Welfare Losses from Food Safety Regulation in the Poultry Industry

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SP 07 2000 2000

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Southern Agricultural Economics Association: Annual Meetings
January 31 - February 2, 2000, Lexington, Kentucky

Abstract: Results of surveys sent to plant managers of eleven firms representing 25 percent of the U.S. broiler volume were used to estimate HACCP implementation costs for poultry kill plants and to perform welfare analysis. First-year welfare losses were $70 million for the broiler industry. There were also substantial consumer losses.

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On July 25, 1996 the United States Department of Agriculture published the proposed *Final Rule for Pathogen Reduction; Hazard Analysis and Critical Control Point (HACCP) Systems*, 9 CFR Part 304. This final rule, often referred to as the AMega-Reg,@ directed the Food Safety Inspection Service (FSIS) to Aestablish requirements applicable to meat and poultry establishments designed to reduce the occurrence and numbers of pathogenic microorganisms on meat and poultry products, reduce the incidence of foodborne illness associated with the consumption of these products and provide a framework for modernization of the current system of meat and poultry inspection.@ The AMega-Reg@ was to utilize the HACCP approach to achieve its goal of reducing pathogens in food. HACCP represents a new approach to food safety in the meat industry because it focuses on prevention of microbial hazards, rather than *ex post* inspection for contamination (Unnevehr and Jensen).

HACCP implementation for all meat and poultry plants employing more than 500 persons began January 26, 1998. On the same date in 1999, plants with 11 up to 499 employees were added to the HACCP inspection list. Approximately 7,000 inspectors operating from 17 regional USDA-FSIS offices are currently dedicated to HACCP implementation and enforcement. The pathogen reduction regulation was expected to have a major impact on the safety of meat and poultry products and on industry production methods.

While the philosophy that food safety is a shared responsibility between consumers and producers is widely accepted, the issue of who bears costs and risks is still controversial. Federal legislation does not require an efficient allocation of resources among the various aspects of food safety and health policy. Health and safety regulations are only coincidentally efficient in the sense that an additional dollar spent on each program yields the same risk reduction.

USDA FSIS carried out an economic impact assessment of the regulation that showed that expected benefits would greatly exceed expected costs. In spite of the demonstrated benefits, the assessment was met with controversy. The major reason for controversy was the difficulty in estimating *ex ante* costs (Unnevehr and Jensen). For instance, Knutson *et al.*, provided a much higher than FSIS estimates for HACCP implementation costs. The other reason for controversy was the uncertainty associated with forecasting the regulation's ultimate impact on foodborne illnesses. Pathogens can enter food supply at any point from producer to consumer. The regulation addresses only the slaughter and processing portion of the food chain. It is still unclear whether or to what extent pathogen reductions in raw meat products will reduce the incidence of foodborne illnesses. Furthermore, current technologies to detect and prevent food-related hazards are unable to guarantee a food supply that is 100 percent safe.

The economic impacts of foodborne illness on the food industry have been largely neglected in attempts to place a value on food safety improvements. Current efforts have focused primarily on improvements in measuring loss of life, loss of productivity due to illness, and direct costs of medical treatment (Roberts and Smallwood). Improved estimates of these very real human and social costs are of clear importance in placing a value on food safety improvements and should not be minimized. The FSIS provided only ‘unconditional’ estimates for costs, i.e., assuming that costs and benefits would occur with certainty. Incidence of costs and benefits was secondary to the overall analysis of whether benefits exceed costs, and was therefore not analyzed by FSIS.

This study focuses on how the incidence of costs from new regulatory action affects the poultry industry. The equilibrium displacement model (EDM) is employed for the analysis. This model takes into account costs imposed by the regulation as well as substitution effects among poultry, pork, and beef products. The estimates of the supply shock for poultry industry are based on data gathered from broiler plants in the U.S. The estimates provided by the model analyses show how the incidence of pathogen reduction regulation cost affects both the poultry industry and the consumer.

Data

Estimates of HACCP costs for poultry slaughter industry used in this study are based on surveys of plant managers from the eleven firms participating in the HACCP Roundtable, an academic, governmental, and industry group which meets monthly to discuss issues related to HACCP implementation and monitoring. A survey of 56 broiler slaughter plants was conducted to assess costs associated with the first year of HACCP Mega-Reg implementation.

Surveys were sent to the respective plant managers or their designee for completion and were returned to the University of Arkansas for analysis. Of the 56 surveys sent, 35 were returned in usable form. Total slaughter capacity for these 35 plants represented over 25 per cent of the total U.S. broiler slaughter in 1998, 2.05 billion of the 8 billion total. The survey focused on additional 1998 capital and capital monitoring costs as well as operational costs incurred since HACCP implementation. Operational costs included water costs, maintenance and monitoring costs, personnel costs and additional training costs related to HACCP monitoring and record keeping. The results of the survey are presented in table A1 in the Appendix. Goodwin and Shiptsova used survey results to estimate HACCP costs for the U.S. broiler industry, performed benefit/costs analysis for HACCP regulation and developed policy recommendations.

