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Michael Ollinger, Sang V. Nguyen, Donald Blayney, Bill Chambers, and Ken Nelson

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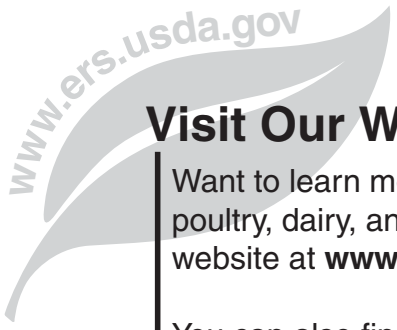

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Structural Change in the Meat, Poultry, Dairy, and Grain Processing Industries

Michael Ollinger, Sang V. Nguyen, Donald Blayney, Bill Chambers, and Ken Nelson

Abstract

Consolidation and structural changes in the food industry have had profound impacts on firms, employees, and communities in many parts of the United States. Over 1972-92, eight important food industries underwent a structural transformation in which the number of plants declined by about one-third and the number of employees needed to staff the remaining plants dropped by more than 100,000 (20 percent). The number of plants in one other industry also dropped, but that industry added jobs. Economists generally attribute structural changes such as these to rising or falling demand and shifts in technology. This report examines consolidation and structural change in meatpacking, meat processing, poultry slaughter and processing, cheese products, fluid milk, flour milling, corn milling, feed, and soybean processing. Plant size and output per employee rose sharply in all industries, and even industries with rapidly growing demand—such as soybean processing and poultry slaughter/processing—used fewer plants. These findings suggest that technological change was the major force driving structural change.

Keywords: structural change, food processing, consolidation, grain processing, meat slaughter, dairy processing

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Contents

Summary

Consolidation and structural changes in the food industry have had profound impacts on firms, employees, and communities in many parts of the United States. In many cases, the emergence of new scale economies causes consolidation into larger plants and firms. When market demand is growing slowly, increased consolidation (larger plants and firms) can lead to increased concentration (fewer competitors). Such structural change can harm small-scale producers but may benefit consumers and society.

What Is the Issue?

Food processing industries have undergone a major transformation in recent years. Over 1972-92 (the most recent period of rapid consolidation for which data were available at the time this study began), the number of plants in eight important food industries—meatpacking, meat processing, cheese products, fluid milk, flour milling, corn milling, feed, and soybean processing—declined by about one-third and the number of workers declined by more than 100,000 (20 percent). Of the nine industries studied, only one—poultry slaughtering and processing—added workers, and that was due mainly to a shift from producing primarily whole birds to a variety of processed products like deboned poultry parts, poultry hot dogs, and turkey hams.

What Did the Project Find?

Economists generally believe that changes in technology and demand contribute to structural change. A new report by ERS, *Structural Change in the Meat, Poultry, Dairy, and Grain Processing Industries*, suggests that technology played the dominant role in the food processing industries. The nine food industries examined lost about 30 percent of their plants over 1972-92, while the average total value of shipments per plant rose by one-third to about $43 million in inflation-adjusted prices.

The drop in the number of plants, sharp rise in plant size, and a leveling or decline in the per capita consumption of red meat, fluid milk, and flour products led to a 50-percent increase in average four-firm concentration levels—to about 46 percent for all nine industries. Two industries—corn milling and soybean processing—had four-firm concentration ratios exceeding 70 percent, and two other industries—meatpacking and poultry slaughter and processing—had 50-percent increases in four-firm concentration ratios by 1992.

New plants have continued to enter food industries, but their survival rates are not encouraging. Half of all new plant entrants from 1972 to 1987 failed within 5 years, and two-thirds exited within 10 years. New plant entrants were typically about one-half the average industry plant size and about two-thirds the industry average size after 10 years, suggesting that entrants underestimate the size needed to compete in food manufacturing and must grow rapidly to attain a sufficient scale.

Labor productivity advanced substantially. Real output (measured by weight) per employee rose by an average of 78 percent over 1972-92 without accounting for quality changes (meat and poultry plants, for example, produced a greater mix of higher value products by 1992). Data for all nine industries also show that employment leveled off. But these data mask industry-level changes: the number of workers declined by about one-fourth in meatpacking and by about one-half in fluid milk, but rose more than 150 percent in poultry slaughter and processing.

This contraction in plants and workers decreased wages, especially for meatpacking and meat processing employees whose wages dropped by about one-third. Workers in other industries realized little change in real wages. Overall, average worker compensation, deflated by the consumer price index, fell 25 percent. This drop in wages, combined with the gain in output per worker, means that labor costs per unit of output dropped dramatically. Although the associated cost reductions were likely passed along to consumers in the form of lower prices, the price impact was probably small because labor costs are only a small part of the cost of food processing.

The type of plant that exits and the composition of the plants that remain in an industry are of vital interest to entrepreneurs assessing the viability of starting a plant and regulators seeking to understand industry dynamics. About 50 percent of all plants that existed in 1972 and exited within 10 years had only about a 25-percent share of the market in 1972. In other words, they were small in 1972 and subsequently failed. By contrast, the 18 percent of the 1972 plants that exited over the subsequent 10-year period (1982-92) were more than twice as large in 1972 than the plants that exited earlier. A similar picture emerges for plants operating in 1992. Plant entrants over 1987-92 accounted for about one-fourth of all plants, but only about 10 percent of all market share. By contrast, plants operating since 1972 numbered about 40 percent of all plants and controlled about 60 percent of the market in 1992.

How Was the Project Conducted?

This report investigates structural changes among meat and poultry, dairy, and grain milling/oilseed processors. Within these three major food groups, we consider nine industries—meatpacking, meat processing, poultry slaughter and processing, cheese, fluid milk, flour, feeds, wet corn milling, and soybean processing—because of their dramatic structural changes and their importance to farmers who look to them as an outlet for their products, consumers who view them as providers of final products, and manufacturers who regard them as source of ingredients for food products or animal feed. The industries produce commodity products in cost-driven industries that require little advertising or research expenditures. Since the technology is exogenous, our discussion closely adheres to the traditional paradigm of market structure.

Structural Change in Nine Meat, Poultry, Dairy, and Grain Processing Industries

Introduction

Structural change in food processing over 1972-92 led to greater worker productivity and likely helped control price increases, but it came at the cost of lost jobs and plant shutdowns.[1] Over 1972-92, the number of workers dropped by more than 100,000 (20 percent) and the number of plants declined by about one-third in eight food industries in the meat, dairy, and grain and oilseed processing sectors. One other industry, poultry slaughter and processing, realized a substantial increase in employment (120,000 workers). But even these added workers may not have increased U.S. employment as many of the added workers cut up poultry, eliminating the need to cut up poultry in grocery stores and at home.

[1] The 1972-92 period constitutes an important era for structural change in food industries. Thus, we focus on those years. Whenever necessary and possible, we have used more recent data.

Traditionally, economists such as Scherer (1980) have argued that structural changes as in these nine industries are determined by changes in demand and technology. All other things being equal, growth in demand leads to an increase in the number of operating firms, while a decline in demand leads to a contraction in the number of firms. Technological change, on the other hand, can either reduce or increase the number of firms. If technological change reduces production or administrative costs, then plant size likely would grow, the number of firms would drop, and the concentration ratio would rise. However, if technological change reduces barriers to entry, such as high transportation costs, then the number of firms that a market can profitably sustain may rise and concentration ratios drop since entrants have a lower threshold of output at which they can profitably produce.

Sutton (1991) recognized that fixed costs are sunk if they can be used for only one purpose and can be either exogenously or endogenously determined. Exogenous sunk costs include fixed investment for plant and equipment, while research and development and advertising are the most common types of endogenous sunk costs. Using this characterization, Sutton demonstrates that the number of firms that a market can sustain depends on—in addition to demand and technological change—whether fixed costs are exogenous or endogeneous, whether the product market is homogenous or differentiated, and the degree to which firms in an industry are willing to cut prices in order to maintain market share (price toughness). If fixed costs are exogenous and markets are homogeneous, then concentration ratios increase with price toughness and drop as the ratio of market size to exogenous costs rises. For exogenously determined fixed costs and differentiated product markets, on the other hand, the lower bound for the number of firms in the industry increases as the market size rises. This possibility is akin to the traditional Hotelling model of differentiated products.

