VARIABILITY IN THE IMPACT ON INDUSTRY OF FOOD SAFETY REGULATION: A REVIEW OF EX POST ANALYSES

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ABSTRACT

The report reviews studies on the costs incurred by companies in complying with food safety regulation across meat, leafy greens, almond and orange industries. The cost comparison is based on changes in average costs from surveys of companies affected by government regulations and by voluntary industry programs. The results show that the compliance costs varied across companies of different sizes with medium-sized companies incurring the largest cost in three of the four industries considered. In addition, cost function estimation pre- and post-regulation demonstrates that companies producing higher-value meat products tend to experience higher costs and greater variation in costs than do slaughter businesses and processors of raw meat.

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EXECUTIVE SUMMARY

Recent analyses of the costs to industry of compliance with food safety regulations are reviewed and summarized in this report. The studies are from diverse industries, including meats, fresh produce, and tree nuts. The research results include summary statistics such as changes in average costs per unit of output and per acre. We also focus on the variation in compliance costs that is observed across various types of enterprises. Policy makers and regulators are often concerned with anticipating the potential adverse impact of a regulation on small business, thus it is of interest to find out whether there is evidence of differential effects after the implementation of regulations.

In three of the four industries studied, medium-sized operations experience the largest cost of compliance among size categories. It should be noted that while there is a commonality in considering size groupings, there is no common threshold for size that is used to define a small business in the food safety studies.

Size is not the only dimension of variation in the costs of compliance with food safety rules. The costs of compliance in the meat industries tend to be larger and more variable for the value-added processing companies in contrast to the companies involved in slaughter operations and first-level processing.

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INTRODUCTION

This report provides a detailed review of the literature on the impact of food safety regulation and the variation in impact within the industry. The meat processing industry is subject to the 1996 Pathogen Reduction-Hazard Analysis Critical Control Points (PR-HACCP) regulation administered by USDA-FSIS. After 2003, as food safety problems were traced to products that had not previously been considered high-risk, producers of fresh produce and tree nuts developed food safety programs.

COST OF COMPLIANCE IN MEAT INDUSTRIES

Food safety regulations affecting the meat industries require a combination of process improvements, documentation of the process controls, and microbiological testing of samples of finished goods (Ollinger and Moore, 2009). The U.S. Department of Agriculture's Economic Research Service studied both the short-run and long-run impact of the PR-HACCP regulation.

A national survey on HACCP compliance costs was commissioned in 2001 to evaluate the short-run costs of the regulation. The results of the survey provide costs of compliance for meat producing firms of differing sizes, by product type and by extent of value-added processing. The Ollinger and Moore (2009) paper decomposes compliance costs as "direct" (imposed by regulation) or "indirect" (differences associated with how companies implement compliance programs). In addition, the cross-sectional analysis separated costs between those specified in standards and those adopted voluntarily in response to customers' requirements.

The effect of size of the establishment on compliance cost was estimated with a statistical model that decomposes food safety costs. The explanatory factors are wage rates, capital-to-labor ratios, and size of the plant and the firm, among others. Plant size is represented with data on the number of employees. Variables for multi-plant firms and for specialization by product type are also included.

Larger plants are found to have a cost advantage, particularly when the marginal effects are calculated in a way that represents the wide distribution of plant sizes in the sample (Ollinger and Moore 2009). Doubling of plant size is associated with a compliance cost reduction of 11% for hog slaughter and up to 40% lower food safety compliance costs in chicken processing.

In a later study, administrative data from the FSIS and U.S. Census records were used to identify the long-run impact of PR-HACCP on the industry cost function (Ollinger 2011). The cost function is fit to Census data at the available 5-year increments between 1992-2002 and corresponds to the pre- and post-HACCP periods. Ollinger finds that, over the period, most meat processing sectors experienced an increase in the labor cost share relative to the meat cost

share in the total cost of production. This trend is consistent with cost increases as a result of implementing the PR-HACCP rule. As Ollinger explains:

> "It would be ideal to contrast the performance of regulated plants against those of a control group not affected by regulation. However, this type of test is not possible because food safety regulation affected all plants, except for a small group of specialty plants called custom-exempt plants. As an alternative, changes in costs were examined over a period spanning the pre- and postregulation periods and across plants of different sizes. All other things being equal, a change in costs over a time coinciding with promulgation and implementation of food safety regulation should indicate a systematic impact of regulation on all plants." (Ollinger 2011, page 245).

