Approaches to Examining HACCP Costs and Food Safety Performance and Technologies.

By

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and

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This paper describes the survey methodology needed to obtain data to support several empirical analyses dealing with food safety issues. The most striking feature of the survey is the much higher response rate due to the use of priority mail and an incentive payment of $5 versus either priority mail only or first class mail only. Letters of support from the major meat and poultry trade associations and the up to five contacts of potential survey respondents by the surveying organization also appear to have improved the response rate. Overall, the survey yielded nearly 1,000 responses from 1,705 possible meat and poultry plants on their costs of compliance with the Pathogen Reduction /Hazard Analysis Critical Control Point rule of 1996, plant characteristics, and use of food safety technologies and practices.

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Regulators and economists have had a strong interest in examining the sources of changes in food safety performance and the costs of food safety regulation and pathogens control. For example, Boland et al. (2001) and Ollinger and Mueller (2003) estimated the costs, Antle (2000) projected costs relative to benefits, and USDA's Food Safety and Inspection Service (FSIS) estimated the costs and benefits of the Pathogen Reduction /Hazard Analysis Critical Control Point rule of 1996 (PR/HACCP). These studies have yielded important results, but they have either covered only a small fraction of meat and poultry plants (Boland et al, 2001) or have lacked the data needed to make precise estimates. FSIS, for example, used engineering estimates of the manpower required to perform prescribed tasks and average labor costs to project total regulatory costs of the PR/HACCP rule. Other research either followed a similar route or used regression analyses and proxies for regulation to make estimates based on available cost data.

Equipment suppliers provide engineering estimates of the costs of operating their equipment and performance levels under ideal operating conditions. However, cost estimates do not include the idiosyncratic nature of production and so cannot account for the costs (benefits) of changes in staffing requirements, operating procedures, downtime, and product quality unique to each installation.

The USDA's Economic Research Service (ERS) recognized that plant-level food safety cost and technology data could be used to examine the factors that drive improved food safety performance, assess the characteristics of plants that use various types of food safety technologies, and estimate the costs of complying with the PR/HACCP rule and of using

assorted food safety technologies. Since findings from such studies could be used to enhance

food safety performance and reduce the costs of food safety, ERS financially supported a survey

to collect food safety technology and cost data. Below, we sketch some projects for which ERS

felt survey data would be useful and then discuss in detail the survey methodology used to

collect the data.

I. EMPIRICAL MODELS

A. Models Measuring the Costs of HACCP Regulation and Pathogen Control.

Evaluating the costs of the PR/HACCP rule and other means to enhance food safety is

important because cost estimates can give FSIS an assessment of the costs relative to the benefits

of its programs. Economists (Antle, 2000; Boland et al, 2001; Ollinger and Mueller, 2003) have

used various approaches to measuring the costs of the PR/HACCP rule. However, no single

approach is able to simultaneously measure marginal effects and short-term and long-term costs

accurately, making the use of multiple analyses necessary. Below, we outline four approaches to

measuring short-run and long-run costs and marginal effects.

First, in Ollinger et al. (2004), we used accounting methods and ERS survey data to

summarize the state of food safety technology that now exists and show the short-run costs of

compliance with the PR/HACCP rule. Ollinger, et al (2004) also shows that market forces have

worked in conjunction with regulation to promote the use of more sophisticated food safety

technologies, and plants control pathogens in a variety of ways: large plants favor capital

intensive technologies, such as steam pasteurizing equipment, and small plants prefer more labor

intensive cleaning and sanitation practices. All plants together incurred about $380 million in annual expenditures and made $570 million in long term investments over 1998-2000 to comply with the regulation. Market-based incentives encouraged the industry to spend an additional $360 million on food safety investments. These are significant investments for an industry that had $1.8 billion in total capital expenditures in 1997.

In two other analyses we examine the long-run effects of the PR/HACCP rule with models of plant exits and long-run costs. Studies of plant exits are important because an increase in the rate of plant failures indicates declining long-run profitability. Reasons for failure range from not adopting current technologies to a lack of management foresight. A change in the failure rate after promulgation of the PR/HACCP rule of 1996 would indicate a decline in long-run profitability caused by the regulation. See appendix A for a fuller model description.

Considerable debate has existed over the impact of the PR/HACCP rule on plant costs and market structure. Antle (2000) shows that manufacturing costs could be at least five times higher than the FSIS-estimated costs and the American Meat Institute argues that small producers are at a competitive disadvantage relative to large plants, causing them to lose their profitability. In this analysis, we use a regression in a long-run cost function to estimate long run costs over the period of time surrounding promulgation of the PR/HACCP rule of 1996. We want to see if costs changed after enactment of the rule. Dummy variables representing time will indicate changes in cost. See appendix A for a description of the model.

