

Factors Affecting Plant Exit from the U.S. Meat Slaughter, Poultry Slaughter, and Processing Industries: Comparisons Across Industries

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1. Introduction

Meat and poultry plants have historically had high rates of plant exit and entry with the total number of plants declining over time. Recent food safety regulations (PR/HACCP, for Pathogen Reduction and Hazard Analysis and Critical Control Points) that have increased the costs of producing meat and poultry products may have affected the rate of plant exit during the 1996 to early 2000 time period over which the regulations were implemented. The PR/HACCP regulations were phased in over a 3-year period (see Table 1) to allow smaller plants more time to make the necessary changes and capital investments and thus avoid closure. While controlling for other factors that affect plant exit, we estimated probit models to determine whether different size plants were more or less likely to exit. We estimated three separate models for federally inspected plants: meat slaughter plants, poultry slaughter plants, and meat and poultry processing only plants. We present the results of these three models and compare the factors affecting plant exit across industries.

Table 1. PR/HACCP Implementation Schedule for Meat and Poultry Plants

Implementation Date	Affected Plant Sizes	Implementation Requirements
January 1997	All plants	<ul style="list-style-type: none"> • Sanitation standard operating procedures (SSOPs) • Generic <i>E. coli</i> carcass testing
January 1998	Plants with more than 500 employees (large)	<ul style="list-style-type: none"> • HACCP • <i>Salmonella</i> testing on selected raw products
January 1999	Plants with 10–500 employees (small)	<ul style="list-style-type: none"> • HACCP • <i>Salmonella</i> testing on selected raw products
January 2000	Plants with fewer than 10 employees or less than \$2.5 million in annual sales (very small)	<ul style="list-style-type: none"> • HACCP • <i>Salmonella</i> testing on selected raw products

2. Plant Entry & Exit Patterns

- The total numbers of meat and poultry plants have been relatively constant over the 1993 to 2000 time period (Figure 1)
- Exit rates increased for very small plants but decreased for small and large plants during PR/HACCP implementation (Figure 2).
- Entry rates increased for very small and small plants but decreased for large plants during PR/HACCP implementation (Figure 3).
- During PR/HACCP implementation, exit rates were highest for meat slaughter plants, followed by processing-only plants, and then poultry slaughter plants (Table 2).

Table 2. Rates of Entry and Exit of U.S. Federally Inspected Meat and Poultry Plants, 1993 to 1996 and 1996 to Early 2000

Plant Type ^a and HACCP Size ^b	Entry Rates		Exit Rates	
	1993–1996	1996–2000 ^c	1993–1996	1996–2000 ^c
Meat Slaughter Plants				
Very small plants	7.8%	13.0%	12.5%	19.9%
Small plants	6.6%	6.5%	16.4%	17.0%
Large plants	11.9%	0.0%	3.4%	1.6%
Total meat slaughter plants	7.7%	10.3%	3.1%	17.8%
Poultry Slaughter Plants				
Very small plants	37.0%	85.7%	33.3%	32.1%
Small plants	3.5%	26.4%	11.3%	13.2%
Large plants	4.3%	3.4%	0.7%	3.4%
Total poultry slaughter plants	7.1%	20.4%	8.1%	10.0%
Processing Plants				
Very small plants	13.6%	27.8%	15.2%	20.8%
Small plants	9.6%	13.1%	15.8%	12.0%
Large plants	7.5%	6.3%	17.0%	18.8%
Total processing plants	11.6%	20.9%	15.5%	16.9%

^aSlaughter plants include only those slaughtering at least 50 animals per year. Processing plants include only those that do not slaughter.
^bVery small plants have fewer than 10 employees or less than \$2.5 million in annual sales. Small plants have between 10 and 500 employees. Large plants have more than 500 employees.
^cPR/HACCP implementation period.

Figure 1. Number of Active Federally Inspected Meat and Poultry Plants

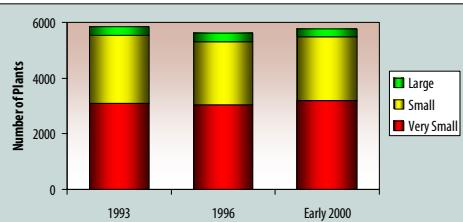


Figure 2. Exit Rates for Federally Inspected Meat and Poultry Plants

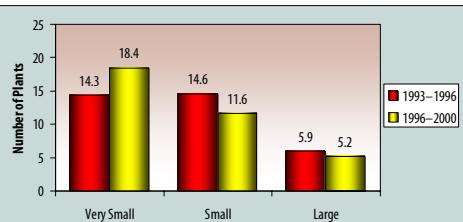
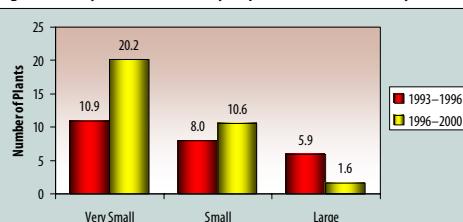


Figure 3. Entry Rates for Federally Inspected Meat and Poultry Plants



3. A Model of the Plant Exit Decision

- A plant will exit the industry when:
$$\pi_i < V_{1,t} - e^{-rt}V_{t+1}$$

where π_i is profits, $V_{1,t}$ is the value of the firm from exiting, and $e^{-rt}V_{t+1}$ is the discounted value of the firm from remaining in the market at the end of the period.

