Assessing the Costs and Benefits of Pathogen Reduction

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There has been increasing concern in recent years over the human health risks posed by microbial pathogens—bacteria, parasites, fungi, and viruses—in the food supply. Each year an estimated 6 million to 33 million cases of foodborne disease occur in the United States, and up to 9,000 people die. USDA's Economic Research Service (ERS) has estimated that diseases caused by seven major pathogens alone may cause between $6.6 billion and $37.1 billion annually in medical costs and productivity losses.

These estimated social costs of foodborne illness, while suggesting the extent of the burden of these illnesses on society, are only a starting point. Policymakers are also interested in how efforts to prevent foodborne illness can reduce this burden, and the relationship between the benefits of safer food and the costs of achieving this goal. Ideally, the costs of regulations and other efforts to control foodborne disease and to reduce pathogens will be less than the benefits of reduced medical costs and productivity losses.

Most government regulations have some sort of economic effect on producers and consumers. Regulations governing how foods are produced can raise production costs. Regulations require resource commitments, which, in turn, may raise costs and food prices. On the other hand, regulations that improve the safety of the food supply benefit consumers by reducing the number and/or severity of foodborne illnesses. Economic analysis can play an important role in the public decisionmaking process by identifying and comparing the benefits and costs of food safety policies. Currently, all regulations with an annual economic impact of over $100 million are required by Executive Order to have undergone a cost-benefit analysis to show that the expected benefits of the regulation exceed the expected costs. The cost-benefit analysis will also explain why the planned regulatory alternative is preferred.

One such regulation is the 1996 Hazard Analysis and Critical Control Points (HACCP) pathogen reduction rule for livestock and poultry slaughter and processing establishments. ERS analyzed this rule to estimate the economic costs and benefits of this new approach to meat and poultry inspection.

Meat and Poultry Inspection Modernized

Federal inspection of meat and poultry processing and slaughter plants has been in place for decades. Prior to 1996, USDA's Food Safety and Inspection Service (FSIS) program employees relied on labor-intensive examinations of each animal and carcass and its internal organs to identify obviously diseased animals. FSIS program employees also checked for unsanitary operating conditions. This inspection system removed diseased animals from the food supply and enforced sanitary standards in livestock and poultry slaughter and processing by relying on sensory methods—sight, smell, and sense of touch—to identify unsafe products. This system, however, could not detect the presence of microbial pathogens that could cause human illness.

To encourage the use of new technologies, including new methods that can detect pathogens efficiently and effectively, FSIS began to strengthen the meat and poultry products inspection process in the early 1990's. On February 3, 1995, FSIS published a proposed rule that

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would require all federally inspected livestock and poultry slaugher and processing plants to do the following:

- Adopt HACCP procedures.
- Set targets for microbial pathogen reduction.
- Require microbial testing to determine compliance with the targets.
- Establish written sanitary standard operating procedures.

Under a HACCP plan, plants must identify potential sources of food safety hazards in their operations and the critical points where controls could prevent or reduce hazards. Plants must then establish critical limits for each hazard at each critical control point. Plants are also required to develop written procedures to show how they will meet daily sanitation requirements. HACCP-related activities are to be monitored and verified, including microbial testing for *Salmonella* by FSIS, and for *E. coli* by industry. The rule was adopted in 1996 following public comment, and the regulations began to take effect in 1998. (See "New Federal Policies and Programs for Food Safety" elsewhere in this issue for a more in-depth discussion of the new HACCP pathogen reduction rule.)

Benefits of HACCP Hinge on Assumptions

To evaluate the economic benefits of HACCP, we need to estimate how implementing the new inspection system will affect the level of foodborne illness. In addition, we must choose a methodology for expressing the value of improved food safety in economic terms.

