

The economic forces driving the costs of food safety regulation

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ABSTRACT

The cost of compliance with the Pathogen Reduction Hazard Analysis Critical Control Program (PR/HACCP) rule of 1996 has been controversial from the time it was first proposed. Recent survey evidence indicates costs of about \$0.01 per pound. These estimates may capture actual costs but do not indicate how different components of the rule itself, such as HACCP tasks, and indirect influences, such as plant size, affect costs differently. The purpose of this paper is to empirically examine these direct and indirect influences. Preliminary results suggest that plant size has a small, if any influence on costs. The most substantial direct cost is the cost of performing sanitation and tasks associated with a plant's HACCP process control plan.

Keywords: food safety, regulation, HACCP, costs of regulation

The Economic Forces Driving the Costs of Food Safety Regulation

The Food Safety and Inspection Service (FSIS) established the Pathogen Reduction Hazard Analysis Critical Control Program (PR/HACCP) rule in 1996 as the primary vehicle through which it regulates meat and poultry processing plants. The implementation cost of the regulation was critical to enactment and is as important and controversial today as it was then. At issue today are the incremental costs of additional sanitation and monitoring tasks, more planning and reporting requirements, and further testing mandates.

Cost estimates before promulgation of PR/HACCP met heavy criticism. FSIS (1996) projected costs of 0.12 cent per pound, but Knutsen et al. (1995) had much higher estimates. Later, econometric analyses (Antle, 2000; Ollinger and Mueller, 2003) estimated costs of 1.3 and 0.9 cents per pound, and a regional survey (Boland et al., 2001) and a national survey (Ollinger, Moore, and Chandran, 2004) suggested costs of 0.9 and 0.7 cents per pound. These recent estimates may accurately assess average costs but do not indicate how different components of PR/HACCP drives economic costs.

In this report, we examine how direct and indirect regulatory effects of the PR/HACCP rule, private market actions, and control variables have affected the costs of providing food safety process control since 1996. The direct costs come from three functional obligations imposed on plants under PR/HACCP -- planning for a HACCP system, monitoring operations and performing miscellaneous tasks, and testing products for pathogens. Indirect costs, on the other hand, arise from the comparative advantage some plants enjoy in performing regulatory requirements. For example, larger plants might be able to spread the costs of certain fixed regulatory costs over a larger volume of output. Private actions include the effects that a plant's

customers (buyers) and the plant-determined need for superior technology have on food safety process control costs. We also allow for control variables, such as the experience plants have with maintaining a food safety quality control program.

An important feature of this study is the use of three unique datasets. One data set has the costs of complying with the PR/HACCP rule and the various food safety practices and technologies those plants use as reported in a survey conducted by the Economic Research Service of USDA. Data sets from the Food Safety Inspection Service (FSIS) provide information on food safety monitoring practices and plant characteristics. Finally, Census data has detailed plant-level production data.

The PR/HACCP rule increases the stringency of meat and poultry food safety regulation.

FSIS promulgated the final PR/HACCP rule on July 25, 1996 and completely phased it in by January 31, 2000. The rule mandated that (1) all meat and poultry slaughter and processing plants had to develop, implement, and take responsibility for standard sanitation operating procedures (SSOPs) and a HACCP process control program, (2) all slaughter plants must conduct generic *E. coli* microbial tests to verify control over fecal contamination, and (3) all slaughter and ground meat plants comply with *Salmonella* standards established by FSIS in a testing program conducted by FSIS.

The SSOPs mandated under PR/HACCP were in addition to the SSOPs mandated by FSIS under the former regulatory regime. Plants still had to meet the previously mandated SSOPs and also had to comply with the facility control tasks that were also mandated under the former regime. SSOPs are cleaning and sanitizing tasks that enhance pathogen control; facility

control tasks require plants to monitor and control rodent infestations, dripping condensation, and other sources of harmful contaminants. See Ollinger and Mueller (2003) for a complete description of the regulatory regime prior to the PR/HACCP rule.

The chief elements of the regulatory regime that preceded PR/HACCP included (1) verification that plants completed SSOPs and facility control tasks, (2) animal inspections to ensure that butchered animals were free of harmful animal diseases, and (3) adherence to various processing equipment specifications, such as requiring the use of stainless steel for surfaces that contact finished products. With the introduction of the PR/HACCP rule, FSIS retained SSOPs and facility control tasks, reduced inspector responsibilities for animal inspection, and did away with some machinery and building standards.

HACCP controls differ markedly from SSOPs and facility control tasks in that plants design and implement their own HACCP plans under the guidance of FSIS. More importantly, HACCP systems serve as monitoring devices that call for action if food safety deviates from acceptable limits. Plants correct deviations from acceptable food safety limits in any manner that they choose. SSOPs and facility control tasks, on the other hand, are mandated by FSIS and are considered completed if an FSIS inspector verifies that the plant carried out its tasks.

