Epidémiol. santé anim., 1997, 31-32

THE USE OF EQUILIBRIUM WELFARE ANALYSIS FOR EVALUATING THE INDUSTRY EFFECTS OF DISEASE CONTROL PROGRAMS WITH APPLICATIONS TO *SALMONELLA ENTERITIDIS* IN EGGS

Morales R.A.[1]

Alors que les décideurs sont de plus en plus souvent amenés à justifier l'affectation de ressources au contrôle des maladies et aux programmes d'éradication, le besoin d'évaluation des programmes dépasse la prévision des coûts et des effets au niveau de la ferme. Il en est ainsi car ces programmes affectent généralement l'offre et la demande de la filière et par conséquent les prix et les quantités du marché. La prévision des effets sur la filière devient dès lors une entrée importante dans le processus décisionnel et dans l'évaluation de la limite acceptable pour le coût du programme.

Cette communication présente une méthode socio-économique pour estimer les réponses potentielles de l'offre et de la demande à la mise en place de programmes de contrôle des maladies ou d'éradication et pour prévoir la manière dont vont être affectés le prix et la quantité d'un produit donné et de ses produits dérivés. L'analyse de l'équilibre socio-économique permet également de définir la proportion des coûts du programme qui serait prise en charge par les producteurs, les consommateurs et le gouvernement. La méthode est appliquée à un hypothétique programme national obligatoire de testage et de contrôle de Salmonella enteritidis. La valeur de l'information collectée au niveau de la ferme sur les coûts de prévision des effets des programmes réglementaires sur une filière est illustrée ici.

L'analyse socio-économique montre que le marché des oeufs en coquille, et les producteurs en particulier, supporte à court terme la charge financière d'un programme national de contrôle et de testage pour Salmonella enteritidis. Au cours du temps, une redistribution des effets socio-économiques s'établit qui fait que les coûts sont plus équitablement partagés par les consommateurs et les producteurs. En supposant que le programme de contrôle de Salmonella enteritidis représente un coût additionnel de 1 cent par douzaine d'oeufs à la coque, les producteurs supportent une perte globale d'excédent de 44,9 millions de dollars tandis que les consommateurs ne contribuent au financement du programme qu'à hauteur de 2,4 millions de dollars sur le court terme. Sur le marché du cassage des oeufs, les consommateurs risquent de bénéficier d'une baisse potentielle des prix grâce à un programme de contrôle des oeufs en coquille appliqué à toute la filière.

INTRODUCTION

Foodborne illness is a major cause of morbidity in the U.S. resulting in an estimated 6.5 to 33 million cases and up to 9,000 deaths annually (CAST 1994). Seven *pathogens (Salmonella sp.* included) from all food sources result in an estimated annual costs of human illness ranging from $5.6 to $9.4 billion, with illnesses related to meat and poultry constituting the largest share of costs from $4.5 to $7.5 billion (Federal Register, 1995). Costs of illness for foodborne Salmonellosis alone have ranged from $0.6 to $3.5 billion annually based on an estimated 696,000 to 3,840,000 cases (Buzby et al., 1996). Furthermore, recent outbreaks of emerging pathogens have resulted in rising trends in foodborne illness, increasing consumer concern and subsequently, greater pressure for regulatory attention. *Salmonella enteritidis* is one example of an emerging pathogen whose increasing incidence has been noted not only in the U.S. (CDC, 1992) but also worldwide (Rodrique, et al., 1990). Furthermore, epidemiological evidence has linked a high proportion of S.e.-related food poisoning outbreaks to the consumption of Grade A shell eggs.

Regulatory response to the rising incidence of S.e. resulted in the institution of two Federal programs under the U.S. Department of Agriculture (USDA). The first program involved mandatory testing of breeder flocks for S.e. for the purpose of eliminating transmission of S.e. to laying hens and their environments. The second program was designed to trace eggs implicated in reported human S.e. outbreaks back to the egg-laying flocks of origin. Under this Federal Traceback Program, eggs from test-positive flocks were restricted for sale as shell eggs. The producer with an S.e. test-positive flock could either retain the flock through completion of its production cycle but divert eggs to the breaker egg market for pasteurization, or depopulate and restock with S.e.-negative layers. Over the first two years of the traceback program, 19 out of 25 laying flocks involved in a traceback were restricted, resulting in the voluntary depopulation of 3.1 million birds and the diversion of 1.2 billion eggs (1% of total egg production per year of the Federal Program) to the breaker market. In October 1995, as private and state-level control programs emerged, Federal funding was deferred and the traceback program was discontinued by the USDA.