In our final cost analysis we use regression techniques to measure the extent to which each component of the PR/HACCP rule -- compliances with HACCP and Standard Sanitation Operating Procedure (SSOP) plans and *Salmonella* and generic *E Coli*. standards – and other factors affect the costs of complying with the PR/HACCP rule. Using survey data, we regress

the plant-level costs of compliance with the PR/HACCP rule on several control variables and

four dummy variables indicating whether operators perceived a HACCP component to be very

costly. The perceived costliness of a HACCP component is a subjective assessment by the plant

operator of whether the HACCP component, e.g. HACCP plans, was very costly, somewhat

costly, etc. These dummy variables will indicate how plans allocated expenditures among the

various HACCP components. See appendix A for a description of the empirical model.

B. Models Estimating the Impact of Food Safety technology and other factors on pathogen-reduction

There are two types of food safety performance data available from ERS and FSIS data.

First, there is a subjective measure of operator assessments of the effectiveness of the four

components of the PR/HACCP rule in controlling pathogens. We use these assessments in a

family of regressions in which we regress whether an operator rated a HACCP component as

beneficial for pathogen reduction on the costs of complying with the PR/HACCP rule and other

factors. Results will enable us to better characterize the economic and technological forces that

encourage managers to judge a HACCP component as beneficial for pathogen reduction.

Presumably, managers know how to best control pathogens in their plants. See appendix B for a

description of the model.

The other measure of food safety performance is obtained from *Salmonella* data that

FSIS collects when it tests for the presence of *Salmonella* on animal carcasses and ground meat,

as required under the PR/HACCP rule. We use *Salmonella* test data in a Tobit regression in

which we regress the number of *Salmonella* samples failing FSIS inspection as a share of all

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Salmonella samples taken by FSIS on plant technology, HACCP performance variables (FSIS

measures of the degree to which the plant adheres to its HACCP plans and SSOPs), and other

factors (equation 1).[1] Results from this regression indicate the extent to which various plant

technologies and plant, firm, and market characteristics and a plant's compliance with HACCP

and SSOP plans affect pathogen levels. See appendix B for a description of the model.

C. A model estimating the characteristics of food safety technology users

Plants have different incentives for adopting new technologies. Some plants will adopt

new equipment very readily and others will not. For example a high volume beef slaughter plant

may adopt an automated steam pasteurizer because of the volume of its production, but a small

plant (e.g. less than 10 animals per week) may never adopt one. The purpose of this analysis is

to examine the factors that affect food safety technology choices. The results will indicate the

market forces driving food safety technology use. Technologies to be examined include

equipment, such as the use of steam vacuum units, and production practices (aspects of a plant's

operating practices), such as environmental pathogen-testing and employee empowerment

programs, such as permitting employees to take corrective actions when they deem it necessary.

II. DATA

Existing datasets from FSIS and the Census Bureau and newly received data from a

survey of meat and poultry plants by ERS are used in models. Data from FSIS includes the

number and types of animals slaughtered, types of meat and poultry processing techniques used

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[1] FSIS randomly selects slaughter and ground meat producers to be tested for the presence of Salmonella on their
products. Test samples not meeting Salmonella standards fail the test. Plants that fail a predetermined number of

in the plant, and very crude estimates of sales and employment. Other FSIS data gives the

numbers of pathogen samples failing or passing *Salmonella* performance tests over 1998-2003,

and regulatory compliance data that indicates share of HACCP tasks that plants perform

satisfactorily. Census data includes a wide variety of cost and plant characteristics data,

including wages, number of employees total product costs, etc. The most unique data are from a

survey conducted by the Economic Research Service. We discuss this in detail below.

III. THE SURVEY

A major stumbling block facing analysts who examine meat and poultry food safety is a lack

of data on the types of food safety technologies plants are using, the types of markets plants

serve, and the costs plants are incurring to ensure food safety. Given these limitations, the

Economic Research Service (ERS) of the United States Department of Agriculture (USDA)

funded a survey of meat and poultry processing plants on their use of various food safety

processing practices and technologies and their costs of implementing and complying with the

PR/HACCP rule of 1996. The data cannot be made available directly to researchers because of

concern about confidentiality. However, it may be possible to conduct cooperative studies with

ERS researchers who would use the data at ERS.

A. Survey Techniques

The Social and Economic Sciences Research Center (SESRC), located at Washington

State University in Pullman, Washington, in cooperation with ERS conducted a survey of meat

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samples can eventually have their meat or poultry license taken away.

and poultry plants on meat and poultry plant cost of compliance with the PR/HACCP rule of 1996 and use of food safety equipment and production practices. With guidance from SESRC, ERS did most of the initial work of drafting a questionnaire and obtaining regulatory approval from the Office of Management and Budget (OMB). It also provided SESRC with a list of key personnel in plants to whom the surveys could be sent. SESRC, then, fielded a two-part survey consisting of pilot and main studies beginning in the September of 2001. The study was deemed complete in May of 2002.

