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PART ONE: Vertical Market Coordination and Power

1. Structural Change in the U.S. Meat and Poultry Industries

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Structural Change in the U.S. Meat and Poultry Industries

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Industry structure has long been of concern to public policy makers. Product safety policy-makers speculate about the impact of regulations on small firms, while policy-makers dealing with antitrust issues question noncompetitive firm behavior. For example, concern about a disproportionate impact of meat and poultry food safety regulation on small firms led the Food Safety and Inspection Service of the United States Department of Agriculture (USDA) to modify some meat-handling requirements for small plants. Additionally, concern about rising concentration among steer and heifer slaughter plants in the beef industry led to a major study on the impact of concentration in the red meat packing industry by the Packers and Stockyards Administration of USDA.

An earlier report (MacDonald et al. In Press) showed that industry concentration, as measured by share of value of shipments, in the beef slaughter industry rose from 26 to 71 percent (Table 1.1) and that the share of industry value of shipments by large plants (over 399 employees) rose from 31 to 72 percent over the 1963-92 period (Table 1.2). This paper also documented substantial increases in industry concentration and large plant market share in the pork, chicken, and turkey slaughter industries.²

The purpose of this paper is to examine some sources of structural change in the meat and poultry industries. Economic historians regard technological, government policy, and demand changes as vehicles for long-term structural changes. Since government policy changes were modest over the study period, we focus on technological responses by the industry to changes in demand for further processed meat and poultry products from slaughtered animal inputs.

The paper differs from previous studies in that it uses Census plant-specific microdata to assess plant entry and acquisitions, the survival of entry plants, and changes in product output composition and animal input species specialization. It shows that each industry in the dataset experienced continuous change and consistently high rates of plant entry and exit. With new plant capacity averaging less than 2 percent per year after 1972, most of this change occurred as new and incumbent firms acquired existing plants. The paper also shows a much lower survival rate for small plants and substantial changes in output composition (particularly in beef slaughter) and increases in animal input species specialization in the slaughter industries. In general, the paper illustrates the importance of considering structure in an historical rather than cross-sectional context.

The paper proceeds in the following manner. After defining entry and identifying the source of the data, we discuss entry both in terms of the number of plants (Tables 1.3, 1.5, and 1.7) and the market share of those plants (Tables 1.4, 1.6, and 1.8). Next, we consider entrant survival (Tables 1.9-1.11); examine changes in output composition (Tables 1.12-1.14); and investigate changes in animal input specialization (Tables 1.15 and 1.16). Finally, we further discuss the structural changes and their implications.

TABLE 1.1 Share of Value of Shipments Held by Four Largest Firms in Four Slaughter and Three Processing Product Classes in Selected Years

Product Class	1963	1967	1972	1977	1982	1987	1992
Slaughter^a							
Beef	26	26	30	25	44	58	71
Pork	36	33	37	36	39	38	54
Chicken	14	23	18	22	32	42	41
Turkey	23	28	41	41	40	38	45
Processing^b							
Pork, not sausage	25	22	23	21	22	31	31
Sausage	20	20	20	26	26	36	38
Processed poultry	52	49	35	48	37	36	46

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census; concentration ratios are based on plant shares of total industry value of shipments.

^aThe slaughter classes refer to five digit SIC codes 20111 (beef), 20114 (pork), 20151 (chicken), and 20153 (turkeys).

^bThe processing classes refer to 20116 and 20136 (processed pork, such as ham, bacon, salt pork, and barbecued pork); 20117 and 20137 (sausage); and 20155 (processed chicken and turkey).

TABLE 1.2 Share of Value of Shipments Held by Large Establishments, in Selected Years, for Four Slaughter and Three Processing Classes

Product Class	1963	1967	1972	1977	1982	1987	1992
Slaughter^a							
Beef	31	29	32	37	51	58	72
Pork	64	59	57	63	67	70	88
Chicken	d	29	34	45	65	76	88
Turkey	d	16	15	29	35	64	83
Processing^b							
Pork, not sausage	56	54	51	55	37	57	59
Sausage	37	38	36	38	29	35	41
Processed poultry	d	d	41	51	53	65	71

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions.

^aThe slaughter classes refer to five digit SIC codes 20111 (beef), 20114 (pork), 20151 (chicken), and 20153 (turkeys).

^bThe processing classes refer to 20116 and 20136 (processed pork, such as ham, bacon, salt pork, and barbecued pork); 20117 and 20137 (sausage); and 20155 (processed chicken and turkey).

Data

The data came from the Census Bureau's Longitudinal Research Base (LRD) for 1972-92 and the Census of Manufactures for 1963 and 1967. The LRD consists of linked microdata on manufacturing plants from the Census Bureau's Annual Survey of Manufactures (ASM) and Census of Manufactures for 1972, 1977, 1982, 1987, and 1992. We use data from the Census of Manufactures because only these data are based on a survey of all manufacturing plants.

Our dataset includes all plants with at least 50 percent of their total value of shipments from the beef (SIC 20111), pork (SIC 20114), chicken (20151), and turkey (20153) slaughter and processed or cured pork (20116 and 20136), and sausage (20117 and 20137) industries. We omit plants in which fresh meat and livestock are not the primary inputs. We also omit plants that have more than 50 percent of their output from products the Census Bureau defines as not otherwise classified.

We assigned plants to industries in the following way. First, we created five digit SIC code product classes from Census seven digit SIC codes. Next, we summed plant total value of shipments by product class. Finally, we ranked plant output by product class and assigned a plant to the five digit Census SIC code product class (industry) in which the plant had the most output.