Methods

Equilibrium displacement models (EDM) will be employed to quantify producer losses, resulting from HACCP Mega-Reg implementation. These models allow for the approximation of losses or gains accruing to producers, consumers, or both when the market equilibrium is disturbed by an exogenous shock. Within these models, the market equilibrium is characterized by functions that are linear in supply and demand elasticities. Such models have been used extensively in the analysis of agricultural and food policies (e.g., Summer and Wohlgenant; Beghin and Chang; Brown; Unnevehr *et al.*). More specifically, EDM models have been used to analyze food safety policy. Unnevehr *et al*. used EDM methods to estimate the incidence of producer welfare loss resulting from HACCP regulations. Their study examines how new regulation to reduce microbial pathogens may influence competitiveness among the beef, pork, and poultry industries. The EDM model is used to simulate producer welfare losses taking into account costs imposed by the regulation and substitution effects in consumption.

The use of an EDM framework allows for an examination of the impact of an exogenous shock on the endogenous variables of the model both in terms of the direct and indirect effects. Elasticity estimates are required to implement this type of model.

Estimates of supply and demand elasticities utilized by Unnevehr *et al.*, will be used in this paper. The shock in supply is derived from the previously mentioned estimated HACCP costs for the U.S. broiler industry. This is the first study on HACCP implementation that has used real rather than simulated data for HACCP costs.

<u>Model Specification.</u>

Consumer demand and supply equations for each industry are:

$$
\begin{aligned}
Q_i^s &= f_i^s(P_i, S_i) \\
Q_i^d &= f_i^d(P_{br}, P_p, P_b) \\
Q_i^d &= Q_i^s = Q_i \\
S_i &= \frac{C_i}{Q_i} \\
i &= b, br, p
\end{aligned}
\qquad (1)
$$

where:

br is broilers

p is pork

b is beef

C_i is total HACCP costs to industry

In the elasticity form, the model is:

$$
\begin{aligned}
Q_{br}^* &= \varepsilon_{br}(P_{br}^* - s_{br}) \\
Q_{br}^* &= \eta_{br} P_{br}^* + \eta_{br,p} P_p^* + \eta_{br,b} P_b^* \\
Q_p^* &= \varepsilon_p (P_p^* - s_p) \\
Q_p^* &= \eta_p P_p^* + \eta_{p,br} P_{br}^* + \eta_{p,b} P_b^* \\
Q_b^* &= \varepsilon_b (P_b^* - s_b) \\
Q_b^* &= \eta_b P_b^* + \eta_{b,br} P_{br}^* + \eta_{b,p} P_p^* \\
W_i^* &= T_i P_i^*
\end{aligned}
\qquad (2)
$$

where:

W_i is a wholesale price for good *i*

P_i is a retail price for good *i*

T_i is price transmission elasticity for good *i*, and

W^*, P^*, and Q^* are percentage change in wholesale price, retail price, and quantity, respectively.

Since only large broiler plants had to be compliant with the pathogen reduction regulation in 1998, the shock *s* in the model is assumed to be proportional to the volume produced. In the competitive environment, a change in the cost per unit produced equals a change in marginal costs (AC=MC=P). A change in marginal cost s_i for product *i* is expressed as:

$$s_i = \frac{DS_i}{W_i} = \frac{1}{W_i}\left(\frac{C_i}{Q_i}\right) \qquad (3)$$

Costs as a percentage of industry sales are given in table 1.

Table 1. Total annual costs and production by industry

	Broilers	Beef	Pork
HACCP costs[a] (million $)	124	521	345
Total production (million lb)	27,612	25,760	19,001
Industry sales (million $)	17,745.31	39,412.8	18,487.97
Costs as per cent of sales	0.7	1.32	1.87

[a]HACCP costs are empirically estimated for broiler industry only, IFSE simulated HACCP costs estimates are used for beef and pork

Proportional changes in quantities and prices of pork, beef, and chicken are endogenous to the model; changes in prices received by the producer due to additional costs are exogenous shocks. Change in producer surplus is for commodity *i* is expressed as:

$$\Delta PS_i = W_i Q_i \{ W_i^* - W_i^* Q_i^* - (W_i^*)^2 / 2 - 0.5[1 - ((W_i - S_i)/W_i)^2]\} \qquad (4)$$

and change in consumer surplus is:

$$\Delta CS_i = -P_i Q_i P_i^* (1 + 0.5 Q_i^*). \qquad (5)$$

However, total consumer surplus change is difficult to assess because of the lack of information on human health improvement.