SESRC used some innovative techniques that likely improved response rates. The survey consisted of five contacts made over a two-month period: a pre-notification letter, a survey questionnaire, a follow-up postcard, a second questionnaire, and a final notice. SESRC sent letters from USDA's acting undersecretary for food safety and five industry trade associations (included in appendix D) with the pre-notification letter and the first questionnaire to encourage support. The most important innovation, however, was including a $5 incentive with the questionnaire in a package sent by 2-day priority mail.

OMB stipulated that incentives could only be used if a pilot study demonstrated its effectiveness. As a result, SESRC, first, conducted a pilot study in which it packaged questionnaire mailings differently for three separate groups in each of the two main industries (meat and poultry). The three mail packages were: questionnaire with first-class postage mailing and no incentive, questionnaire with 2-day priority mail and no incentive, and questionnaire with 2-day priority mail and a $5 incentive. We detail the results of the pilot study below.

1. Mail Modes for Various Treatment Groups.

ERS created the sample of plants to be surveyed from the Enhanced Facilities Database (EFD) of FSIS. The EFD contains a wide variety of detailed data on plant activities for all plants monitored by FSIS. It also contains some information on plants inspected by State inspection agencies. In total, the EFD contains at least some information on the more than 9,000 meat and poultry plants inspected by FSIS and state agencies. The vast majority of these plants produce meat or poultry products as side businesses. Data includes the number and type of animals slaughtered, Standard Industrial Classifications of plant output, plant sales, whether a plant produced meat or poultry, and categorical data on process types, e.g. whether a plant slaughters animals.

The population of plants that ERS drew from the EFD included only the 1,705 plants that ERS determined to be primarily manufacturers of meat or poultry products. These plants consisted mainly of FSIS-inspected plants and included all for-profit meat and poultry slaughter facilities reported in the 2000 EFD dataset, all further processors that were defined in the EFD as meat packers (SIC 2011), meat processors (SIC 2013), or poultry slaughter or processors (SIC 2015), and some of the largest remaining plants. Canned meat and poultry producers were excluded. The EFD data also contains a contact person at each plant that deals with matters related to FSIS and food safety. SESRC sent survey correspondence to this person because he/she appeared to be the individual best able to respond.

SESRC proceeded with its pilot study test in the following way. First, the sample list was randomly assigned to pilot and full study. The pilot study group was further randomized to 3 treatment groups each for poultry and red meat, making six experimental treatment groups in total.

The treatment groups varied by the stimuli: U.S. postal service postage level and the use of an incentive payment. Group 1 (poultry and red meat plants are separate groups) received a questionnaire sent with first class mail postage ($0.55) and no incentive; group 2 received a questionnaire sent by postal service two-day priority mail ($3.50) and no incentive; group 3 received a questionnaire and a $5 incentive sent by U.S. postal service two-day priority mail. All groups received a $0.55 pre-posted large envelope for return of the questionnaire.

2. Data Collection Activities.

There were four main contacts with respondents. As shown in table 1, SESRC sent an advance notification letter stating the purpose of the survey and informing the recipient about the mechanics of the survey. The letter also requested updated contact information if the mailing was sent to the wrong person or wrong address. SESRC placed this letter on USDA letterhead and put it in a mailing package that included a form requesting contact information updates.

The first questionnaire mailing included a 14-page booklet with a graphic cover and a last page for comments, a cover letter on SESRC letterhead, two support letters from industry associations, and a prepaid posted return envelope. A postcard was sent about one week after the first questionnaire mailing to remind respondents to return the questionnaire if they had not done so already and also thanked them if they had. The second questionnaire was sent about two weeks after the postcard. This mailing included a new version of the cover letter and a replacement questionnaire. All forms and questionnaires were pre-labeled with an identification number on the backside. This identification number allowed SESRC personnel to track which questionnaires were either returned or were undeliverable. This was important because SESRC

could remove these questionnaires from the mailing list for follow-up or resend them if the mailing address or contact name was updated.

Several contact information correction forms were received throughout the month and a new contact sequence was started on 10/3/01 for newly named replacement contacts using the stimulus designated for the sample assignment. Table 1 lists the number of sample cases that were impacted by information changes. If a questionnaire was returned as undeliverable, SESRC tried to determine the correct address and resent a follow-up packet as part of the re-contact sequence. Since the priority-mailing with a $5 incentive proved to be the most successful survey treatment group, as discussed below, SESRC also sent a follow-up mailing with an incentive to all nonrespondents on 12/06/01.

3. Responses to the Survey

Table 2 summarizes the response rates of poultry and red meat plants assigned to the pilot study. Group 3 (two-day priority mail combined with a $5 incentive payment at each of the questionnaire mailings) had the highest response rate (25 of 45 questionnaires were returned) after 101 days of data collection and was the most effective of the experimental survey treatments tried. This resulted in an adjusted completion rate of 60.98%.

Figure 1 gives the cumulative response from poultry processors for each of the three experimental treatment groups. As shown in Table 3 there is a significant difference when group 3 is compared to groups 1 and 2. The largest difference is between groups 3 and 1.