Regulatory responsibilties for the traceback program have since been assumed by the Food and Drug Administration (FDA). In the past, FDA has advocated an industrywide mandatory S.e. control program that would require the testing of all laying flocks, not just those implicated in S.e. food poisoning outbreaks (USAHA, 1989). Further, the USDA Food Safety & Inspection Service (FSIS) is currently conducting a risk assessment and cost-

[1] Dept. of Agricultural and Resource Economics, North Carolina State University, Raleigh, NC 27695-8109, USA

benefit analysis relative to implementation of mandatory quality assurance programs or HACCP (Hazard Analysis of Critical Control Points) systems. This paper sketches the broad outlines of a method that would allow the assessment of potential industry responses (supply, demand, market prices and quantities) to the institution of mandatory S.e. control programs. Distributional effects of a mandatory control program (i.e., who bears the costs) can also be determined. Equilibrium welfare analysis using a multimarket approach can furthermore be used to evaluate the potential spillover effects of a control program in one market on related markets. For example, an S.e. control program with egg diversion for pasteurization as an option will affect not only shell egg prices and quantities but will likely cause changes in breaking egg supply and demand as well. The potential costs to be borne by consumers and producers, taking all related market effects into account, can then be accurately evaluated.

THE EQUILIBRIUM WELFARE MODEL

A necessary first step in assessing the costs of a nationwide control program is to have a notion of alternative control options and their corresponding costs. Examples of such additional inputs for an S.e. control program might include placement of certified S.e.-negative pullets, in-house testing/monitoring for S.e., feed additives, vaccination, rodent control, strict temperature controls, and improved egg handling practices. In effect, a mandatory S.e. control program will raise sanitary and phytosanitary standards above what the market would otherwise require, and subsequently increase the marginal costs of selling eggs in the shell market. Oftentimes though, this type of information is available only at the farm level and as point estimates. However, the equilibrium welfare model developed (Morales 1995) would allow utilizing such information to evaluate the industry- wide effects of a policy to control S.e. in shell eggs.

Several assumptions were made in developing the equilibrium model for shell and breaking egg production: 1) a representative agent model was used; 2) shell and breaker eggs are substitutes in demand and supply, thus the respective demand and supply curves are also dependent on the other market's price; 3) given the likely nature of the data to be had on the costs of alternative control strategies, the control program effect is incorporated via an S.e. regulatory input price per unit of shell egg output, enabling a taxlike representation of the S.e. program effect; 4) a nationwide testing and control program for S.e. would increase the marginal costs of selling in the shell egg market, shifting shell egg supply back in the aggregate; and 5) policy effects would spillover into the breaker egg market since shell and breaker eggs are highly substitutable in supply.

Simultaneous equations systems for the supply and demand equations of shell and breaker eggs in the U.S. were estimated using time series data and correcting for autocorrelation. Estimated supply and demand elasticities were used to simulate the welfare effects of the control program (Morales 1995). Note that this model accommodates diversion in its cost accounting of the effects of a nationwide control program through the cross-price supply elasticity and spillover effects into the breaker market.

EMPIRICAL APPLICATIONS TO S.E. IN EGGS

Management practice changes and additional farm-level costs for S.e. control were identified through a producer survey (Morales 1995 and 1996). The subsequent shifts in the supply and demand curves of both shell and breaking egg markets with interventions to control *S. enteritidis* in shell eggs were modeled, and the distributional effects of the market intervention were simulated over a range of input costs for S.e. control. Surplus changes were parcelled out to producers and consumers of both shell and breaking eggs over the short- and long-run.

For purposes of illustration, assume a U.S. control program that will increase input costs for S.e. control by 1 cent per dozen eggs. Under this policy scenario, the net surplus change to producers and consumers ($39.41 vs. $39.40 million per year) would essentially be the same whether or not the diversion of eggs for pasteurization is a policy option (Table I). However, producers could potentially minimize their short-run losses if diversion of eggs were a program option. The short-run costs of the control program would be higher than the long-run costs ($47.32 vs. $39.41 million per year), and the burden of program costs borne primarily by shell egg producers in the short-run (Table II). Over time, the program costs would be more evenly shared between consumers and producers, with consumers bearing the burden of the program costs in the long-run.