Results

Elasticity estimates from three different studies are utilized in identifying producer and consumer surplus changes. These estimates are compared and contrasted in Tables 2 and 3, respectively (elasticities are also presented in the appendix tables A2-A4). The price transmission elasticity for the broiler industry of 1.3 was estimated as the average price transmission elasticity over 1998. The supply elasticities for pork (0.4) and beef (0.15) are from Wohlgenant (1993), and for broilers (0.65) is from Sullivan *et al.* (1990).

Table 2. Change in producer surplus (millions of dollars)

	With substitution effects	Without substitution effects
Huang	-62.25	-22.18
LW[1]	-37.64	-37.88
EU[2](3SLS)	-30.66	-4.52

[1]Lemieux and Wohlgenant
[2]Eales and Unnevehr

The results with and without substitution effects indicate that producer surplus loss ranges from approximately $4 to $63 million per year. The differences in estimated producer welfare changes demonstrate the importance of consumer behavior on altering producer welfare. Without the substitution effects, higher own price elasticities yield higher producer welfare losses. Own price elasticity for broilers are -.37, -.56, and –.23 for Huang, LW, and EU, respectively. When demand is inelastic, a small decrease in quantity leads to a large increase in price, which offsets a large part of producer losses. When no substitution occurs, the total adjustment to shifts in supply is reflected by movement along the broiler demand curve. When the substitution occurs, producer losses are smaller or larger depending on the direction and magnitude of the demand shift.

The losses for broiler industry range from $4 to $38 million per year without the substitution effects. The losses with substitution effects range from $30 to $63 million per year. Loss comparison with and without substitutability again emphasizes the importance of consumer behavior on producer welfare losses. When the consumer substitutes among different commodities, a price increase causes an inward shift in demand that leads to greater producer loss.

Consumer surplus loss is on average much larger than producer loss (see table 3). Consumer surplus loss is smaller with the substitution effect – substitution between different commodities helps the consumer to reduce losses. Consumer health benefits are yet difficult to assess. It has been only two years since the regulation was implemented, and there have been no sufficient statistics to test a statistically significant decrease in foodborne illness. Center for Disease Control data[2] indicate that there have been no significant changes in human health in 1998.

Table 3. Change in consumer surplus (millions of dollars)

	With substitution effects	Without substitution effects
Huang	-49.91	-79.74
LW	-67.37	-67.36
EU(3SLS)	-72.65	-92.22

2 The data can be located at htttp://www.cdc.gov/epo/mmwr/preview/mmwrhtml/00056654.htr

Conclusions

This study is the first study that employed real cost of HACCP estimates to analyze welfare losses resulting from the new regulation. Overall, the results show that producer welfare losses are substantial for the broiler industry. The cost estimates are based on 1998 survey when small plants were not yet introduced to HACCP. Costs to small plants are expected to be greater than costs to large ones. Further, HACCP costs for broiler slaughter plants were underestimated because most pathogen reduction compliance costs were not included. Also, costs for poultry further processing plants were not included. However, even these underestimated costs of HACCP compliance result in a substantial decrease in social welfare. The welfare losses for broiler industry may as high as $62 million per year. Consumer welfare losses are even higher than producer losses (up to $92 million per year) but are contingent on reduction in foodborne illness. More information must be gathered to accurately assess total consumer surplus change resulting from any human health improvement. According to the Center for Disease Control data, there has been no significant reduction in the incidence of human health in 1998. In this case, producer and consumer welfare loss is not offset by the benefits of health improvement.

Bibliography

Antle, J. M. *Choice and Efficiency in Food Safety Policy*. The AEI Press, Washington, D.C., 1995.

Beghin, J., and R. Chang. “Differentiated Products and Supply Controls in the Analysis of Agricultural Policy Reform: The Case of Tobacco.” *Agricultural Economics* 7(1992):301-15.

Brown, A.B. “Cigarette Taxes and Smoking Restrictions: Impacts and Policy Implications.” *American Journal of Agricultural Economics* 77(November 1995):946-51.

Davis, G. C. and Maria Cristina Espinoza, A Unified Approach to Sensitivity Analysis in Equilibrium Displacement Models, *American Journal of Agricultural Economics*, November 1998, pp.868-879.

Eales, J. S., and L. J. Unnevehr. “Simultaneity and Structural Change in U.S. Meat Demand.” *American Journal of Agricultural Economics*, 75(1993):259-68

Gardner, B.L., The Farm-Retail Price Spread in a Competitive Food Industry, *American Journal of Agricultural Economics*, August 1975, V. 57: 399-409.

Goodwin, H.L. and R. Shiptsova. ”HACCP Implementation and Human Health Improvement: Is the Public Getting Its Money’s Worth?” Working paper of the University of Arkansas.

Huang, K.S. “U.S. Demand for Food: A complete System of Price and Income Effects.” Washington, D.C.: USDA, *ERS Technical Bulletin No. 1821*, 1993.