Group 2 for poultry, which used the repeated stimulus of two-day priority mail and no incentive for each of the questionnaire mailings, had the second highest response level (18 responses of 45). The adjusted completion rate of group 2 of 45% is a significantly higher

response level than group 1 (Table 3). Group 1 (first class mail with no incentive) garnered the lowest response level at day 101 (6 of 45 questionnaire responses – an adjusted 15% completion rate).

For red meat processors, group 3 again had a significantly higher response level than either groups 1 or 2 (127 returns for group 3 compared to 104 returns for group 2 and 97 returns for group 2) -- Table 3 and Figure 2. Group 3 was statistically different from both group 2 and group 1. Group 1 and group 2 were not statistically different from each other.

B. Questionnaire Design

ERS's goal in questionnaire design was to develop an instrument that minimized respondent burden yet detailed enough to be useful for analyses.   If these two objectives were achieved, ERS felt that operators would be willing to share information on their cost of compliance with the PR/HACCP rule since it was likely to yield results that were much higher than those projected by FSIS. ERS also thought that plants would give information about their food safety technologies since their responses were kept strictly confidential and the questions dealt with commonly used technologies and commercially available equipment.

To minimize respondent burden, ERS limited the use of open-ended questions and used the guidance of the industry associations to write questions that operators would both be able and willing to answer. The associations were particularly helpful in crafting the questions dealing with the PR/HACCP rule. University and industry experts contributed many of the food safety technology questions, as did Tanya Roberts and Paul Frenzen of ERS and Bob Brewer and Ron Meekhoff of FSIS.

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ERS developed separate questionnaires for the red meat and poultry industries. Each questionnaire contained questions dealing with slaughter operations that plants without slaughtering facilities could skip. The remaining questions dealt with the costs of compliance with the PR/HACCP rule, plant characteristics, plant food safety technology, and miscellaneous factors.

ERS designed the food safety technology questions to get an overall picture of the types of practices and equipment that plants used to maintain food safety and should not be considered as a comprehensive assessment of each plant's food safety technology. Questions were not designed to get a detailed account of how a plant complied with HACCP regulation because that would have required extremely detailed questions tailored for many different types of production processes that are designed to produce a wide array of products under varying conditions.

Food safety technology and practices questions included questions dealing with plant operations, product and environmental testing, sanitation, equipment, and dehiding. Examples of each type of question are provided in appendix E.

C. The Final Survey

The pilot study showed that sending questionnaires via priority mail elicited a greater response than by first class mail only and that the use of a $5 incentive improved the response rate even more. As a result, in the final survey, we used priority mail with a $5 incentive.

Table 3 describes the sample of plants and the respondents by type of production operation --- either slaughter or processing. It shows that 996 (58 percent) of all plants responded to the survey. Hog slaughter plants had the highest response rate at 67 percent while

chicken slaughter plants had the lowest response rate at 50 percent. Not all plants answered all

questions but plants did complete most questions.[2]

As shown in table 3, completed questionnaires were returned by plants that slaughtered

42 percent of all cattle, 75 percent of all hogs, 42 percent of all chickens, and 48 percent of all

turkeys, and accounted for 55 percent of all processed meat and poultry products from processors

with no slaughter operations. The overall survey response rate of 58 percent of all plants was

substantially higher than that achieved in recent surveys of much smaller samples of plants by

Hooker et al. (1999) who had a less than 50 percent response rate (41 out of 98 questionnaires)

and Boland et al. (2001) who reported a 36 percent response rate (18 of 50 questionnaires).

SESRC attributed the relatively high response rate to three factors: (1) the survey was

sponsored by a government agency whose reports are widely read by policy-makers and research

institutes, (2) the five major meat and poultry industry associations and the acting undersecretary

for food safety wrote letters urging operators to respond to the survey, (3) and, the use of a $5

incentive and 2-day priority mail to encourage survey participation.

IV. CONCLUDING COMMENTS

This paper explains the methodology employed by SESRC and ERS to survey 1,705 meat

and poultry slaughter and processing plants on their costs of compliance with the PR/HACCP

rule and food safety technologies. In a pilot study preceding the final survey, SESRC achieved

significantly higher response rates with the use of a $5 incentive and a priority postal mailing

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[2] The survey was not designed to be a nationally representative of all plant types. Besides excluding all
nonmanufacturing plants, the sample includes only those plants that responded to the survey, making the sample
inherently biased. There does appear to be a fair degree of balance in the responses in that the share of total output
of plant respondents closely tracks the number of plants that participated.

versus either a first class mailing with no incentive or a priority mailing with no incentive. The

priority mailing with no incentive garnered a significantly higher response rate relative to the

first class mailing in poultry but not in red meat. The paper also describes a set of empirical

models for which the survey data are useful. The models measure the costs and benefits

(pathogen reduction) of food safety regulation and evaluate the factors influencing the use of

certain food safety technologies.