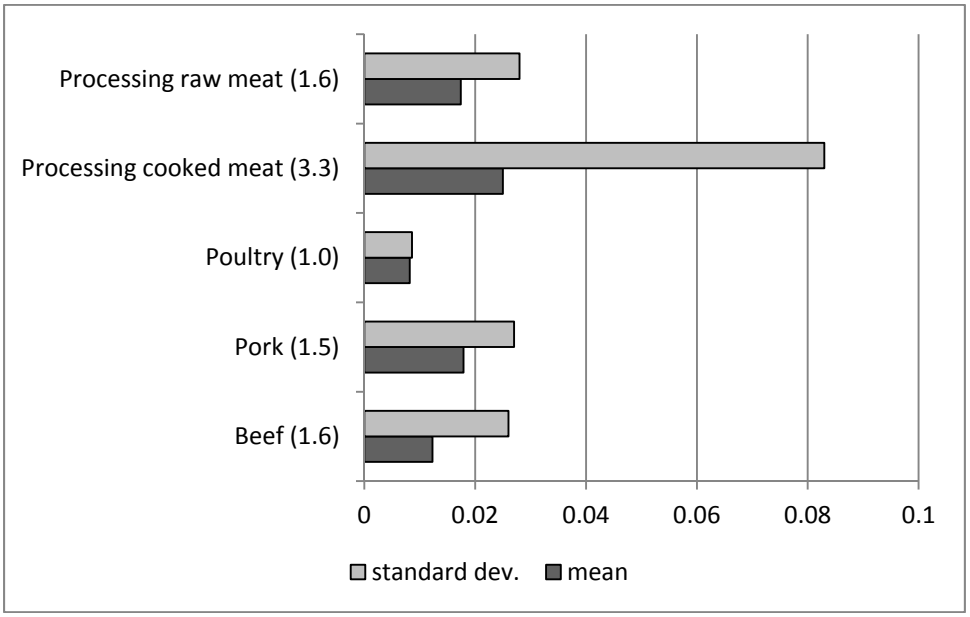
The reasoning to link labor cost shares with regulation is as follows. HACCP plans in meat slaughter and processing commonly include additional sanitation, which is relatively labor-intensive. The raw material cost share would not have been changed by food safety regulations because there are no federal requirements for meat and poultry pathogen-reduction measures on the farm. Thus, Ollinger concludes that higher cost shares for labor indicate that safety regulation might explain the increase in the cost of production indices.

In contrast to the findings from the 2001 survey (Ollinger and Moore), the chronological study in Ollinger 2011 did not provide consistent evidence about size effects for each of the meat industries. The ratio of cost shares of large plants compared to small plants changed from 1992 to 2002 such that large plants' relative cost shares fell (in three of the five meat industry sectors that were examined). The relative cost advantage of large plants improved to the greatest extent (by .06 and .09) in cattle slaughter and sausage making, but by only .02 for chicken slaughter and processing.

Apart from the impact of plant size, there has been variability in compliance costs across industry subsectors. Ollinger and Moore report detail for slaughter operations (for three meat types), and value added processing of raw meat or cooked meats (mainly sausage making). Figure 1 illustrates the differences in regulatory cost burdens as a share of sales in 2001. The operations that process cooked meats and presumably make higher-valued output have the largest mean cost of food safety compliance, more than 2% of the value of sales. And, cooked meat processors report the highest variability in cost as measured by standard deviation and coefficient of variation (standard deviation as a percentage of the mean). The coefficient of variation of 3.3% for cooked meat processors is more than double the variation for the slaughter plants and for the raw meat processors. The standard deviation of costs is 3- to 4-times higher for the cooked meat processors.