Sutton also argues that since increases in sunk costs—such as advertising and research and development—lead to increases in market and firm size, an increase in sunk costs results in a rise in the lower bound of industry concentration. Similarly, he shows that greater demand responsiveness to sunk costs leads to a higher lower bound of the concentration level.

In this report, we investigate structural changes among meat and poultry, dairy, and grain milling/oilseed processors. Within these three major food groups, we consider nine industries: meatpacking, meat processing, poultry slaughter and processing, cheese, fluid milk, flour, feeds, wet corn milling, and soybean processing. We focus on these nine industries because of their dramatic structural changes and their importance to farmers who look to them as an outlet for their products, consumers who view them as providers of final products, and manufacturers who regard them as sources of ingredients for food products or animal feed.

We examine the nine industries in the context of changing technological and demand conditions from 1972 to 1992. The industries produce commodity products that are cost driven and require little advertising or research expenditures. Since the technology is exogenously given, our discussion closely adheres to the traditional paradigm of market structure. We begin by outlining some major changes in the demand for meat and poultry, dairy, and grain and oilseed products since 1972, and then provide evidence of a shift in plant technologies. We conclude that changes in technology played the dominant role in structural change.

Changes in Demand

Meat and Poultry

Meat and poultry consumption changed very little over 1972-92, rising incrementally from about 168 pounds per person in 1972 to about 175 pounds in 1992 on a retail boneless-equivalent basis (table 1).[2] This modest change in overall consumption obscures a dramatic shift in American food choices away from red meat toward poultry, providing a backdrop for changes occurring in the meat and poultry sector.

[2] Retail boneless is an estimate of meat consumption without bones included as part of the weight.

During the 1960s, large poultry slaughter plants adopted an integrated production system, enabling them to produce vast quantities of low-cost poultry products. At first, they produced mainly whole chickens, but beginning around 1967 chicken parts became more important. Cut-up parts provided consumers with convenience and allowed processors to garner higher profits by providing a higher valued product. Shortly thereafter, poultry plants began producing further processed products, such as packaged, sliced turkey breast; chicken hot dogs; and turkey bologna.

These marketing innovations and the adoption by poultry plants of an integrated production system provided consumers with low-cost, convenient alternatives to red meats. Refinements to the integrated production system and larger poultry plants filled with new high-speed processing equipment led to an increase in the relative price of a composite of choice beef to whole fryers on a per-pound basis from about 2 to 1 in 1963 to 5.8 to 1 in

Table 1—Per capita consumption and production of meat and poultry products, 1972-1992

Year	Per capita consumption			Production		
	Red meat[1]	Processed meat[2.3]	Poultry[1]	Red meat[1]	Processed meat[2.3]	Poultry[4]
	----------Pounds/person----------			*--------Billion pounds---------*		
1972	132.3	52.2	35.9	37.0	14.59	14.45
1975	125.8	54.3	33.4	36.8	15.87	13.85
1977	132.9	45.8	36.4	39.7	13.69	16.15
1980	127.1	49.1	41.3	39.0	15.07	19.32
1982	120.5	47.7	42.7	37.6	14.88	20.83
1985	125.4	52.3	45.9	39.4	16.45	23.48
1987	117.9	49.8	51.4	38.7	16.34	27.44
1990	112.7	n.a.	56.7	38.8	n.a.	31.60
1992	114.0	n.a.	61.3	41.2	n.a.	35.10

[1]Based on retail boneless equivalent and includes meat for processing.
[2] Per capita consumption not available so figures were estimated by multiplying red meat per capita consumption times the ratio of processed meat production to red meat production.
[3] Includes smoked, dried, or cooked pork; sausage; sliced packaged meat; meat used in convenience products; and miscellaneous processed meat products inspected by the Food Safety Inspection Service. Does not include meat processed in State-inspected meat processing plants. These plants generally account for about 5 percent of U.S. output. Output derived from meat coming from meatpacking plants.
[4] Ready-to-cook basis.
n.a. = Not available.
Source: USDA, *Statistical Handbook*; *Agricultural Statistics*, various issues.

1972. This ratio peaked at about 6.6 to 1 in 1987 and declined afterwards.[3] At the same time, concerns arose over reports of adverse health effects due to the overconsumption of red meats and other products high in saturated fats. The twin effects of lower relative prices and relative healthfulness led to a more than 70-percent increase in per capita poultry consumption over 1972-92 and a 15-percent decline in per capita red meat consumption (table 1).[4]

Increased U.S. poultry consumption resulted in a problem for poultry firms: U.S. consumers preferred breasts and white meat to dark meat, yet chickens and turkeys still had two feet, two legs, and two thighs. Recognizing that Asian countries would pay higher prices for some chicken parts, such as chicken feet, and that consumers in many countries preferred dark to white meat, U.S. poultry plants dramatically increased exports. The combined pull of higher prices for some products in overseas markets and a low-cost production system that relied on vast economies of scale led to a sharp increase in poultry exports from less than 150 million pounds in 1972 to about 4.6 billion pounds by 1999 (Ollinger et al., 2000). Combined, these exports and rising domestic consumption led a 150-percent increase in live-weight poultry production over 1972-92.

The story was much different for red meats. Saddled with higher production costs per pound of output and a dearth of new, convenient products, U.S. red meat consumption stagnated. Beef consumption bore most of the brunt,

[3] Composite beef basis is a measure in which all types of products are considered on a weighted basis. For example, if consumers eat hamburger one-fourth of the time, then hamburger accounts for one-fourth of consumption.
[4] Live weight is used for poultry and includes the weight of the entire carcass. Carcass weight includes the weight of the all bones but excludes the hide.

dropping from 85.1 retail pounds per person in 1972 to about 66 pounds per person in 1992, where it remained through the 1990s. Meanwhile, pork consumption barely changed from around 52 pounds per person over 1971-95 (MacDonald et al., 2000). Since exports scarcely changed for both beef and pork, growth could only come from population growth, permitting red meat production by carcass weight to rise by only 10 percent (table 1).

Even though per capita red meat consumption dropped, further processed meat products rose by about 10 percent per person. This increase, coupled with population growth, led to a 40-percent increase in processed meat production. Sausages and convenience food products posted substantial increases, while production of smoked and cured products, such as smoked hams and bacon, barely changed.

Milk and Cheese

The middle to late 1940s marked a watershed in milk production and marketing (Manchester and Blayney, 1997). Before this time, farmers separated about one-third of their milk production into skim milk and cream, selling the cream to consumers and retaining the skim milk for onfarm use. During the war, the value of the nonfat solids in milk increased substantially, creating incentives for processors to specialize on a product basis and encouraging farmers to sell whole milk. Milk quality also improved. Grade A milk production (suitable for fluid milk and dairy product processing) rose from about 58 percent of all milk production in 1945 to 95 percent in 1995. Grade B milk (the alternative to grade A) can only be used for manufacturing products.

After World War II, rising consumer affluence and technological changes affected product demand. Butter demand declined due to increased consumption of margarines and other substitutes, but the use of nonfat dry milk as an ingredient in food processing—and widespread adoption of modern refrigerators in homes and supermarkets—spurred growth in demand for ice cream and other frozen products. Since 1975, per capita consumption of milk and most dairy products has declined. Only cheese and dry dairy products like dried milk have had sustained growth (table 2).

Most of the decline in per capita milk consumption is due to a 50-percent decline in consumption of whole milk. Higher consumption of lower fat milk and skim milk—both flavored and unflavored—offset some but not all the decline (table 3). Since exports and imports account for very little U.S. dairy production (about 2 percent of production each) and per capita consumption dropped, aggregate demand for fluid milk remained stable as population growth offset dropping per capita consumption.