Appendix A

1. Model of plant exits under HACCP regulation

We use a Probit model and Census data over 1987-2002 to examine the characteristics of plants that exit the industry and assess whether HACCP regulation had a role. This model is expressed as

$$\text{Exit}_{it} = \alpha_0 + \beta_{it} \text{Prod}_{it} + \Sigma\delta_{kt} \text{Plant}_{kt} + \Sigma\alpha_{nt} \text{Firm}_{nt} + \Sigma \kappa_{jt} \text{Market}_{jt} + \Sigma \gamma_{mt} T_{mt} + \xi. \qquad (A.1)$$

where Exit $= 1$ if the plant exits the industry over a five year interval from 1987-92 (1987-92, 1992-97, or 1997-2002) and zero otherwise, Prod is the plant productivity, Plant_k is a vector of plant characteristic variables; Firm_n is a vector of firm variables, such as firm size and share of firm sales generated from this industry; Market_j is a vector of market characteristics, including the outlet for firms' products and composition of output, e.g. output shares of ground meat, carcasses, etc.; and, T is a vector of time dummy variables in which the group of plants that existed in 1987 is the comparison group and always defined as zero while plants that existed in 1992 are defined as one for 1992 and zero otherwise and plants existing in 1997 are defined as one for 1997 and zero otherwise. A significant result for either the 1992 or 1997 would indicate that the propensity to exit the industry changed during the period surrounding introduction of the PR/HACCP rule.

2. Estimation of Long-Run Costs

In this analysis, a translog cost function is used to examine the long run costs of the PR/HACCP rule. The model (equation A.2) follows that used by numerous others, including MacDonald et al. (2000) in the cattle and hog slaughter industries and Ollinger et al. (2000) in the chicken and turkey slaughter industries.

$$\ln C = \alpha_0 + \Sigma\beta_i \ln P_i + (\tfrac{1}{2})\Sigma\Sigma\beta_{ij} \ln P_i \ln P_j \tag{A.2}$$

$$+ \gamma_1 \ln Q + (\tfrac{1}{2}) \gamma_2 (\ln Q)^2 + \Sigma\gamma_{1i} \ln Q \ln P_i$$

$$+ \Sigma\delta_k \ln Plant_k + (\tfrac{1}{2}) \Sigma\Sigma\delta_{kl} \ln Plant_k \ln Plant_l$$

$$+ \Sigma\Sigma\delta_{ik} \ln P_i \ln Plant_k + \Sigma\delta_{1k} \ln Q \ln Plant_k$$

$$+ \Sigma\alpha_k T_l + \Sigma\Sigma\alpha_{ik} \ln P_i T_l + \Sigma\alpha_{1k} T \ln Q$$

$$+ \Sigma\alpha_k T_l \ln Z_j + \Sigma\Sigma\alpha_{ik} T_l \ln Plant_k + \varepsilon_i$$

where C is total cost, P is a vector of factor prices (in this case, labor, animal and meat materials, other materials, and capital), Q is output, and ln is the natural log operator, Plant is a vector of plant characteristics, and T is a dummy variable defined as one in years after HACCP regulation is enacted and zero otherwise.

Cost function elasticities and direct cost estimates from the model can be used to assess the impact of various technologies on plant costs and the T dummy variables can be used to assess changes in long-run costs after imposition of the PR/HACCP rule of 1996. Additionally, interaction terms between time and plant size yield information about how costs changed with time for various size plants.

Gains in estimation efficiency can be realized by estimating the optimal, cost-minimizing input demand, or cost-share, equations jointly with the cost function. The equations are derived directly from the cost function, as the derivatives of total cost with respect to each input price, and share parameters with the cost function:

$$(\partial \ln C)/(\partial \ln P_i) = (P_i X_i)/C = \beta_i + \Sigma \beta_{ij} \ln P_j + \gamma_{1i} \ln Q + \delta_{ik} \Sigma \ln \text{Plant}_k + \Sigma \alpha_l T_n \quad \text{(A.3)}$$

Because we follow standard practice and normalize all variables (dividing them by their mean values before estimation), the first order terms (the β_i) can be interpreted as the estimated cost share of input, i, at mean values of the right hand side variables; the other coefficients capture changes in the estimated factor share over time and as variables move away from their mean values. Price elasticities of input demand can be derived from the share equations. We will also impose the usual restrictions and impose symmetry in order to gain further improvements in efficiency (Berndt, 1991).

3. Estimation of costs of HACCP practices

We use an OLS regression to estimate the cost of the components of the PR/HACCP rule (e.g. compliance with HACCP plans and implementation). Results from the regression indicate the degree to which various components of the PR/HACCP rule and plant and firm characteristics affected the costs of compliance with the PR/HACCP rule. A derivative of the equation will indicate the marginal costs of each component. We express the regression as:

$$HACCPCOST = \alpha_0 + \Sigma\beta_i \text{ PerCost\_HACCP\_Comp}_i + \Sigma\delta_k \text{ Plant}_k + \Sigma\alpha_n \text{ Firm}_n$$

$$+ \Sigma \kappa_j \text{ Market}_j + \xi. \qquad\qquad\qquad (A.4)$$

where HACCPCOST is total costs of HACCP implementation, as reported on the survey; PerCost_HACCP_Comp$_i$ (also from survey data) is a vector of dummy variables in which we set Cost_HACCP_Comp i equal to 1 if it this component of HACCP regulation, e.g. implementation of HACCP plans, is very costly and zero otherwise. The other variables have been defined.