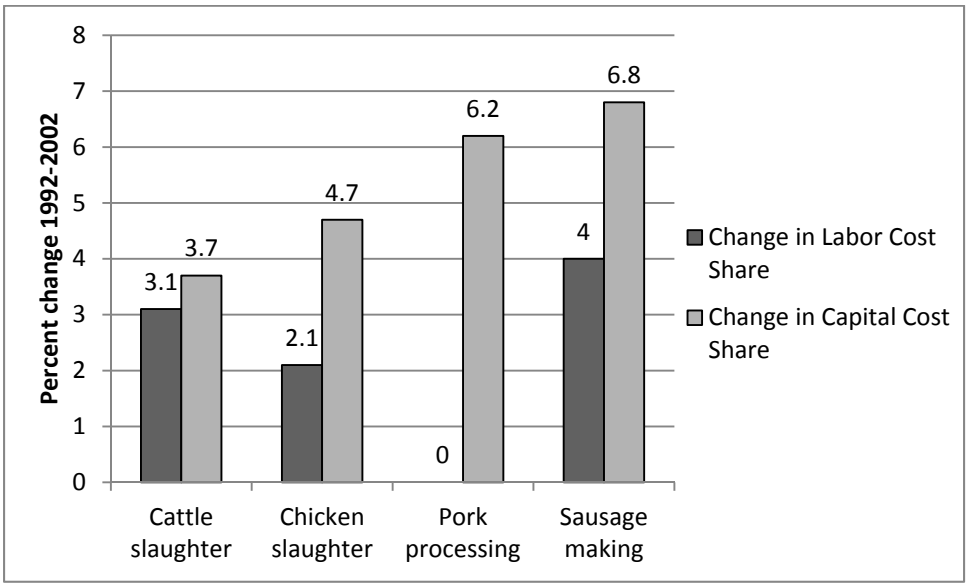
There are risk-based reasons to expect that controls might cost more at operations that conduct further-processing, compared with primary slaughter. Foodborne pathogens might be re-introduced in processing of cooked meats and there is no kill step in further processing or within households to remove those pathogens. This phenomenon was a factor in the outbreaks of listeriosis associated with deli meat and sausages. Thus, precautions undertaken at processing facilities involve chemical control and additional sanitation and might be more costly than the procedures used at other types of operations.

Figure 1: Cost of Compliance with Food Safety Regulation and Variation of Costs across Firms, as a Share of Sales, by Meat and Poultry Plant Type, 2001 (Coefficient of variation is shown in parentheses).



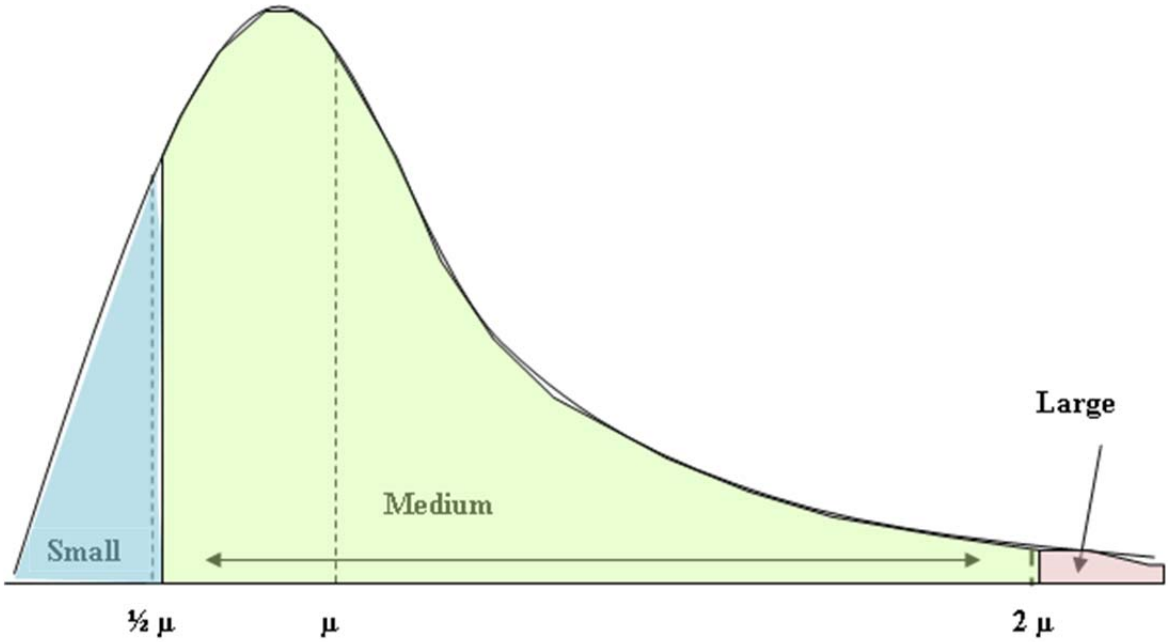
Source: Ollinger and Moore, 2009.