Four key assumptions, which affect our analysis of the benefits of HACCP, flow from the following questions:

- How effective will HACCP be in reducing microbial pathogens in meat and poultry?
- What is the relationship between pathogen reduction and the level of foodborne illness associated with meat and poultry products?
- Since HACCP will be implemented over time, what is the appropriate way to express long-term benefits in present value terms? When do benefits begin to accrue?
- How should we quantify the benefits of reducing foodborne illnesses, particularly for those who die prematurely or are never able to return to work because of a foodborne illness?

Effectivness of HACCP

In its initial assessment of HACCP, FSIS assumed that, when fully in place, the new meat and poultry inspection system would reduce microbial pathogens 90 percent across the board. Some commentors on the proposed rule asserted that this assumption about HACCP effectiveness was not scientifically justified. In the final rule, FSIS concluded, "... there is insufficient knowledge to predict with certainty the effectiveness of the rule, where effectiveness refers to the percentage of pathogens eliminated at the manufacturing stage." Consequently, FSIS assumed multiple effectiveness estimates, ranging from 10- to 100-percent reduction in pathogen levels.

Pathogen Reduction and Foodborne Illness

The relationship between human exposure to microbial pathogens and any resulting illness is very complex. A number of factors influence whether a person, once exposed, becomes ill and the severity of the illness. Factors include the level of pathogens in the food, the way the consumer handles the product before cooking, the final cooking temperature, and the susceptibility of the individual to infection. In addition, the relationship between pathogen levels and disease varies across pathogens. Some pathogens, such as *E. coli* O157:H7, are believed to be infective at very low doses, while others require ingestion of higher doses to cause illness.

Conducting a comprehensive risk assessment to establish the relationships between pathogen levels, illnesses, and deaths is beyond the scope of our charge. Therefore, we make the assumption that HACCP will reduce illnesses and deaths in proportion to the assumed reduction in pathogen levels. In other words, if HACCP is assumed to be 50-percent effective in lowering the level of pathogens, then we assumed a 50-percent reduction in foodborne illness.

Present Value of Benefits

In our analysis, we follow FSIS' assumption that the pathogen reductions associated with HACCP will begin to accrue in year 5 of the program. We also follow their analysis by estimating the benefits over a 20-year time horizon; that is, benefits begin in year 5 and extend over the next 20 years.

"Present value" expresses future payments of income or cost savings in terms of current value. That is, a certain stream of payments extending into the future can be expressed as a given amount of money invested today at a given interest (or discount) rate. The initial benefits

Table 1
Five HACCP[1] Scenarios Illustrate Range of Benefits

Scenario	Effectiveness of pathogen[2] reduction	Discount rate	Valuation method for premature death/disability	Annualized benefits Low	High
	Percent			*Billion 1995 dollars*	
1995 FSIS analysis	90	7	Human capital	8.4	42.1
Low-range benefits estimates	20	7	Human capital	1.9	9.3
Mid-range benefits estimates	50	7	Human capital	4.7	23.4
Mid-range benefits estimates	50	3	Labor market	26.2	95.4
High-range benefits estimates	90	3	Labor market	47.2	171.8

[1]Hazard Analysis and Critical Control Point (HACCP) Pathogen Reduction Rule. [2]Pathogens included in this analysis are *E. coli* O157:H7, *Campylobacter, Staphylococcus aureus, Salmonella, Clostridium perfringens, and Listeria monocytogenes.*

estimates published in 1995 were calculated using a 7-percent discount rate, as recommended by the U.S. Office of Management and Budget. Other analysts have argued for a lower discount rate. Economists at the U.S. Centers for Disease Control and Prevention (CDC) recommend using a 3-percent discount rate to calculate the present value of HACCP benefits over time, and also looking at the size of benefits when valued at rates of 0, 5, and 7 percent.

Valuing Premature Death

Because there is no consensus on how to best value premature death, we used two approaches. The human capital approach estimates a value for a statistical life using average wages adjusted by a risk premium derived from life insurance studies. The labor market approach estimates a value based on the higher wages people demand for accepting risky jobs.