Our industry definitions may differ from other definitions. For example, we combine SIC 20116 and 20136 into a single industry because they have identical outputs. Census categorizes these plants differently because plants in SIC 20116 slaughter hogs while plants in SIC 20136 used packed meat inputs. Additionally, Census data does not allow us to separate steer and heifers from cows and bulls, but does enable us to distinguish more broadly defined animal species slaughter classes, such as veal, pork, or sheep. Finally, note that our industry definitions differ substantially from those used by Packers and Stockyards and the Food Safety and Inspection Service because we have assigned plants to industries based on outputs rather than inputs.

Besides seven digit product SIC codes, the LRD contains data on number of employees and animal input costs by animal species. These data enable us to determine concentration ratios, share of value of shipments by plant size, share of plant sales by product class and plant size, and primary live animal input cost as a share of total live animal input costs.

Census identifies each plant with a unique plant number that does not change over its entire life. Census also assigns a firm identification number to each plant. This firm identification number changes with ownership of the plant. The longitudinal nature of the data combined with the plant and firm identification numbers allows us to distinguish plant and firm entrants from plant and firm incumbents. We define plant (firm) entrants as plants (firms) in the first year in which they produce at least one product in the selected industry. Plant (firm) incumbents are plants (firms) that have previously produced at least one product in the selected industry.

Data presented in Tables 1.1 and 1.2 and 1.12-1.16 are derived from all production data classified under selected five digit SIC code product industry categories. Tables 1.3-1.11 contain summary statistics on various combinations of plant and firm entrants. As such, these data are based on a much smaller subset of the original dataset. The far fewer number of observations supporting each table statistic and Census confidentiality rules prevent disclosure of some statistics. As a result, we compressed the nine five digit SIC code industries into three more broadly defined industries. These industries are beef and pork slaughter, chicken and turkey slaughter and processing, and processed pork and sausage.

Plant Entry

Tables 1.3 through 1.8 describe several dimensions of entry in three industry categories: cattle and hog slaughter, pork processing and sausage preparation, and poultry slaughter and processing. We

aggregate to these industry categories in order to avoid disclosure of confidential information, while retaining meaningful industry distinctions.

The data show that new plant entry rates remain substantial throughout the period and match the averages for all manufacturing in the U.S. (Dunn et al. 1988) and Canada (Baldwin 1995). But overall plant numbers declined sharply in beef and pork slaughter and processing because of extraordinarily high exit rates.

We consider both the number and rate of entry for five entrant types: entry firms with entry plants, incumbent firm with entry plant, entry firm buys incumbent plant, incumbent plant diversification, and incumbent firm buys incumbent plant. These five categories allow us to (1) contrast new plant entrants (entrant firm with entrant plant and incumbent firm with entrant plant) with plant acquisitions (incumbent firm buys incumbent plant and entry firm buys incumbent plant); (2) compare the impact of new firm entrants (entrant firm with entrant plant and entrant firm buys incumbent plant) to firm expansion (incumbent firm with entrant plant and incumbent firm buys incumbent plant); and (3) examine plant diversification.

We also distinguish between plants with less than 25 employees and those with more than 24 employees in order to isolate very small plants from larger ones. We choose only two size classes in order to reduce disclosure violations. We provide small plant information only for entry firms with entry plants because other entrant categories contained very few plants with less than 25 employees.

Table 1.3 (beef and pork slaughter) shows that plant entry as a share of the total number of plants remained relatively constant over the 1963-92 period, fluctuating between 9 and 21 percent for each intracensal period. However, the number of entry plants dropped 65 percent and the number of plants in the industry declined 69 percent, reflecting a much more rapid exit rate than entry rate.³ The largest decline in plant entrants came from entry firms with small (less than 25 employees) entry plants, which dropped 89 percent. The number of entry firms with large (more than 24 employees) entry plants and incumbent firms with large entry plants dropped to a lesser degree.

Over the 1978-92 period, plant acquisitions and firm expansions had an increasingly important influence on the structure of the industry. In both 1982 and 1992, total plant acquisitions and firm expansions exceeded total plant and firm entrants.

Table 1.4 shows the total value of shipments as a share of industry value of shipments (market share) of various types of entrants in the beef and pork slaughter industries. Market share trends are consistent with the trends for the number of plants.

We define plant embodied technology as plant obsolescence caused by the geographical location of the plant or the structural restrictions imposed by the plant on the processing of material inputs into final products. A substantial change in plant embodied technology requires the replacement of the existing plant with a new one.⁴

Table 1.3 indicates that the number of plant acquisitions and firm expansions remained almost unchanged over the 1963-92 period, while the number of new plant entrants and new firm entrants dropped dramatically. Table 1.4 shows that the market share of plant acquisitions and incumbent firm expansions exceeded the market share of new plant and new firm entrants. The rise in the number and market share of plant acquisitions relative to new plants suggests little change in plant embodied technology. The increase in firm expansions relative to new firm entrants implies an industry consolidation and a shift to greater firm economies of scale, i.e. firm size.

Tables 1.5 and 1.6 give an overview of entry into the chicken and turkey slaughter and processing industries. In contrast to beef and pork, there was only a modest decline (about 16 percent) in the number of plants in the industry. Plant entry rates fluctuated between 9 and 32 percent of beginning-of-period plants; the number of entry firms with entry plants declined; and entry firms preferred large plants to small ones. Additionally, gross exit rates were far lower than in beef and beef and pork slaughter; the number of incumbent firms with entry plants increased over time; and, firm entry exceeded firm expansion in most years.