Figure 2: Cost Share Changes for Meat Industries during the Period of Food Safety Regulation Implementation, by Sector, in Percent Change, 1992-2002



Source: Ollinger, 2011.

Figure 3: Classification of the Size of Establishment Used for Meat Processing Firms



Source: Author's representation of classification used in Ollinger 2011. The range is defined by Ollinger although the height and shape of the distribution are the author's, based on distributions typical of food sectors.

It may be the case that the cooked meat processors tend to be smaller-size operations in terms of employee numbers. Compared with slaughter facilities that tend to hire large work crews, the cooked meat processors might classify as small. Thus the causal source of variation, size or position in the value chain, cannot be disentangled easily.

Overall, the ERS studies indicate that economies of scale prevail in the meat processing industry, and the beneficial effects of large size in terms of reducing average cost of production accounted for considerable variation in the costs of compliance in the first few years after food safety regulation. There were differences in compliance costs across industry subsectors, which may be explained by the risk profile of the product type or by the position of the regulated firm in the value chain. Variation along the value chain was substantial, with the coefficient of variation in costs as a share of sales more than two times greater for the cooked meat processors compared with slaughter facilities.

LEAFY GREENS FARMS

The Leafy Greens Marketing Agreement (LGMA) is a voluntary program the California and Arizona greens growers initiated following the 2006 outbreak of foodborne illness associated with fresh spinach and subsequent other incidents involving lettuce. The LGMA is a hybrid sort of public-private food safety program. While growers are not legally obligated to join the

LGMA, once a grower has joined, the requirements are monitored by on-site Federal inspectors hired with LGMA collective funds. Growers who do not comply are not subject to the force of law, so strictly speaking, the LGMA is not a legal requirement, but a grower dismissed from the LGMA is likely to lose the ability to market greens because most large buyers require the LGMA certification.

Hardesty and Kusunose (2009) surveyed leafy greens growers in California during 2008 and 2009 regarding food safety compliance costs. Growers reported that their seasonal food safety costs more than doubled after the implementation of the LGMA, increasing from a mean of $24.04 per acre to $54.63 per acre in 2007 (Table 1).

The results were reported for 3 size groups, measured in terms of annual revenue (Table 2):

- less than $1 million,
- between $1 million and $10 million,
- more than $10 million.

The size groupings that Hardesty and Kusunose selected differ from those used by the Small Business Administration (SBA) or in U.S. Department of Agriculture analyses. The smallest category threshold of $1 million in sales revenue or less to classify as a small business is above SBA's $750,000 threshold for small farms.

Leafy greens growers in the mid-size category reported the highest modification costs per acre among the size groups. Medium-sized growers' costs were reported to be $18.05 per acre, which is 159% higher than the average for the largest growers. The farms in the small-size classification reported $14.82 in food safety costs per acre. The largest growers had the lowest modification costs ($8.29 per acre) (Table 2). Similarly, Tootelian (2008) notes that medium volume leafy greens shippers (100,000 to 1 million cartons) appear to lose a higher percentage of acreage due to buffer zones and animal activity, and that they also incur higher water testing costs.