FSIS inspectors monitor HACCP, SSOP, and facility control tasks to ensure compliance. If a task has not been performed, then an FSIS inspector files a noncompliance report. Chronic failure to comply can lead to penalties. Maintenance of the HACCP, SSOP, and facility control tasks requires labor inputs but no capital investments.

The PR/HACCP rule did not explicitly require any new equipment or investment. However, plants did have to bring their food safety process control technologies up to FSIS standards and may have had to make additional investments in labor and capital equipment to

adhere to their HACCP plan and comply with the generic *E coli* and *Salmonella* standards. For example, plants may have invested in steam vacuum equipment to remove fecal matter. This equipment requires an operator to vacuum away condensed steam and any fecal matter from a carcass (usually hogs or cattle). Alternatively, a plant could have installed an animal carcass heat treating unit to kill harmful pathogens, such as *Salmonella*. This equipment works by raising the exterior temperature of a carcass over 165 degrees F. – a temperature at which pathogens cannot survive.

Private actions have a large influence on food safety.

The PR/HACCP rule established a minimum standard that plants had to meet in order to have a license to produce meat or poultry. Many plants either chose or were forced by their customers to go beyond those standards. Ollinger and Mueller (2003) describe some events that spurred industry actions. For example, after a television program cast a negative light on chicken processor efforts to control pathogens, the chicken industry invested millions of dollars in various pathogen-control technologies. Moreover, major buyers, such as McDonalds and other fast food restaurants, required suppliers to adhere to standards that exceeded those of FSIS, mandated extensive testing, and compelled meat and poultry plants to install the most up-to-date pathogen-control equipment.

In recent years meat and poultry has become less of a generic commodity business and more an industry in which buyers purchased meat and poultry from one supplier, making it easy to identify plants that ship off-quality meat. This change motivated many meat and poultry suppliers to upgrade their food safety systems. Some suppliers needed no threat. Rather, they

made superior food safety process control a part of their strategic plan long before the introduction of the PR/HACCP rule. For example, many plants voluntarily participated in Total Quality Control and Partial Quality Control programs promoted by FSIS during the 1980s. Others introduced superior food safety process controls in order to win new customers (Ollinger and Mueller, 2003; Golan et al., 2004). Combined, these twin forces encouraged some plants to make the use of the most up-to-date food safety technology a part of their business strategy. These investments increased food safety process control costs but yielded benefits to firms, including a lower risk of incurring a costly recall, higher prices for better products, larger volume orders, and the development of long-term contractual relationships.

Costs of the PR/HACCP rule are higher for small plants.

Cost information from a survey of meat and poultry plants conducted by the Economic Research Service (see Data section for description) indicates substantial costs of compliance with the PR/HACCP rule and also gives evidence of some benefits, such as extended shelf-life. Table 1 (from Ollinger, Moore, and Chandran, 2004) summarizes the cost information. It gives both the weighted average cost per pound and average cost per pound across plants for cattle, hog, and chicken slaughter and cooked and raw processed meat. The weighted cost is much lower than the average cost per pound per plant because the very largest plants have miniscule costs per pound and those plants produce most of the output.¹ If plants were of generally equal size, then average cost per pound per plant would equal the weighted cost per pound.

¹ The weighted average cost is weighted by plant output and was constructed by summing costs within a percentile grouping and then summing output within the same grouping. Cost per pound is then the sum of costs divided by the sum of output. The unweighted cost is the mean of cost per pound of all plants.

Table 1 shows that the average variable cost-per-pound-per-plant was around 1.5 to 2.5 cents per pound for cattle and hog slaughter plants. The three right columns show that the weighted cost per pound is much lower than the mean cost per pound. For both hogs and cattle slaughter, the weighted cost per pound was less than one-half of a cent and about one-seventh the average cost per pound per plant. Data in the table also provide some evidence of apparent economies of scale in regulatory compliance, showing that unweighted variable costs were three times higher for the smallest relative to the largest cattle slaughter plants and fixed costs were more than six times larger.²

The cattle and hog slaughter industries are comprised of a few very large plants that produce most output and numerous smaller plants that produce a blend of commodity and niche products. In cattle slaughter, plants in the 80-99th quintile produce about 90 percent of all output and most of that quintile's output was produced by a few giant plants. The giant plants, in turn, have very low costs of compliance with PR/HACCP, making the weighted regulatory cost per pound much lower than the average cost per pound per plant. Poultry slaughter and the processing industries have similar effects.

The relationship between plant size and food safety costs is only one linkage among many influences that affect food safety costs. Other direct and indirect effects of the PR/HACCP rule make it necessary to conduct econometric analyses to evaluate the costs of the PR/HACCP rule.