TABLE 1.3 Number of Various Types of Entrants in the Beef and Pork Slaughter Industry

Entrant Category	Employees	Year						
		63 (initial stock)	67	72	77	82	87	92
-----plants-----								
Plant Entry								
Entry firm with entry plant	0-24	355	75	58	26	11	10	8
Entry firm with entry plant	over 24	677	69	78	55	32	37	22
Incumbent firm with entry plant	over 24	-	17	17	22	6	16	9
Total plant entrants (plants)		-	161	153	103	49	63	39
Total plant entrants (%) of all plants		-	15.6	18.4	14.9	9.3	20.6	15.7
Plant Acquisitions								
Incumbent firm buys incum- bent plant	over 24	-	40	73	32	55	11	31
Entry firm buys incumbent plant	over 24	-	6	11	19	14	21	14
Total plant acquisitions		-	46	84	51	69	32	45
Total plant acquisitions share (%) of all plants		-	4.4	8.1	7.4	13.1	10.5	18.2
Other Entry								
Incumbent plant diversifies	over 24	-	17	18	9	15	5	8
Firm entrants: includes en- trant firms with entrant or incumbent plants		-	150	147	90	57	68	44
Firm entrant plants (%) of all plants		-	14.5	17.7	13.1	10.8	22.2	17.8
Firm expansions: includes incumbent firms with entrant or incumbent plants		-	57	90	54	61	27	40
Firm expansion plants (%) of all plants		-	5.5	10.8	7.8	11.6	8.8	16.2
Total plants		1032	830	689	528	306	247	174

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The beef industry refers to five digit SIC code 20111 and the pork industry refers to SIC code 20114.

TABLE 1.4 Market Share of Various Types of Entrants in the Beef and Pork Slaughter Industries

Entrant Category	Employees	Year					
		1967	1972	1977	1982	1987	1992
-----market share-----							
Plant Entry							
Entry firm with entry plant	0-24	0.9	0.5	0.3	0.1	0.2	d
Entry firm with entry plant	over 24	6.5	14.2	5.0	5.3	4.3	6.0
Incumbent firm with entry plant	over 24	5.4	d	7.6	d	7.8	d
Total plant entrant market share ^a		12.8	14.7	12.9	5.4	12.3	6.0
Plant Acquisitions							
Incumbent firm buys incumbent plant	over 24	14.0	17.0	7.4	33.1	6.3	31.0
Entry firm buys incumbent plant	over 24	d	3.1	6.9	d	16.4	d
Total plant acquisitions ^a		14.0	20.1	14.3	33.1	22.7	31.0
Other Entry							
Incumbent plant diversifies	over 24	0.2	0.1	d	0.1	d	d
Firm entrants: includes entrant firms with entrant or incumbent plants ^a		7.4	17.8	12.2	5.4	20.9	6.0
Firm expansions: includes incumbent firms with entrant or incumbent plants ^a		19.4	17.0	15.0	33.1	14.1	31

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The beef industry refers to five digit SIC 20111 and the pork industry refers to SIC 20114. Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions.

^aDoes not include entries labeled "d."

Table 1.6 shows that the influence of plant acquisitions far exceeded plant entrant market share in most Census years. It also indicates that firm entry remains a strong force in the industry, surpassing firm expansions in two of the three most recent Census periods. The increase in the number and market share of plant acquisitions relative to new plant entrants suggests a decline in the rate of change in plant embodied technology over the 1963-92 period. Additionally, the high rate of new firm entry implies modest consolidation in the industry.

TABLE 1.5 Number of Various Entrant Types in Chicken and Turkey Slaughter and Processing Industries

Entrant Type	Employees	Year						
		63 (initial stock)	67	72	77	82	87	92
-----plants-----								
Plant Entry								
Entry firm with entry plant	0-24	25	7	5	d	d	d	5
Entry firm with entry plant	over 24	295	33	71	20	17	25	17
Incumbent firm with entry plant	over 24	-	12	12	20	7	17	37
Total plant entrants ^a		-	52	88	40	24	42	59
Total plant entrant share (%) of all plants		-	16.3	31.9	13.6	9.0	18.8	26
Plant Acquisitions								
Incumbent firm buys incum- bent plant	over 24	-	17	48	24	23	19	11
Entry firm buys incumbent plant	over 24	-	7	6	13	32	41	31
Total plant acquisitions (plants) ^a		-	24	54	37	55	60	42
Total plant acquisitions share (%) of all plants		-	7.5	19.6	12.6	20.7	26.9	18.5
Other Entry								
Incumbent plant diversifies	over 24	-	17	18	9	15	5	8
Firm entrants: includes en- trant firms with entrant or incumbent plants ^a		-	47	82	33	49	66	48
Firm entrant plants share (%) of all plants		-	14.7	29.7	11.2	18.4	29.6	21.1
Firm expansions: includes incumbent firms with entrant or incumbent plants ^a		-	29	60	44	30	36	48
Firm expansion plants share (%) of all plants		-	9.1	21.7	15.0	11.3	16.1	21.1
Total plants		320	276	294	266	223	227	270

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. Chicken industry refers to SIC 20151, turkey industry refers to SIC 20153, and poultry processing industry refers to SIC 20155. Entries labeled "d" cannot be disclosed due to confidentiality restrictions.

