so may result in costly litigation and in reductions in consumer welfare. It seems likely that the choice between efficient production and environmental quality will be made in the policy arena.

[8] Market power refers to the ability of a small number of firms in an industry to affect prices or other terms of trade for an industry.

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