Growers with revenue over $10 million per year benefit from significant economies of size in complying with the LGMA and other food safety provisions, and thus they have the greatest capacity to absorb these costs, according to Hardesty and Kusunose. The larger operators hire food safety specialists to manage their compliance programs, while small growers (with revenue under $1 million) typically choose to manage these complex programs themselves. When management takes on such new efforts, he or she may be successful in leveraging the existing talent and experience within the organization. However, it is also possible that the costs to the smallest firms are under-reported, because there is no new direct expense of the additional management effort, but there are opportunity costs of the managers' time and transactions costs which are not easy to report in a survey.

Economic impact was reported in detail for the modifications that were installed to prevent contamination. These seem to be one-time investments, for the most part. In terms of total expenditure on farm modifications for the LGMA, the range across all responses is $150,500 compared with the average cost of $21,490 per operation (Table 3). The per-acre average is $13.60 with a range of $106 (standard deviation of $20.40). The cost of modifications excludes

Table 1: Leafy Greens Growers' Costs of Food Safety Activities, Pre- and Post-Marketing Agreement, 2006 and 2007

Respondents Reporting Impacts					
Food Safety Impact	**Unit**		**Percent**	**Mean**	**Median**
Animal Activity ***	Cartons	2006	38	3,247	2,000
		2007	73	6,387	3,000
Flooding Concerns	Cartons	2006	7	28,583	5,000
		2007	5	1,000	1,000
Field Monitoring***	Hours/week	2006	89	16.07	5
		2007	97	24.18	10
Procedures	Hours/week	2006	83	10.86	3.5
Documentation***		2007	100	17.54	6
Water Testing***	Tests/Month	2006	87	12.27	3
		2007	100	19.36	9
Employee Training*	Hours/session	2006	97	99.25	10
		2007	100	130.69	18
Compost Expenses	$	2006	31	240,250	65,000
		2007	27	264,959	50,000
Food Safety Specialists***	Full-time	2006	36	1.31	1
	equivalents	2007	53	1.45	1
Average food safety costs	$/acre	2006		24.04	15
		2007		54.63	40

*Difference between 2006 and 2007 is statistically significant at .10 level.
**Difference between 2006 and 2007 is statistically significant at .05 level.
***Difference between 2006 and 2007 is statistically significant at .01 level.
Source: Hardesty and Kusunose, 2009.

Table 2: Leafy Greens Growers' Modification Costs by Farm Size (mean $ per acre)

Modification	**<$1 million**	**$1-$10 million**	**>$10 million**	**Range**
Installed additional fencing	13.38	24.02	9.84	14.18
Increased/modified sanitary facilities	7.42	2.62	2.49	4.93
Lined wells/modified water system	1.00	4.61	1.04	3.61
Modified compost storage area	0.56	0.00	1.93	1.93
Made other modifications	10.42	1.68	3.57	8.74
Total per-acre modification costs	14.82	18.05	8.29	9.76

Source: Hardesty and Kusunose, 2009.
Size groups are in annual sales volume.

ongoing variable expenses, like training, sanitation supplies, and audits. The repeated annual costs are not available by size of operation (Table 3).

In order to rank the most highly variable item among the modifications, there must be a measure of variation selected and the ranking is not consistent among the different measures. For example, fencing has the highest standard deviation of cost per operation as well as the highest range in cost per acre. However, fencing modifications were ranked only fourth of the five modifications on the basis of coefficient of variation. The most variable item when ranked by coefficient of variation is the modification to bathroom facilities.

Part of the variability in economic impact of the leafy greens food safety program is due to the choices among preventive measures. There are a variety of farm-level modifications that have the potential to prevent contamination, according to microbiologists, and not all were implemented by each firm. For example, some farms may have had adequate sanitation facilities for workers prior to the LGMA or may not have needed to change the packing area. The differences in the need to adopt a modification explain part of the variation in costs per farm. Even for a particular modification, there is variation in impact related to size of the operation or the technology of the modification itself. The large standard deviation in the cost of modifications for fencing is likely tied to size of the operation. Water treatment or sanitation equipment investments are not as dependent on size and the cost variation is likely driven by technology.