^aDoes not include entries labeled "d."

TABLE 1.6 Market Share of Various Entrant Types in Chicken and Turkey Slaughter and Processing Industries

Entrant Type	Employees	Year					
		1967	1972	1977	1982	1987	1992
-----market share-----							
Plant Entry							
Entry firm with entry plant	0-24	d	d	d	d	d	d
Entry firm with entry plant	over 24	8.5	24.2	3.3	3.1	5.5	1.7
Incumbent firm with entry plant	over 24	d	d	6.8	d	3.6	13.7
Plant entrant market share ^a		8.5	24.2	10.1	3.1	9.1	15.4
Plant Acquisitions							
Incumbent firm buys incumbent plant	over 24	10.1	24.5	9.8	8.5	6.8	d
Entry firm buys incumbent plant	over 24	d	d	5.7	13.7	18.8	9.1
Total plant acquisitions ^a		10.1	24.5	15.5	22.2	25.6	9.1
Other Entry							
Incumbent plant diversifies	over 24	d	d	d	1.4	1.1	0.9
Firm entrants: includes entrant firms with entrant or incumbent plants ^a		8.5	24.2	9.0	16.8	24.3	10.8
Firm expansions: includes incumbent firms with entrant or incumbent plants ^a		10.1	24.5	16.6	8.5	10.4	13.7

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. Chicken industry refers to five digit SIC 20151, turkey industry refers to SIC 20153, and poultry processing industry refers to SIC 20155.

^aDoes not include entries labeled "d."

Tables 1.7 and 1.8 provide information about entry into the pork processing and sausage industries. Table 1.7 shows a 69 percent decline in the number of plants and a 65 percent decrease in the number of plant entrants in the pork processing and sausage industries. Combining the decline in new plant entrants and their constant market share with an increase in both the number and the market share of plant acquisitions suggests little displacement of existing plants and thus little change in plant embodied technology. However, despite a decline in the number of entry and incumbent plants of entry firms, the

TABLE 1.7 Number of Various Types of Entrants in the Pork Processing and Sausage Industries

Entrant Type	Employees	Year						
		63 (initial stock)	67	72	77	82	87	92
-----plants-----								
Plant Entry								
Entry firm with entry plant	0-24	357	73	76	30	29	26	17
Entry firm with entry plant	over 24	691	84	58	39	32	54	27
Incumbent firm with entry plant	over 24	-	11	24	40	8	23	15
Total plant entrants		-	163	145	79	71	102	73
Total plant entrant share (%) of all plants		-	15.5	17.6	11.4	14.1	25.3	18.6
Plant Acquisitions								
Incumbent firm buys incumbent plant	over 24	-	31	65	25	41	24	22
Entry firm buys incumbent plant	over 24	-	6	11	10	10	22	29
Total plant acquisitions (plants)		-	37	76	35	51	46	51
Total plant acquisitions share (%) of all plants		-	3.5	9.2	5.1	10.1	11.4	13.0
Other Entry								
Incumbent plant diversifies	over 24	-	25	8	4	6	6	6
Firm entrants: includes entrant firms with entrant or incumbent plants		-	166	145	79	71	102	72
Firm entrant plants share (%) of all plants		-	15.8	17.6	11.4	14.1	25.3	18.4
Firm expansions: includes incumbent firms with entrant or incumbent plants		-	42	89	65	49	47	37
Firm expansion plants share (%) of all plants		-	4.0	10.8	9.4	9.7	11.7	9.4
Total plants		1048	822	689	504	403	392	327

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. Pork processing refers to five digit SIC codes 20116 and 20136 and sausage refers to SIC codes 20117 and 20137.

TABLE 1.8 Market Share of Various Types of Entrants in the Pork Processing and Sausage Industries

Entrant Type	Employees	Year					
		1967	1972	1977	1982	1987	1992
-----market share-----							
Plant Entry							
Entry firm with entry plant	0-24	0.7	0.9	0.3	0.6	0.4	0.3
Entry firm with entry plant	over 24	6.6	5.1	1.8	2.4	6.4	1.9
Incumbent firm with entry plant	over 24	1.3	5.1	7.6	d	5.6	4.0
Total plant entrant market share		7.9	11.1	9.7	3.0	12.4	6.2
Plant Acquisitions							
Incumbent firm buys incumbent plant	over 24	9.9	17.8	5.1	16.8	11.5	6.5
Entry firm buys incumbent plant	over 24	d	d	d	d	10.5	13.3
Total plant acquisitions ^a		9.9	17.8	5.1	16.8	22.0	19.8
Other Entry							
Incumbent plant diversifies	over 24	1.0	d	d	d	d	d
Firm entrants: includes entrant firms with entrant or incumbent plants ^a		7.9	11.1	9.7	3.0	12.4	6.2
Firm expansions: includes incumbent firms with entrant or incumbent plants		7.9	11.1	9.7	3.0	12.4	6.2

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. Pork processing refers to five digit SIC codes 20116 and 20136 and sausage refers to SIC codes 20117 and 20137. Entries labeled "d" are shares that cannot be disclosed due to confidentiality restrictions.

^aDoes not include entries labeled "d."

market share of firm entrants exceeded the market share of expanding firms in several years, suggesting that the influence of new firm entrants remained strong in 1992.