American and other-than-American natural cheese consumption were the only segments of the U.S. dairy sector to have maintained vigorous growth, nearly doubling in per capita consumption (table 2). This, combined with population growth, led to a fourfold increase in cheese production (table 4). American cheese varieties, such as Cheddar, Colby, and Jack cheeses, dominated production until 1988 when other-than-American natural cheeses—such as Mozzarella, Provolone, and other Italian and non-Italian

Table 2—Per capita consumption of dairy products, 1975-2002

Year	Fluid milk/ cream	Butter/ cottage cheese	American cheese	Other aged cheese	Frozen dairy[1]	Evaporated/ condensed milk[2]	Dry products[3]	All products[4]
				Pounds per person				
1975	261	9.4	8.4	6.1	28.7	8.9	3.8	539
1978	254	9.1	9.6	7.4	27.3	7.6	6.0	544
1981	242	8.5	10.2	8.0	26.3	7.3	5.4	541
1984	238	9.0	11.9	9.6	27.1	7.4	6.3	582
1987	237	8.6	12.4	11.7	28.1	7.9	6.8	601
1990	233	7.8	11.1	13.5	28.5	8.0	7.4	568
1993	224	7.5	11.3	14.7	29.2	8.1	6.8	569
1996	220	6.9	11.8	15.5	28.2	6.3	7.6	566
1999	213	7.3	12.6	16.4	28.6	6.5	6.6	585
2002	206	7.0	12.9	17.7	26.6	6.0	7.0	584

[1] Includes regular and reduced-fat ice cream, sherbet, and other frozen products.
[2] Includes canned whole, bulk whole, and bulk and canned skim.
[3] Includes dry buttermilk, whey, and whole and skim milk.
[4] Fluid-milk equivalent.
Source: National Agricultural Statistical Service.

Table 3—Fluid milk sales by product, 1975-2002

Year	Whole milk	Lower fat milk	Skim milk	Flavored whole milk	Other flavored milk	Buttermilk	Total milk
				Million pounds			
1975	36,188	11,468	2,480	1,366	719	1,011	53,232
1977	34,036	13,426	2,617	1,446	1,062	1,007	53,594
1980	31,253	15,918	2,636	1,075	1,197	927	53,006
1982	29,350	17,038	2,449	710	1,283	950	51,780
1985	27,760	19,812	3,009	882	1,430	1,046	53,939
1987	25,644	21,390	3,406	830	1,608	1,040	53,918
1990	21,233	24,509	5,702	691	1,657	879	54,771
1992	20,196	25,225	6,357	689	1,745	808	55,020
1995	18,662	24,202	8,359	704	1,914	739	54,580
1997	18,413	23,709	9,139	676	2,154	691	54,782
1999	18,467	23,571	8,985	877	2,339	668	54,907
2002	17,960	23,610	8,030	1,030	3,010	576	54,216

Source: National Agricultural Statistical Service.

cheeses—overtook them, partly due to their use in pizza and other prepared foods. U.S. exports and imports of American cheeses are quite small, but imports of other-than-American natural cheese approach 10 percent of domestic production.

Flour, Feed, and Oilseeds

Demand for flour, feeds, wet-milled corn products, and processed soybeans has taken a somewhat different path since 1972. Per capita consumption of wheat flour rose from about 110 to 140 pounds from 1972 to 1992, lifting domestic production to nearly 800 million bushels of wheat (table 5). Meanwhile, output of wet-milled corn products more than doubled, crushed

Table 4—Production and imports of American and other-than-American cheese, 1972-2002

	American natural cheese			Other-than-American natural cheese		
Year	Production[1]	Imports	Total[2]	Production[1]	Imports	Total[2]
			Million pounds			
1972	1,652	15	1,667	952	164	1,116
1975	1,660	16	1,676	1,152	163	1,315
1977	2,047	16	2,063	1,311	194	1,505
1980	2,381	18	2,399	1,603	213	1,816
1982	2,759	18	2,777	1,782	251	2,033
1985	2,855	20	2,875	2,226	283	2,609
1987	2,717	15	2,732	2,628	250	2,878
1990	2,894	21	2,915	3,167	277	3,444
1992	2,937	18	2,955	3,552	267	3,819
1995	3,131	20	3,151	3,786	317	4,103
1997	3,286	25	3,311	4,044	285	4,329
1999	3,533	65	3,598	4,361	364	4,725
2002	3,709	84	3,793	4,890	388	5,378

[1].U.S. exports not included in production figures and generally amount to about 1 percent of production for U.S. consumption and in no year exceed 2 percent of U.S. consumption.
Source: National Agricultural Statistical Service.

soybeans nearly doubled, and commercial feeds rose by about 25 percent (table 5). Wet milled corn products consist of high-fructose corn syrup and other sweeteners, alcoholic products not generally used for human consumption, and other products. Feeds consist of oilseed meal, of which 90 percent by weight is soybean meal, animal proteins, and grain mill products.

The case of soybean crushings is particularly important to agriculture. Processed meal (about 60 percent of the value of processed soybeans) is an important input to feeds and a major export. Soybean oil accounts for the remaining 40 percent of the value and has many uses other than as cooking oil.

About 60 percent of the U.S. soybean supply was crushed domestically and 35 percent was exported over 1998-2002 (World Agricultural Supply and Demand Estimates, USDA). Smaller proportions of soybean meal (20 percent) and oil (10 percent) were exported because many importing countries prefer to crush the beans in order to develop their own industries. Trade in soybeans and soybean products has expanded significantly in recent years. U.S. crushings rose from about 1.1 to 1.7 billion bushels and soybean exports jumped from about 500 million to over 1 billion bushels from 1988 to 2002. To meet greater demand, the U.S. soybean industry increased its crushing capacity 58 percent between 1980 and 2002, to 1.6 billion bushels per year.

In 2002/03, the U.S. share of global sales of soybeans, soybean oil, and soybean meal amounted to 40 percent, 11 percent, and 13 percent. Although U.S. soybean exports have risen substantially over the past 15 years and soybean product exports have been relatively stable, the emergence of South America as a major producer reduced the U.S. global share of production to about 40 percent in 2002 from about 50 percent in 1990.

Table 5—U.S. production of wheat flour, wet-milled corn products, crushed soybeans, and feed, 1972-92

Year	Wheat flour	Wet-milled corn products	Soybean crushings	Feed		
				Oilseed cake and meal[2]	Animal protein and mill products	Total feed
	Million bushels			*Million tons*		
1972	504	na	711	14.7	12.8	27.5
1975	552	328	877	17.4	16.0	33.4
1977	565	384	946	18.6	15.3	33.9
1980	588	503	1,014	19.9	12.9	32.8
1982	593	660	1,120	21.6	14.6	36.2
1985	637	853	1,056	21.2	15.3	36.5
1987	699	913	1,175	23.6	15.7	39.3
1990	747	998	1,194	25.1	13.3	38.4
1992	790	1,097	1,276	26.2	14.1	40.3

[1] Wet-milled corn products include high-fructose corn syrup, glucose and dextrose, starch, and wet-milled alcohol.
[2] Soybean meal comprises about 90 percent of oilseed cake and meal.
[3] Animal protein comprises about 20-25 percent and mill products the remainder.
na = not available
Sources: Various *Situation and Outlooks* for feed and wet-milled corn products; USDA statistics for other data.

Consolidation and Structural Changes

Changes in demand for meat and poultry, dairy, and grain and oilseed products, combined with technological change, have transformed food industry structures over 1972-92. Below, we outline those changes among meat and poultry, dairy products, and grain milling and oilseed processors.

Companion reports examine the efficiency of one of the most controversial aspects of restructuring—mergers and acquisitions—and their impact on plant closures, employment, and wages.

Meat and Poultry Sector

Beef and pork have been important staples of the American diet since the Nation's founding. Poultry became a major component after World War II when entrepreneurs began to grow chickens on specialized farms and process them in highly automated factories.

The long history of the meatpacking and meat processing industries is matched by a long history of labor strife, accusations of anticompetitive behavior, and regulatory restrictions. Beginning in 1920, a consent agreement between the five largest meatpackers—Armour, Morris, Wilson Foods, John Morrel, and Swift and Co.—and the U.S. Government prevented the largest companies from owning public stockyards, stockyard railroads, market newspapers, and cold storage facilities. The agreement also denied the "Big Five" rights to engage in retail sales or use of their distribution channels for purposes other than distributing their own meat and dairy products.

The importance of the consent decree diminished after World War II as reductions in transportation costs shifted the locus of meatpacking operations away from terminal livestock markets to plants nearer livestock

production. In this economic environment, new independent firms—such as Iowa Beef Processors (IBP), Spencer Beef, and Monfort of Colorado—grew rapidly by building new plants and acquiring others. As a result, the four-firm concentration ratio fell into the 20-percent range and the long-term demise of many smaller and some larger high-cost or poorly located slaughter facilities began to take place.