Table I

Consumer and Producer Gains and Losses (Long-Run) Under an S.e. Control Program With and Without Diversion of Eggs for Pasteurization as a Policy Option (Annual)

		WITH DIVERSION (Million $)	WITHOUT DIVERSION (Million $)
CONSUMER SURPLUS	Shell Egg Market	(17.90)	(1.95)
	Breaking Egg Market	2.24	(0.09)
	Total Consumer Surplus	(15.66)	(2.04)
PRODUCER SURPLUS	Shell Egg Market	(21.50)	(37.45)
	Breaking Egg Market	(2.24)	0.09
	Total Producer Surplus	(23.75)	(37.36)
NET SURPLUS CHANGE		**(39.41)**	**(39.40)**

Table II
Short-Run and Long-Run Consumer and Producer Gains and Losses Under an S.e. Control Program With Diversion of Eggs for Pasteurization (Annual)

		SHORT-RUN Million $	LONG-RUN Million $
CONSUMER SURPLUS	Shell Egg Market	(6.67)	(17.90)
	Breaking Egg Market	4.24	2.24
	Total Consumer Surplus	(2.43)	(15.66)
PRODUCER SURPLUS	Shell Egg Market	(40.62)	(21.50)
	Breaking Egg Market	(4.25)	(2.24)
	Total Producer Surplus	(44.87)	(23.75)
NET SURPLUS CHANGE		**(47.32)**	**(39.41)**

CONCLUSIONS

In an SE control program without diversion possibilities, the burden of the program costs fall on the producers of shell eggs ($37.45 million). The welfare losses to consumers of both shell and breaker eggs are minimized due to a relatively small price increase from the increasing production costs induced by the control program. On the other hand, under this same scenario, producers of breaking eggs stand to profit from an increase in breaking egg price as demand rises.

In a control program with diversion possibilities, producers and consumers begin to share the burden of the program costs over time ($15.66 million and $23.75 million in consumer and producer welfare losses, respectively). In other words, producers are able to pass on more of the program costs to the consumer. Note that if control programs are regulatory in nature, then government costs would need to be added into the cost accounting on top of the consumer and producer welfare gains and losses.

The implications of this analysis point to the potential for producers to minimize their losses under an SE control program if they can divert eggs into the breaking egg market for pasteurization. Diversion may therefore not be an unreasonable program option particularly since none of the SE outbreaks in the U.S. have been associated with pasteurized egg products.

Finally, the effects of a control and eradication programs are likely to show up in the costs of production and profitability of individual firms. However, in terms of the industry as a whole, control programs have the potential to shift back the supply of that particular product as well as indirectly affect other related markets. Point estimates at the farm level can provide information that can be used toward evaluating the industry effects of various control programs. Therefore, as control methods are evaluated and applied, concurrent collection of information on the costs of alternative control methods becomes important to program evaluation.

BIBLIOGRAPHY

Buzby J.C., Roberts T., Lin C.-T.J. and MacDonald J.M., 1996. Bacterial foodborne disease: Medical costs and productivity losses. ERS/USDA Agricultural Economic Report No. 741.

Centers for Disease Control and Prevention (CDC), 1992. Outbreak of *Salmonella enteritidis* infection associated with consumption of raw shell eggs, 1991. Morbidity and Mortality Weekly Report 41: 369-372.

Council for Agricultural Science and Technology (CAST) Report, 1994. Foodborne pathogens: Risks and consequences. Library of Congress, Washington DC.

Federal Register, 1995. Pathogen reduction; Hazard analysis and critical control point (HACCP) systems. Preliminary regulatory impact assessment for Docket No. 93-016P 60(23): 6774-6889.

Morales R. A., 1995. Equilibrium Welfare Analysis of Food Safety Regulation: The Case of *Salmonella enteritidis* in eggs. Ph.D. dissertation. Department of Agricultural and Resource Economics, North Carolina State University. Raleigh, NC.

Morales R.A., 1996. Farm-level costs for control of *Salmonella enteritidis* in laying flocks. In: J.A. Caswell (ed.), The Economics of Reducing Health Risk From Food. Food Marketing Policy Center, University of Connecticut, Storrs, CT. Pages 99-108.

Rodrique D. C., Tauxe R. V. and Rowe B., 1990. "International increase of *S. enteritidis*: A new pandemic?" Epidem. Infect. 105: 21-27.

U.S. Animal Health Association (USAHA), 1989. Report of the committee on transmissible diseases of poultry and other avian species. Proceedings of the 93rd Annual Meeting of the U.S. Animal Health Association, Las Vegas, NV.