In terms of technological change, Tables 1.3 through 1.8 suggest a general shift to greater plant scale economies but, except for chicken and turkey slaughter and processing, little change in plant embodied technology. Two features of the data illustrate these changes. First, the much lower small plant entry rates than large plant entry rates and the preference of firms to acquire very large plants suggest a shift in economies of scale to larger plants. Second, the number of plant acquisitions increased over time and often accounted for 20 percent of market share over a five year Census period, while new plant

construction usually accounted for less than 10 percent of industry market share over a five year Census period, suggesting little change in plant embodied technology.

Plant Survival

As shown in Tables 1.3, 1.5, and 1.7, meat and poultry slaughter and processing industries exhibit high rates of entry in the face of even higher gross exits. In Tables 1.9, 1.10, and 1.11 we consider the survival of new small and large entrant plants with entrant firms. The survival rates for other entry categories are not reported because most table entries failed disclosure requirements. Plants survive from one period to the next if they remain operating under the same ownership. Thus, “failure” can occur in these tables due to closure, a change in product line to products outside of the industry, or plant sale. Closed facilities may be reopened under new owners, and thus would be reported later as plant entry.

The data show that plants fail at very high rates from one Census year to the next. The smallest plants (less than 25 employees) fail at noticeably higher rates than large (over 24 employees) plants, but both categories show sharp attrition. Between 60 and 90 percent of entrants in all three industry categories fail within two Census periods.

Table 1.9 indicates that the survival rates of small entry plants over each Census period varied from 9.1 to 36.2 percent in the beef and pork slaughter industries. Large entry plant survival rates over each Census period, on the other hand, ranged from 18.2 to 53.8 percent. Table 1.9 also indicates that only about 62 percent of the 677 large plants that existed in 1963 still remained in 1967 and by 1992 only 2.1 percent of the original 1963 plants still existed under their original owners.

Tables 1.10 and 1.11 show the survival rate of entry firms with entry plants in chicken and turkey slaughter and processing and in pork processing and sausage. We exclude small plants from Table 1.10 because almost all small entry plant table statistics are disclosure violations. Survival rates for chicken and turkey slaughter and processing and pork processing and sausage are similar to those found in the beef and pork slaughter industries. Although more plants survived from 1963 to 1992 in pork processing and sausage industries than in either of the other industries, only 5.1 percent of the large 1963 plants still remained in 1992 under their original owners.

Changes in the Composition of Output

We exploit a distinctive feature of the Census data in order to measure product mix. The Bureau reports plant outputs for a series of seven digit (narrowly defined) product codes. For example, in beef and pork slaughter, these product categories include: carcasses, boxed meat, boneless beef, including hamburger (beef slaughter only), variety meats (edible organs), and not otherwise classified products. For chicken and turkey slaughter categories, the product categories include various types of carcass products, traypacks for chickens, turkey parts for turkeys, and not otherwise classified. For chicken and turkey processing, the product categories include canned poultry, cooked or smoked poultry, other processed poultry, and not otherwise classified. Pork processing product categories include ham, bacon, salt pork, and barbecued pork, while sausage product categories include frankfurters, fresh sausage (dry or semi-dry), other sausages, jellied goods, and not otherwise classified.

A number of economists, including Nelson (1985), report that boxed beef output rose dramatically over the 1963-92 period. We follow that work in presenting boxed beef and boxed pork as percentages of total output in Table 1.12. We isolate beef slaughter from pork slaughter and create four size categories because our much bigger dataset, which includes all beef and pork slaughter plants, provides a greater number of observations to support each table statistic.

TABLE 1.9 The Survival (Percent Remaining) of Cohorts of Small and Large Entry Beef and Pork Slaughter Plants

Size	Cohort	Year						
		1963	1967	1972	1977	1982	1987	1992
0-24 employees	1963 (initial stock)	100	23.6	13.6	7.2	4.0	1.9	d
	1967	.	100	36.2	11.6	10.1	d	d
	1972	.	.	100	15.4	12.8	10.3	d
	1977	.	.	.	100	9.1	7.3	d
	1982	.	.	.	.	100	d	d
	1987	.	.	.	.	.	100	13.5
	1992	.	.	.	.	.	.	100
	over 24 employees	1963 (initial stock)	100	61.9	31.6	21.6	9.3	5.2	2.1
1967		.	100	33.3	17.4	10.1	5.8	d
1972		.	.	100	53.8	21.8	12.8	6.4
1977		.	.	.	100	18.2	9.1	7.2
1982		.	.	.	.	100	34.3	18.7
1987		.	.	.	.	.	100	24.3
1992		.	.	.	.	.	.	100

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The beef industry refers to five digit SIC code 20111 and the pork industry refers to SIC code 20114. Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions. 1963 plants include all plants in the sample.

TABLE 1.10 The Survival of Cohorts of Entry Chicken and Turkey Slaughter and Processing Plants

Size	Cohort	Year						
		1963	1967	1972	1977	1982	1987	1992
over 24 employees	1963 (initial stock)	100	47.8	29.2	19.0	11.5	6.1	3.1
	1967	.	100	18.2	d	d	d	d
	1972	.	.	100	57.7	39.4	29.6	23.9
	1977	.	.	.	100	35.0	30.0	d
	1982	.	.	.	.	100	35.3	35.3
	1987	.	.	.	.	.	100	28.0
	1992	.	.	.	.	.	.	100

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The chicken industry refers to five digit SIC code 20151, the turkey industry refers to SIC code 20153, and the chicken processing industry refers to SIC code 20155. Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions. 1963 plants include all plants in the sample.

