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

$$\text{(A.1.1)} \quad AC_{t,} = a_0 + a_1 Ln\ RLP_t\text{-}1 + a_2 Ln\ SIZE_{t-1} + {}_{a3}Ln\ SPEC_{t-1}$$
$$+ a_4 OUTSIDE + a_5 NOT\_FOOD + a_6 Ln\ RLP_{t-1} {*} Ln\ SIZE_{t-1}$$
$$+ a_7 Ln\ RLP_{t-1} {*} Ln\ SPEC_{t-1} + a_8 Ln\ RLP_{t-1} {*} OUTSIDE$$
$$+ a_8 Ln\ RLP_{t-1} {*} NOT\_FOOD + u_i,$$

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.

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

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.