² The fixed costs are the costs of compliance with the PR/HACCP rule since its inception in 1996. We do not know precisely when plants made their investments, so these costs are not all in current dollars. Despite this inaccuracy, the magnitude of the differences suggests differences in costs. Larger plants had to comply with the PR/HACCP rule prior to the smallest plants; thus, their investments would have likely been made before the smaller plants, suggesting that their fixed costs may have actually been higher in current dollars than those of smaller plants.

The economic framework for analyzing the sources of the costs of the PR/HACCP rule.

Bartel and Thomas (1987) argue that regulatory costs have direct and indirect effects. Direct effects come from the regulation itself, e.g. performing SSOP and HACCP tasks. Indirect effects stem from the asymmetrical distribution of compliance costs due to the differing characteristics of plants. Previous research of indirect effects has shown that regulation favors (1) large, capital intensive plants since these plants benefit from economies of scale in compliance costs (Pashigian, 1982), (2) union workers because regulation tends to raise the costs of providing worker benefits (Pashigian, 1984), (3) importers because domestic producers have to comply with regulatory costs (Bartel and Thomas, 1987), and (4) incumbents since regulation tends to raise the industry entry costs (Moore, 1986). Using these ideas, we develop an empirical model of the direct and indirect costs of regulation to an analysis of the costs of the PR/HACCP rule. We focus on costs to domestic incumbents only since imports are relatively small in the meat and poultry sector and we cannot consider entrants with our cross-sectional data.

We express a basic model of the effect of indirect and direct effects on HACCP costs in equation 1:

$$\text{HACCP_COST} = f(\mathbf{ID}, \mathbf{D}, \mathbf{X}) \quad (1)$$

where HACCP_COST is the yearly cost of adhering to plant food safety process control practices adopted after 1996 divided by plant sales, \mathbf{ID} and \mathbf{D} are vectors of variables representing the indirect and direct costs of regulation, and \mathbf{X} is a vector of measures reflecting actions and control variables.

Previous research points to three variables that should be included in the vector **D**. We use (1) pounds of output to reflect economies of scale in plant regulatory compliance (Pashigian, 1984), (2) a dummy variable indicating whether a plant is part of a multi-plant firm to capture firm size (Pashigian, 1984; Bartel and Thomas 1987), and (3) the capital to labor ratio to capture capital intensity (Pashigian, 1984). Plant and firm size should negatively affect the costs of compliance with the PR/HACCP rule due to economies of scale. We include capital intensity as a control variable without projecting a sign.

The PR/HACCP rule requires plants to develop SSOP and HACCP plans for each of their FSIS-defined products, perform SSOPs, monitor their HACCP systems, and ensure that their products meet FSIS-established pathogen tolerance limits. To capture these direct costs of regulation, the vector **D** includes HACCP planning costs as a share of sales and the number of performed SSOP and HACCP tasks divided by the number of employees. Both variables should positively affect the costs of complying with the PR/HACCP rule since higher planning costs and more tasks should drive up the cost of complying with the PR/HACCP rule. We also use HACCP tasks as a share of SSOP and HACCP tasks to see if costs vary by task type.

The PR/HACCP rule and other regulatory actions require plants to meet certain pathogen tolerances. Currently, there are zero tolerances for *Lysteria Monocytogenes* and *E coli* 0157:H7 and a zero tolerance for fecal matter. Plants that want to increase their margin of safety against producing products tainted by pathogens or that cannot meet the zero fecal matter and pathogen performance standards may have to hire additional production workers to operate food safety equipment, such as steam vacuum units, or staff new operational procedures, such as more intensive cleaning. Since meeting new food safety goals requires more production workers, we use production workers hired for food safety process control purposes as a share of total

production and quality control workers hired for food safety purposes as a measure of changes in operations brought about by the PR/HACCP rule. The variable should positively affect the costs of complying with the PR/HACCP rule.

Ollinger, Moore, and Chandran (2004) and Golan et al. (2004) provide insights into several aspects of plant operations that affect food safety and the costs of complying with the PR/HACCP rule. Both reports discuss the key role McDonalds, Costco, and other large restaurants and grocery store chains play in demanding food safety practices that are stricter than those imposed by FSIS. To account for these demands, we isolate plants that complied with food safety requirements imposed on them by their customers.

We also take into consideration a plant's own private strategic food safety technology goals. Ollinger, Moore, and Chandran (2004) provide an index that representing a plant's overall food safety technology. The index is a continuous variable between zero and one with one assigned to a highly developed food safety process control technology score and zero ascribed to a very marginal control technology. Plants with higher index values use more sophisticated equipment, do more frequent cleaning, have superior worker training systems, and/or have other practices and technologies that are superior in controlling pathogens than plants with lower index values.