Some food safety technologies and practices are designed specifically for high-speed or low-speed production lines and large and small plants; thus, we include plant technology variables, such as plant size and production line speed. Further, since larger firms have far greater financial risk if they get a reputation for selling pathogen-laden meat, we also consider firm size. Finally, since the susceptibility of production processes, such as ground beef production, to pathogen contamination varies, it is important to control for production processes.

1. Factors affecting the perceived benefits of the PR/HACCP rule.

In a set of regressions, Probit models are used measure the impact of plant, firm, and market characteristics on the perceived benefits of a component of the HACCP regulation (Benefit_HACCP_Comp). The dependent variable equals 1 if the component (compliance with SSOPs, HACCP plans, Salmonella testing, or the zero fecal standard) is judged by the plant to be very beneficial for pathogen reduction and zero otherwise. The independent variables have been defined above. Results will show how various factors affect perceived pathogen reduction. A derivative will show how a change in costs of the PR/HACCP rule affect a change in perceived benefits.

$$\text{Benefit\_HACCP\_Comp} = \alpha_0 + \Sigma\,\beta_i\,\text{HACCPCOST}_i + \Sigma\delta_k\,\text{Plant}_k + \Sigma\alpha_n\,\text{Firm}_n$$

$$+\ \Sigma\,\kappa_j\,\text{Market}_j + \xi \qquad\qquad (\text{B.1})$$

2. Factors affecting *Salmonella* performance

We use a Tobit regression to examine the impact of plant food safety technology, performance of HAACP and SSOP tasks and plant, firm, and market characteristics on the percentage of samples testing positive for Salmonella under the Salmonella control standard as promulgated under PR/HACCP.

$$\text{Pathogens} = \alpha_0 + \Sigma\beta_i\,\text{Tech}_i + \Sigma\delta_k\,\text{Plant}_k + \Sigma\alpha_n\,\text{Firm}_n + \Sigma\,\kappa_j\,\text{Market}_j + \Sigma\,\gamma_m\,\text{HACCP}_m + \xi. \qquad (\text{B.2})$$

where Pathogens is the number of samples testing positive for *Salmonella* as a percentage of all test samples, as reported by FSIS; $Tech_i$ is a vector of food safety technologies; $HACCP_m$ is a vector that measures compliance with either HACCP or SSOP plans; the other variables have been defined above.

The food safety technology variables vary by industry. For example, for cattle slaughter they include steam pasteurization, steam vacuum for spot removal, and several others. HACCP performance measures are defined as HACCP and SSOP tasks not in compliance with HACCP and SSOP plans as a share of all HACCP and SSOP tasks.

A model estimating the characteristics of food safety technology users

The first step in this analysis is to classify technologies by technology type, e.g. steam pasteurizing equipment. We will then use a probit econometric model to examine characteristics of plants that adopt food safety technologies. This model is expressed as

$$P = Pr(Y=0)=C+(1-C)F(x'b) \qquad (C.1)$$

where b is a vector or parameter estimates, F is a cumulative distribution function, x is a vector of independent variables, P is the probability of a response, and C is the threshold response rate. Since the voluntary incentives to adopt a particular innovation are examined, the vector of covariates, x, includes plant technology, output market, and firm effects variables. These have been discussed above.
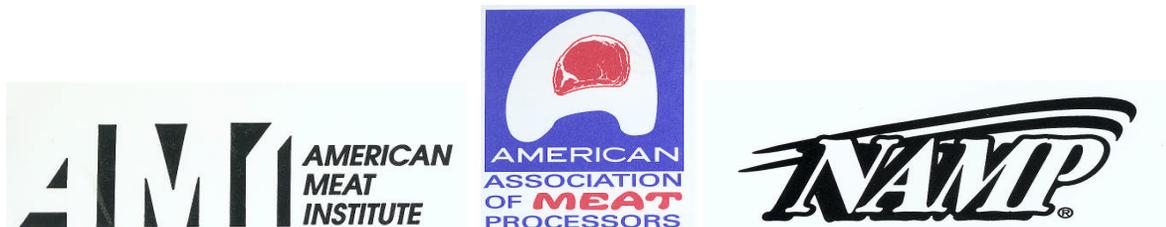
Date: August, 2001

To FSIS Contact:

The U.S. Congress has requested a report assessing the costs incurred by the meat and poultry industry of implementing and administering the HACCP/Pathogen Reduction rule (the rule), which was promulgated in 1996. Your participation is essential for providing accurate information.

