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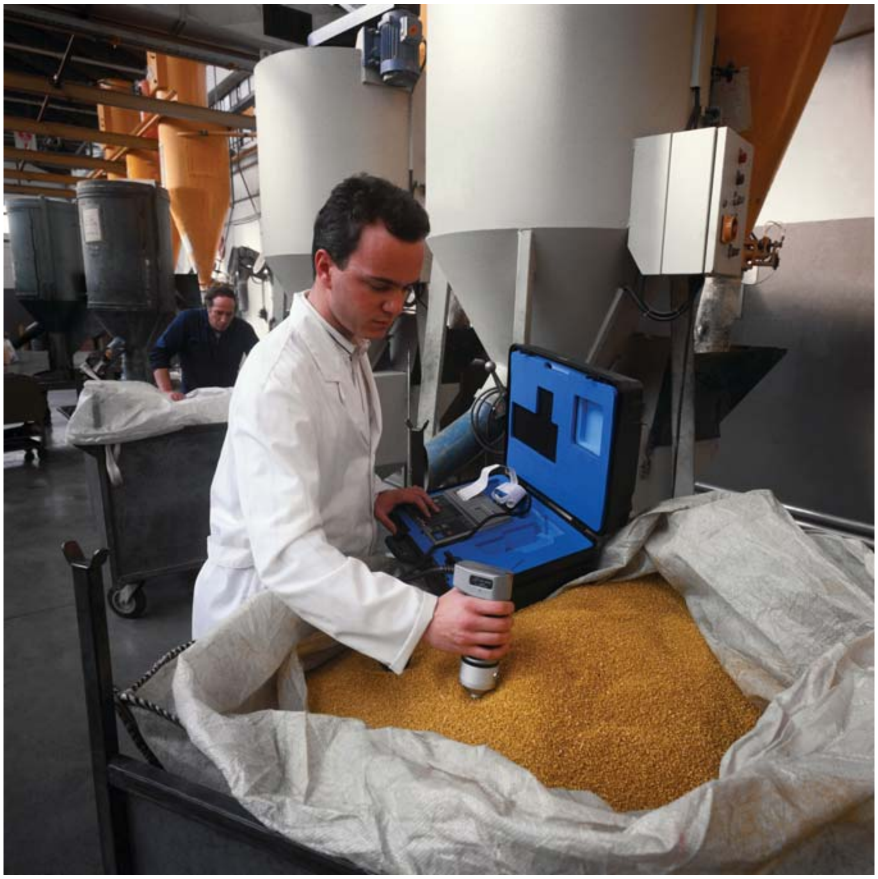

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Abstract

Processing plants in eight major food industries were highly productive before being acquired and they significantly improved their labor productivity afterward, Economic Research Service and U.S. Census Bureau researchers found in their analysis of Census data. The plant-level data on production inputs and costs provided a detailed picture of food-production facilities involved in mergers and acquisitions. The industries are meatpacking, meat processing, poultry slaughtering and processing, cheese making, fluid milk processing, flour milling, feed processing, and oilseed crushing. The analysis suggests that mergers and acquisitions contributed to the general improvement in labor productivity, echoing an earlier ERS study. Labor productivity is defined as output per worker.

Keywords: Mergers, acquisitions, labor productivity, consolidation, structural change

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Contents

Summary

Mergers and acquisitions in the U.S. food industry have provoked controversy for many years. Critics are concerned that mergers, by reducing the numbers of firms and increasing industry concentration, make it easier for firms to increase output prices and lower wages and input prices. Others argue that mergers and acquisitions (M&As) increase efficiencies and boost productivity by allowing companies to lower costs and provide consumers with goods at lower prices.

What Is the Issue?

Until 1977, consolidation was not much of an issue for most food industries. At that time, the average four-firm concentration ratios for eight food industries—meatpacking, meat processing, poultry slaughter and processing, cheese making, fluid milk processing, flour milling, feed processing, and oilseed crushing (soybean, cottonseed, and corn)—were about 31 percent. A wave of mergers and acquisitions led to a jump in average concentration to about 44 percent by 1992. Were these M&As efficient, and did acquired companies increase their productivity after being acquired?

What Did the Study Find?

Labor productivity, or output per worker, is one measure of production efficiency. Using U.S. Census Bureau plant-level data to examine processing plants in eight food industries, ERS and Census researchers found that processing plants in eight major food industries were highly productive before being acquired and they significantly improved their labor productivity afterward. The analysis suggests that mergers and acquisitions contributed to the general improvement in labor productivity, echoing an earlier ERS study.

These results for M&As and labor productivity are not entirely consistent with previous research. Other researchers found that large acquired plants had below-average productivity prior to their acquisitions, but the ERS and Census researchers found that both large and small plants had above-average labor productivity before their mergers. Productivity growth results also differed somewhat.

These differences and substantial variation in estimated effects across the eight industries suggest that conduct and performance of individual industries differ from that of a broadly defined sector such as the entire food industry. Studies at the individual-industry level are necessary to evaluate the impact of certain types of economic activity, such as M&As.

How Was the Study Conducted?

By using plant-level Census of Manufacturers data from the U.S. Census Bureau, researchers obtained a detailed picture of plant outputs, inputs of labor and materials, costs of production, and plant assets. These data also allow researchers to trace plants across time and ownership status. The research concentrated on two merger waves, 1977-82 and 1982-87, which encompass particularly active times for M&As in an era of structural change

that persists to this day. In the productivity performance analyses, the labor productivity of plants acquired over 1977-82 and 1982-87 was compared with control groups of plants that were not acquired. For productivity growth, researchers evaluated plant productivity growth over 10-year periods (1977-87 and 1982-92).

Introduction

Mergers and acquisitions have been sources of controversy for many years, particularly during periods of major structural changes in the U.S. economy. Concern about economic changes occurring in meat and grain processing has led to criticism of the Grain Inspection, Packers and Stockyards Administration (GIPSA). Recent news reports discussed allegations of lax oversight by GIPSA (Martin, 2006). Additionally, Senator Tom Harkin (D-Iowa) supported the establishment of a special counsel at the U.S. Department of Agriculture to investigate price-fixing allegations (Brasher, 2006).

Consolidation was not much of an issue for most food industries until about 1977. At that time, the average four-firm concentration ratios for the eight food industries examined herein stood at about 31 percent. This marked the low point before industry consolidation, including a wave of mergers and acquisitions (M&As), led to a jump in average concentration to about 44 percent by 1992. Four-firm concentration ratios in some industries, such as meatpacking and poultry slaughter and processing, more than doubled (Ollinger et al., April 2005).

Firms in the meatpacking, meat processing, cheese making, fluid milk processing, flour milling, feed processing, and oilseed crushing (soybean, cottonseed, and corn) industries transferred about 20 percent of industry market share to other firms through M&As over each of three 5-year periods: 1977-82, 1982-87, and 1987-92 (Ollinger et al., April 2005). By contrast, M&As accounted for only about 7 percent of all output over 1972-77.

Output per worker improved dramatically during this period of rising concentration and M&A activity. The four major food industries identified in *Structural Change in the Meat, Poultry, Dairy, and Grain Processing Industries* (Ollinger et al., April 2005) doubled their output per worker, and three of the industries realized at least 50-percent increases in output per worker over 1972-92. Only two of nine industries failed to increase output per worker, and, one of them, poultry, experienced a vast increase in the processing of value-added products as plants switched from producing whole birds to producing poultry parts.

The M&As, combined with the rise in concentration of firms, particularly in beef packing, caused concern among policymakers. Congressional hearings in 1990 on company behavior in the purchase of live cattle, for example, led to a call for an examination of entry, exit, mergers, market shares, and other market factors affecting the industry. Charges of lax enforcement by GIPSA and a recent court case against Tyson's Beef alleging price fixing indicate that the interest in M&As, concentration, and structural change in food industries persists (MeatPoultry.com, accessed April 13, 2006).

This study's purpose is to evaluate the economic efficiency of M&As in eight meat and poultry, dairy, and grain processing industries over 1977-92. For consumers, greater efficiency in a competitive market can lead to lower prices because fewer resources are used to produce the same output. Labor productivity is used as a measure of economic efficiency (see later discussion) to evaluate the pre-acquisition plant performance and evaluate labor productivity growth over the subsequent 10-year period to determine if new management improved performance. Food production plants that are acquired yield efficiencies if productivity improves and generate synergies if the plants were productive before the acquisitions and then raise labor productivity to an even higher level afterward.[1]

M&As have been driven by slow growth in consumer demand for meat, dairy, and grain products and technological changes that have led to a sharp rise in output per worker and in plant sizes (Ollinger et al., April 2005). Over the past 5 years, high-profile M&As include the acquisitions of Iowa Beef Processors by Tyson and ConAgra by a private group in meat packing, Pillsbury by General Foods in flour milling, and parts of Dean Foods by Suiza in fluid milk processing.

The meatpacking, meat processing, poultry slaughtering and processing, cheese making, fluid milk processing, flour milling, feed processing, and oilseed crushing (wet corn milling and soybean and cottonseed processing) industries are examined for three reasons:

1) These industries are important buyers of farm products, providers of intermediate goods to other manufacturers, and suppliers of final food products to consumers.
2) Plants in these industries produce relatively homogeneous products, competing for customers based on price. This type of competition allows us to attribute labor productivity differences across plants to cost changes rather than product changes, such as new brands of cereal or ice cream.
3) Congress specifically called for studies of M&As in the food sector and competitiveness of the food processing industry remains an issue of public concern.

(Wet corn milling, soybean processing, and cottonseed crushing have been combined into one category because Census disclosure rules prevent publication of results from separate industries).

A unique feature of this analysis is the use of plant-level data from the Census of Manufacturers. The data provide a very detailed picture of plant outputs, inputs of labor and materials, costs of production, and plant assets. These data also allow researchers to trace plants across time and determine ownership status.

[1]If a plant is efficient prior to an acquisition and improves its productivity after acquisition, then profits will rise until competitors make adjustments and prices drop to a level equal to costs.

Merger and Acquisition Theories

Economists have promoted several competing theories of M&As. Among them are empire-building (Baumol, 1967; Mueller, 1969), furthering anti-competitive activities, such as monopoly power (Roll, 1986; Mueller, 1993), management-entrenchment (Shleifer and Vishny, 1989), and an overestimation of a manager's ability to improve the performance of a target he or she perceives to be underperforming (Roll, 1986). The theory most relevant to this study is that inefficient plants and firms are taken over and efficient firms survive (Manne, 1965; Mead, 1968; Jensen, 1988).

Theories of M&As are not mutually exclusive. A firm could, for example, seek to gain market power and at the same time be building an empire and believe that it can more efficiently manage the business of a firm or plant it has targeted as a potential acquisition.