TABLE 1.11 The Survival of Cohorts of Large and Small Entry Pork Processing and Sausage Plants

Size	Cohort	Year						
		1963	1967	1972	1977	1982	1987	1992
0-24 employees	1963 (initial stock)	100	22.2	13.7	5.9	4.5	3.6	1.4
	1967	.	100	19.0	5.9	5.9	d	d
	1972	.	.	100	29.3	24.1	13.8	10.3
	1977	.	.	.	100	10.3	10.3	10.3
	1982	.	.	.	.	100	25.0	15.6
	1987	.	.	.	.	.	100	12.9
	1992	.	.	.	.	.	.	100
over 24 employees	1963 (initial stock)	100	61.8	34.6	23.7	14.8	9.4	5.1
	1967	.	100	44.0	22.6	15.5	11.9	8.3
	1972	.	.	100	43.1	13.8	15.5	15.5
	1977	.	.	.	100	43.6	33.3	33.3
	1982	.	.	.	.	100	43.8	40.6
	1987	.	.	.	.	.	100	37.0
	1992	.	.	.	.	.	.	100

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. Pork processing refers to five digit SIC 20116 and 20136 and sausage refers to SIC 20117 and 20137. Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions. 1963 plants include all plants in the sample.

TABLE 1.12 The Share of Sales (%) from Boxed Products in the Beef and Pork Slaughter Industries

Slaughter Industry	Product	Employees	Year						
			1963	1967	1972	1977	1982	1987	1992
Beef	Boxed Beef	0-24	10.9	12.9	11.0	14.0	16.8	21.6	d
		25-99	7.7	9.3	11.4	11.7	15.8	16.3	19.1
		100-399	10.1	8.5	12.6	11.0	12.7	19.8	11.7
		over 399	7.9	10.5	21.3	22.2	47.5	63.0	67.2
Pork	Boxed Pork	0-24	33.4	33.4	27.5	d	d	d	d
		25-99	36.0	28.0	34.5	38.5	47.9	50.9	45.3
		100-399	37.7	44.9	50.4	57.6	63.9	61.5	67.2
		over 399	43.1	35.2	46.0	52.2	50.8	54.1	71.8

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The slaughter industries refer to five digit SIC codes 20111 (beef) and 20114 (pork). Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions.

The most striking change is in boxed beef production by very large plants (over 399 employees), which rose to 67.2 percent of output from only 7.9 percent in 1963. Boxed beef products for the plants with less than 400 employees, on the other hand, rose to less than 20 percent of output by 1992. The increase in boxed beef output was accompanied by an increase in hamburger production from 3 to 9 percent of total value of shipments and matched by declines in beef carcass and pork products production. Beef carcass and pork product sales as a share of total value of shipments by very large beef plants dropped to 4.5 percent and 0 percent in 1992 from 27 and 18 percent in 1963. Carcass sales and pork product sales by plants with less than 400 employees remained at over 32 and 12 percent of total value of shipments. These two trends suggest a segmentation of the market in which larger plants serve the boxed beef market, while the smaller plants serve other market needs. Moreover, combining this segmentation of the beef market with the growing importance of large plants (Table 1.2) suggests a causal link from changes in plant level product mix to plant sizes, exit rates, and changes in scale economies.

As in beef slaughter plants, boxed pork products as a share of total value of shipments rose to 71.8 percent from 43 percent in 1963 for very large pork slaughter plants. Unlike the beef slaughter industry, boxed pork sales for plants with less than 400 and more than 99 employees increased almost as much as that for the largest pork slaughter plants. Additionally, there was little change in pork carcass production. The biggest decline as a share of output occurred for other products, which includes variety meats, not otherwise classified products, processed meats, and non-pork slaughter products.

Table 1.13 indicates that chicken traypacks as a share of total output by chicken slaughter plants with over 399 employees held steady at about 29 percent of output over the 1972-92 period, while

TABLE 1.13 The Share of Sales (%) from Traypack Products in the Chicken and Turkey Slaughter Industries and Processed Poultry Products in the Poultry Processing Industry

Slaughter Industry	Product	Employees	Year						
			1963	1967	1972	1977	1982	1987	1992
Chicken	Chicken traypacks	0-24	n.a.	n.a.	d	d	d	d	d
		25-99	n.a.	n.a.	9.8	19.5	11.5	d	d
		100-399	n.a.	n.a.	5.1	6.4	5.2	7.8	7.5
		over 399	n.a.	n.a.	29.5	24.8	27.3	29.5	23.0
Turkey	Turkey parts	0-24	n.a.	n.a.	n.a.	n.a.	n.a.	d	d
		25-99	n.a.	n.a.	n.a.	n.a.	n.a.	d	d
		100-399	n.a.	n.a.	n.a.	n.a.	n.a.	33.0	14.3
		over 399	n.a.	n.a.	n.a.	n.a.	n.a.	27.9	43.4
Processed poultry	Canned poultry/ cooked or smoked poultry	0-24	d	d	d	d	d	d	d
		25-99	d	d	93.1	d	d	d	61.7
		100-399	80.1	82.3	84.4	89.3	86.3	87.4	91.9
		over 399	d	d	d	d	d	87.7	84.2

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The slaughter industries refer to five digit SIC codes 20151 (chicken), 20153 (turkeys) and 20155 (processed chicken and turkey). Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions. Entries labeled "n.a." are not available because the question was not asked until 1972 for chicken and 1987 for turkey.

chicken traypack production by smaller plants accounted for a much smaller share of plant output. Prior to 1972, Census does not report traypack data. Table 1.13 also shows that, as in chicken after 1967, there was an increase in turkey parts production after 1982. The increases in traypack production in the chicken slaughter and turkey parts in the turkey industries were matched by declines in whole birds. There was little change in other products, which includes not otherwise classified products and products outside the industry category of the plant.