We also control for output type (raw or processed meat) to account for regulatory differences between specific product types and allow for geographic wage differentials. Additionally, since adjustment costs to a HACCP system should be lower for plants that had formal food safety process control systems prior to enactment of PR/HACCP, we include a measure that accounts for existing process control programs. All of these variables are more precisely defined in the next section.

The model accounts for the effects of indirect and direct regulation and private actions.

We use Ordinary Least Squares (OLS) to empirically examine the direct and indirect effects of the PR/HACCP rule. As illustrated in equation 2, we regress the reported cost of complying with the PR/HACCP rule as a share of plant sales ($SHAR_HACCP_i$) on factors that may have direct and indirect effects on costs and control variables.

$$\begin{aligned} SHAR_HACCP = & \beta_0 + \beta_1 LPOUNDS_i + \beta_2 MULTI_i + \beta_3 CAP_LAB_i + \beta_4 PLANS_SALE_i + \\ & \beta_5 TASKS_EMP_i + \beta_6 SHAR_HACCP_TASK_i + \beta_7 PW_QC_i + \\ & \beta_8 STATE_WAGE_i + \beta_9 BUYER_i + \beta_{10} FS_TECH_i + \beta_{11} RAW_MEAT_i + \\ & \beta_{12} EXPERIENCE_QC_i + \varepsilon_i \end{aligned} \quad (2)$$

where $LPOUNDS_i$ is the log of pounds of output. $MULTI_i$ equals one for plants owned by firms that own more than one establishment and zero otherwise. CAP_LAB_i is the capital to labor ratio and equals the ratio of the plant's value of buildings and equipment at the end of the period divided by the plant's total employment. $PLANS_SALE_i$ equals a plant's cost of developing HACCP and SSOPs plans as a share of its value of shipments. $TASKS_EMP_i$ equals the number of SSOPs and HACCP tasks performed in 2001 in order to comply with the PR/HACCP rule divided by the total number of employees. $SHAR_HACCP_TASK$ equals HACCP tasks divided by the HACCP and SSOP tasks required to comply with HACCP and SSOP plans. PW_QC_i equals production workers hired since 1996 for food safety purposes as a share of production and quality control workers hired for food safety control purposes since 1996. $STATE_WAGE_i$ is the average state wage for meat and poultry production workers in the state in which the plant was located. $BUYER_i$ equals one for plants that have customers that impose requirements on

them that are more stringent than those demanded by FSIS. FS_TECH_i is the value of an index of food safety technology, as given in files obtained from Ollinger, Moore, and Chandran (2004). RAW_MEAT_i equals one for plants that produce ground meat, fabricated cuts, or other raw meat and zero otherwise. $EXPERIENCE_QC$ equals one for plants that had a food safety process control system prior to implementation of the PR/HACCP rule in 1996 and zero otherwise.

The costs of complying with the PR/HACCP rule and planning costs come from the ERS survey and Census data. HACCP costs equal the non-labor variable costs (question 14 on the ERS survey) plus the number of production and quality control workers hired to meet requirements of the PR/HACCP rule (question 7 on the ERS survey) times the average wage of meat and poultry slaughter and processing workers for 2000 obtained from Census files.

Planning costs are the number of days required to make HACCP plans for plant product lines (question 15 on the ERS survey) times the average wage from Census files divided by 270 days (the number of workdays in a year). All other variables come directly from the ERS survey or other datasets. See the data section for description of all data sources.

We use the log form for plant pounds of output to mitigate the influence of sharp changes in output among meat and poultry producers. Plant output varies from less than one million pounds per year to billions of pounds per year. None of the other independent variables require a log form because they are dummy-variables, ratios that weight a large numerator, or do not have swings in size as sharp as those of the plant size variable.

Three unique datasets provide the data.

Data are a matched dataset that includes data from a survey conducted by the Economic Research Service in 2001 on the costs of the PR/HACCP rule and food safety technology, the Enhanced Facilities Database (EFD) of FSIS for 2000, and the Longitudinal Research Database (LRD) from the Bureau of the Census.

The survey of meat and poultry slaughter and processing plants queried plant operators about the costs they attribute to food safety process controls since 1996. These costs included all costs due to compliance with the PR/HACCP rule of 1996. The survey also asked operators about their plant's food safety process control technologies. Ollinger, Moore, and Chandran (2004) summarize the responses to the survey and <http://www.ers.usda.gov/data/haccpsurvey/> provides the actual questions and a tabulation of responses.