The two leading M&A efficiency theories are the disciplinary and synergistic merger motives:

- Disciplinary mergers theory suggests that M&As discipline target firms' managers who pursue objectives other than profit maximization. Managers who do not maximize profits presumably would focus attention on goals other than profitability. Since this difference in focus can come at the expense of operating efficiency, a firm's performance may suffer. Poor performance does not go unnoticed, however. Opportunistic buyers may observe the poor performance accompanied by good assets and discipline the poorly performing plant by acquiring it. Thus, the disciplinary theory suggests that acquiring firms merge with poorly performing targets and improve their performance as new management realizes the full potential of a target's assets.
- Synergistic mergers theory holds that firm managers achieve efficiency gains by combining an efficient target with their business and then improving the target's performance. Buyers recognize specific complementarities between their business and that of the target. Thus, even though the target is already performing well, it should perform even better when it is combined with its complementary counterpart, the buyer firm. The synergistic theory implies that target firms (or plants) perform well both before and after mergers.

Empirical research evaluating the efficiency of M&As has generated mixed results. Connor and Geithman (1988) remind us that many economic studies have shown that returns to acquiring firms are zero or negative. Finance-study reviews (Jensen and Ruback, 1983; Smith, 1986) and industrial-organization studies (Mueller and Burkhard, 1999; Bhuyan, 2002) found little evidence of efficiency gains from M&As. However, Lichtenberg and Siegel (1992a), who used a balanced panel of large continuous U.S. manufacturing plants from the U.S. Census Bureau's Longitudinal Research Database, found that ownership changes are negatively related to plants' pre-acquisition labor productivity and that acquired plants had significantly improved labor productivity after mergers. They concluded that ownership change is motivated by lapses in productive efficiency.

McGuckin and Nguyen (1995), on the other hand, found that ownership change is positively related to initial labor productivity and labor productivity growth for small plants but not for large ones. They concluded that buyer firms acquire poorly performing large targets because they are good assets that appeared to be worth fixing and make smaller acquisitions for synergistic reasons.

The two studies dealing only with manufacturing (Lichtenberg and Siegel, 1992a; and McGuckin and Nguyen, 1995) are important in assessing the efficiencies gained from M&As in manufacturing. However, they either used data for the entire U.S. manufacturing sector (Lichtenberg and Siegel, 1992a) or for a broadly defined industry, such as the entire U.S. food and beverage industry (McGuckin and Nguyen, 1995). Thus, their results may not hold for the more narrowly defined four-digit Standard Industrial Classification (SIC) industries, such as meatpacking, examined in this report.

This report differs from previous research in several ways. First, it generalizes McGuckin and Nguyen's (1995) study by considering two merger periods—1977-82 and 1982-1987. Second, it looks at much more narrowly defined industries. Third, several factors that were not considered in previous studies are shown here to affect acquisition choice and productivity growth. Finally and more technically, ownership change is treated as endogenous, making the final result more statistically valid.

Production Plants as Appropriate Units of Analysis

We used a plant-level productivity analysis to evaluate the performance of mergers and acquisitions. There are two primary reasons for adopting a plant-level approach. First, many times it is impossible to distinguish acquiring firms from selling firms. A buying firm could buy another firm in its entirety, or some of a firm's plants in one or more industries, or single plants. Similarly, a selling firm could sell all or just some of its plants. Finally, a firm can be both a buyer and a seller, buying plants in one or more industries while also selling plants in one or more industries. These various possibilities mean that measures of firm-level labor productivity may differ markedly from plant-level measures, yet only plants are involved in the transactions. A plant-level analysis avoids this problem because the unit of analysis—the plant—is clearly defined.

Second, in cost-driven industries, firm labor productivity is a composite of the productivities of all of its plants, i.e., the average performance of all of a firm's plants. Yet a firm could have plants that perform superbly and others that fare poorly, making some plants more highly valued assets and others less important. Plants, on the other hand, are stand-alone units with no ambiguity over labor productivity, yielding a clear performance measure.

A recent transaction clarifies this point about the importance of a plant-level analysis. ConAgra sold some of its meat and poultry plants, but the company still produces turkeys and some other meat and poultry products and remains an independent company. In our framework, ConAgra is a seller of plants, but it also may be a buyer, and it remains an independent firm.

Plant-level analysis does not ignore the firm. The firm remains the ultimate decisionmaker, with the capacity to shift resources among the industries that it regards most profitable, and always has the option of selling itself completely. This means that, if we want to know whether a merger was a complete or partial acquisition (only one plant or all plants of the firm are sold), all of the plants owned by firms must be evaluated.

Those plants include:

1) plants within a selected food industry, e.g., meatpacking plants;
2) food plants outside the eight industries we examine but that are owned by a firm that produces within one of the eight industries, e.g., a plant that produces candy and is owned by a firm that owns a meatpacking plant; and
3) plants producing nonfood goods but owned by a firm that also owns plants in one of the eight food industries in our study, e.g., plants that produce cans but are owned by a firm that also owns a meatpacking plant.[2]

[2]Census disclosure rules prevented us from disclosing information about partial and complete divestitures (the sale of some or all of a firm's plants); thus, we had to remove all empirical analyses of divestitures from this report.

Two Census Bureau Datasets

Census of Manufacturers data from the U.S. Census Bureau's Longitudinal Research Database (LRD) and Ownership Change Database (OCD) are used for 1972, 1977, 1982, 1987, and 1992. Only census years are used because these data contain all plants (non-census year data include only a sample of plants). The years 1977-92 were chosen because this period encompasses the beginning and ending years of the latest merger movement for which all data were available.

Longitudinal Research Database: The LRD is a powerful and unique dataset that permits researchers to conduct a wide variety of analyses based on detailed, plant-level data. The data include the value of shipments and units produced at up to the seven-digit SIC code level of detail, material inputs at the six-digit level (e.g., cattle inputs for beef packing), wages and other labor costs, the number of production and total employees, production hours, material and other nonlabor costs, value-added, historical values of property, plant, and equipment, capital purchases, energy consumption and costs, and selected purchased services. An important feature of the LRD is its plant classification and identification information: firm affiliation, location, product and industry, and various status codes that identify birth, death, and ownership changes. Researchers can use these identifying codes to link plants across time and determine plant ownership. For a more complete description of the LRD, see McGuckin and Pascoe (1988). For a detailed discussion of the identification of ownership changes through mergers and acquisitions, see Nguyen (1998).

Ownership Change Database: The OCD contains U.S. manufacturing plants that were acquired at least once over 1963-92. The OCD was used to identify all meat, poultry, dairy, and grain plants acquired during the 1977-82 and 1982-87 periods. After noting firm ownership, all manufacturing plants were identified that were owned by acquiring (buyer) and nonacquiring (nonbuyer) firms at the beginning of each period (1977 or 1982). This identification included all plants owned by firms with meat, poultry, dairy, or grain operations, regardless of whether they were in the target industry or not. Thus, the sample of plants owned by firms in each target industry is greater than the number of plants in that industry because plants owned by target industry firms include food plants in the target industry, food plants outside the target industry, and nonfood plants. Nonfood plants were included in the analysis in order to account for complete divestitures.

Five-Year and 10-Year Study Periods Used

We analyzed differences in pre-merger labor productivity between acquired and nonacquired plants for 1977-82 and 1982-87. In Census Bureau files, plants acquired over 1977-82 appear in the 1977 data as being owned by one firm and appear in the next census (1982) as being owned by a different firm. Since there are no data for the intervening years, the plant could have been acquired in 1977, 1978, 1979, 1980, or 1981. Pre-merger labor productivity for all firms would be labor productivity for 1977 for all plants. Similarly, plants acquired over 1982-87 would appear in the 1982 census as being owned by one firm and in the 1987 census as being owned by a different firm. The acquisition could take place in 1982, 1983, 1984, 1985, or 1986. Pre-merger labor productivity would be labor productivity of 1982 for all plants.

In the second analysis, we assessed the effect of being acquired on labor productivity growth over 1977-87 for plants acquired over 1977-82 and on labor productivity growth over 1982-92 for plants purchased from 1982-87. The 1977-87 and 1982-92 time periods were used because these periods give firms 6 to 10 years to close, sell, or retain plants they acquire. A 6-year time period occurs for plants acquired in 1981 for the 1977-82 merger wave or 1986 for the merger wave of 1982-87. Similarly, a 10-year period occurs for plants in either 1977 for the 1977-82 merger wave or 1982 for the merger wave of 1982-87. If only a 5-year period were used and a plant were acquired in 1981, which is in the first merger wave, then the firm might have only 1 year until the next census in 1982 to determine about what to do with the plant (close, sell, or keep it). By extending the study period to the 1987 census year, we give firms at least 6 years to decide what to do with an acquisition.

A rationale similar to that used for choosing the 1977-87 study period for the 1977-82 merger wave guides the use of the 1982-92 study period for plants acquired over 1982-87. Given a 1982-92 period, firms would have 6 years to consider the viability of plants acquired in 1986 and 10 years for plants obtained in 1982.

In the analyses of the labor productivity of acquired plants, all variables were defined in terms of pre-acquisition values and were taken from the 1977 census for the 1977-82 merger wave and 1982 for the 1982-87 merger wave. In the productivity growth analysis, productivity growth over 1977-87 and 1982-92 was examined. For the 1977-87 analysis, pre-acquisition conditions are taken from the 1977 census and post-acquisition characteristics are taken from the 1987 census. Changes are the differences between final and initial values, i.e., differences in 1987 and 1977 values. Similarly, for the 1982-92 analysis, pre-acquisition conditions from the 1982 census and final values from the 1992 census were taken. Changes are differences between the final values from the 1992 census and initial values from 1982 census.

Acquired Plants Are More Likely To Survive Than Nonacquired Plants

Tables 1 and 2 show the disposition of plants (acquired, kept, or closed) over 1977-87 and 1982-92 by ownership type (buyer or nonbuyer firm). The first row of table 1, top panel, gives the number of plants that firms acquired over 1977-82 and kept until 1987. The next two rows provide the number of plants firms acquired over 1977-82 and either sold or closed by 1987.[3] These data indicate that buyer firms kept about half the plants they acquired, closed about 25 percent, and sold about 25 percent. Although firms held and closed higher percentages of plants over 1982-92, the overall pattern remained similar.

[3]A plant purchased over 1977-82 could have been closed by 1982, e.g., the plant could have been acquired in 1978 and closed in 1981.