As documented by MacDonald et al. (2000), decreased per capita consumption of meat products during the 1980s meant that growth in sales volume could occur only if one firm took market share from another. For firms competing in markets for semi-processed goods, such as meat packers and processors, this meant that plants had to compete on selling prices, putting pressure on their own wage and operating costs. This encouraged firms to employ larger plants with more sophisticated equipment designed to handle much greater throughput, but requiring nonstop production. In the process, highly competitive meatpacking and processing industries emerged.

Previously, small meatpacking and processing plants competed against larger firms by paying sharply lower wages to their largely nonunion workforce. In the new environment, large new competitors paying nonunion wages that were willing to shift production to lower cost regions in the Western Plains States rapidly took market share from large entrenched rivals and drove many large and small slaughter plants out of business. The net result was a complete displacement of the largest meatpacking and processing plants. By 1981, the firm that had long dominated the meatpacking business—Swift & Co.—was displaced by IBP as the leading seller. Still, Swift & Co., along with Wilson Foods and John Morrell, remained among the top five firms (table 6). However, pressure on the old-line processors to reduce costs remained intense. Wilson, for example, filed for Chapter 11 bankruptcy in 1983, voided its labor agreements, and reopened with a new, lower base wage.

During the 1980s, general conglomerates, such as Greyhound and Occidental, which entered the business during the 1970s by purchasing Armour and IBP, respectively, sold out. Many of the large slaughter plants owned by the old big five were also closed or sold to new meatpackers, such as IBP, and mainline agribusinesses. ConAgra, for example, bought Monfort. Cargill bought the operations of MBPXL and Spencer Beef, renaming them EXCEL. These firms and Tyson, which recently acquired IBP, are now among the top firms in meatpacking.

Some old-line firms have remained in the meat business, but gave up slaughtering in order to concentrate on value-added and brand-name processed products with higher returns. New firms, on the other hand, concentrated on low-cost semi-processed products such as carcasses and boxed beef and pork. In many cases, they employed nonunion workers or forced a reduction in negotiated contracts through hard bargaining.

The old-line meat packers were not the only losers in the turmoil of the 1980s. Production workers experienced a significant decline in relative wages, with average rates dropping by about one-third, in constant dollar terms, from 1972 to 1992. Wages in other agricultural processing industries, on the other hand, remained steady (table 7). During the 1980s, the

Table 6—Top 10 meat and poultry companies by net sales, 1982-2001

Rank	1982	1991	2001
1	Iowa Beef Processors, Inc	ConAgra, Inc.	Tyson Foods, Inc.
2	Armour & Co.	IBP, Inc	ConAgra Foods
3	Swift & Co.	Excel / Cargill	Excel Corp. / Cargill
4	Wilson Foods	Tyson Foods, Inc.	Smithfield Foods, Inc.
5	John Morrell & Co.	Sara Lee Packaged Meats	Farmland
6	Swift Indep. Packing Co.	Geo. A Hormel & Co.	Sara Lee Packaged Meats
7	Oscar Mayer & Co.	Oscar Mayer Foods Corp.	Hormel Foods Corp.
8	MBPXL Corp.	John Morrell & Co./ Chiquita Brands Int.	Oscar Mayer
9	Geo. A Hormel & Co.	Beef America Operating Co. Inc.	Perdue Farms, Inc.
10	Land O'Lakes	International Multifoods	Pilgrim's Pride Corp.

Source: Meat & Poultry Magazine, July 1991 and 2002.

number of meatpacking plants dropped by 40 percent to about 1,400 in 1987. Meanwhile, technological changes led to a doubling in plant size and a 45-percent increase in output per worker (table 8).

The poultry side of the industry was also consolidating. Poultry leader Holly Farms was one of many acquisitions by Tyson Foods which increased its sales by a factor of 10 during the 1980s. Today, Tyson and ConAgra, another company with beef and pork operations, are also among the top four poultry firms. Tyson is the largest beef packer, second largest pork packer, and largest poultry firm.

The twin effects of contracting demand and technological change contributed to a doubling of the four-firm concentration ratio to 57 percent in meatpacking by 1997 (table 9). Four-firm concentration ratios are much higher in individual markets. MacDonald et al. (2000) report that four-firm concentration ratios for steer and heifer, boxed beef, and all cattle slaughter were 80 percent, 83 percent, and 70 percent in 1999. The four-firm concentration ratios for hogs and sheep/lambs were 54 percent and 62 percent.[5]

Meat processing did not suffer the same kind of plant losses, probably because per capita consumption of further processed meat held steady and the more specialized nature of producing these products did not readily lend itself to the low-cost production methods used in the meatpacking industry. As a consequence, the number of plants remained at around 1,300 throughout 1972-92, even though average plant size increased by about 20 percent. Labor productivity (table 8) barely changed, perhaps because of minimal changes in technology. With little push from either changes in product demand or technology, four-firm concentration ratios barely budged above 20 percent.

The poultry industry prospered at the expense of the red meat sector over 1972-92, as increases in per capita poultry consumption and poultry exports provided the means for industry growth. Although the number of plants declined by about 75, to 575 (table 8), the number of employees rose by more than 150 percent (table 7) and plant output nearly tripled (table 8).

[5] Census figures are on a value-of-shipments basis, meaning that plants that slaughter animals and convert them to a higher value product, such as boxed meat, would be weighed heavier than a strictly slaughter plant. Additionally, the census does not differentiate among types of cattle, e.g., cows/bulls versus steers/heifers, even though they have different uses. MacDonald et al. (2000) used Grain Inspection, Packers and Stockyards Administration (GIPSA) data, which are animal based and, thus, more accurate.

Table 7—Number of workers and their real compensation in nine food industries over 1972-92

Industry	1972	1977	1982	1987	1992
			1,000 employees		
Number of workers:					
Meatpacking	157.5	146.2	134.4	113.9	121.2
Meat processing	58.1	65.0	65.5	78.7	85.4
Poultry slaughter/ processing	77.6	86.8	104.0	148.0	193.8
Cheese products	25.2	26.7	29.6	33.0	34.5
Fluid milk	126.1	93.5	78.0	72.4	63.4
Flour milling	16.1	15.6	15.1	13.3	13.1
Feed	44.0	39.1	37.5	34.5	24.7
Wet corn milling	12.1	10.9	9.5	8.6	9.3
Soybean processing	9.1	9.4	8.9	7.0	7.4
Total workers	525.8	493.2	482.5	509.4	552.8
			$1,000 per worker in 1992 prices		
Real compensation per worker:					
Meatpacking	32.7	33.4	27.7	23.6	20.1
Meat processing	31.3	31.8	26.9	25.4	23.7
Poultry slaughter/ processing	17.0	16.2	15.2	16.1	16.0
Cheese products	24.9	24.8	23.2	24.7	24.0
Fluid milk	29.0	30.2	27.5	28.8	29.0
Flour milling	32.0	32.9	31.2	33.1	31.2
Feed	23.7	27.6	24.1	25.9	24.7
Wet corn milling	38.4	40.6	39.2	43.2	39.9
Soybean processing	30.7	32.2	30.9	30.5	30.4
Average compensation	28.6	28.8	24.7	23.3	21.5
Consumer Price Index	3.37	2.32	1.46	1.24	1.00

Source: Economic Research Service estimates based on data from the Bureau of the Census.

Over 1972-92, poultry plants introduced numerous labor saving devices and dramatically improved labor productivity (Ollinger et al., 2000). Yet, pounds of poultry per employee (panel 3 of table 8) remained flat, as higher labor productivity in poultry slaughter was offset by an increase in the number of workers engaged in poultry cut-up and further processing (Ollinger et al., 2000).

Although four-firm concentration ratios rose in meatpacking and poultry slaughter and processing over 1972-92 (table 9), vertical and horizontal linkages among the three main industries have been weak and backward vertical relationships to input suppliers limited. Table 10 illustrates some of these linkages. The first row of the top panel shows that meatpacking firms (defined as a firm that owns at least one meatpacking plant) were very modestly forward integrated into further processing (owners of the 2,077 meatpacking plants owned only 74 meat processing plants in 1982) and backward integrated into feed (meat firms owned 108 plants).