Table 3: Cost of Food Safety Investments/Modifications Related to the Leafy Greens Marketing Agreement (Average Per Operation)

Respondents who have…	Share modif-ying	Mean Cost	Stan-dard Devia-tion	Coef. of Var-iation	Min-imum	Max-imum
	%	$	$	%	$	$
Installed additional fencing	57	28,354	36,977	130	1,200	148,000
Increased/modified bathroom/hand-washing facilities	57	6,964	19,627	282	0	100,000
Lined wells/irrigation canals, made other changes to water system	23	3,167	1,008	127	0	10,000
Modified compost storage area	11	2,625	4,922	188	0	10,000
Modified packing area	2	10,000	-	0	10,000	10,000
Other	16	2,416	3,878	161	0	10,000
Total Costs (41 Observations)		21,490	36,331	169	0	150,500
Cost per acre of leafy greens		13.60	20.40	150	0	106.00

Source: Hardesty and Kusunose, 2009

It is difficult to assess economic impact of food safety programs because some of the corrective actions had been implemented before the regulations as a result of management choices and requirements of customers. These managerial factors are not necessarily correlated with size. A firm that already had a high-quality packing area, or that chooses not to pack on its farm but to sell to a larger packer, had lower expenses for modifications immediately after the regulation. Researchers have a great deal of difficulty in ascertaining the proportion of firms that have already adopted a food safety system in advance of regulations and therefore will experience no new costs after the law.

ALMOND HANDLING INDUSTRY

The Almond Board of California initiated a Food Safety Action Plan which became part of the industry's marketing order under the final rule entitled "Almonds Grown in California: Outgoing Quality Control Requirements" (7 CFR Part 981), effective September 1, 2007. The rule is under the administrative law jurisdiction of the Agricultural Marketing Service, U.S. Department of Agriculture. Handlers are required to assure that raw almonds are treated to reduce the potential presence of salmonella. A few firms installed treatment facilities onsite and others use an outsourced provider to conduct the treatment. The treatment process may be fumigation, steam, or other heating processes such as roasting or blanching.

The food safety requirements for the almond industry affect the handling firms, which receive shelled almonds and undertake storage, shipment, or further processing operations. There are around 100 firms in the California almond handling industry. Most are single-establishment operations. Some of the handlers are relatively large and have well-known brands.

Salin and Jones (2009) report on a survey to elicit cost of compliance with the Action Plan. Questions on the total cost of compliance and on the costs of capital investments were asked; the coefficient of variation for capital expenses and variable costs are reported in Table 4.

Several questions on cost detail were asked in categorical terms using a Likert-type scale. With categorical questions, it is difficult to obtain a statistic on variability. For example, the response options were "no change in costs," "increase of 1-2 cents per pound," etc, up to "increase of 5 cents per pound or more." For many cost items, there is a clustering of responses, indicating relatively little variation. The clustering is especially notable for the costs of using hired outside providers to conduct the treatment. In part, that is because the charges for treatment were well-established in the market. An error in the questionnaire also explains the clustering in this instance; the categories listed in the questionnaire were too low to accurately capture any upside variation of the charges paid to outside treatment providers.

While users of outsource treatment reported little variability in the operating cost of compliance, the few firms that began to operate their own treatment facilities experienced greater variation in costs. Of those engaging in on-site treatment for food safety, several indicated that the incremental costs were zero, because they had voluntarily installed treatment prior to the Action Plan requirement going into force. Some of these companies had been involved with outbreaks

Table 4: Variability in Almond Handlers' Costs to Implement Food Safety Action Plan, by Cost Item, 2009

	Coefficient of variation (%)
Total increment to operating cost	67.1
New capital investments, total	102.5
Modifications to capital stock	95.7
Facility modification	97.6
New equipment	91.9
Validation: Process authority	68.0
Validation: Microbial testing	162.8

Source: Salin and Jones, 2009.

of foodborne illness and after that experience, had proactively sought treatment solutions. As a result of the choice to implement before the industry-wide regulation, the reported impact is lower and more variable than in cases in which all firms implement a change subsequent to a new regulation.