The second panel shows the disposition by 1987 of the plants that buyer firms owned in 1977. It indicates that, by 1987, buyer firms retained only 35 percent of the plants they had owned in 1977. Buyer firms sold about 30

Table 1
Firms keep proportionately more acquired plants than nonacquired plants, 1977-87, in eight food industries

Disposition of plants	Meat-packing	Meat processing	Poultry	Cheese	Fluid milk	Flour	Feed	Oilseeds	Total
					Number				
Plants acquired 1977-82:									
Plants kept 1977-87[1]	118	70	157	119	197	178	215	170	1,224
Plants sold by 1987	56	66	94	43	99	38	106	55	557
Plants closed by 1987	77	42	61	59	109	67	118	66	599
Total acquired plants	251	178	312	221	405	283	439	291	2,380
Plants owned by buyer firms in 1977:									
Plants kept 1977-87	210	*	235	*	337	*	290	*	1,072[2]
Plants kept in 1982 but sold by 1987	209	*	135	*	278	*	275	*	897[1]
Plants closed by 1982[3]	187	*	85	*	216	*	171	*	659[2]
Plants closed by 1987	78	*	63	*	140	*	96	*	377[2]
Total buyer plants	684	*	518	*	971	*	832	*	3,005[2]
Plants owned by nonbuyer firms in 1977:									
Plants kept 1977-87	610	604[4]	169	482[4]	494	578[4]	628	318[4]	3,883[4]
Plants kept in 1982 but sold by 1987	35	197[4]	26	52[4]	37	266[4]	37	143[4]	793[4]
Plants closed by 1982[3]	1,073	395[4]	160	292[4]	641	319[4]	502	80[4]	3,462[4]
Plants closed by 1987	324	430[4]	87	152[4]	249	187[4]	252	152[4]	1,833[4]
Total nonbuyer plants	2,042	1,626[4]	442	978[4]	1,421	1,350[4]	1,419	693[4]	9,971[4]
Total plants	2,977	1,804	1,272	1,199	2,797	1,633	2,690	984	15,356

*Buyer and nonbuyer firms are combined due to potential disclosure violations.
[1]Plant was purchased in 1977, 1978, 1979, 1980, or 1981 and still was owned by buyer in 1987. The convention for the other entries is similar.
[2]Does not include buyer plants in which there are disclosure violations.
[3]Plants were open in 1977 but were closed in 1978 or 1979-81.
[4]Includes buyer and nonbuyer firms in instances where there were insufficient observations for one to stand alone and not be a disclosure violation.

Source: ERS estimates based on U.S. Census Bureau data. Industries include meatpacking, meat processing, poultry slaughter and processing, fluid milk processing, cheese making, flour milling, feed processing, and the combined industry of wet corn milling and cottonseed and soybean crushing.

Table 2

Firms close proportionately more nonacquired plants than acquired plants, 1982-92, in eight food industries

Disposition of plants	Meat-packing	Meat processing	Poultry	Cheese	Fluid milk	Flour	Feed	Oilseeds	Total
					Number				
Plants acquired 1982-87:									
Plants kept 1982-92[1]	145	190	184	75	142	268	273	297	1,574
Plants sold by 1992	21	99	94	50	77	81	**	49	371
Plants closed by 1992	60	92	76	50	114	131	129	107	759
Total acquired plants	226	381	505	175	333	480	4,021	453	2,804
Plants owned by buyer firms in 1982:									
Plants kept 1982-92	195	271	260	152	221	217	274	*	1,590
Plants kept in 1987 but sold by 1992	*	99	*	*	*	*	*	*	99
Plants closed by 1987[3]	63	137	154	*	170	*	121	*	645
Plants closed by 1992	*	54	44	*	85	*	43	*	226
Total buyer plants	258[1]	561	408	152[2]	476	217[2]	438	*	2,560[2]
Plants owned by nonbuyer firms in 1982:									
Plants kept 1982-92	541	598	178	247	422	416	626	492[4]	3,520
Plants kept in 1987 but sold by 1992	454	18	97[4]	92[4]	169[4]	624	624	129[4]	674
Plants closed by 1987[3]	479	355	120	254[4]	271	265[4]	350	205[4]	2,299
Plants closed by 1992	318[4]	205	50	155[4]	152	123[4]	221	95[4]	1,319
Total nonbuyer plants	1,383[4]	1,176	4454	748[4]	1,014 [4]	866[4]	1,259[4]	921[4]	7,812[4]
Total plants	1,867	2,078	1,207	1,079	1,823	1,563	2,099	1,374	13,176

* Buyer and nonbuyer firms are combined due to potential disclosure violations.

** Combined with acquired over 1982-87 and sold by 1992 due to potential disclosure violation.

[1]This means that a plant was purchased in 1982, 1983, 1984, 1985, or 1986 and still was owned by the buyer in 1992. The convention for the other entries is similar.

[2]Does not include buyer plants in which there are disclosure violations.

[3]Plants were open in 1982 but were closed in 1983 or 1984-86.

[4]Includes plants of buyer and nonbuyer firms for cells in which there were insufficient observations for one to stand alone and not be a disclosure violation.

Source: ERS estimates based on U.S. Census Bureau data. Industries include meatpacking, meat processing, poultry slaughter and processing, fluid milk processing, cheese making, flour milling, feed processing, and the combined industry of wet corn milling and cottonseed and soybean crushing.

percent of the plants they had owned in 1977 over 1982-87 after keeping them until 1982 and shut down about 35 percent of the plants they had held in 1977 by either 1982 or 1987. The third panel is similar to the second except it provides the distribution by 1987 of the plants owned in 1977 by nonbuyer firms. It reveals that nonbuyer firms kept about 40 percent of the plants they owned in 1977 over 1977-87, sold about 10 percent of the plants they had owned in 1977 over the census period from 1982-87, and closed about half the plants they had owned in 1977, by either 1982 or 1987. A similar pattern holds for 1982-92.

Labor Productivity Is Higher for Acquired Plants

Table 3 shows the 1977 and 1982 mean relative labor productivities for the same categories of plants identified in tables 1 and 2. All labor productivity values are normalized to their sample means. Normalization assigns a value of one to the industry average. Plants with normalized relative labor productivity below one have below-average labor productivity and plants with normalized labor productivity greater than one have above-average labor productivity.

The table shows that acquired plants (panel 1) and the plants of buyer firms (panel 2) had above-average labor productivity (index values greater than 1) for all categories except plants owned by buyer firms in 1977 and closed by 1982. By contrast, the plants that nonbuyer firms kept (panel 3) had below-average labor productivity and the plants they sold had above-average labor productivity. These data indicate that nonbuying firms sold their most productive plants and kept less productive ones. Buyers, in contrast, kept their most productive plants and closed or resold less productive ones.[4]

Table 3 suggests that firms purchase highly performing plants. However, since plant size and other factors could account for labor productivity differences, we conducted regression analyses to isolate labor productivity effects from other sources of change. The effect of labor productivity on whether a plant was acquired was examined and then we determined whether acquired plants improved their labor productivity over two Censuses (6-10 years). In both regressions, plant size and some other variables representing sources of change serve as control variables.

Relative Labor Productivity Removes Inflationary Biases

Labor productivity is recognized by many economists as an accurate reflection of production performance and has been used by numerous authors, including McGuckin and Nguyen (1995), to evaluate plant performance. Economists have measured labor productivity in several different ways. The two most common approaches are output per unit of input, such as labor (labor productivity), and output from all inputs, total factor labor productivity (TFP). Theoretically, TFP is superior because it takes into account all inputs, but, since plant material input data are not available for all plants, we use labor productivity.

[4]The labor productivity of closed plants could be overstated because it is likely that sales from inventory and labor reductions around the time of closing may have "inflated" labor productivity. Additionally, plants could be identified as "closed" that actually were reclassified as nonmanufacturing plants. These plants would have disappeared from the Census of Manufacturers because the majority of their output (sales) comes from nonmanufacturing. For example, cold storage plants often do some meat processing. If meat processing sales decline, the facility could be reclassified as a storage plant and disappear from the Census of Manufacturers.

Table 3

Acquired plants have higher initial labor productivity than plants owned by nonbuyer firms over 1977-87 and 1982-92 in eight food industries

Disposition of plants	1977-87 Number of plants	1977-87 Labor productivity relative to sample mean	1982-92 Number of plants	1982-92 Labor productivity relative to sample mean
Plants acquired 1977-92:				
Plants kept until 1987 or 1992	1,224	1.160	1,575	1.211
Plants sold by 1987 or 1992	567	1.020	471[1]	1.084[1]
Plants closed by 1987 or 1992	589	1.090	759[2]	1.008[2]
Total acquired plants	2,380	----	2,805	---
Plants of buyer firms:				
Plants kept until 1987 or 1992	3,054[3]	1.175[3]	2,082[4]	1.291[4]
Plants sold by 1987 or 1992	1,555[3]	1.102[3]	759[5]	1.289[5]
Plants closed by 1982 or 1987	1,817[3]	0.941[3]	1,300[6]	1.116[6]
Plants closed by 1987 or 1992	1,226[3]	1.101[3]	936[7]	1.033[7]
Total plants of buyers	7,652[3]	---	5,077	---
Plants of nonbuyer firms:				
Plants kept until 1987 or 1992	1,901[8]	0.856[8]	3,028[9]	0.896[9]
Plants sold by 1987 or 1992	135[8]	1.117[8]	18[10]	1.406[10]
Plants closed by 1982 or 1987	2376[8]	0.826[8]	1,609[11]	0.819[11]
Plants closed by 1987 or 1992	912[8]	0.863[8]	622[12]	0.861[12]
Total plants of nonbuyers	5,324[8]	---	5,277	---
All plants	15,356	---	13,159	---

--- = Not applicable.
[1]Excludes feed plants.
[2]Includes feed plants sold by the end of the period.
[3]Includes nonbuyer meat processing, cheese making, flour milling, and oilseed crushing plants due to disclosure rule conflicts.
[4]Includes nonbuyer oilseed plants.
[5]Includes nonbuyer meatpacking, poultry slaughtering and processing, fluid milk processing, cheese making, flour milling, feed processing, and oilseed crushing plants.
[6]Includes nonbuyer cheese making, flour milling, and oilseed crushing plants.
[7]Includes nonbuyer meatpacking, cheese making, flour milling, and oilseed crushing plants.
[8]Excludes nonbuyer meat processing, cheese making, flour milling, and oilseed crushing plants due to disclosure rules.
[9]Excludes oilseed crushing plants.
[10]Only meat processing plants included.
[11]Excludes cheese making, flour milling, and oilseed crushing plants.
[12]Excludes meatpacking, cheese making, flour milling, and oilseed crushing plants.

Source: ERS estimates based on U.S. Census Bureau data. Industries include meatpacking, meat processing, poultry slaughter and processing, fluid milk processing, cheese making, flour milling, feed processing, and the combined industry of wet corn milling and cottonseed and soybean crushing.

We would like to define labor productivity as real output divided by labor inputs. However, the only available measure of output—the total value of shipments—is in nominal dollars, and varies with inflation. To account for inflation, it would be ideal to adjust the nominal values with a deflator that is based on a portfolio of products that do not change over time. Unfortunately, output prices are not available, and we cannot construct such a deflator.[5] As an alternative, we use relative labor productivity (RLP)—the ratio of plant labor productivity (LP) to average industry labor productivity (ALP). Labor productivity equals the value of total value of shipments, in current dollars, divided by plant production worker hours. Relative labor productivity deflates the plant's value of shipments by the price changes encountered by the entire industry, and, since different portfolios of products have different values, it also adjusts for industrywide changes in output mix. Thus, above-average plants must produce more of the same type of output per worker, the same quantity of higher value products per worker, or both more and higher value output per worker. Mathematically, it is defined as:

$$RLP_{ij} = LP_{ij} / ALP_j , \qquad (1)$$

where i and j denote plant i and four-digit SIC industry j, respectively. Plant labor productivity (LP) is defined as the total value of shipments in current dollars divided by total work hours for plant i in industry j and ALP is the sum of all labor productivities of all plants in an industry divided by the number of plants in that industry, $\left(\sum LP_{ij} / N_j\right)$[6].