Lemiex, C. M, and M.K.Wohlgenant. “Ex Ante Evaluation of the Economic Impact of Agricultural Biotechnology: The Case of Porcine Somatotropin.” *American Journal of Agricultural Economics* 71(1989):903-14.

Muth, R.F., The Derived Demand Curve for a Productive Factor and the Industry Supply Curve, *Oxford Economic Papers*, 1964, V. 16:221-34.

Ospina, Enrique and C. Richard Shumway, Disaggregated Econometric Analysis of U.S. Slaughter Beef Supply, 1979, The Texas Agricultural Experiment Station

Richards, T. J. and P. M. Patterson. “The Economic Value of Spin Control: Food Safety and the Strawberry Case.” National Food and Agricultural Policy Project, Arizona State University, 1998.

Summer, D.A., and M.K. Wohlgenant. “Effects of an Increase in the Federal Excise Tax on Cigarettes.” *American Journal of Agricultural Economics* 67(May 1985):235-42.

Sullivan, J., J Wainio, V Roningen, A Database for Trade Liberalization Studies, Washington, D.C., USDA, ERS, Agricultural Trade and Analysis Division, 1990.

Unnevehr, Laurian J and Helen H. Jensen, HACCP as a Regulatory Innovation to Improve Food Safety in the Meat Industry, *American Journal of Agricultural Economics*, 1996, pp. 764-69.

Unnevehr, Laurian J, Migues I. Gomez, and Philip Garcia, The Incidence of Producer Welfare Losses from Food Safety Regulation in the Meat Industry, *Review of Agricultural Economics*, V.20 (1): 186-201

Wohlgenant, M.K. “Distribution Gains from Research and Promotion in Multi-Stage Production Systems: The Case of the U.S. Beef and Pork Industries, *American Journal of Agricultural Economics*, 1993, V. 75: 642-51.

Appendix

Table A1. Cost increases for Poultry Slaughter Plants incurred Since HACCP Implementation, Responding Broiler Plants, January 26, 1998 to January 26, 1999

Costs Category		Sum	Mean (SD)
I. Capital Costs	Change in equipment	$5,260,194	$154,712 (201,142)
II. Capital monitoring costs	Machinery	$247,764	$9,911 (27,260)
	Chemicals	$463,750	$18,550 (65,028)
	Product loss	$8,700	$2,000 (7,187)
	Packaging	$48,000	$363 (1,138)
	Other	$275,500	$11,479 (33,229)
	Total capital monitoring costs	$1,043,714$	$30,697 (92,060)
	Total Change in capital costs	$6,303,907	$180,112 (214,246)
II. Operational Costs			
A. Water Costs	Change in annual water costs 3,	$3,153,412	$98,544 (90,314)
	Change in annual waster water treatment costs	$6,192,243	$213,526 (496,217)
	Change in gallons	2,102,274,632	65,696,082 (60,209,451)
	Total change in water costs	$9,345,655	$292,052 (491,570)

3 Calculated as $1.50 per 1,000 gallons of water

(continued from previous page)

B. Maintenance and Monitoring Costs	Costs of plant manager time spent on HACCP monitoring, appeals and compliance4	$251,604	$7,862 (10,146)
	Additional preventive maintenance	$1,402,934	$43,842 (120,197)
	Costs of additional preventive management personnel since HACCP began	$7,653,080	$255,103 (527,930)
	Total HACCP maintenance and monitoring costs	$9,307,618	$273,753 (600,339)
C. Personnel Costs	Additional personnel costs	$4,898,963	$148,453 (119,861)
	Consulting expertise costs	$117,129	$3,549 (6,259)
	HACCP training costs	$706,895	$21,421 (19,340)
	Loss of management5	$62,390	$3,889 (4,928)
	Total HACCP personnel costs	$5,785,377	$165,296 (128,790)
D. Additional Training Costs		$1,000,000	$500,000
Total operational costs		25,438,650	
Total fixed and variable costs		$31,742,557	

4 Estimated at wage rate of $20 per hour
5 Assumed that 30% of managers quit since HACCP began

Table A2. Huang elasticities of demand

	Beef	*Pork*	*Chicken*
Beef	-0.6088	0.1214	0.0207
Pork	0.2130	-0.7162	0.0167
Chicken	0.1054	0.0484	-0.3718

Table A3. Lemieux-Wohlgenant elasticities of demand

	Beef	*Pork*	*Chicken*
Beef	-0.63	0.13	0.08
Pork	0.22	-0.80	0.01
Chicken	0.30	0.21	-0.56

Table A4. Eales-Unnevehr/3SLS elasticities of demand

	Beef	*Pork*	*Chicken*
Beef	-0.85	-0.04	0.07
Pork	-0.11	-1.23	0.01
Chicken	0.38	0.04	-0.23