HACCP Rule Yields Social Savings

Obviously, there is no single correct estimate of the benefits of HACCP; the estimates depend on the assumptions used in the analysis. In our analysis, we chose several different combinations of assumptions about HACCP's effectiveness, the discount rate for valuing future benefits, and the value of a premature death resulting from a foodborne illness.

Our first scenario used the original FSIS assumptions of 90 percent effectiveness, a 7-percent discount rate, and the more conservative, human capital approach for valuing premature death in the cost-of-illness calculations. Next, we considered four alternative scenarios: one yielding a smaller set of benefits estimates, two yielding mid-range estimates, and one set of assumptions yielding the greatest estimate of the benefits of pathogen reduction associated with HACCP (table 1).

As expected, the benefits estimates varied widely, from $1.9 billion to $171.8 billion. No matter what the assumptions, the HACCP rule (even at low effectiveness rates) can be expected to generate considerable social savings by reducing foodborne illness.

Costs of HACCP Rule

A complete economic assessment requires a consideration of the costs of HACCP and how they compare with the expected benefits. FSIS estimated the costs of implementing the HACCP pathogen reduction rule as part of the rule-making process, including the likely costs for plants to develop and implement their HACCP plans and sanitation standard operating procedures and to comply with *Salmonella* and *E. coli* standards. These costs include the expenses involved with assessing and developing control procedures, antimicrobial treatments, record-keeping, employee training, and microbial testing. FSIS also included the cost to FSIS to administer the new rules.

To make a meaningful comparison, the costs of HACCP must be annualized in the same manner as its benefits. FSIS estimated the costs of the proposed rule to be $2.3 billion in a preliminary analysis in 1995, annualized over a 20-year period, starting in 2000 (when all provisions of the final HACCP rule become fully effective). FSIS made changes to the final rule based on public comments on the proposed rule. These changes lowered the estimated costs of the final HACCP rule to $1.1 billion to $1.3 billion, again annualized over 20 years.

Table 2
Benefits of HACCP[1] Outweigh Costs Under All Scenarios

Scenario	Annualized benefits		Annualized costs	
	Low	High	Low	High
	Billion 1995 dollars			
1995 FSIS analysis	8.4	42.1	2.3	2.3
Low-range benefits estimates	1.9	9.3	1.1	1.3
Mid-range benefits estimates I	4.7	23.4	1.1	1.3
Mid-range benefits estimates II	26.2	95.4	1.1	1.3
High-range benefits estimates	47.2	171.8	1.1	1.3

[1]Hazard Analysis and Critical Control Point (HACCP) Pathogen Reduction Rule.

HACCP Rule's Benefits Outweigh Costs

Estimating the benefits and costs of the HACCP rule helps policymakers assess the economic consequences of reforming the meat and poultry inspection system. Our analysis found the benefits of the HACCP rule to be greater than the costs for all five scenarios (table 2). Even at relatively low effectiveness (20-percent pathogen reduction assumed for the low-range scenario), the new rules save at least $1.9 billion in medical costs and productivity losses, and are greater than the $1.1 billion to $1.3 billion in estimated costs. Higher pathogen reduction rates and increased cost estimates for premature death and disability widen the margin between costs and benefits.

The results of this analysis indicate that implementation of the HACCP rule will reduce medical costs and productivity losses associated with foodborne illness by an amount greater than the costs of the rule. Our benefits estimates (especially the low values) are conservative, encompassing foodborne diseases from only six pathogens for which we have epidemiologic and cost-of-illness data. Implementing the HACCP rule could likely produce additional benefits by controlling other microbial pathogens not included in this analysis.

ERS is continuing to research the benefits and costs of programs and policies to improve the safety of the Nation's food supply. Collaborative efforts are underway with the U.S. Food and Drug Administration (FDA), FSIS, and CDC to refine our estimates of the benefits of safer food using new data gathered from the Foodborne Diseases Active Surveillance Network (see "*Salmonella* Cost Estimate Updated Using FoodNet Data" elsewhere in this issue). ERS is also working with the FDA to assess the benefits and costs of efforts to improve the safety of fresh and imported produce.

References

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