[5]Using plant-level 1982 Census of Manufacturers data, Abbot (1989) found that seven-digit product level prices vary substantially across plants.

[6]This relative labor productivity ranking approach was suggested by Christensen et. al. (1981), and has been applied in recent labor productivity analyses using plant level data from the LRD (e.g., Bartelsman and Dhrymes, 1992; Bailey et al., 1992, McGuckin and Nguyen, 1995). An important property of this labor productivity measure is that it does not depend on an output deflator because output in all plants is measured in current-year dollars. Accordingly, it can be used in intertemporal comparisons (see Bailey et al., 1992, p. 192).

Acquired Plants Have Higher Initial Labor Productivity Than Nonacquired Plants

We constructed an empirical econometric model similar to one used by McGuckin and Nguyen (1995) and Lichtenberg and Siegel (1992a) to examine the impact of pre-acquisition plant labor productivity on ownership change. With this model, we accounted for intervening factors and were able to evaluate whether plants bought "good assets," i.e., highly productive plants or "bad assets," i.e., poorly performing plants. A full description of the model and definitions of all the variables are provided in the appendix. The key variables are labor productivity (as defined earlier), plant size (total number of employees), and plant specialization (value of a plant's primary product as a share of the value of plant shipments). Primary products are the major products of a plant. For example, primary products for meatpacking plants include ground beef, boxed beef, carcasses, etc. All other products, such as poultry products or nonmeat products, are considered secondary products.

Econometric results of the full model are given in appendix tables 1, 2, and 3. Columns 1, 3, and 5 for appendix tables 1 and 3; and columns 1 and 3 only for appendix table 2 have the 1977-82 results. Columns 2, 4, and 6 for appendix tables 1 and 3; and columns 2 and 4 only for appendix table 2 contain the 1982-87 results. The models are highly significant in all cases. Results shown in the tables indicate that initial relative labor productivity, plant size, and plant specialization have generally significant and positive effects on mergers and acquisitions, i.e., encourage a buyer to make an acquisition, when all other factors are held constant.

Only cheese (both periods) and fluid milk and oilseeds for 1977-82 deviate from the positive and significant pattern for labor productivity. Cheese making for 1977-82 has a negative coefficient while the others are positive but not significant. The negative coefficient for plant size for oilseeds plants is the only unexpected result for plant size. Coefficients for specialization for meatpacking (1982-87), feed (1982-87), and oilseeds (both periods) differ from the expected positive results. Overall, the results are consistent with those of McGuckin and Nguyen (1995) in that buyer firms preferred to acquire large, highly specialized, and productive plants.

Our general finding that firms acquired productive plants differs from Lichtenberg and Siegel (1992a), who found that firms acquired less productive plants. There are two likely reasons. First, Lichtenberg and Siegel (1992a) considered all manufacturing plants with at least 250 employees. We, on the other hand, evaluated very specific food industries and plants of all sizes.[7] Second, our model controls for plant specialization while Lichtenberg and Siegel's (1992a) model does not.

To illustrate the importance of plant size and plant labor productivity in M&A decisions, we provide estimates of the probability of a plant's being acquired at selected percentiles of plant labor productivity and plant size (tables 4, 5, and 6). The tables clearly show that plant labor productivity and size are key determinants of the acquisition decision.

[7]As pointed out by an anonymous reviewer, we could directly compare our results with Lichtenberg and Siegel (1992a) by considering only plants with more than 250 workers. While this is a good suggestion, we cannot perform the analysis because census data access rules prevent us from doing so.

Table 4
Meat and poultry plant acquisition probability rises with plant size and labor productivity

Industry	Percentile for relative labor productivity	Percentile for total employment: 1977-82: 10	50	90	95	1982-87: 10	50	90	95
		Probability							
Meatpacking									
	10	0.21	1.03	3.86	4.86	0.06	0.93	6.86	10.32
	50	0.54	4.20	17.96	22.52	0.44	2.75	11.32	15.18
	90	0.86	7.71	31.67	38.69	2.38	7.35	18.03	21.86
	95	1.05	9.84	38.90	46.80	3.55	9.31	20.24	23.94
Meat processing									
	10	0.35	2.28	6.97	8.77	0.69	2.83	8.99	11.26
	50	0.57	4.10	12.61	15.74	1.80	6.94	19.72	23.94
	90	0.78	5.88	17.84	22.05	3.78	13.44	33.69	39.55
	95	0.88	6.80	20.42	25.12	4.68	16.17	38.83	45.08
Poultry slaughtering and processing									
	10	19.97	38.48	55.82	59.87	2.98	9.22	19.41	22.07
	50	27.56	49.70	67.82	71.68	4.68	14.88	30.44	34.24
	90	39.03	64.04	80.76	83.87	7.00	22.22	43.19	47.89
	95	43.26	68.62	84.33	87.11	8.20	25.80	48.82	53.75

Source: ERS estimates based on U.S. Census Bureau data and on the parameter estimates of the nonlinear probit model of plant acquisitions. Sample sizes: 2,977 plants for 1977-82 and 1,867 plants for 1982-87 in meatpacking, 1,804 plants for 1977-82 and 2,078 plants for 1982-87 in meat processing, and 1,272 plants for 1977-82 and 1,207 plants for 1982-87 in poultry slaughtering and processing.

Consider meatpacking as an example. The upper left-hand corner cell of table 4 indicates the probability that a meatpacking plant in the 10th percentile of relative labor productivity and 10th percentile of plant size in 1977 would be acquired over 1977-82. This probability is 0.21 percent.

Proceeding horizontally, a plant in the 95th percentile of size and 10th percentile of labor productivity in the meatpacking industry had a 4.86-percent probability of being acquired over 1977-82. Similarly, a plant in the 95th percentile of plant labor productivity and 10th percentile of plant size in the meatpacking industry had a 1.05-percent probability of being acquired. Finally, a plant in the 95th percentile of plant labor productivity and 95th percentile of plant size has about a 47-percent probability of being acquired. The last four columns in the table show the probabilities of being acquired by percentile and labor productivity for 1982-87. For meatpacking, they indicate a similar trend but with lower overall probabilities of being acquired.

The trend from lower probability to higher probability values as plant labor productivity and size increases is similar in 11 of the 16 cases shown in tables 7, 8, and 9. Plants in the 10th percentiles of plant size and labor productivity had less than a 5-percent probability of being acquired while plants in the 95th percentiles of plant size and labor productivity had probabilities of being acquired ranging from about 15 percent in fluid milk over 1982-87 to more than 57 percent in cheese making over 1977-82.

Table 5

Cheese and fluid milk plant acquisition probability rises with plant size and labor productivity in 1977-82 but not in 1982-87

		Percentile for total employment							
		1977-82				1982-87			
Industry	Percentile for relative labor productivity	10	50	90	95	10	50	90	95
		Probability							
Cheese making									
	10	2.22	6.23	12.20	13.71	0.00	0.01	0.23	0.47
	50	1.95	10.36	26.27	30.36	0.00	0.01	0.10	0.19
	90	1.75	15.05	42.26	48.68	0.00	0.00	0.04	0.07
	95	1.67	17.37	49.52	56.63	0.00	0.00	0.03	0.06
Fluid milk processing									
	10	2.28	7.43	13.99	16.06	0.29	2.29	6.84	8.99
	50	3.07	11.44	22.20	25.49	0.73	3.76	9.07	11.35
	90	4.04	16.69	32.46	37.05	1.63	5.82	11.71	14.01
	95	4.50	19.22	37.12	42.19	1.98	6.49	12.49	14.78

Source: ERS estimates based on U.S. Census Bureau data, based on the parameter estimates of the nonlinear probit model of plant acquisitions. Sample sizes: 1,199 plants for 1977-82 and 1,079 plants for 1982-87 in cheese making and 2,797 plants for 1977-82 and 1,823 plants for 1982-87 in fluid milk processing.

The exceptions included poultry slaughter and processing for 1977-82, cheese making and feed processing for 1982-87, and oilseeds for both periods. Poultry slaughtering and processing over 1977-82, feed processing over 1982-87, and oilseed crushing over 1982-87 differ in that even plants with low labor productivity and of small size had a substantial probability of being acquired. The general trend of more productive, larger plants having a greater probability of being acquired still holds. Cheese making plants, on the other hand, had almost no probability of being acquired over 1987-92. Only oilseed plants over 1977-82 have radically different probabilities of being acquired in that period.

In this case, the least productive plants had the greatest probability of being acquired. Our data do not allow us to see precisely why this industry differed so dramatically from the others. We do note, however, that the number of cottonseed crushing plants dropped by 33 percent over 1977-87 while the number of corn milling plants rose by about 25 percent and soybean processing plants by about 50 percent. This major change in industry composition meant that firms had to increase their capacity by building new corn milling and soybean processing plants and firms reduced capacity by closing cottonseed crushing plants, some of which may have been quite large. The only attractive acquisitions in such an environment may have been the smaller plants with specialty operations.

Summarizing, our regression and probability analyses indicate that mergers and acquisitions are positively correlated with labor productivity and plant size. Results are consistent with findings of Ravenscraft and Scherer (1987), Matsusaka (1993), and McGuckin and Nguyen (1995) for small plants but differ from Lichtenberg and Siegel's (1992a) conclusion that low labor

Table 6

Probability of being acquired rises with plant size and labor productivity in flour milling and feed processing over 1977-82 and 1982-87 and oilseed processing over 1982-87

		Percentile for total employment							
	Percentile for relative labor productivity	1977-82				1982-87			
Industry		10	50	90	95	10	50	90	95
		Probability							
Cheese making									
	10	2.22	6.23	12.20	13.71	0.00	0.01	0.23	0.47
Flour milling									
	10	1.81	3.17	4.92	5.39	2.40	7.54	17.52	20.46
	50	6.02	10.86	16.84	18.39	5.90	15.46	30.60	34.55
	90	13.78	24.14	35.60	38.36	11.61	26.04	44.95	49.37
	95	17.53	30.10	43.30	46.37	14.29	30.40	50.16	54.60
Feed processing									
	10	1.28	4.01	9.83	11.74	60.51	78.75	93.79	95.66
	50	3.05	6.27	11.32	12.78	80.04	90.72	97.69	98.43
	90	6.26	9.22	12.87	13.82	92.07	96.71	99.27	99.51
	95	7.97	10.53	13.48	14.22	94.21	97.67	99.49	99.66
Oilseed processing									
	10	36.54	34.63	32.79	32.44	21.50	30.06	39.41	41.66
	50	15.69	15.25	14.82	14.74	29.90	34.01	38.13	39.09
	90	4.67	4.81	4.95	4.99	38.67	37.79	36.97	36.78
	95	3.12	3.30	3.47	3.51	41.85	39.12	36.57	35.99

Source: ERS estimates based on U.S. Census Bureau data, based on the parameter estimates of the nonlinear probit model of plant acquisitions. Sample sizes: 1,633 plants for 1977-82 and 1,563 plants for 1982-87 in flour milling, 2,690 plants for 1977-82 and 2,099 plants for 1982-87 in feed processing, and 984 plants for 1977-82 and 1,374 plants for 1982-87 in poultry slaughtering and processing.

productivity leads to ownership change. Results are most consistent with Baldwin (1991), who found that acquired Canadian manufacturing plants of all types had higher average labor productivity than other Canadian plants and Lichtenberg and Siegel (1992b), who found that plants involved in leveraged buyouts in U.S. manufacturing had above-average relative labor productivity during the 3 years after their buyouts.