The survey garnered responses from about 1,000 of the 1,720 plants in the registry of plants regulated by the Food Safety Inspection Service (FSIS) and considered to be manufacturers. FSIS regulates all establishments, including retail stores, restaurants, and manufacturing facilities, that process meat or poultry and ship products across state lines and many plants that ship strictly within state borders. The 1,720 plants selected as manufacturers and subsequently sent questionnaires include all plants slaughter plants and all other plants that produce meat or poultry and are designated as manufacturers, i.e. were assigned to SIC 2011, 2013, or 2015, and have sales exceeding \$7.0 million per year or production greater than 1.0 million pounds.

The ERS data include only plants from the EFD that responded to the survey and are not nationally representative, so it may not be valid to generalize results. However, several reasons lead us to believe that the bias is small. First, the final dataset has a large number of plants,

including 252 of the 407 federally inspected cattle and hog slaughter plants, 122 of the 236 federally inspected poultry slaughter plants, and 622 federally inspected cooked and raw meat processors with no slaughter operations. Second, the share of total output closely tracks the share of plants responding to the survey. Third, a regression analysis by the authors suggests that no correlation exists between plant size and survey response.

To account for remaining biases in the data, we treated it with a post-stratification adjustment (Gelman and Carlin, 2002). Under this approach, the regression is adjusted with a response weight equal to the reciprocal of the share of plants responding to the survey.

The ERS data include approximately 10 questions dealing strictly with costs and benefits of HACCP regulation, 35 on food safety technologies and practices, and 15 miscellaneous questions about plant and other characteristics. The questions about the costs of the PR/HACCP rule dealt with the number and types of workers hired, planning costs, non-labor variable costs, and capital investments. The HACCP questions also asked subjective questions, such as the aspect of the PR/HACCP that was most costly.

The 35 technology questions in the survey were based on five types of food safety technologies and practices. They included questions about (1) food safety equipment, such as heat treating equipment, (2) plant equipment, such as the use of positive air ventilation to prevent pathogen dispersal in the air to finished product areas, (3) cleaning and sanitation frequency and type, (4) food safety operating procedures and training, and (5) hide-removal practices (cattle slaughter only). Within each category, Ollinger, Moore, and Chandran (2004) create an index with a value of one equaling the most rigorous technology and zero the least rigorous technology.

The EFD has data on plant production and animal inputs and covers about 9,000 manufacturing and other establishments monitored by FSIS and state food safety agencies. These establishments include all meat and poultry manufacturing plants and other establishments that process meat or poultry as a minor business, e.g. some grocery stores. The EFD provides very little production data for plants monitored by state agencies but data for plants inspected by FSIS include counts of the number of slaughtered animals, estimated sales and employment, types of processing operations (e.g. animal carcasses or ready-to-eat products), and some other data on establishment characteristics.

The LRD includes information on all meat and poultry manufacturers from its survey of Manufacturers taken at five year intervals. The most recent survey was taken in 2002. The LRD also has data on a subset of larger plants and a sampling of smaller plants for the inter-Census years. Data in the LRD are highly detailed plant-level cost and production data. Data include value of shipments, number of workers, production hours, wages, end of period value of buildings, end of period value of machinery, etc.

Direct regulation and private actions contribute equally to the cost of complying with the PR/HACCP rule.

Results are given in table 2. The R^2 statistics vary from 0.19 to 0.64. Results suggest that indirect regulatory effects are weak. We had hypothesized that the large, more capital intensive plants and firms would have lower costs relative to smaller, more labor-intensive plants and firms. Empirically, we should obtain negative values for LPOUNDS and Multi. Pounds of output and the multi-plant dummy variable are each negative in four of their five cases but each

has only one significant effect. The capital-to-labor ratio is even weaker. All cases are insignificant and only two are negative.

The direct effects -- tasks per employee, planning costs, and ratio of production workers to quality control workers -- are much stronger. We expected positive signs. Consistent with this expectation, only one of the coefficients was negative and 11 of the 14 positive coefficients were significant. These positive signs mean that food safety costs rise with greater HACCP requirements. The coefficients for HACCP tasks as a share of the total of SSOP and HACCP tasks were negative but insignificant in all cases. A negative sign means that it is less costly to perform HACCP tasks than SSOP tasks. Since SSOPs require cleaning and sanitizing while HACCP tasks involve recording information, it is understandable that SSOP tasks are more costly to perform than HACCP tasks.

The coefficients for planning costs per unit of sales vary from near zero for cattle and hogs to 6.874 for chicken slaughter. A 100 percent increase in planning costs per unit of sales for chicken would result in a 28 percent increase in the costs of complying with the PR/HACCP rule per unit of sales. Similar 100 percent changes in cooked and raw products lead to planning cost changes of 6.1 and 32.0 percents, respectively (table 4). These percent changes were obtained by multiplying the coefficient on the variable (6.874 for chicken—table 2) times a 100 percent change in the mean value of the variable (0.00034 for chicken-table 3) divided by mean HACCP costs as a share of sales (0.0082 for chicken-table 3).