The Social and Economic Sciences Research Center (SESRC) of Washington State University will gather the information for analysis by the Economic Research Service, an agency of the U.S. Department of Agriculture. SESRC has been advised to contact you because you may the one best able to respond to questions about the costs of the rule. So, please take a few minutes to complete the attached questionnaire.

The information you provide will not be used as individual data about your operation, but rather will be combined to show overall costs and trends regarding the implementation of HACCP in your plant. Thus, the results will aid in the understanding the true costs and effectiveness of the inspection system in plants like yours. It could also help influence or affect the way future changes are made in the inspection program requirements.

Again, your cooperation is appreciated. Thank you in advance for your consideration.

Sincerely,

Mark Dopp   Bernard F. Shire
Senior Vice-President for Regulatory Affairs   Director, Legislative and Regulatory Affairs
American Meat Institute (AMI)   American Association of Meat Processors
(AAMP)

Marty Holmes
Executive Vice-President
North American Meat Processors Association (NAMP)

HACCP Cost Question:

How many additional employees has this plant hired due to the Pathogen Reduction/HACCP Rule enacted in 1996? (Answer ZERO if this plant hired no one. New employees should include additional quality control personnel as well as production workers. Each part-time worker should be counted as one-half of a worker.

Number of Production Workers _____

Number of lab and other nonproduction workers _____

Plant Operations Question:

For each situation described, please tell us what production workers do if they detect feces, condensation, or other contamination on the meat, or some other unsanitary condition near the meat.

	Yes	No
Take corrective actions on their own initiative if in their personal work area	___	____
Notify the production worker responsible for work area if		
outside worker's personal area.	____	____
Notify the supervisor for all unsanitary conditions	____	____

Product or Environmental Testing Question

Over and above that which is required under the Pathogen Reduction/HACCP Rule, does this plant test raw or cooked product with...

	No	Yes	Don't Know
Aerobic plate counts (APC) tests.	____	____	____
Tests for *Salmonella* or generic *E. coli*.	____	____	____
Tests for *E. coli* O157 or *Listeria.*	____	____	____

Plant Sanitation Question:

Outside of direct contamination, which ONE statement best describes the routine practice in this plant for sanitizing hands or gloves that contact raw or cooked product in the finished product processing area? (Please circle one)

1. No routine, sanitize when contaminated

2. Sanitize one or more times per shift, less than once per hour

3. Sanitize one or more times per hour, less than each unit

4. Sanitize after each unit of product

5. Don't know

Equipment Question:

Does this plant use a steam carcass pasteurizer, such as a Frigoscandia, to pasteurize carcasses?

1. No

2. Yes.

3. Don't know.

Dehiding Question:

Does this plant use an air exhaust system vacuum or other system that creates a negative pressure around the carcass in the dehiding area? (Circle one)

1. No

2. Yes.

3. Don't Know.

References

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Table 1. Data collection activities and dates for each experimental treatment group.

Treatment Group	Advance Letter	First Questionnaire mailing	Post Card Reminder	Replacement Questionnaire Nonrespondents	Number of recontacts address/name was incorrect	Date of Extra contact	Incentive Follow-up nonrespond
Poultry Group 1 p_fc_noinc	8/21/01	8/28/01	9/11/01	9/25/01	9	10/3/01	12/6/01
Poultry Group 2 p_p_noinc	8/21/01	8/28/01	9/11/01	9/25/01	12	10/3/01	12/6/01
Poultry Group 3 p_p_$$	8/21/01	8/28/01	9/11/01	9/25/01	6	10/3/01	12/6/01
Red meat Group 1 m_fc_noinc	8/21/01	8/28/01	9/11/01	9/25/01	23	10/3/01	12/6/01
Red meat Group 2 m_p_noinc	8/21/01	8/28/01	9/11/01	9/25/01	27	10/3/01	12/6/01
Red meat Group 3 m_p_$$	8/21/01	8/28/01	9/11/01	9/25/01	33	10/3/01	12/6/01

Note:

p_fc_no is treatment group 1, for poultry, where the stimulus was first class mail postage level and no inclusion of an incentive with each questionnaire mailing.

p_pr_no is treatment group 2, for poultry, where the stimulus was two-day priority mail postage level and packaging and no inclusion of an incentive with each questionnaire mailing.

p_pr_$$ is treatment group 3, for poultry, where the stimuli were two day priority mail and $5 incentive with each questionnaire mailing.

m_fc_no is treatment group 1, for red meat plants, where the stimulus was first class mail postage level and no inclusion of an incentive with each questionnaire mailing.

m_pr_no is treatment group 2, for red meat plants, where the stimulus was two-day priority mail postage level and packaging and no inclusion of an incentive with each questionnaire mailing.

m_pr_$$ is treatment group 3, for red meat plants, where the stimuli were two day priority mail and $5 incentive with each questionnaire mailing.

Table 2. Response rate for each treatment group after 101 days of data collection.