Most Acquired Plants Have Higher Labor Productivity Growth

To see whether the transfer of plants from one firm to another is efficient, acquisitions' effect on labor productivity must be evaluated. We examined labor productivity as a measure of plant performance over two census periods. We regressed plant acquisition status, i.e., whether a plant was acquired, and several control variables on plant productivity growth. The control variables include beginning-of-period plant labor productivity (RLP), beginning-of-period plant size, Log(SIZE), the change in capital/sales ratio (△ (K/S)), the change in human capital (△ (NPW/PW)), and several dummy variables denoting plant type. For technical reasons, we use probability of being acquired (PR(AC)) as a measure of acquisition status. This probability was estimated earlier. See the appendix for an explanation of why this variable was used and for a complete description of the other variables and the model.

Tables 7, 8, and 9 contain the results of the labor productivity growth regressions. The R^2 statistics range from 0.19 to 0.40 over the two periods: 1977-87 abd 1982-92. We are mainly interested in the performance of acquired plants. A positive sign indicates that a variable encourages labor productivity growth and a negative sign suggests the opposite. The estimated coefficient for the probability of ownership change—Pr(AC)—is positive and significant in six of the eight industries and positive in one of the two remaining industries over 1977-87. Similarly, it is positive and significant in four of the industries and negative in only one industry over 1982-92. This positive sign means that, at least for small plants, being acquired has a positive influence on productivity growth.

The sign on the interaction of probability of ownership change and plant size—Pr (AC)*Log (SIZE)—indicates how productivity growth changes for plants of different sizes. It is negative and significant in seven of the eight industries over 1977-87 and in three of eight industries over 1982-92. In four of the 1982-92 cases, Pr (AC)* Log (SIZE) was negative but insignificant. Taken together, the positive sign on Pr(AC) and the negative sign on Pr (AC)*Log (SIZE) means that productivity growth is lower for larger aquired plants than for smaller ones.

Results also show that initial labor productivity and changes in the capital-to-sales ratio and the ratio of nonproduction workers to production workers were negatively associated with labor productivity growth. Initial plant size had a positive effect on productivity growth. The other control variables had no significant effect. An increase in nonproduction workers decreases labor productivity if the new workers must be added to comply with new regulation or new quality concerns, such as food safety.

We were mainly interested in knowing which plants have positive productivity growth. To determine this, we further examined the coefficients on Pr(AC) and Pr(AC)*Log(SIZE). A positive coefficient on Pr(AC) and a negative coefficient on Pr(AC)*Log(SIZE) indicates that labor productivity growth diminishes with size and eventually becomes negative. The size of the transition from positive to negative is important because it may be that most plants have

Table 7
Small and medium size acquired plants have higher labor productivity growth than other meat plants, 1977-87, and than all other meat and poultry plants, 1982-92

Dependent variable	Meat-packing	Meat processing	Poultry slaughtering	Meat-packing	Meat processing	Poultry slaughtering and processing
	1977-87			1982-92		
Intercept	-0.53***	-0.59***	0.32***	-0.61***	0.25*	0.05
	(0.05)	(0.06)	(0.12)	(0.08)-	(0.07)	(0.12)
Log (RLP)	-0.74***	-0.89***	0.11	-0.40***	-0.70***	-0.20*
	(0.06)	0.10)	(0.13)	(0.08)	(0.07)	(0.11)
Log (SIZE)	0.11***	0.13***	-0.08***	0.12***	0.04**	0.003
	(0.015)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Pr. (AC)	1.07***	2.48***	-0.73*	0.94**	0.76*	0.33
	(0.27)	(0.53)	(0.43)	(0.46)	(0.44)	(0.42)
BUYER_PLANT	0.56***	-0.08	0.21	0.09	0.01	-0.32**
	(0.14)	(0.27)	(0.15)	(0.17)	(0.13)	(0.13)
OUTSIDE[1]	0.012**	-0.07	-0.05	0.27***	0.22***	0.15**
	(0.055)	(0.08)	(0.07)	(0.08)	(0.06)	(0.06)
NOT_FOOD	-0.04	-0.07	-0.15*	-0.007	0.01	-0.09
	(0.07)	(0.13)	(0.09)	(0.10)	(0.07)	(0.07)
MULTI	0.04	0.07	0.02	0.02	-0.02	-0.11**
	(0.05)	(0.06)	(0.06)	(0.06)	(0.04)	(0.05)
AGE72	-0.07*	-0.06	0.01	-0.04	0.05	-0.07
	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
AGE77	---	---	---	-0.08	0.06	-0.11
				(0.06)	(0.05)	(0.065)
△ (K/S)	-0.49***	-0.50***	-0.59***	-0.56***	-0.53***	-0.53***
	(0.07)	(0.07)	(0.08)	(0.06)	(0.06)	(0.07)
△ (NPW/PW)	-0.11***	-0.09***	-0.08**	0.03	0.01	0.0001
	(0.03)	(0.03)	(0.04)	(0.04)	(0.02)	(0.02)
Log (RLP)*	0.09***	0.10***	-0.11***	0.01	0.058***	0.02
Log (SIZE	(0.016)	(0.025)	(0.03)	(0.02)	(0.016)	(0.02)
Pr. (AC)*	-0.21***	-0.47***	0.19**	-0.20***	-0.12*	-0.03
Log (SIZE)	(0.05)	(0.09)	(0.08)	(0.07)	(0.07)	(0.07)
BUYER_PLANT*	-0.10***	-0.018	-0.03	-0.02	-0.01	0.06**
Log (SIZE)	(0.027)	(0.05)	(0.03)	(0.03)	(0.03)	(0.025)
Adj. R^2	0.31	0.37	0.30	0.21	0.32	0.23
N	922	658	554	843	1035	609

--- = Not applicable. T-statistics are in parentheses.
* = significant at 10-percent level; ** = significant at 5-percent level; *** = significant at 1-percent level.
Dependent variable: (RLPt - RLPt-1)/ (RLPt /2 + RLPt-1/2)
[1]OUTSIDE equals 1 for plants outside the industry in question (meatpacking, meat processing, and poultry slaughtering and processing) and 0 otherwise.

Source: ERS estimates based on U.S. Census Bureau data.

Table 8

Small and medium size acquired plants have higher labor productivity growth than other plants in cheesemaking and fluid milk, 1977-87 and 1982-92

Dependent variable	Cheese making	Fluid milk processing	Cheese making	Fluid milk processing
	1977-87		1982-92	
Intercept	-0.60***	-0.27***	-0.27***	-0.02
	(0.08)	(0.07)	(0.08)	(0.07)
Log (RLP)	-0.61***	-0.66***	-0.50***	-0.41***
	(0.10)	(0.02)	(0.04)	(0.03)
Log (SIZE)	0.13***	0.07***	0.002	0.006
	(0.02)	(0.02)	(0.04)	(0.03)
Pr. (AC)	1.02**	0.48	0.55**	0.53*
	(0.43)	(0.39)	(0.25)	(0.32)
BUYER_PLANT	0.40**	0.08	0.09	0.04
	(0.18)	(0.13)	(0.06)	(0.05)
OUTSIDE[1]	0.025	0.20***	0.03	-0.02
	(0.06)	(0.05)	(0.11)	(0.05)
NOT_FOOD	0.01	-0.13**	-0.45***	-0.07
	(0.08)	(0.05)	(0.17)	(0.07)
WEST	0.18	0.04	-0.025	0.09**
	(0.24)	(0.12)	(0.07)	(0.04)
MULTI	0.10	0.13**	0.21**	0.10*
	(0.08)	(0.05)	(0.09)	(0.054)
AGE72	-0.00	-0.10**	0.04	-0.19***
	(0.06)	(0.05)	(0.06)	(0.06)
AGE77	---	---	0.03	-0.19**
			(0.08)	(0.08)
△ (K/S)	-0.63***	-0.39***	-0.70***	-0.51***
	(0.10)	(0.05)	(0.10)	(0.08)
△ (NPW/PW)	-0.07**	-0.04***	-0.09***	-0.01
	(0.03)	(0.01)	(0.03)	(0.01)
Log (RLP)*	0.06**	0.06***	0.08**	0.05**
Log (SIZE)	(0.025)	(0.02)	(0.03)	(0.02)
Pr. (AC)*	-0.23***	-0.16**	-0.22**	0.07
Log (SIZE)	(0.07)	(0.07)	(0.10)	(0.14)
BUYER_PLANT*	-0.10**	-0.03	-0.02	-0.03
Log (SIZE)	(0.04)	(0.03)	(0.05)	(0.04)
WEST*	-0.04	-0.01	0.03	0.09**
Log (SIZE)	(0.06)	(0.03)	(0.06)	(0.04)
Adj. R^2	0.28	0.28	0.40	0.27
N	575	981	462	759

--- = Not applicable. T-statistics are in parentheses. Standard errors are in parentheses.

* = significant at 10-percent level; ** = significant at 5-percent level; *** = significant at 1-percent level.

Dependent variable: (RLPt - RLPt-1)/ (RLPt /2 + RLPt-1/2).

[1]OUTSIDE equals 1 for plants outside the industry in question (cheese and fluid milk) and 0 otherwise.

Source: ERS estimates based on U.S. Census Bureau data.