We cannot assess differences in composition of output between different size plants in turkey and chicken processing because most table statistics are disclosure violations. However, the decrease in the number of table statistics with disclosure violations over time suggest an increase in the number of plants producing processed poultry products.

Table 1.14 shows the share of pork processing plant output from ham, bacon, salt pork, and barbecued pork products and the share of sausage plant output from frankfurters, fresh sausage, dry or semi-dry salami, other sausages, and jellied goods products. Excluded are not otherwise classified products and products outside of the industry classification of the plant. The most notable feature of the

TABLE 1.14 The Share (%) of Sales from Processed Pork or Sausage in the Processed Pork and Sausage Industries

Industry	Employees	Year						
		1963	1967	1972	1977	1982	1987	1992
Processed pork from plants with some slaughter	0-24	d	d	d	d	d	d	d
	25-99	42.5	42.2	42.9	41.4	47.9	57.0	57.8
	100-399	35.6	36.9	32.4	d	d	d	d
	over 399	d	d	d	d	d	d	d
Processed pork from plants with no slaughter	0-24	82.5	81.5	89.4	93.3	d	84.8	91.8
	25-99	70.9	78.9	75.6	82.5	85.4	82.5	73.6
	100-399	54.6	58.2	64.4	73.5	69.6	82.3	74.0
	over 399	d	d	d	d	d	64.7	72.6
Sausage from plants with some slaughter	0-24	76.1	75.0	79.4	d	d	d	d
	25-99	50.2	52.6	72.6	78.6	78.5	81.9	77.1
	100-399	38.8	37.4	46.2	62.9	66.3	d	d
	over 399	d	d	d	d	d	d	d
Sausage from plants with no slaughter	0-24	85.9	85.2	87.0	86.6	82.9	89.8	77.5
	25-99	75.9	77.9	76.1	88.3	80.9	82.8	78.5
	100-399	69.1	65.7	68.9	82.0	71.9	81.4	79.7
	over 399	d	d	d	d	d	d	81.2

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The processing classes refer to 20116 and 20136 (processed pork, such as ham, bacon, salt pork, and barbecued pork); 20117 and 20137 (sausage, such as fresh and dry sausage, frankfurters and jellied goods). Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions.

tables are the number of disclosure violations for the processed pork with slaughter plants and the sausage with slaughter plants. By 1992, only one size category for each of these industry categories could be reported. By contrast, all of the table statistics by the processed pork and sausage plants that do not slaughter could be reported. Since output does not vary substantially between the types of processed pork plants and the two kinds of packed meat plants, the vastly larger number of disclosure violations for processing plants with live animal inputs suggests a decline in live animal input usage in pork processing and sausage plants.

Animal Input Species Specialization

Census data also provide details on input mixes. The data show that large slaughter plants increasingly specialize in a single species (Table 1.15). For example, in 1963, large beef packing plants slaughtered a large number of hogs and lambs. By 1992, however, large beef packing plants slaughtered only cattle. The rise in animal species specialization at the large plants (over 99 employees) over the 1963-92 period, particularly in the largest beef slaughter plants, suggests a substantial change in the production processes in these plants. There was only a modest change in animal species specialization in the smaller plants.

Table 1.16 indicates that both chicken and turkey slaughter plants had an increase in animal input specialization over the 1963-92 period. Chicken plant animal input specialization exceeded 92 percent and turkey input specialization was 100 percent by 1992. Additionally, the failures to meet disclosure requirements in the smallest size category in 1992 and the largest size categories in 1963 suggest a shift over time to larger plant size.

TABLE 1.15 Share (%) of Live Cattle or Hog Animal Input Costs in the Beef or Pork Slaughter Industries

Slaughter Industry	Animal Input	Employees	Year						
			1963	1967	1972	1977	1982	1987	1992
Beef	Cattle	0-24	81.6	82.3	84.8	86.7	89.9	87.3	d
		25-99	82.0	85.2	88.4	90.2	88.4	88.2	84.6
		100-399	75.1	79.3	90.4	93.0	90.3	93.6	98.4
		over 399	52.5	60.2	67.6	81.3	92.1	99.2	100
Pork	Hogs	0-24	75.8	77.2	71.1	d	d	d	d
		25-99	80.6	78.7	86.7	82.7	88.0	90.0	88.7
		100-399	83.5	87.5	94.4	90.8	98.4	93.3	99.7
		over 399	84.5	79.0	90.9	94.3	93.4	97.4	98.9

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The slaughter industries refer to five digit SIC codes 20111 (beef) and 20114 (pork). Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions.