Table 8—Number of plants, mean size, and productivity in nine food industries, 1972-92

Industry	1972	1977	1982	1987	1992
Number of plants:					
Meatpacking	2,474	2,590	1,780	1,434	1,405
Meat processing	1,311	1,345	1,311	1,343	1,260
Poultry slaughter/processing	646	594	530	464	575
Cheese products	873	791	704	604	573
Fluid milk	2,507	1,924	1,190	946	779
Flour milling	457	407	360	358	371
Feed	2,120	2,063	1,827	1,738	1,673
Wet-corn milling	41	39	42	60	58
Soybeans	94	121	114	106	99
Total	10,523	9,874	7,858	7,053	6,822
Output per plant:					
Meatpacking (million pounds, carcass weight)	15.0	15.3	21.1	27.0	29.3
Meat processing (million pounds)[1]	9.9	10.2	11.4	12.2	n.a.
Poultry slaughter/processing (million pounds, live weight basis)	22.4	27.2	39.3	59.1	61.0
Cheese products (million pounds)	3.0	4.2	6.5	8.8	11.3
Fluid milk (million fluid pounds)	n.a.	27.9	43.5	57.0	70.6
Flour milling (million bushels of wheat)	1.1	1.4	1.6	2.0	2.1
Feed (1,000 tons feed)	13.0	16.2	19.8	22.6	24.1
Wet corn milling (million bushels)	n.a.	9.8	15.7	15.2	18.9
Soybeans (million bushels)	7.6	7.8	9.8	11.1	12.9
Labor productivity in annual output per employee:					
Meatpacking (1,000 pounds, carcass weight)	235	272	277	340	340
Meat processing (1,000 pounds)[1]	223	211	227	208	n.a.
Poultry slaughter/processing (1,000 pounds, live weight)	186	186	200	185	181
Cheese products (1,000 pounds)	103	126	153	162	188
Fluid milk (1,000 fluid pounds)	n.a.	573	664	745	868
Flour milling (1,000 bushelst)	31.3	36.2	39.3	52.6	60.3
Feed (tons)	625	867	965	1,139	1,632
Wet-corn milling (1,000 bushels)	n.a.	35.2	69.5	106	118
Soybeans (million bushels)	78	101	126	168	172

[1] Includes smoked, dried, or cooked pork; sausage; sliced packaged meat; meat used in convenience products; and miscellaneous processed meat products inspected by the Food Safety Inspection Service. Does not include meat processed in State-inspected meat processing plants. These plants generally account for about 5 percent of U.S. output. Output derived from meat coming from meatpacking plants (in *Agricultural Statistics*, various issues).
Sources: Economic Research Service estimates based on U.S. Census data and National Agricultural Statistical Service.

Table 9—Four-firm concentration ratios in nine food industries, 1972-97

	1972	1977	1982	1987	1992	1997
Meatpacking	26.0	21.0	29.0	39.0	50.0.	57.0
Meat processing	16.0	18.0	19.0	20.0	25.0	20.4
Poultry slaughter/ processing	17.0	17.0	22.0	29.0	34.0	40.6
Cheese products	40.0	38.0	34.0	41.0	42.0	52.4
Fluid milk	17.0	17.0	16.0	21.0	22.0	21.3
Flour milling	32.0	33.0	40.0	44.0	56.0	48.4
Feed	22.0	21.0	20.0	19.0	23.0	23.7
Wet-corn milling	63.0	61.0	74.0	74.0	73.0	71.7
Soybean processing	52.0	50.0	61.0	71.0	71.0	79.6
Mean industry concentration	31.7	30.7	35.0	39.8	44.0	46.1

Source: U.S. Bureau of the Census reports on concentration ratios in manufacturing.

Table 10—Plants owned by meat and poultry firms over 1977-82 and 1982-87[1]

	Industry of plants owned by meat and poultry firms					
Industry of firm	Meatpacking	Meat processing	Poultry slaughter/	Feed	Other food and nonfood	Total
			Number of plants			
1977-82:						
Meatpacking	2,077	74	23	108	695	2,977
Meat processing	68	1,146	7	6	577	1,804
Poultry slaughter/ processing	23	22	516	154	557	1,272
1982-87:						
Meatpacking	1,371	58	32	79	327	1,867
Meat processing	66	1,163	59	122	668	2,078
Poultry slaughter/ processing	38	40	442	158	529	1,207

[1] Data do not include plants that had no financial or employment information.
Source: Economic Research Service estimates based on U.S. Census data.

A different picture emerges for poultry slaughter and processing. Firms in this industry owned more than 150 feed plants in the 1977-82 and 1982-87 census periods. This amounts to about a third of poultry slaughter and processing plants. (Ollinger et al. (2000) explain the efficiency reasons for backward integration into feeds for poultry suppliers.)

Firms owning poultry plants were also the most broadly diversified of the meat and poultry firms, owning about twice as many plants outside of poultry slaughter and processing than in it over 1982-87. Owners of meatpacking plants and meat processors, by contrast, owned less than 50 percent more plants outside of meatpacking than in it.

Table 11—Number of plant exits and their market share by census year for plants existing in 1972[1]

Industry	Initial count 1972	1977	1982	1987	1992	Cumulative
			Number of plants			
Number of plant exits:						
Meatpacking	2,374	880	764	243	152	2,039
Meat processing	1,312	465	254	170	96	985
Poultry slaughter/ processing	646	204	103	69	41	417
Cheese products	873	293	187	97	87	664
Fluid milk	2,503	913	635	280	163	1,991
Flour milling	457	155	70	45	24	294
Feed	2,121	735	402	236	153	1,526
Oilseeds[2]	187	38	39	19	17	113
Total	10,473	3,683	2,454	1,159	733	8,029
Mean share of initial count (percent)		35.2	23.4	11.1	7.0	76.7
			Percent			
Market share of closed plants:						
Meatpacking		10.3	20.3	19.9	6.6	57.1
Meat processing		18.0	17.3	15.5	12.1	62.9
Poultry slaughter/processing		13.9	8.5	10.0	5.0	37.4
Cheese products		13.9	7.4	9.9	10.6	41.8
Fluid milk		17.2	15.8	13.0	11.0	57.0
Flour milling		7.4	5.2	6.9	3.3	22.8
Feed		15.9	11.1	13.0	8.5	48.5
Oilseeds[2]		2.9	2.8	5.1	11.4	22.2
Mean share loss		12.4	11.1	13.3	8.6	45.4

[1] Number of plants initial count may be less than in previous tables because plants with no reported financial data were dropped.
[2] Oilseeds include wet-corn milling, cottonseed, and soybean plants combined to avoid disclosures. Cottonseed industry not considered earlier because of its limited size.
Source: Economic Research Service estimates based on Census data.

Although the meat and poultry sector consolidated over 1972-92, the meatpacking, meat processing, and poultry slaughter/processing industries remained vibrant industries. The top panels of table 11 trace plant closures for plants existing in 1972 (first column) over the subsequent 20 years (next 4 columns) and the bottom panel tracks their associated market shares. By 1992, each industry lost at least 60 percent of the plants that existed in 1972. Overall, about 75 percent of all plants that existed in 1972 were gone by 1992. About one-third of the plants in the meatpacking, meat processing, and poultry industries departed by 1977, even though the number of meatpackers and meat processors rose and the number of poultry plants dropped modestly (table 7). Since plants exiting by 1977 had only about a 12-percent market share, they were on average quite small. Plants that exited later were slightly larger. Since relatively large plants started departing after 10 years, it may be that large plant technology started to become obsolete after about 10 years (small plant technology either could not compete or became obsolete after only 5 years).