Table 9

Small and medium size acquired plants have higher labor productivity growth than other plants in flour milling and oilseeds, 1977-87, and in flour milling, feed processing, and oilseed processing, 1982-92

Dependent variable	Flour milling	Feed processing	Oilseed processing	Flour milling	Feed processing	Oilseed processing
	1977-87			1982-92		
Intercept	-0.52***	-0.31***	0.15	-0.17*	-0.10*	-0.26
	(0.08)	(0.06)	(0.31)	(0.10)	(0.06)	(0.44)
Log (RLP)	-0.32***	-0.46***	-0.34***	-0.44***	-0.31***	-0.35***
	(0.08)	(0.07)	(0.12)	(0.08)	(0.03)	(0.11)
Log (SIZE)	0.10***	0.07***	-0.01	0.001	0.09***	0.04
	(0.024)	(0.02)	(0.07)	(0.03)	(0.03)	(0.21)
Pr. (AC)	1.60***	0.75**	0.65*	0.44	-0.61**	0.32
	(0.44)	(0.38)	(0.40)	(0.40)	(0.30)	(1.17)
BUYER_PLANT	0.048	0.22*	0.05	0.05	-0.01	-0.07
	(0.13)	(0.12)	(0.20)	(0.19)	(0.04)	(0.16)
OUTSIDE[1]	0.015	-0.08	---	0.10	0.20***	---
	(0.05)	(0.09)		(0.06)	(0.05)	
CORN	---	---	-0.53			-0.74**
			(0.43)	---	---	(0.32)
COTTONSEED	---	---	-0.39			0.64
			(0.42)	---	---	-(0.62)
SOY	---	---	0.19			-0.27
			(0.33)	---	---	(0.32)
NOT_FOOD	0.21***	-0.01	-0.44**	-0.11**	-0.08	-0.03
	(0.05)	(0.06)	(0.23)	(0.05)	(0.05)	(0.18)
MULTI	0.11*	0.12**	-0.16	0.16***	0.27***	0.17
	(0.06)	(0.05)	(0.31)	(0.06)	(0.07)	(0.29)
AGE72	0.03	-0.09**	-0.09	0.05	-0.05	-0.07
	(0.05)	(0.04)	(0.06)	(0.06)	(0.04)	(0.06)
AGE77	---	---	---	-0.02	-0.04	-0.09
				(0.07)	(0.05)	(0.07)
△ (K/S)	-0.26***	-0.33***	-0.28***	-0.38***	-0.27***	-0.23***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
△ (NPW/PW)	-0.03	-0.05**	-0.03	-0.07***	-0.06***	0.0001
	(0.018)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)
Log (RLP)*	0.01	0.02	0.005	0.02	-0.2	0.02
Log (SIZE)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Pr. (AC)*	-0.35***	-0.14**	-0.13*	-0.02	-0.03	-0.03
Log (SIZE)	(0.09)	(0.06)	(0.076)	(0.07)	(0.09)	(0.19)
BUYER_PLANT*	0.003	-0.03	-0.02	-0.003	-0.02	0.00
Log (SIZE)	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)	(0.03)
CORN*	---	---	0.07			0.10*
Log (SIZE)			(0.07)	---	---	(0.06)
COTTONSEED	---	---	0.11			-0.01
* Log (SIZE)			(0.10)	---	---	(0.13)
SOY*	---	---	-0.03			0.10
Log (SIZE)			(0.08)	---	---	(0.08)
Adj. R^2	0.29	0.23	0.27	0.27	0.19	0.30
N	730	988	476	810	1092	771

--- = Not applicable. T-statistics are in parentheses.

* = significant at 10-percent level; ** = significant at 5-percent level; *** = significant at 1-percent level.

Dependent variable: (RLPt - RLPt-1)/ (RLPt /2 + RLPt-1/2)

[1]OUTSIDE equals 1 for plants outside the industry in question (flour milling or feed processing) and 0 otherwise. Several dummy variables control for types of oilseed, which include corn, cottonseed, and soy.

Source: ERS estimates based on U.S. Census Bureau data.

negative productivity growth even with a positive coefficient on Pr(AC). Alternatively, if productivity growth becomes negative after more than 500 to 1,000 workers, then labor productivity growth is positive for nearly the entire industry.

Table 10 shows which industries and plants have positive productivity growth.[8] Columns 2 and 4 indicate the size of plants realizing labor productivity growth after an acquisition. In order to give a basis of comparison, we noted the average plant size in columns 3 and 5. The first cell in column 2 indicates that meatpacking plants acquired over 1977-87, with fewer than 163 employees, had positive growth in relative labor productivity. A comparison of this number to the average plant size given in the next column (56.4 employees), indicates that both below-average and many above-average plants had positive productivity growth after their acquisition.

A comparison of the results shown in column 2 to the average size plant shown in column 3 indicates that small and many above-average size acquired plants in seven industries had positive labor productivity growth over 1977-87. Their sizes ranged from feed processing plants with fewer than 212 workers to fluid milk processing plants with fewer than 20 employees. Fluid milk is the only one of the industries in which some below-average size plants failed to improve labor productivity. In poultry slaughtering and processing, the one other industry in which small plants had lower productivity growth, small acquired plants did not improve their relative labor productivity but many below-average size acquired plants (those with more than 46 workers) and all above-average size acquired plants did.

The results for 1982-92 differed somewhat from the earlier period in that all plants in four industries had positive labor productivity growth and nearly all in one industry (meat processing) had positive labor productivity growth.[9] Of the remaining three industries, all acquired feed processing plants had negative labor productivity growth, and above-average and small meatpacking plants and very small cheese making plants had positive labor productivity growth.

Overall, our results are similar to McGuckin and Nguyen (1995) but differ from those of Lichtenberg and Siegel (1992a). We found that, in most industries and time periods, only small and medium-size plants registered an increase in labor productivity after ownership change whereas Lichtenberg and Siegel (1992a) found labor productivity increased for all plants. The difference may be due to the size of plants we considered. Lichtenberg and Siegel (1992a) examined only plants with more than 250 employees while our threshold for small plants (the inflection point shown in table 10) is below 250 employees for 7 of the 8 industries during the first period and 2 of the 8 industries in the second period.

[8]To determine the point at which labor productivity growth becomes negative, we took the derivative of equation 2 with respect to Pr (AC) equal to 0 and solved for plant size. This means that $0 = a1 + a13 \ln SIZE_{t-1}$, which in turn, means that $\ln SIZE_{t-1} = -a1/a13$. If both coefficients are negative, then labor productivity growth always decreases with size, and if both are positive, then labor productivity growth always increases with size. If a1 is positive and a13 is negative, then plants with fewer than EXP(a1/a13) employees have positive labor productivity growth and if the signs are reversed, then plants with more than that number of employees have positive labor productivity growth.

[9]Plants with positive labor productivity growth had transition points that were either very large or the coefficient for Pr(AC)*SIZE was positive.

Table 10

Most small and above-average size and some large acquired plants realized increases in labor productivity growth over 1977-87 and 1982-92 in eight food industries

Industry	1977-87 Size in 1977 of plants acquired over 1977-82 with positive labor productivity growth over 1977-87	1977-87 Average size plant in 1977	1982-92 Size in 1982 of plants acquired over 1982-87 with positive labor productivity growth over 1982-92	1982-92 Average size plant in 1982
	Number of employees			
Meat and poultry:				
Meatpacking	Fewer than 163	56.4	Fewer than 110	75.5
Meat processing	Fewer than 196	48.3	Fewer than 563	50.0
Poultry slaughtering and processing	More than 46	146.1	All plants increase	196.4
Dairy:				
Cheese	Fewer than 84	33.8	Fewer than 12	42.0
Fluid milk	Fewer than 20	48.6	All plants increase	65.5
Grains and oilseeds:				
Flour milling	Fewer than 97	38.3	All plants increase	41.9
Feed	Fewer than 212	19.0	All plants decrease	20.5
Oilseed processing (corn, cotton, and soy)	Fewer than 148	126.9	All plants increase	117.9

Source: ERS estimates based on U.S. Census Bureau data.

Conclusion: Firms Buy Efficient Plants and Improve Their Labor Productivity

This study used plant-level data consisting of all plants surveyed in the Census of Manufacturers to examine whether mergers and acquisitions in food manufacturing were efficient and, if so, whether the resulting combinations yielded synergies. We evaluated labor productivity, a measure of efficiency, before and after M&As over two merger periods and found that acquired plants were highly productive before their mergers and became more productive afterward. These results lead us to conclude that since labor productivity grew, M&As were efficient, and, since acquired plants had high labor productivity before their mergers, M&As yielded synergies.

The finding that M&As yielded synergies is important. If plants had low labor productivity prior to their mergers and improved their labor productivity afterwards, then they could have just average labor productivity after the merger and may not exert pressure on competitors to improve their own performances.[10] However, since acquired plants were efficient prior to their acquisition and improved their labor productivity afterward, acquired plants had to have better-than-average labor productivity afterward and could force other plants to either improve their own labor productivity or exit the industry. The resulting industrywide labor productivity gains likely contributed to the sharp improvement in labor productivity in the food industry over 1976-92. Ollinger et al. (April 2005) indicate that labor productivity rose by 50 percent to 300 percent in seven food industries: meat packing, cheese making, fluid milk processing, flour milling, feed processing, wet corn milling and soybean processing. Only two—meat processing and poultry slaughtering and processing—of the nine industries examined by Ollinger et al. (April 2005) showed no apparent improvement in labor productivity. But poultry slaughtering and processing actually had a substantial increase in labor productivity that is obscured in the labor productivity data. That is because production in poultry plants was shifted from less-processed products (whole fryers) to value-added products (chicken parts, boneless chicken cuts, and chicken nuggets).

The finding that meat, dairy, grain, and oilseed processors were highly productive before mergers is consistent with McGuckin and Nguyen's (1995) findings for small plants but not large plants for the entire food and beverage sector. McGuckin and Nguyen (1995) found that large acquired plants had below-average productivity, but our results indicate that both large and small plants had above-average labor productivity prior to their acquisitions. Additionally, we found that all poultry slaughtering and processing plants, except for very small ones, acquired over 1977-82, and all fluid milk processing plants acquired over 1982-87 had above-average labor productivity growth after their acquisitions. No feed processing plants acquired over 1982-87, however, had above-average labor productivity growth after their acquisitions. These differences and substantial variation in parameter estimates across the eight industries suggest that conduct and performance of an individual industry differs from that of a broadly defined sector such as the entire food industry. Thus, studies at the individual industry level, where industry-specific variables can be employed as control

[10] Plants with low labor productivity before their acquisition that improved their labor productivity afterward could have above-average productivity, but we cannot say that for sure. We can only say that labor productivity improved.

variables and a more focused analysis can be conducted, are necessary to evaluate the impact of certain types of economic activity, such as M&As.

Overall, M&As facilitated the transfers of plants to firms that valued them more highly and were, in general, better able to improve their operations (raise labor productivity). The resulting combinations had higher labor productivity than their predecessors. Data show that plants that closed had very low labor productivity and could not compete in a changed competitive environment.

References

Abbot, T.A. *Price Dispersion in U.S. Manufacturing*. Discussion Paper CES 89-7, Center for Economic Studies, U.S. Census Bureau, 1989.

Bailey, M.N., D. Campbell, and C. Hulten. "The Distribution of Labor Productivity in Manufacturing Plants," *Brookings Papers: Microeconomics*. The Brookings Institution: Washington, DC. 1992.

Baldwin, J. *The Dynamics of the Competitive Process* mimeograph, Queen's University, Kingston, Ontario, Canada, 1991.