HACCP and SSOP tasks-per-employee has an impact on compliance costs in all of the industries except chicken. Coefficients range from 0.00005 in hogs to 0.00012 for cattle. Changes in costs belie the small coefficients. A 100 percent change in the mean value of tasks

per employee leads to changes in HACCP costs per unit of sales ranging from 4.7 to 84.0 percent in the cattle and hog slaughter and the cooked and raw meat processing industries (table 4).

The need to add production workers to comply with the PR/HACCP rule also has an important effect on HACCP costs. Coefficients range from 0.003 in chicken to 0.009 in cattle slaughter and each of the process industries. A 100 percent change in the mean value of production workers as a share of all production and quality control workers hired leads to increases in HACCP costs per unit of sales of 4.2 to 10.8 percent in the cattle, hog, and chicken slaughter and the cooked and raw meat processing industries (table 4).

Three control variables requiring some type of private action had substantial effects on costs. Each of these factors required the plant to commit to change as a part of its business strategy independent of government requirements. All of the coefficients for two important factors -- Buyer requirements and technology (FS_Tech) -- are positive and eight of them are significant. Four of the five variables representing plants with existing process control systems prior to Pr/HACCP are negative and two of them are significant.

Plants subject to buyer requirements and having more sophisticated food safety process controls incurred higher costs than other plants. Plants subject to customer food safety requirements raises food safety process control costs per unit of sales by 20 to 67 percent (table 4). In a similar vein, raising the technology index by about 50 percent increases food safety process control costs as a share of total sales from 7.3 to 34.6 percent in slaughter and processing (table 4). Note, the dependent variable includes costs due to both compliance with the PR/HACCP rule and some other food safety process control costs since operator records often do not distinguish between the two.

One private action lowered costs of food safety process controls. Having a sophisticated process control system prior to HACCP has a very large impact on cattle slaughter plants (an 89 percent reduction) but relatively small effects on the others – 3.9 - 17.2 percents in hog slaughter and raw and cooked processed meat. Chicken slaughter plants realized no cost reductions.

Table 4 shows the change in costs arising from 100 percent changes in the variables representing direct regulatory costs and private actions. The right hand column shows the mean change. It indicates that SSOPs and HACCP tasks have, on average the greatest impact of the direct regulatory effects (about 50 percent of the total direct regulatory impact). However, planning costs are greatest contributor to regulatory costs for chicken slaughter and raw meat processing plants and the three direct regulatory effects make about equal contributions to cooked meat processing direct regulatory costs. SSOP and HACCP tasks are the greatest contributors to costs for cattle and hog slaughter.

Table 4 also shows that buyer requirements is the greatest contributor to costs among the private actions and among both regulatory and private actions. Buyer requirements is markedly higher than any contributor to costs for hog slaughter and is a greater contributor than technology for cattle slaughter. Technology is the greatest contributor to costs among private and regulatory factors in cooked meat processing and makes about the same contribution as buyer requirements for chicken slaughter and raw meat processing.

It's interesting to note that contributions to costs are about the same for direct regulatory effects and private actions. It's also noteworthy that preliminary analyses by Ollinger (2004) suggests that regulation and private actions make similar contributions to *Salmonella* reduction. Combined, these costs and pathogen reductions suggest that each dollar expended for complying

with regulation has about the same effect on pathogen reduction as each dollar spent to satisfy private needs.

Concluding Comments

This paper empirically examined the effects of indirect and direct regulation and private actions on the costs of complying with the PR/HACCP rule. Preliminary results suggest that plant size has a small, if any influence on costs. The most substantial direct cost of regulation is the cost of performing sanitation and tasks. Planning costs also made sizeable contributions to compliance costs for poultry slaughter and raw meat processing.

Private actions accounted for nearly half of the costs of complying with the PR/HACCP rule. Buyer requirements is much more costly than technology (the only other private action) in hog and cattle slaughter and about equally costly in the other industries.

It is interesting to note that Ollinger (2004) attribute about half of all *Salmonella* reduction due to regulation and half due to private actions. Combining these results with the results presented in this paper on the effect of regulation and private actions on the costs of PR/HACCP rule suggests that the cost of providing food safety process control per unit of *Salmonella* reduction is about the same for regulation and private actions.

There are two likely reasons why private actions have such a significant impact on the costs of complying with the PR/HACCP rule. First, if a buyer's business strategy is to have highest food safety quality standards, then the buyer would have stiffen its requirements whenever the benchmark quality increases. The benchmark quality in this case is given by the requirements of

the PR/HACCP rule. Since buyer requirements may not have increased without stricter regulatory standards, the increase in costs is due to regulation, i.e. the PR/HACCP rule.