Table 12—Year of entry of all 1992 plants and their 1992 market share[1]

Item	All plants 1992	Year of entry 1972[3]	1977	1982	1987	1992
			Number			
Number of plant entrants:						
Meatpacking	1,470	380	147	195	202	546
Meat processing	1,169	356	136	149	204	324
Poultry slaughter/ processing	575	229	40	38	51	217
Cheese products	542	204	65	58	87	128
Fluid milk	779	514	59	43	69	94
Flour milling	371	166	30	36	50	89
Feed	1,673	609	196	196	226	446
Oilseeds[2]	119	68	7	10	8	26
Total	6,698	2,526	680	725	897	1,870
Mean share of final count (percent)		37.7	10.2	10.8	13.4	27.9
			Percent			
Market share of new plants:						
Meatpacking		54.2	15.3	10.9	8.5	11.1
Meat processing		37.1	18.3	9.6	18.0	17.0
Poultry slaughter/processing		64.0	6.4	4.6	8.7	16.3
Cheese products		62.5	8.0	5.5	10.2	13.8
Fluid milk		78.0	5.0	6.5	5.4	5.1
Flour milling		73.2	6.4	4.2	7.3	8.9
Feed		52.0	10.4	9.9	11.2	16.5
Oilseeds[2]		72.9	10.6	5.6	8.0	2.9
Mean market share		61.7	10.1	7.1	9.7	11.4

[1] Number of plants in initial count may be less than in previous tables because plants with no reported financial data were dropped.
[2] Oilseeds include wet corn milling, cottonseed, and soybean plants combined to avoid disclosures. Cottonseed industry not considered earlier because of its limited size.
[3] Third column of first panel has plants entering in 1972 and earlier; third column of second panel has market share of 1972 plants.
Source: Economic Research Service estimates based on U.S. Census data.

New plants are a source of vitality in an industry and, even in consolidating industries, there will be some entrepreneurs that see profitable opportunities. Plant entry can come about through plant construction/startup or diversification from another line of business. New plants account for a sizeable share of all plants in each industry.

Table 12 traces the years of entry and the associated 1992 market share of all plants that existed in 1992 over the previous 20 years. Overall, new plants comprised about 28 percent of the plants that existed in 1992. New meatpacking and poultry plants accounted for more than one-third of plants in their industries. However, they were smaller than average, having only 11 and 16 percent of their industries' market shares. In meat processing, entrants comprised about one-fourth of the 1992 plants and had 17 percent of all output. Plants that existed in 1972 and remained in 1992 accounted for 25 to 40 percent of the 1992 plants (table 12) and controlled 37-64

Table 13—Number of plant entrants and their survival rate over 1972-92[1]

Entry year	1977	1982	1987	1992
		Plant counts		
Number of plant entrants:				
1972 plants existing in 1977	6,809	4,428	3,369	2,521
1977 entrants	2,994	1,440	934	685
1982 entrants	-	2006	1088	725
1987 entrants	-	-	1,634	897
1992 entrants	-	-	-	1,870
Total	9,803	7,874	7,045	6,698
		Percent exiting		
Share of entry plants exiting after 5 or more years:				
1972 existing in 1977	-	35	51	63
1977 entrants	-	52	69	77
1982 entrants	-	-	46	64
1987 entrants	-	-	-	45
		$ million (nominal)		
Value of shipments per plant:				
1977 entrants	6.5	15.1	27.9	45.3
1982 entrants	-	7.2	16.3	30.8
1987 entrants	-	-	16.3	33.3
1992 entrants	-	-	-	24.1
Industry mean value of shipments per plant:	14.8	21.3	30.7	41.6
Total value of shipments	89,160	125,580	140,860	171,990
		Percent		
Entry plant value of shipments per plant as a share of industry mean shipments:				
1977 entrants	44	71	91	109
1982 entrants	-	34	53	74
1987 entrants	-	-	53	80
1992 entrants	-	-	-	58

[1] Includes meatpacking, meat processing, poultry slaughter, fluid milk, cheese, flour milling, feeds, and the combined industry of soybeans, wet-corn milling, and cottonseed.
Source: Economic Research Service estimates based on Census data.

percent of industry production, indicating that old plants are larger than average.

Tables 11 and 12 indicate that there are a large number of entrants, and these plants tend to be much smaller than existing plants. Table 13 describes the lifespan and size of plants entering the meat, dairy, and grain milling/oilseed industries over 1972-92.[6] The initial entry in the top panel gives the number of entrants over the previous 5-year Census period. For example, the second row of the top panel shows the number of plants that entered between 1972 and 1977 (the first row of the top panel gives the number of non-entrants, or incumbents). The market share, average value of shipments per plant (plant size), and the plant size of entrants relative to incumbents are given in subsequent panels.

[6] We do not provide exit rates and entry plant sizes for the individual industries because of space requirements. The information is available from the authors. The trends, in general, are consistent across all industries.

Over half of the 1972-77 entry plants (table 13, second column, second row of panel 1) went out of business by 1982, 69 percent were gone by 1987, and 77 percent exited by 1992. Exit rates were somewhat lower for other years of entry. For the meat and poultry sector alone (not shown), about 60 percent of the 1972-77 meatpacking entrants failed by 1982, while a little less than 50 percent of the meat processing and poultry plants exited by 1982. Trends were similar to those shown in table 13 for other years of entry, with meatpackers suffering higher exit rates and meat processing and poultry plants somewhat lower rates.

Plants entering the industry over 1972-77 were less than half the industry average plant size (table 13, first column, top row in panel four) but, by 1992, the cohort of 1977 plants exceeded the industry average size. This pattern of very small entry plant size and growth in subsequent periods also holds for the 1982 and 1987 plants. The only exception to these trends for meat and poultry was that meat processing plants entered their industry at about two-thirds the industry mean plant size and, perhaps for that reason, had lower new plant exit rates than other industries. Together, these data suggest that entry plants both had higher exit rates and were smaller than incumbent plants, further suggesting that size plays an important role in plant survival.

Growth in poultry sector employment more than compensated for a decline in meatpacking jobs. Overall employment in the nine industries jumped by about one-third over 1972-92 (table 7, panel 1). This increase obscures important industry dynamics, however, as meatpackers cut employment by about 25 percent while poultry slaughter/processing jobs more than doubled and meat processing employment rose by about 50 percent. One might think that compensation would drop in industries under pressure to consolidate and increase in faster growing industries. However, this was not entirely the case. Meatpacking and meat processing compensation rates did drop—by about 33 percent—but poultry slaughter and processing compensation barely changed (table 7, panel 2). MacDonald et al. (2000) attribute the decline in meatpacker (and perhaps meat processor) compensation to a precipitous decline in the wages paid to workers employed by the largest meatpackers and processors. Meanwhile, poultry plants added low-skill workers to cut-up operations that converted whole-bird carcasses into parts and further processed products.

Dairy Sector

Milk and manufactured dairy products, especially cheese, have been staples of the American diet for most of the 20th century. Although still important, their position in food consumption has undergone changes that have had ramifications for their industries. In fluid milk, a gloomy demand picture and technological change leading to larger processing plants has forced a major consolidation. The average plant size more than doubled from 1972 to 1992, and the number of plants dropped by about 70 percent (table 8).

None of the three major types of organizations engaged in fluid milk processing—dairy cooperatives, supermarket and convenience store chains, and large proprietary (investor-owned) dairy companies—escaped the

consolidation. Dairy cooperatives are a relatively small part of the fluid milk processing sector, but were quite popular during the 1930s. Cooperatives now control around 7 percent of the market.[7] According to Manchester (1984), several factors—including high pasteurization costs, technologically out-of-date plants, and a lack of management skills—led to the decline of fluid milk cooperatives.

Conditions during the 1960s and 70s encouraged retailers, especially supermarket and convenience/dairy store chains, to become processors of high-volume dairy products like whole and lower fat milks. Resale price controls, for example, created a particularly favorable situation because they established a guaranteed margin, while Federal regulatory rulings encouraged backward integration into milk processing. Additionally, cost savings accrued from labor relationships that allowed chain-store employees to deliver fluid products to loading docks rather than stocking individual containers in milk coolers. Finally, the chains' own stores offered a guaranteed outlet for packaged fluid products and an alternative growth opportunity.

The situation changed in the 1980s when the A&P, Kroger, and Safeway food chains disposed of their fluid milk plants and, in the case of A&P, exited fluid milk processing altogether. Several factors contributed to the reversal, including changing State resale price regulations, the need for major investments in plant upgrades, and the disappearance of labor contracts favoring integrated operations. During the 1980s, the share of fluid milk sales held by supermarket plants averaged about 15 percent, but had rebounded to about 20 percent by 2001.

The integrated convenience store and dairy store chains followed much the same pattern as the supermarket chains. Southland (known for its 7-Eleven chain) and other convenience stores and dairy chains invested in their own fluid milk processing operations as a way to cut costs. However, profits proved to be illusory. Southland and others sold their dairy processing operations in 1988, signaling the decline of the integrated convenience store/fluid milk organizational form. By 2001, the percentage of fluid milk sold by convenience stores from their own plants dropped to 23 percent after amounting to about 60 percent in the late 1970s.