Bartelsman, E.J., and P.J. Dhrymes. *Labor Productivity Dynamics: U.S. Manufacturing Plants, 1972-86*. Discussion Paper CES 92-1, Center for Economic Studies, U.S. Census Bureau, 1992.

Baumol, W.J. *Business Behavior, Value, and Growth*. Harcourt, Brace, and World: New York, NY, 1967.

Bhuyan, Sanjib. "Impact of Vertical Mergers on Industry Profitability: An Empirical Evaluation," *Review of Industrial Organization* (20):61-79, 2002.

Brasher, Phillip. "Harkin's Bill Fights for Special Ag Counsel," *Des Moines Register*, April 9, 2006.

Christensen, L.R., D. Cummings, and D.W. Jorgenson. "Relative Labor Productivity Levels, 1947-73: An International Comparison," *European Economic Review* (16):61-94, 1981.

Connor, Ron, and Frederick F. Geithman. "Mergers in the Food Industries: Trends, Motives, and Policies," *Agribusiness: An International Journal* (4):331-346, 1988.

Dunne, T., M.J. Roberts, and L. Samuelson. "The Growth and Failure of U.S. Manufacturing Plants," *The Quarterly Journal of Economics* 104(4):671-98, 1989.

Dunne, T., and M. Roberts. "The Long-Run Demand for Labor: Estimates from Census Establishment Data," Discussion Paper CES 93-13, Center for Economic Studies, U.S. Census Bureau, 1993.

Greene, William H. *Econometric Analysis.* MacMillan Publishing: New York, NY, 1993.

Jensen, M.C. "The Takeover Controversy: Analysis and Evidence," *Knights, Raiders, and Targets: The Impact of Hostile Takeover.* J.C. Coffee, Jr., L. Lowenstein, and S. Rose-Ackerman (Eds.), Oxford University Press: Oxford, UK, 1988.

Jensen, M.C., and R.S. Ruback. "The Market for Corporate Control: The Scientific Evidence," *Journal of Financial Economics* (11):5-50, 1983.

Lichtenberg, F., and D. Siegel. "Productivity and Changes in Ownership of Manufacturing Plants," *Corporate Takeovers and Productivity.* F.R. Lichtenberg (Ed.), The MIT Press: Cambridge, MA, 1992a.

Lichtenberg, F., and D. Siegel. "Leveraged Buyouts," *Corporate Takeovers and Productivity*. F.R. Lichtenberg (Ed.), The MIT Press: Cambridge, MA, 1992b.

MacDonald, James M., Michael Ollinger, Kenneth Nelson, and Charles Handy. *Consolidation in U.S. Meatpacking*. AER-785, Economic Research Service, U.S. Department of Agriculture, 2000.

Manne, H.G. "Mergers and the Market for Corporate Control," *Journal of Political Economy* (73):110-120, April 1965.

Martin, Andrew. "Audit: USDA Blocks Real Probes, Records Fake Ones," *Chicago Tribune*. January 19, 2006.

Matsusaka, J.G. "Target Profits and Managerial Discipline During the Conglomerate Merger Wave," *Journal of Industrial Economics* (41):179-189, 1993.

McGuckin, R.H., and S.V. Nguyen. "On Labor Productivity and Plant Ownership Change: New Evidence from the LRD," *The Rand Journal of Economics* (26:2):257-276, 1995.

McGuckin, R.H., and G. Pascoe. "The Longitudinal Research Database: Status and Research Possibilities," *Survey of Current Business* (68:11):30-37, 1988.

Meade, J.E. "Is the New Industrial State Inevitable?" *Economic Journal* (78):372-392, June 1968.

MeatPoultry.com. "Packers Fined $9.25 Million in Price-Fixing Case." Accessed April 13, 2006.

Mueller, D.C., and Raunig Burkhard. "Heterogeneities Within Industries and Structure-Performance Models," *Review of Industrial Organization* (15):303-320, 1999.

Mueller, D.C. "Mergers: Theory and Evidence," *Mergers, Markets and Public Policy*. Giuliano Mussati (Ed.), Kluwer: Dordrecht, the Netherlands, 1993.

Mueller, D.C. "A Theory of Conglomerate Mergers," *Quarterly Journal of Economics* (83):643-659, November 1969.

Nguyen, S.V. "The Manufacturing Plant Ownership Change Database: Its Construction and Usefulness," *Journal of Economic and Social Measurement* (24):209-232, 1998.

Ollinger, Michael, James MacDonald, and Milton Madison. *Structural Change in U.S. Chicken and Turkey Slaughter,* AER-787, Economic Research Service, U.S. Department of Agriculture, 2000.

Ollinger, Michael, Sang V. Nguyen, Donald Blayney, Bill Chambers, and Ken Nelson. *Effect of Food Industry Mergers and Acquisitions on Employment and Wages*, ERR-13, Economic Research Service, U.S. Department of Agriculture, December 2005.

Ollinger, Michael, Sang V. Nguyen, Donald Blayney, Bill Chambers, and Ken Nelson. *Structural Change in the Meat, Poultry, Dairy, and Grain Processing Industries*, ERR-3, Economic Research Service, U.S. Department of Agriculture, April 2005.

Ravenscraft, D.J., and F. M. Scherer. *The Mergers Selloff and Economic Efficiency*. The Brookings Institution, Washington, DC. 1987.

Roll, R. "The Hubris Hypothesis of Corporate Takeovers," *Journal of Business* (59): 197-216, April 1986.

Shleiffer, A., and R.W. Vishney. "Management Entrenchment: The Case of Manager-Specific Investments," *Journal of Financial Economics* (25):123-139, 1989.

Smith, C.W. Jr., "Investment Banking and the Capital Acquisition Process," *Journal of Financial Economics* (15):3-29, 1986.

U.S. Census Bureau, U.S. Dept. of Commerce, *Longitudinal Research Data Base,* 1972-92.

U.S. Census Bureau, U.S. Dept. of Commerce, *Ownership Change Data Base*, 1972-92.

Appendix

A Probit Model of the Effect of Plant Labor Productivity on Ownership Change

We use a probit regression to measure the probability of a plant being acquired. See Greene (1993) for a complete discussion of this econometric approach. The estimated equation is

(A.1.1) $$AC_{t,} = a_0 + a_1\text{Ln RLP}_t\text{-1} + a_2\text{Ln SIZE}_{t-1} + {}_{a3}\text{Ln SPEC}_{t-1}$$
$$+ a_4\text{OUTSIDE} + a_5\text{NOT\_FOOD} + a_6\text{Ln RLP}_{t-1}\text{*Ln SIZE}_{t-1}$$
$$+ a_7\text{Ln RLP}_{t-1}\text{*Ln SPEC}_{t-1} + a_8\text{Ln RLP}_{t-1}\text{*OUTSIDE}$$
$$+ a_8\text{Ln RLP}_{t-1}\text{*NOT\_FOOD} + u_i,$$

where AC_t, equals 1 if the plant was acquired over the period from time = t-1 to t and 0 if not acquired.[11] Relative labor productivity (RLP) has been defined earlier. A positive coefficient for RLP suggests that acquirers purchased efficient plants, while a negative coefficient on RLP indicates the acquisition of an inefficient plant. Plant size (SIZE) equals the number of employees in the Census year before the merger or acquisition, i.e., 1977 employment levels for plants acquired over 1977-81 and 1982 for plants acquired over 1982-86. We include size in the model because Dunne, Roberts, and Samuelson (1989) found that larger plants have lower failure rates than small plants and McGuckin and Nguyen (1995) and Lichtenberg and Siegel (1992a) found that plant size positively affected acquisitions. SPEC denotes the plants' primary specialization ratio and is defined as the value of shipments of products from a single five-digit Census SIC code line of products as a share of total value of shipments. For a beef packing plant, 5-digit level products include beef carcasses and boxed beef but not poultry products and flour. We control for specialization because MacDonald et al. (2000) and Ollinger et al. (2000) found that plants shifted dramatically toward a greater specialized output mix over 1967-92. The variable OUTSIDE equals 1 for plants that produce products outside of the industry being analyzed, i.e., outside of meatpacking for a meatpacking firm.[12] NOT_FOOD represents plants that are assigned by the census to a nonfood line of business, such as canned goods or fertilizers. We include OUTSIDE and NOT_FOOD to control for plant type. Finally, we use interaction terms to show how labor productivity varies with other variables.

The cheese making, fluid milk processing, and oilseed crushing industry regressions include some additional control variables. For cheese and fluid milk, we account for western dairy production because of the shift in production in those industries from the Central States to the West. The variable WEST equals 1 for plants located in Arizona, California, Montana, Nevada, New Mexico, Oregon, Texas, Washington, and Wyoming and 0 otherwise.

We control for specific oilseed industries with dummy variables in the oilseed regression. CORN equals 1 for corn plants and 0 otherwise. COTTONSEED equals 1 for cottonseed plants and 0 otherwise. SOY equals 1 for soybean plants and 0 otherwise. Since the oilseed regression accounts

[11]Acquisitions occur over 1977-81 for the 1977-82 study period and 1982-86 for the 1982-87 study period.

[12]For example, in the meatpacking regression we include meatpacking plants and any feed, flour, can making and other plants that may also be owned by a meatpacking firm. We included plants not in the meatpacking industry in order to account for complete and partial divestitures (the sale of all plants or some plants of the firm). We dropped the variable representing divestitures because it was not significant and, more importantly, its disclosure may have violated census disclosure rules.

for oilseed type, we drop the variable OUTSIDE because the plant type (corn, cottonseed, or soy) plus OUTSIDE equals 1.

A Model of the Impact of M&As on Growth of Plant Labor Productivity

To see whether the transfer of plants from one firm to another is efficient, we must evaluate how acquisitions affect labor productivity. We use Ordinary Least Squares (OLS). See Greene (1993) for a discussion of OLS regressions.

(A.1.2)
$$\begin{aligned} RPG_t &= a_0 + a_1 Pr(ACt) + a_2\ BUYER\_PLANT + a_3 Ln\ RLP_{t-1} \\ &+ a_4 Ln\ SIZE_{t-1} + a_5\ Ln \triangle (K/S)_t + a_6 AGE72 + a_7 AGE77 \\ &+ a_8 MULTI + a_9 OUTSIDE + a_{10} NOT\_FOOD \\ &+ a_{11}\ Ln \triangle (NPW/PW)_t + a_{12} Ln\ RLP_{t-1} * Ln\ SIZE_{t-1} \\ &+ a_{13}\ Pr(AC_t) * Ln\ SIZE_{t-1} + a_{14}\ BUYER\_PLANT * Ln\ SIZE_{t-1} + u_t. \end{aligned}$$

where RPG is the growth in the plant's relative labor productivity over 1977-87 or 1982-92. It is defined as plant relative labor productivity for 1987 minus plant relative labor productivity for 1977 divided by average plant labor productivity for 1977 and 1987 for the 1977-87 period. For the 1982-92 period, relative labor productivity for 1992 minus relative labor productivity for 1982 is divided by average plant labor productivity for 1982 and 1992.[13] We use a 10-year period because this allows us to evaluate the performance 6 to 10 years after the acquisition. This minimum period of 6 years provides sufficient time for an acquiring firm to integrate acquired plants into their operations or to dispose of them (McGuckin and Nguyen, 1995).