The choice among technologies also affects variability of the economic impact of the almond Action Plan. Investments ranged from a modified temperature monitor on a blanching line to an entirely new steam treatment plant. Naturally, new facilities for treatment are quite costly even when land costs are excluded. Capital investments for new equipment and for modifications to existing processing lines to attain the temperatures for pathogen control were more variable across firms than the operating costs (coefficient of variation around 100% compared with 67%). The coefficient of variation reported here is based on the few respondents that installed new equipment.

Validation of the treatment facility to assure that it accomplishes the required pathogen reduction is associated with costs within a fairly narrow range. Validation is an initial requirement before the facility opens and is not repeated on a frequent basis. The market pricing for expert technical services in the conduct of the validation (the Process Authority) also had relatively low variability (coefficient of variation at 68%). Microbial testing had the greatest variability among the items surveyed. In this instance, one facility underwent repeated testing in an effort to balance quality standards with pathogen control, and as a result, accumulated significant laboratory testing costs during the validation phase.

ORANGE GROWERS COST OF COMPLIANCE WITH GAPS

Good Agricultural Practices (GAPs) are a set of requirements for farm-level businesses. GAPs are intended to reduce risk of pathogen contamination and may also include features affecting workers and the environment. Like the system for leafy greens growers, GAPs are not required

by legislation, but frequently are part of state-level marketing agreements and customers' contracts. There are various means to satisfy GAP requirements, and several different sets of GAP standards, and thus costs to comply vary. In the orange production industry, Paggi et al (2010) find higher GAP compliance costs per acre for medium-size operations than for the larger farms. In addition to size-based variation, the study provides a contrast in costs for two different states, California and Texas.

The study by Paggi provides an indicator of variability in economic impact using a simulation of the risk that the operator will shut down when faced with costs of compliance with GAPs. The explicit scenario analysis makes it unique in the food safety literature in its treatment of uncertainty. However, the regulatory costs themselves are treated in a deterministic manner. The stochastic components are realizations of market prices for the product and for the crop yields. The results indicate that, with GAP compliance costs in place, the probability of business failure[1] increases. For the Texas model, the simulated probability of failure rises from 42% to 52%. In California, the higher GAP compliance costs leads to a larger increase in the chance of failure, from 36% to 53%.

The cost of GAP compliance, a key input into the risk that the business will shut down, is greater in California compared with Texas (Table 5). The information in the table is collected from focus groups with growers.

Table 5: Orange Growers' Cost of Compliance with Good Agricultural Practices, for California and Texas, in $ Per Acre.

Item	California	Texas	Range
Education/Training	15.04	18.00	2.96
Air quality requirements	18.34	1.00	17.34
Water quality requirements	1.11	12.00	10.89
Department of Pesticide regulation	21.44	0	21.44
Labor requirements	32.66	13.00	19.66
Capital investment	100.00	0	100.00
Risk management / food safety	25.00	0	25
Clerical / assessment expenses	2.60	0	2.6
Total regulatory compliance costs	216.19	44.00	172.19

Source: Paggi et al, 2010, Table 8. From panel of growers.

[1] Paggi et al simulate the present value (PV) of net after tax farm income aggregated over a 5-year horizon. We use the term "business failure" for shorthand to represent the outcome in which the 5-year cumulative present value is less than zero. It should be noted that the net after tax income includes returns to management and to all other overhead charges, so that the decision criterion is not strictly the same as a variable-cost shut-down criterion. A rational decision-maker would be willing to operate when PV of income is 0 or larger. It may be the case that the annual operating cash flow covers short-run variable costs in most of the 5 years, but one year of poor outcome drives the 5-year present value into the "failure" outcome. Further, the simulated business excludes non-farm income or revenue from farm products other than citrus, which affects total household income of the farm business operator.

It should be noted that state-level regulations in California differ considerably from Texas, particularly in air quality, pesticide, and labor requirements. Interestingly, modifications to achieve water quality are relatively more costly in Texas compared with California. The data collection approach in the Paggi et. al study is a grower panel. With this approach, multiple growers provide input data through a focus group that results in a consensus formulation of a "representative farm model." The resulting farm business model contains an income statement and balance sheet which are used to examine the firm-level impact of scenarios in a stochastic simulation. The grower group does not discuss variability, because the goal of the focus group is to arrive at a reasonable representation of an operating business.