The role of large proprietary companies in fluid milk processing is of particular interest. Many of the largest and most recognized fluid milk companies of the 1970s have been absorbed by other companies or have left the dairy industry (Manchester and Blayney, 1997). During the 1980s, Borden and Dean Foods, the two largest fluid milk processors, competed in product development and acquisition of strong regional brands, exploiting economies of scale in processing and distribution. In 1989, as Borden began its exit from the fluid business, Suiza Foods emerged as a major force by purchasing more than 20 fluid milk companies in the 1990s and increasing its sales to $4.5 billion by 1999. Meanwhile, Dean acquired 14 fluid milk companies in 1997 and 1998, resulting in sales of $3.8 billion in 1999.

As average plant size rose and labor productivity increased (table 8), the number of plants dropped by about 70 percent and employment declined by about 50 percent from 1972 to 1992. Productivity grew with the use of high-speed packaging equipment that benefited from the replacement of

[7] Today, only one cooperative, Prairie Farms, Inc., has a long history of success in fluid milk processing.

glass bottles with plastic. Plastic bottles could be handled with less care during filling and could be produced directly on the filling line, eliminating the need for many bottle handlers.

Despite the changes in productivity, four-firm concentration ratios remained low and real compensation barely changed (table 7). Market share for the four largest fluid milk processing firms was 21 percent in 1992, up from 17 percent in 1972 (table 9). Concentration may have recently risen much higher, however. A merger between the two largest proprietary fluid processing firms—Suiza, Inc. and Dean Foods—at the very end of 2001 created a firm accounting for 35 percent of the fluid milk processed. In the maneuvering to meet antitrust concerns, Dairy Farmers of America (DFA), the largest farmer-owned dairy cooperative in the United States, and other investors created a joint venture called National Dairy Holding Group L.P. This new company traded DFA's interest in the Suiza Dairy Group (38.2 percent) for 11 fluid plants that were in areas where both Dean and Suiza had operations.

The cheese industry is structured like fluid milk in that proprietary firms and dairy cooperatives play major roles; retail stores, however, have only a marginal role. In 2002, dairy cooperatives marketed about 40 percent of total cheese production, mostly American cheeses. Cooperatives marketed just 15-25 percent of the other-than-American natural cheese products, which in 2002 had a 57-percent share of all cheese production, up from 18 percent in 1970.

A relatively recent phenomenon is the rapid growth of cheese production by large, low-cost plants in Idaho, New Mexico, and California. Leprino Foods recently opened a large Mozzarella plant in Lemoore, CA, slated to handle 6 million pounds of milk per day when it reaches full capacity. Wisconsin is still the largest cheese-producing State and is followed by California, New York, Minnesota, and Idaho.

The shift to the large-scale modern cheese plants enabled producers to shift from small- to large-batch processing systems that feed high-speed processing lines. The result was a marked improvement in labor productivity, which rose from about 103,000 pounds per worker per year to 188,000 pounds over 1972-92 (table 8). Despite this 80-percent increase in productivity, a sharp increase in demand for cheese products led to a rise in the industry's workforce of about 40 percent (table 7).

Greater cheese demand did not allow the cheese industry to escape consolidation. USDA reported that 403 plants produced cheese in 2002, down by almost 60 percent from 1970 (993 plants). This, coupled with rising demand, saw average cheese production per plant quadruple from 1972 to 1992 (table 8). Despite the rise in plant size, four-firm concentration levels have remained at about 42 percent over 1972-97 (table 9), probably because of the heterogeneity of product types.

Small plants were the first to depart the fluid milk and cheese industries. More than one-third of the 1972 fluid milk and cheese plants exited by 1977, with departing plants in each industry controlling less than 20 percent of the 1972 market share (table 11). The percentage of exiting 1972 plants

shrank and their relative market share increased over time. Plant entrants accounted for only about 10 percent (94 of 779 total plants) of all 1992 fluid milk plants, but nearly 25 percent of all cheese plants (table 12). In both industries, however, average new plant market share is only about one-half the share of other plants.

A pattern comparable to that shown in table 13 for all plant entrants holds for fluid milk processors. About 50 percent of new entrants left within 5 years and new entrant size ranged from about one-third the mean plant size for 1972-77 entrants to about one-half the size for 1982-87 entrants. The pattern for cheese plants is a little weaker, as plant entrant size ranged from about 20 percent of the industry average in 1977 to about 50 percent in 1992. Despite the small size, exit rates (less than 40 percent in three of the four periods) were lower than for other industries.

Grain Milling and Oilseed Processing Sectors

Feeds, soybean processing, and flour and wet corn milling have been important outlets for three mainstays of U.S. farms: soybeans, wheat, and corn. These four food processing industries are more horizontally diversified and vertically integrated into other commodity products than meat, poultry, or dairy firms. For example, ADM, Bunge, and Cargill deal in numerous product lines including flour, feed, and soybean products and also have a global reach. Some of these same firms and others have also expanded beyond commodity origination and transportation business into further processed products, such as frozen dinners.

Corn millers and oilseed processing firms have long had strong horizontal links to grain and oilseed plants outside of their primary business. For example, corn millers owned 38 corn milling plants in 1977 and 59 other oilseed and grain products plants (table 14). Similarly, soybean processors owned 64 soybean plants, 57 other grain and oilseed plants, and 371 plants outside of either one of these lines of business.

Oilseed processing can represent a backward linkage for feed companies because oilseed meal, particularly from soybeans and cottonseeds, is a major component of commercial feeds. Oilseed companies amounted to 10 percent or less of plants owned by feed companies in 1977-87, suggesting that backward linkages are not extremely important. Flour millers had modest horizontal linkages to other grain and oilseed plants, which amounted to 15-25 percent of the number of flour plants. However, flour millers had three times more plants outside of the flour industry in other food and nonfood industries, making them the most diversified of all food companies examined (table 14).

The emergence of highly diversified flour milling plants is a recent phenomenon. Wilson (1998) indicates that grain elevator operators, such as Pillsbury, which vertically integrated into flour milling, dominated the industry prior to 1972. However, multi-plant grain companies, such as Cargill, moved the integrated firms aside after 1972 and pushed the regional and local millers to the fringe. By 1992, the multi-plant grain millers, which

Table 14—Plants owned by grain and oilseed firms, 1977-82 and 1982-87[1]

Industry of firm	Industry of plant owned by grain and oilseed firms							
	Flour	Feed	Corn	Cotton-seed	Soybean	Grain/ oilseed	Other food/ nonfood	Total
				Number of plants				
1977-82:								
Flour milling	365	-	-	-	-	46	1,222[2]	1,633
Feed	-	1,575	-	-	-	132	983[3]	2,690
Corn milling	-	-	38	-	-	59	298[4]	395
Cottonseed milling	-	-	-	90	-	44	193	n.a.
Soybean milling	-	-	-	-	64	57	371	492
1982-87:								
Flour milling	314	-	-	-	-	75	1,174	1,563
Feed	-	1,377	-	-	-	98	624[5]	2,099
Corn milling	-	-	47	-	-	130	447[6]	624
Cottonseed milling	-	-	-	66	-	52	179	231
Soybean milling	-	-	-	-	91	77	635	803

- = not available
[1] Data do not include plants that had no financial or employment information.
[2] Includes 203 plants with missing industry codes.
[3] Includes 26 plants with missing industry codes and 145 meat and poultry plants.
[4] Includes 41 plants with missing industry codes.
[5] Includes 12 plants with missing industry codes and 176 meat and poultry plants.
[6] Includes 30 plants with missing industry codes.
Source: Economic Research Service estimates based on Census data.

had only about 30 percent of the market in 1972, had a 60-percent market share—about twice as much as the vertically integrated firms. U.S. Census Bureau data reflect the changed circumstances, showing that the four-firm concentration ratio rose from 32 to 48 percent over 1972-97 (table 9).

The decline in the total number of plants in flour milling from 1972 to 1992 was not nearly as sharp as in meatpacking and dairy, but it still totaled 80 plants (table 8). Wilson reports that most of the failed plants were smaller regional and local plants. With aggregate flour demand rising, the decline in the number of plants was more than offset by a near doubling of both average plant size and average worker productivity (table 8). Workers saw about a 20-percent reduction in jobs and near-constant compensation (table 7).