	Poultry Group 1	Poultry Group 2	Poultry Group 3	Red meat Group 1	Red meat Group 2	Red meat Group 3
Respondents by Category						
a. Number of completed questionnaires	6	18	25	97	104	127
b. Number of questionnaires not returned	34	22	16	128	123	98
c. Number of Refusals	0	0	0	1	1	4
d. Number of Potential Respondents [a+b+c]	40	40	41	226	228	229
e. Number of return to senders	5	4	3	10	7	7
f. Number of others	0	1	1	0	0	1
g. Number of ineligibles.	0	0	0	1	2	1
h. Number excluded from sample [e+f+g]	5	5	4	11	9	9
I. Number in total sample	45	45	45	237	237	237
Response Rate [a/I]	0.13	0.40	0.56	0.41	0.44	0.54
Completion Rate [a/a+b+c]	0.15	0.45	0.61	0.43	0.46	0.56
F-Tests relative to first-class no-incentive package	-	7.79^{***}	19.53^{***}	-	0.42	7.19^{***}
F-Tests relative to priority mail no-incentive package	-7.79^{***}	-	2.65^{*}	-0.42	-	2.65^{**}

* significant at the 10 percent level; ** significant at the 5 percent level; *** significant at the 1 percent level.

Table 3—Completed questionnaires by plant type.

Plant type	Population	Respondents	Percent	
Cattle slaughter	108	55	51	
Hog slaughter	114	76	67	
Cattle and hog slaughter	185	121	65	
Chicken slaughter	181	91	50	
Turkey slaughter	33	19	58	
Chicken and turkey slaughter	21	12	57	
Processing only	1,063	622	62	
Total	1,705	996	58	

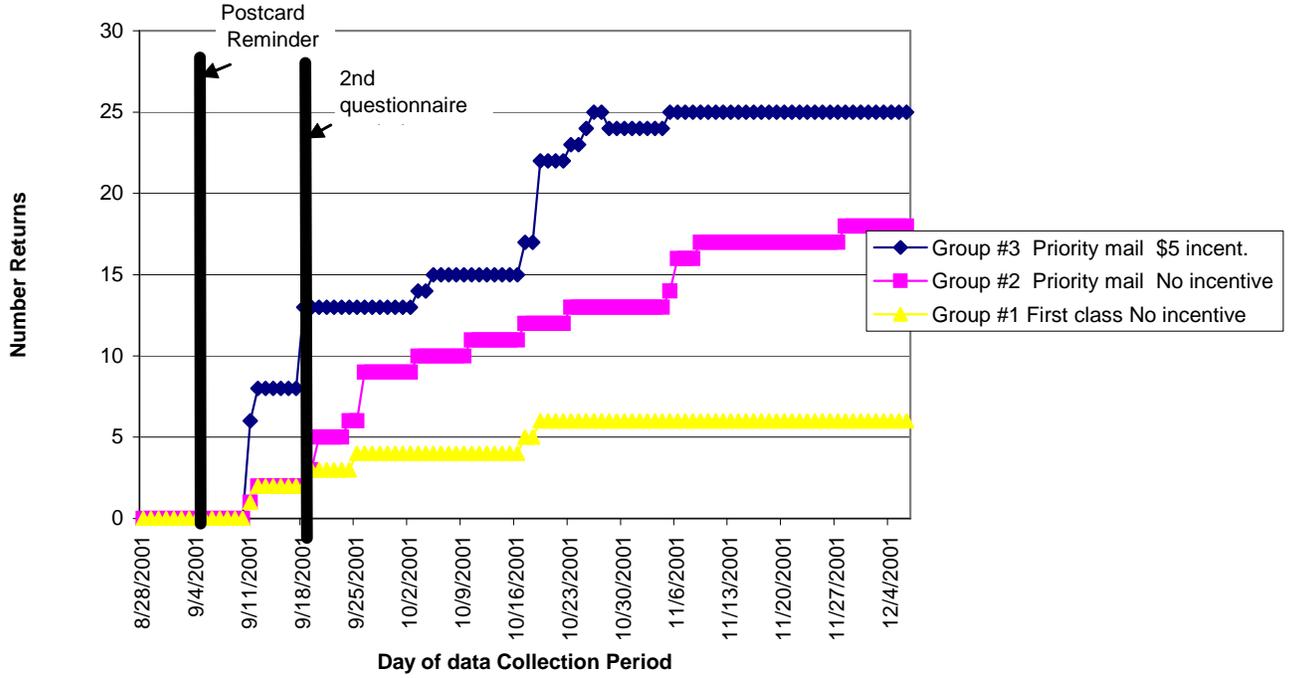Source: ERS.

Figure 1: Poultry Processors Pilot Survey Response

Figure 2: Redmeat ProcessorsPilot Survey Response

Legend:
- Group #3 Priority mail $[amount]
- Group #2 Priority mail N[...]
- Group #1 First class No i[...]

X-axis: Day of Data Collection
Y-axis: Number of Returns

Annotations: PostCard Reminder, 2nd Questionnaire