- Let X_i be the vector of variables influencing the present value of profit for plant i . Then, the payoff function can be written as follows:
$$\Pi_i = \beta'X_i + \epsilon_i$$
- The X_i vector includes plant-, company-, and regional-level characteristics and regional supply conditions for each plant.

4. Description of Data

- Plant-level data were obtained from USDA's Food Safety Inspection Service and augmented with company-level data from a private vendor, infoUSA, and with regional-level data from the Bureau of Labor Statistics and National Agricultural Statistics Service.

Table 3. Variable Definitions, Sources, and Means for the Plant Exit Models

Variables	Source ^a	Definitions	Meat Slaughter Plants (n=920)	Poultry Slaughter Plants (n=280)	Processing-Only Plants (n=4,299)
Plant Characteristics					
Slaughter volume	ADRS	Plant's slaughter volume (million head), 1996	0.148	27.76	—
Slaughter volume ²	ADRS	Plant's slaughter volume squared, 1996	0.305	1,365	—
Age	CORE	Plant's age in 1996 based on year of grant of inspection or grant status date, whichever is earliest	16.95	18.87	14.97
Age ²	CORE	Plant's age squared	370.1	473.8	320.2
Very small	FAIM/infoUSA	Plant is very small (binary)	0.662	0.100	0.540
Small size	FAIM/infoUSA	Plant is small (binary)	0.268	0.379	0.438
Large size	FAIM/infoUSA	Plant is large (binary)	0.070	0.521	0.022
Slaughters cattle	ADRS	Plant slaughters cattle (binary)	0.839	—	—
Slaughters hogs	ADRS	Plant slaughters hogs (binary)	0.768	—	—
Slaughters chicken	ADRS	Plant slaughters chickens (binary)	—	0.832	—
Slaughters turkey	ADRS	Plant slaughters turkeys (binary)	—	0.254	—
Processing at plant	PBIS	Plant also conducts processing activities (binary)	0.695	0.604	—
Poultry Slaughter Plants					
Slaughter volume (million head)	—	—	—	—	—
Very small size ^d	—	Each additional million birds slaughtered decreases the probability of exit by 0.04 percent up to 65 million birds, and then each additional million birds increases the probability of exit.	—	—	—
Small size ^d	—	A very small plant is 35 percent more likely to exit than a large plant.	—	—	—
Regional entry rate	—	An increase in the regional plant entry rate by 1 percent decreases the probability of exit by 13.2 percent.	—	—	—
Regional competitive fringe index (CFI)	—	An increase in the CFI by one standard deviation (3.839) increases the probability of exit by 4.3 percent.	—	—	—
Wage rates	—	An increase in the state-level food processing wage of \$1 per hour decreases the probability of exit by 2.2 percent.	—	—	—
Processing-Only Plants					
Plant age	—	Each additional year of age decreases the probability of exit by 0.4 percent until 46 years of age, and then each additional year increases the probability of exit.	—	—	—
Number of plants owned by the company	—	Each additional plant owned by the same company increases the probability of exit by 0.4 percent.	—	—	—
Regional entry rate	—	An increase in the regional entry rate of 1 percent decreases the probability of exit by 2.8 percent.	—	—	—
Number of other processing plants in the region	—	Each additional processing plant in the region decreases the probability of exit by 0.01 percent.	—	—	—
Energy price index	—	An increase in the energy price index by 1 unit increases the probability of exit by 0.7 percent.	—	—	—

^aOnly variables that were found to have a significant effect on the probability of exit are listed.

^bWe evaluated the marginal effects of the variables at the sample means for continuous variables and for a discrete change from 0 to 1 for the binary variables.

^cWe also tested the null hypothesis that the very small and small dummy variable coefficients are actually equal, but we could not reject it ($p=0.25$).

► The exit/stay decision is viewed in a probabilistic sense as follows:

$$\text{prob } (\Pi_i < 0) = \text{prob } (Y_i = 1 \mid X_i) = F(\beta'X_i)$$

where $F(\cdot)$ is the cumulative normal distribution function, $Y_i = 1$ if plant i slaughtered in 1996 (exit) but not in early 2000, and $Y_i = 0$ if plant i slaughtered in both 1996 and early 2000 (stay).

- Because changes in input prices (included in regional supply conditions) reflect the combined effects of changes in plant costs and the indirect effect of induced changes in output price, the signs on these coefficients are unknown *a priori*.

5. Results of Probit Estimation

- Plant-level characteristics were jointly significant in explaining plant exit in all three models.
- Regional-level characteristics were also jointly significant in explaining plant exit for meat slaughter plants, and supply conditions were also jointly significant in explaining plant exit for poultry slaughter and for processing-only plants.
- The signs of the coefficients on a few of the variables such as regional entry rates and state-level wages suggest that plants in regions with better economic conditions are less likely to exit.
- Many of the differences in results across plant types are likely because of differences in industry organization for meat slaughter, poultry slaughter, and processing.

Table 4. Statistically Significant Factors Explaining the Probability of Plant Exit

Variable ^a	Effect on Exit ^b
Meat Slaughter Plants	
Plant age	Each additional year of age decreases the probability of exit by 0.4