Technological change and consolidation in the feed industry led to a near doubling of plant size and an improvement in worker productivity of about 150 percent (table 8) over 1972-92. These changes, combined with the introduction of on-farm feed mixing by integrated livestock and poultry plants, enabled many buyers to prepare their own feeds, putting pressure on smaller feed supply companies (Kimle and Hayenga, 1993). As a result, despite a 50-percent increase in feed production to about 40 million tons, the number of feed industry plants fell 20 percent (table 8) and employment dropped from about 44,000 to 25,000 workers over 1972-92 (table 7). Today, the industry is dominated by large integrated poultry firms and, to a lesser extent, meat plants and large national feed companies. Although four-firm concentration ratios are quite low (table 9), some large manufacturers, such as Agway in the Northeast and Farmland in the Plains and Midwest, dominate regional and local markets (Houston, 1998).

Unlike flour milling and feeds, wet-corn milling has been a growth industry, as inputs of corn more than tripled over 1975-92 (table 5). Most of the growth arose from much higher demand for high-fructose corn syrup (HFCS) and fuel alcohol. As a result, the number of wet-corn milling plants increased by about 40 percent to 58 even though plant size rose by about 100 percent and labor productivity jumped 233 percent (table 8).

Farris (1998) reports that only 26 wet-corn milling establishments with 100 or more employees in 1992 accounted for 97 percent of production, while the other 32 plants produced the remainder. Operations are quite capital intensive, as the number of employees dropped by about 1,500 workers to 9,300 over 1977-92 (table 7) while output tripled (table 5).

Capital-intensive industries often are more concentrated (Sutton, 1991) and wet-corn milling is no exception, as the four-firm concentration ratio rose from 63 percent to about 72 percent over 1972-97 (table 9) and much higher for individual products. Farris indicates that the top five processors of two types of high-fructose corn syrup—HFCS-42 and HFCS-55—had more than 80-percent market shares. Archer Daniels Midland alone controlled over 30 percent of the output in each market. The other large processors were American Fructose, Cargill, CPS International, and A.E. Staley. Marion and Kim (1991) indicate that about half of the rise in four-firm concentration ratios in the sweetener market is due to internal growth and about half is due to mergers and acquisitions.

Like wet-corn milling, soybean processing has grown (about 55 percent) over 1972-92. Also, like wet-corn milling, there has been a strong push to larger plants with greater capacity and reduced labor requirements.

Most U.S. soybean crush is processed in plants that separate oil and crush through a solvent extraction process. This approach requires large output, heavy capital investment, and well-developed infrastructure for collection, storage, and distribution. The soybean processing industry has emerged as a highly efficient, large-scale production system that plays to the strengths of large firms engaged in global soybean processing. This has led to growth in plant size that has outstripped increases in product demand, resulting in fewer but larger plants, greater labor productivity, and higher concentration levels.

Soybean plants increased 70 percent in size over 1972-92 (table 8), and up to 130 percent by 1997 (not shown). Further, as the number of production workers declined from 6,600 in 1972 to 4,700 in 1997, the crush per production worker increased by 220 percent.[8] Meanwhile, some firms bought out rivals and promptly expanded plant sizes, incorporated the plants into their own businesses, and integrated complementary activities such as origination, processing, and feeding to achieve more operational efficiency (Larson, 1998).

Mergers and acquisitions accounted for much of the jump in concentration. The four-firm concentration ratio, as measured by Census on a value-of-shipments basis, rose from 52 to 80 percent over 1972-97 (table 9). Marion and Kim (1991) showed that, in the absence of mergers and acquisitions, the four-firm concentration ratio would have increased about 3 percentage points to around 50 percent instead of the 76.4 percent they measured for 1988.[9]

[8] Employment data in table 7 include production and nonproduction workers, so productivity is much lower than when using just production workers.

[9] The four-firm concentration ratios do not always correspond because they often are based on different bases. Marion and Kim (1991) used a private industry source, which does not include all the smaller plants, and uses plant capacity. Census data, on the other hand, include all firms and plants and were calculated using the value of shipments. Regardless of the approach, the same trends are evident.

The change in four-firm concentration ratio has not hurt competition, as reflected in crushing margins—an important variable in determining profitability. Crushing margins equal the value of meal and oil minus the price paid for raw soybeans. The margin after operating costs depends on product transportation costs, plant scale, purchasing practices, and output yield per bushel of soybean inputs.[10]

The ability of small flour milling and oilseed processing plants to compete against their larger competitors matched plants in other industries: 1972 plants exiting their industries over 1972-77 were much smaller than average (table 11). About one-third of the flour milling and feed plants and one-fifth of the oilseed plants exited their industries, yet they accounted for less than 17 percent of their industry's market shares. It was not until 10 to 15 years later that the shares of 1972 plants leaving their industies matched their market shares.

The plant size of entrants is quite small. About one-fourth of the 1992 flour and feed plants and one-fifth of the oilseed plants entered over 1987-92, yet their 1992 market share ranged from 3 percent for oilseeds to about 17 percent for feeds (table 12). By contrast, plants existing since 1972 accounted for one-third of the flour, 38 percent of feed, and nearly 60 percent of oilseed processing plants, yet they had 73, 52, and 73 percent of their respective market shares.

The survival rates and entry plant sizes for flour, feed, and oilseed processing plants are similar to those for the nine food industries combined (table 13). New flour plant average size ranged from 20 to 50 percent of industry mean size and 40-50 percent of them exited within 5 years. Although feed plants tended to enter at a somewhat larger size (50-65 percent of the industry mean), they exited at a faster rate—nearly 60 percent departed the industry within 5 years. Oilseed processing plants were also usually small—about 50 percent of the industry mean size—and also had short lives, with about 60 percent of them exiting within 5 years.

[10] For more information, see numerous *Situation and Outlook* reports by the Economic Research Service.

Structural Change in Summary

In this report, we proposed that technological and demand changes led to a major restructuring of nine of food processing's largest industries over 1972-92. Our data show that technological change played the dominant role. Despite growth in aggregate demand across all of the nine industries, the number of plants dropped in each industry—even those that grew rapidly—as the average total value-of-shipments per plant rose by about one-third to $43 million. These combined changes led to an increase of about 50 percent in the four-firm concentration ratio to about 46 percent over all nine industries. Two industries—wet-corn milling and soybean processing—registered concentration ratios above 70 percent.

Labor productivity advanced substantially. Real output (measured by weight) per employee rose by an average of 78 percent over 1972-92 without accounting for quality changes (meat and poultry plants, for example, produced a greater mix of higher value products by 1992). Data for all nine industries also show that employment leveled off. But these data mask industry-level changes: the number of workers declined by about one-fourth in meatpacking and by about one-half in fluid milk, but rose more than 150 percent in poultry slaughter and processing.

This contraction in plants and workers decreased wages, especially in meat-packing and meat processing, where wages dropped by about one-third. Workers in other industries realized little change in real wages. Overall, average worker compensation, deflated by the consumer price index, fell 25 percent. This drop in wages combined with the gain in output per worker means that labor costs per unit of output dropped dramatically. Although the associated cost reductions were likely passed along to consumers in the form of lower prices, the price impact was probably small because labor costs are only a small part of the cost of food processing.

The type of plant that exits and the composition of the plants that remain in an industry are of vital interest to entrepreneurs assessing the viability of starting a plant and regulators seeking to understand industry dynamics. About 50 percent of all plants that existed in 1972 and exited within 10 years had only about a 25-percent share of the market in 1972. In other words, they were small in 1972 and subsequently failed. By contrast, the 18 percent of the 1972 plants that exited over the subsequent 10-year period (1982-92) were more than twice as large in 1972 as the plants that exited earlier.

A similar picture emerges for plants existing in 1992. Plant entrants over 1987-92 accounted for about one-fourth of all plants, but only about 10 percent of all market share. By contrast, plants existing since 1972 numbered about 40 percent of all plants and controlled about 60 percent of the market in 1992. Moreover, about half of all plant entrants failed within 5 years and two-thirds exited within 10 years. The new plants were typically about one-half the average industry plant size and about two-thirds the industry average size after 10 years. Taken together, data tracing 1972 and 1992 plants over the 1972-92 period show that small plants tended to fail first and that new plants typically were much smaller than the industry mean.

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