It is also likely that data on the costs of complying with the PR/HACCP rule and the costs of providing food safety process control for private needs are commingled. Although plant operators may consider all of these costs as being due to regulation and reported them as such, they are not. Our analysis disentangled these data into separate components.

References

- Antle, John M. "No Such Thing as a Free Lunch: The Cost of Food Safety Regulation in the Meat Industry," *American Journal of Agricultural Economics* 82: 310-22. 2000.
- Bartel, Ann P. and Lacy Glenn Thomas. Predation Through Regulation: The Wage and Profit Effects of the Occupational Safety and Health Administration and the Environmental Protection Agency," *Journal of Law and Economics* 30: 239-264, 1987.
- Boland, Michael, Dana Peterson-Hoffman, and J.A. (Sean) Fox. "Postimplementation Costs of HACCP and SPCPs in Great Plains Meat Plants," *Journal of Food Safety* 21:195-204, 2001.
- Bureau of the Census. *Longitudinal Research Database*. (Washington, D.C.: U.S. Bureau of the Census, 1997).
- Economic Research Service. *Survey of HACCP Costs and Food Safety Technology*. Washington, D.C., U.S. Department of Agriculture, Economic Research Service, (2001).
- Gelman, Andrew and John B. Carlin. "Poststratification and Weighting Adjustments." *Survey Nonresponse*. Robert M. Groves, Don A. Dillman, John L. Eltinge, and Roderick J. A. Little, eds., pp. 289-302. New York, NY: John Wiley & Sons, Inc., 2002.
- Golan, Elise, Tanya Roberts, Elisabete Salay, Julie Caswell, Michael Ollinger, and Danna Moore. *Food Safety Innovation in the United States: Evidence from the Meat Industry*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report 831, 2004.
- Knutson, Ronald D., H. Russell Cross, Gary R. Acuff, Leon H. Russell, Fred O. Boadu, John P. Nichols, Suojin Wang, Larry J. Ringer, Asa B. Childers, Jr., and Jeff W. Savell. *Reforming Meat and Poultry Inspection: Impacts of Policy Options*. IFSE Working Paper 95-1, AFPC Working Paper 95-9; Institute for Food Science and Engineering, Agricultural and Food Policy Center, Center for Food Safety, Texas A&M University System, April 1995.
- Moore, Thomas Gale. "The Beneficiaries of Trucking Regulation," *Journal of Law and Economics* 29: 327-343, 1986.
- Ollinger, Michael. "The Impact of Market Mechanisms and HACCP Regulation on Food Safety Quality," Presented at the American Agricultural Economics Association Meetings in Denver, Colorado in August of 2004.
- Ollinger, Michael, Danna Moore, and Ram Chandran. *Meat and Poultry Plants' Food Safety*

Investments: Survey Findings. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Technical Bulletin 1911, 2004.

Ollinger, Michael and Valerie Mueller. *Managing for Safer Food: The Economics of Sanitation and Process Controls in Meat and Poultry Plants.* Washington, DC: U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report 817, 2003.

Pashigian, B. Peter. "The Effect of Environmental Regulation on Optimal Plant Size and Factor Shares," *Journal of Law and Economics* 27: 1-28. 1984

U.S. Department of Agriculture, Food Safety and Inspection Service. *Enhanced Facilities Database.* Washington, D.C.: U.S. Department of Agriculture, 2000.

Table 1—PR/HACCP costs increase with Plant Size

	Unweighted mean cost per pound by percentile ²			Industry weighted mean cost per pound ³		
	Size percentile			Size percentile		
	0-19	80-99	Mean	0-19	80-99	Mean
	Dollars per pound					
Cattle slaughter						
Variable costs	0.023	0.008	0.022	0.010	0.003	0.0033
Fixed costs	0.055	0.009	0.022	0.020	0.004	0.0045
Number of plants	17	27	135	17	27	135
Hog slaughter						
Variable costs	0.016	0.005	0.014	0.008	0.001	0.0020
Fixed costs	0.050	0.008	0.026	0.022	0.003	0.0043
Number of plants	23	22	96	17	22	96
Poultry slaughter						
Variable costs	0.025	0.004	0.010	0.023	0.004	0.0037
Fixed costs	0.013	0.004	0.008	0.012	0.003	0.0047
Number of plants	14	9	58			58
Cooked meat processing /no slaughter ⁴						
Variable costs	0.018	0.005	0.016	0.015	0.005	0.007
Fixed costs	0.079	0.019	0.036	0.057	0.015	0.018
Number of plants	50	37	198	50	37	198
Raw meat processing/no slaughter ^{5,6}						
Variable costs	0.020	0.005	0.013	0.006	0.003	0.0046
Fixed costs	0.027	0.012	0.017	0.006	0.005	0.0080
Number of plants	25	26	139	25	26	139

Source: Ollinger, Moore, and Chandran (2004)