We could use a binary variable AC, which equals 1 for plants that are acquired and 0 otherwise, as an independent variable. However, the relationship of AC with labor productivity growth may suffer from sample selection bias because buying firms may only acquire plants with above normal growth. To avoid this problem, we use the probability of an acquisition Pr (AC) from equation 1.

Sample selection bias arises when data are not randomly selected. For example, school performance comparisons of children going to private and public schools suffer from bias because students in private schools have parents who are financially able and willing to make a greater investment in their child's education than parents who send their children to a public school. One way to correct for this sample selection bias is to use an instrumental variable. In the labor productivity growth equation, an instrumental variable for acquisitions is needed since acquired plants may be predisposed for higher performance. Since we have already estimated the probability of an acquisition, we use it as our instrumental variable. See Greene (1993) for a discussion of instrumental variables and sample selection bias.

There are three plant acquisition statuses: plants that are acquired, plants owned by a buyer firm but not acquired, and plants owned by a nonbuyer firm and not acquired. In the regression, we include two dummy variables to

[13]For the 1977-87 period, it is represented mathematically as RPG = $(RLP_{i,87}-RLP_{i,1977})/((RLP_{i,87}/2 + RLP_{i,1977})/2)$.
A similar definition is used for 1982-92.

account for two categories of plants and suppress one category of plants. The suppressed category serves as a reference. We already have defined one category of plants—those that were acquired. We define the dummy variable BUYER_PLANT as 1 for plants owned by an acquiring firm in 1977 (for the period 1977-82) or in 1982 (for the period 1982-87) and 0 otherwise. Plants owned by nonbuyer firms serve as a reference group. The estimated coefficients for AC and BUYER_PLANT from the regression will provide a measure of labor productivity performance relative to plants owned by nonbuyer firms.

Firms invest in fixed capital equipment and human resources in order to increase labor productivity. To account for these factors, we use the change in capital/sales ratio ($\triangle$ (K/S)) to control for the impact of a change in plant capital intensity on the change in labor productivity. Capital is the value of plant-level equipment and buildings and plant-level sales is defined as the value of shipments, as reported in the Longitudinal Research Database (LRD). We also control for the change labor productivity brought about by changes in human capital by controlling for the amount of the plant's labor made up of higher skilled, nonproduction workers. This variable is defined as the change in the ratio of nonproduction (white-collar) workers to production workers ($\triangle$ (NPW/PW)). The numbers of plant production and nonproduction workers are both available in the LRD.

Two plant age variables (AGE72 and AGE77) are used to control for age since McGuckin and Nguyen (1995) show that age affects labor productivity growth. AGE72 is a dummy variable equal to 1 for plants that existed in 1972 or earlier and 0 otherwise. AGE77 is a dummy variable equal to 1 for plants that entered their industry between 1972 and 1977 and 0 otherwise. MULTI equals 1 for plants that are part of a multi-establishment firm and 0 otherwise. We include it because MacDonald et al. (2000) show that being part of a multi-plant firm negatively affects costs in meat slaughter. We defined other variables earlier.

Appendix table 1

Acquired meat and poultry plants have higher labor productivity than nonacquired plants in both 1977-82 and 1982-87

Dependent variable	Meatpacking		Meat processing		Poultry slaughtering and processing	
	1977-82	1982-87	1977-82	1982-87	1977-82	1982-87
Intercept	-3.56***	-2.17***	-4.44***	-3.21***	-2.22***	-2.68***
	(0.18)	(0.22)	(0.24)	(0.19)	(0.06)	(0.22)
Log (RLP)	0.30***	0.70***	0.18*	0.35***	0.35***	0.19*
	(0.08)	(0.09)	(0.11)	(0.07)	(0.10)	(0.10)
Log (SIZE)	0.30***	0.25***	0.29***	0.29***	0.25***	0.27***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log (SPEC)	0.23***	-0.08*	0.39***	0.17***	0.25***	0.09*
	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)
OUTSIDE[1]	0.25***	0.98***	0.73***	0.61***	0.76***	0.61***
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
NOT_FOOD	0.23***	0.95***	0.16***	0.59***	0.52***	0.33***
	(0.03)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)
Log (SIZE)*	0.090***	-0.07***	0.045*	0.03**	0.027	0.046***
Log (RLP)	(0.016)	(0.02)	(0.024)	(0.015)	(0.017)	(0.018)
OUTSIDE*	-0.64***	-0.64***	-0.45***	-0.43***	-0.53***	-0.26***
Log (RLP)	(0.05)	(0.05)	(0.07)	(0.05)	(0.06)	(0.06)
NOT_FOOD	-1.09***	-1.09***	-1.02***	-0.73***	-0.76***	-0.90***
Log (RLP)	(0.06)	(0.06)	(0.09)	(0.07)	(0.08)	(0.08)
Log Likelihood	-6,277	-4,854	-4,167	-7,193	-5,933	-6,028
N	2,977	1,867	1,804	2,078	1,272	1,207

Standard errors are in parentheses.

[1]OUTSIDE equals 1 for plants outside the industry in question (meatpacking, meat processing, or poultry slaughtering and processing) and 0 otherwise.

* = significant at 10-percent level; ** = significant at 5-percent level; *** = significant at 1-percent level.

Dependent variable: AC

Source: ERS analysis of U.S. Census Bureau data.

Appendix table 2

Acquired cheese and milk plants have modestly higher labor productivity than nonacquired plants in both 1977-82 and 1987-92

Dependent variable	Cheese products		Milk products	
	1977-82	1982-87	1977-82	1982-87
Intercept	-3.21***	-5.10***	-3.64**	-2.64***
	(0.25)	(0.30)	(0.15)	(0.21)
Log (RLP)	-0.18*	0.07	0.09	0.45***
	(0.10)	(0.10)	(0.07)	(0.08)
Log (SIZE)	0.31***	0.36***	0.24***	0.29***
	(0.01)	(0.01)	(0.01)	(0.01)
Log (SPEC)	0.22***	0.50***	0.06***	0.14**
	(0.05)	(0.06)	(0.015)	(0.043)
OUTSIDE	0.46***	0.74***	0.43***	0.45***
	(0.04)	(0.04)	(0.02)	(0.03)
NOT_FOOD	-1.17***	0.61***	-0.26***	-0.29***
	(0.09)	(0.06)	(0.03)	(0.04)
WEST	-0.23***	-0.03	-0.16***	0.06**
	(0.06)	(0.05)	(0.03)	(0.03)
Log (RLP)*	0.16***	-0.07***	0.06***	-0.047***
Log (SIZE)	(0.02)	(0.02)	(0.015)	(0.02)
OUTSIDE*	-0.11*	0.28***	-0.22**	-0.45***
Log (RLP)	(0.07)	(0.07)	(0.04)	(0.04)
NOT_FOOD*	-1.19***	0.14***	-0.67***	-0.05
Log (RLP)	(0.09)	(0.08)	(0.06)	(0.06)
WEST*	0.36***	0.26***	0.17***	0.41***
Log (RLP)	(0.09)	(0.08)	(0.05)	(0.05)
Log Likelihood	-4,117	-3,716	-9,114	-7,301
N	1,199	1,079	2,797	1,823

Standard errors are in parentheses.

[1]OUTSIDE equals 1 for plants outside the industry in question (cheese or fluid milk) and 0 otherwise.

* = significant at 10-percent level; ** = significant at 5-percent level; *** = significant at 1-percent level.

Dependent variable: AC

Source: ERS analysis of U.S. Census Bureau data.

Appendix table 3

Acquired flour, feed, and oilseed plants have higher labor productivity than nonacquired plants in both 1977-82 and 1982-87

Dependent variable	Flour milling		Feed processing		Oilseed crushing (corn, cotton, and soy)	
	1977-82	1982-87	1977-82	1982-87	1977-82	1982-87
Intercept	-2.74***	-3.45***	-2.43***	-0.63***	-0.29*	0.01
	(0.15)	(0.17)	(0.12)	(0.14)	(0.16)	(0.15)
Log (RLP)	0.54***	0.36***	0.48*	0.68***	0.08	0.13**
	(0.09)	(0.08)	(0.06)	(0.05)	(0.08)	(0.065)
Log (SIZE)	0.14***	0.28***	0.13***	0.25***	-0.015	0.078***
	(0.01)	(0.01)	(0.01)	(0.10)	(0.01)	(0.01)
Log (SPEC)	0.21***	0.28***	0.12***	-0.58***	-0.016	-0.17***
	(0.03)	(0.04)	(0.03)	(0.03)	(0.036)	(0.03)
OUTSIDE[1]	0.45***	0.59***	0.94***	0.40***		
	(0.04)	(0.04)	(0.03)	(0.03)	---	---
CORN	---	---	---		-0.48***	-0.11
					(0.08)	(0.07)
COTTONSEED	---	---	---	---	-0.48***	-0.91***
					(0.07)	(0.14)
SOY	---	---	---	---	-0.57***	-0.05
					(0.06)	(0.05)
NOT_FOOD	0.17***	0.05***	-0.14***	-0.32***	-0.15***	-0.023
	(0.05)	(0.03)	(0.04)	(0.04)	(0.03)	(0.027)
Log (RLP)*	0.03*	0.039**	-0.07***	-0.07***	0.017	-0.10***
Log (SIZE)	(0.016)	(0.016)	(0.02)	(0.016)	(0.017)	(0.014)
OUTSIDE *	-0.95***	-0.77***	-0.08*	-0.72***		
Log (RLP)	(0.08)	(0.07)	(0.05)	(0.05)	---	---
CORN*						
Log (RLP)	---	---	---	---	-0.64***	0.07
					(0.13)	(0.11)
COTTONSEED*	---	---	---	---	-0.22*	0.66***
Log (RLP)					(0.12)	(0.15)
SOY*	---	---	---	---	-0.95***	0.44***
Log (RLP)					(0.09)	(0.08)
NOT_FOOD*	0.42***	0.30***	-0.27***	0.001	-0.26***	-0.024
Log (RLP)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.027)
Log Likelihood	-6,530	-8,260	-8,708	-7,750	-5,420	-8,311
N	1,633	1,563	2,690	2,099	984	1,374

--- = Not applicable. Standard errors are in parentheses.

[1]OUTSIDE equals 1 for plants outside the industry in question (flour or feed) and 0 otherwise. Several dummy variables are used to control for different types of oilseeds.

* = significant at 10-percent level; ** = significant at 5-percent level; *** = significant at 1-percent level.

Dependent variable: AC

Source: ERS analysis of U.S. Census Bureau data. Industries include meatpacking, meat processing, poultry slaughtering and processing, fluid milk processing, cheese making, flour milling, feed processing, and the combined industry of wet corn milling and cottonseed and soybean crushing.