Within each state, variation across the items needed for compliance with GAPs is noteworthy. Education and training expenses are the largest component of compliance costs in Texas. In California, there are significant capital investments reported in association with GAPs, as well as risk management for food safety (possibly insurance coverage). The total costs per acre of education and training in the two states are comparable, at $15 and $18 dollars. The training is required so that farm laborers are able to implement the safety-oriented measures. California orange growers face other compliance cost items that are not part of the requirements for Texas growers, mainly for pesticides.

CONCLUSION AND DISCUSSION

This review of studies on the costs to comply with food safety regulations provides some generalities about differences in the impact across sizes of firms. Larger firms experience lower cost per unit to comply, across 4 different industries. In three of the four industries covered by the studies we reviewed, the medium-sized operations reported the highest cost per unit. The finding that small businesses are not the most disadvantaged group may be the result of accommodations for small firms in the implementation plans. It may also be the case that smaller businesses had available capacity in management which gave them the flexibility to adapt to food safety regulations more efficiently than the medium-sized firms.

The research approach of most of the *ex-post* analyses has been to survey the affected firms within a year or two of the new rule going into effect. The timing of the study likely explains some of the variation in costs reported. Food safety concerns developed over many months and sometimes years, as outbreaks of foodborne illness were traced to foods that had not previously been considered high-risk. Thus, industry received strong signals about food safety concerns before rules went into place, and some firms adopted food safety measures in advance of the regulation. The pro-active firms reported no costs from the effective rule because they had already adopted changes.

Further, regulated entities have the option to choose among appropriate controls, and that choice affects variation in the costs to comply. There is flexibility for an establishment to select a type of technology or set of activities that achieve the safety improvement at a cost that is most consistent with cost-minimization across a number of inputs and activities. In some cases, the

firm avoids a capital investment by hiring safety-enhancing services at a fixed rate per unit of output. The economic benefits of the flexible choices will be most apparent where reliable, qualified third-party providers of services and expertise are available in competitive markets. In the almond industry, for example, firms are able to minimize variation in the costs to comply with food safety rules by shipping goods to off-site treatment facilities. The use of outsourced services is a two-edge sword, however, as the user may not have the opportunity to control the costs of the third-party provider. Thus the costs are invariant but may be higher on average than internalizing the control and improving the cost-effectiveness of the routines over time. Outsourcing is less common in meat processing and is infeasible in farming, where the production base and any associated risk of contamination is tied with the physical location of the farm.

In addition to size-based differences in impact, food safety regulations may have distinct effects on firms when they are grouped according to the level of value-added in the processing. These differences might arise because value-adding processes also kill pathogens (such as in cooking) or because there is synergy between the management of quality control needed for product differentiation and the activities needed for safety. One study (by Ollinger) was designed to address whether there is a systematic difference in impact on the primary processor compared with the operations that are engaged in further processing. The final processors had the largest average cost of compliance (as percent of sales) and also experienced much greater variation in costs. Indeed, the coefficient of variation for cost of compliance reported by operators in the value-added business was double that of slaughter. There was little difference in the reported costs per unit for firms that conduct slaughter and the firms that further process raw materials.

Further study of the value chain could shed light on the factors driving uncertainty and variation in the cost of regulations and even the potential effects on consumers. Where there is high value-added in the production/marketing process, the regulated entity could absorb costs of regulation within the existing price mark-up, therefore mitigating pass-through to primary producers or to final consumers. Alternatively, differences in competitive market structures at the levels of the value chain may also contribute to the variability, as fragmented processing firms may not be in a position to pass along regulatory costs to more powerful retailers. It is not well understood whether the differences in compliance costs by size are related to the position of the firm in the value chain.

Only the studies on the meat processing industry were able to provide evidence about the value chain. The other food safety rules affected only one level of the value chain, namely farms (for greens and oranges) and first handlers (for almonds). To our knowledge, there is no methodology to utilize the cost data from these studies for a valid comparison of compliance burden along the value chain that will be broadly generalizable. It may be worth considering the indicators of value-added that can be elicited in future industry studies of the costs of compliance with food safety regulation.

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