Table 2: Direct Regulation, Buyer Requirements, and Food Safety Technology have the greatest impact on the costs of complying with PR/HACCP. ¹

	-----Slaughter-----			-----Processing-----		
Variables	Cattle	Hog	Chicken	Cooked	Raw	
Intercept	0.021 (0.96)	0.023* (1.76)	0.004 (0.30)	-0.003 (-0.24)	-0.008 (-0.97)	
Indirect						
LPOUNDS	-0.0005 (-0.41)	-0.002*** (-3.76)	-0.0001 (-0.13)	-0.0006 (-0.85)	0.00004 (0.09)	
Multi	-0.004 (-0.70)	-0.001 (-0.31)	-0.003+ (-1.50)	-0.0005 (-0.21)	0.002 (0.84)	
Cap_Lab	0.0000 (0.02)	0.0000 (0.71)	-0.0000 (-0.91)	0.0000 (0.77)	-0.0000 (-0.29)	
Direct						
Plans_Sales	0.002 (1.19)	0.00025 (0.62)	6.874*** (5.05)	1.232*** (2.78)	3.476*** (15.77)	
Tasks_EMP	0.00012** (2.30)	0.000053+ (1.54)	-0.0001 (-1.23)	0.0001*** (2.72)	0.00007** (2.34)	
Shar_HACCP_Tasks	-0.002 (-0.10)	-0.014 (-1.22)	-0.009 (-1.07)	-0.010 (-1.03)	-0.004 (-0.49)	
PW_QC	0.009* (1.87)	0.005* (1.75)	0.003+ (1.51)	0.009*** (3.34)	0.009*** (4.68)	
Control						
State_Wage	-0.004 (-1.21)	0.0001 (0.88)	-0.0002 (-1.02)	-0.00001 (-0.08)	-0.00003 (-0.27)	
Buyer	0.005 (1.20)	0.012*** (4.00)	0.004+ (1.46)	0.005** (2.19)	0.004** (2.35)	
FS_Tech	0.017 (1.24)	0.024*** (2.69)	0.002 (0.27)	0.025*** (3.68)	0.014*** (2.79)	
Raw_meat	-0.008+ (-1.56)	-0.002 (-0.71)	0.003+ (1.40)	0.007 (0.79)	0.003 (-0.29)	
Experience_QC	-0.011*** (-2.39)	-0.0007 (-0.24)	0.0006 (0.42)	-0.003 (-1.15)	-0.003 (-1.63)	
R ²	0.19	0.27	0.36	0.20	0.64	
Observations	101	124	77	244	226	

Dependent variable: SHAR_HACCP= cost of complying with PR/HACCP rule divided by plant sales.

1. t-statistics in parentheses. +, *, **, *** 80, 90, 95, and 99 percent levels of significance.

Table 3: The Mean Values of Selected Variables

Variables	-----Slaughter-----			-----Processing-----	
	Cattle	Hog	Chicken	Cooked	Raw
LPOUNDS	14.68	14.78	17.86	15.39	15.36
Plans_Sales	0.0018	0.0024	0.0003	0.0012	0.0012
Tasks_EMP	86.89	88.12	11.67	39.57	44.89
Shar_HACCP_Tasks	0.42	0.44	0.51	0.39	0.39
PW_QC	0.147	0.149	0.380	0.179	0.183
Buyer	0.43	0.41	0.83	0.57	0.58
FS_Tech	0.50	0.48	0.61	0.56	0.55
Raw_meat	0.85	0.86	0.96	0.69	0.79
Experience_QC	0.27	0.27	0.33	0.35	0.35
HACP_COST_SAL	0.0123	0.0179	0.0082	0.0250	0.0174

Table 4: How food safety process control costs as a share of sales changes with 100 percent changes in the value of selected regulation private actions variables.¹

Type of Change	Cattle Slaughter	Hog Slaughter	Chicken Slaughter	Processing	Raw Meat Processing	Mean Change
Costs Due to Regulation						
Planning costs as a share of total sales	-	-	28.0	6.1	32.0	13.2
SSOP and HACCP Tasks	84	24.6	-	4.7	18.1	26.3
Generic <i>E coli</i> and <i>Salmonella</i> controls	10.8	4.2	13.9	6.4	9.5	9.0
Total Regulatory Changes	94.8	28.8	41.9	17.2	59.6	48.5
Private Actions						
Cost Raising Effects						
Buyer	40.6	67.0	4.9	20.0	23.0	31.1
Technology	34.6	32.2	7.3	28.0	22.5	25.0
Total Cost Raising Private Actions	75.2	99.2	12.2	48	45.5	56.1
Cost Lowering Effects						
Existing Process Control System	89.0	3.9	-	12	17.2	24.2

1. Changes for the technology variable are based on a 50 percent increase in the mean value.