TABLE 1.16 Share (%) of Chicken or Turkeys Live Animal Input Costs in the Chicken and Turkey Slaughter Industries

Slaughter Industry	Animal Input	Employees	Year						
			1963	1967	1972	1977	1982	1987	1992
Chicken	Chickens	0-24	50.0	0.0	d	d	d	d	d
		25-99	85.8	85.5	93.6	98.8	89.6	d	d
		100-399	91.4	93.1	98.1	99.2	98.2	98.3	92.4
		over 399	d	83.0	96.5	95.7	99.6	99.9	99.0
Turkey	Turkeys	0-24	d	d	d	d	d	d	d
		25-99	93.2	93.9	98.4	100	d	d	d
		100-399	91.5	95.3	97.9	97.5	98.7	100	100
		over 399	d	d	d	d	d	99.9	100

Source: Authors' tabulations, using the Longitudinal Research Database (LRD) at the Center for Economic Studies, U.S. Bureau of the Census. The slaughter industries refer to five digit SIC codes 20151 (chicken) and 20153 (turkey). Entries labeled "d" represent shares that could not be disclosed due to confidentiality restrictions.

Discussion

Tables 1.1 and 1.2 indicate that 1963-92 was a period of rising industry concentration accompanied by a sharp increase in the importance of large plants, especially in slaughter. Tables 1.3 through 1.16 show how this may have come about. Entry plant market share is about 9 percent over each five year Census period in beef and pork slaughter and chicken and turkey slaughter and 7 percent over each five year Census period in pork processing and sausage after 1972. At this rate, it would take more than 50 years to replace all existing industry capacity. Accordingly, it does not appear that a change in plant embodied technology, which includes changes in geographic location and the amenability of a building to the most efficient production process, was a major contributor to recent structural changes. Consistent with this view, the greater market share of acquired plants than that of entry plants suggests that both incumbent and entry firms found it less costly to buy existing plants than to build new facilities.

Although the physical shape and location of the plant may not have changed substantially, the production processes within plants changed dramatically. In each of the slaughter industries, the largest plants performed substantially more processing of carcasses into boxed meat, traypack, or turkey parts products. Smaller plants tended to produce more carcasses. This difference is particularly distinct for the beef slaughter industry. Over the 1963-92 period, plants with over 399 employees increased boxed beef production from less than 10 percent to more than 60 percent of their output. Over the same period, these plants decreased carcass production from about 30 percent to less than 5 percent and pork products production from more than 15 percent to 0 percent. Plants in the three size categories with less than 400 employees, on the other hand, obtained less than 20 percent of their sales from boxed meat products and had more than 30 percent of their sales from carcasses in 1992.

Increases in animal input species specialization and changes in the composition of output for beef slaughter plants with over 399 employees and for the other slaughter industries with over 99 employees suggest distinct production technologies for large and small slaughter plants. In each of these industries,

a substantial portion of the output of larger plants comes from boxed or traypack products. Smaller plants, however, produce more carcasses of animals of various types. Accordingly, it appears that a segmented market exists in which the larger plants use one animal species to produce fabricated products and smaller plants use multiple species and derive a major share of their output from the sale of animal carcasses.

Combining the changes in product output composition and input animal species specialization with an increasing rate of plant acquisitions suggests that incumbents and entrant firms bought existing firm capacity and then made major changes to the production processes. These production changes increased plant scale economies and enabled meat and poultry slaughter plants to better meet market demands for more boxed meat, chicken traypack, and turkey parts products. As a result, small entry plants both declined in number and had a much lower survival rate than did large plants. Accordingly, it appears plausible that the increase in market concentration and large plant importance in all of the slaughter industries stems from a shift to greater economies of scale for larger plants, which may be better able to meet more complex market needs in which chicken traypacks, turkey parts, and boxed beef or pork play a major role. Moreover, the clear association between plant size and product mix suggests that analyses of scale economies need to explicitly account for the role of product mix in affecting costs, revenues, and realization of scale economies.

In contrast to slaughter plants, pork processors and sausage producers, which produce many finished niche products, had less to gain from greater scale economies and little or no opportunity to branch into additional downstream processing. As a result, the pork processing and sausage industries underwent less change than the slaughter industries.

Although there was a consolidation and a shift to larger scale plants in each of the industries in our sample, firm entry still played a major role in the industry in 1992. Entry firms with either entry or incumbent plants accounted for about 20 percent of the plants in each of the industries. Of this 20 percent, firm entry by plant acquisition rather than with a new plant became more common, rising to about 32 percent of all firm entrants in the beef and pork slaughter industries and over half of all firm entrants in the chicken and turkey slaughter and processing and the pork processing and sausage industries by 1992.

The data also gives insights into the likely impact of HACCP-type regulation on industry structure. A major concern has been the potential effect of regulation on small plants. Tables 1.9 and 1.11 show that over the 1963-92 period only one out of every five small entry plants survived from one Census year to the next in the beef and pork slaughter and pork processing and sausage industries. Small plant entry into the poultry and turkey slaughter and processing industries was almost nonexistent. Combined these trends suggest that any impact of HACCP-type regulation would be difficult to distinguish from the natural economic forces affecting small plant survival.

Notes

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²We define plants with over 399 employees as large in order to avoid disclosure violations and thus maintain comparability across years and industries, while retaining a suitable definition of a large plant. Our measures of concentration are based on value of shipments, and hence may differ from those

published by the Packers and Stockyards Administration, which are based on the number of head slaughtered.

³Net exit rates can be computed by adding entrants for the current Census year to the number of plants in the industry in the previous Census year and then subtracting the number of plants in the current Census year. For example, net exit in beef and pork slaughter over the 1963 to 1967 period was 373 plants.

⁴Plant embodied technological change does not include the arrangement or vintage of processing machinery, the interaction of machinery and personnel, or management expertise. As a result, there may be dramatic changes in the capacity and average costs of an existing plant because of equipment changes, machinery rearrangements, and worker training that will not be reflected in plant embodied technological change.

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