# ECONOMIC ISSUES ASSOCIATED WITH FOOD SAFETY

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## Introduction

American agriculture excels at producing an abundant supply of safe, nourishing food for the nation and the world. Despite the productivity and quality of the nation's food system, concerns remain about the safety and quality of the food we eat and the water we drink. In recent years, some well-publicized incidents, such as the contamination of hamburgers with the *E. coli* O157:H7 bacteria and residues of the pesticide Alar on apples, have led to increased public concern about the possibility of foodborne illness and exposure to potentially hazardous chemicals in the food supply. According to the USDA's 1991 Diet and Health Knowledge Survey, 43 percent of primary meal preparers cited bacteria or parasites in food as the food safety issue of greatest concern to them. An additional 22 percent cited pesticide residues in food as their greatest safety concern. In response, the Agriculture Department has begun several broad-based efforts to make further improvements in the safety and quality of the nation's food supply.

This paper discusses the food safety issue from the economist's perspective. Economics has an important role to play in the public debate about food safety. Fundamental economic principles help explain why a food safety problem may exist. Economic analysis of the costs of foodborne disease helps put the overall social burden of unsafe food into a broader perspective. Finally, economic analysis of the costs and benefits of alternative policies to improve food safety supports public and private decision making by allowing us to rank policy options on the basis of their expected costs and benefits.

The next section gives a brief overview of some of the main food safety concerns in the U. S. This is followed by a section on the details of some of the implications of foodborne pathogens in meat and poultry, and a section on estimates of the costs of foodborne disease related to meat and poultry.

Finally, the role of economics in evaluating public policy options is discussed, with an illustrative example of how our estimates of foodborne disease costs can be used to measure the benefits of pathogen reduction.

## Overview: The Economics of Food Safety

The food supply in the U.S. is generally considered healthy and safe. However, even the modern industrial food system may result in undesired or unanticipated outcomes which may pose a health hazard for consumers. Bacteria and parasites may remain in fresh or processed meat and poultry products, which can cause human illness if the food is improperly prepared or handled. Residues of agricultural chemicals may remain on fruits and vegetables, and prolonged dietary exposure to such chemicals may pose a risk of cancer or other adverse health effects. Finally, chemical residues from fertilizers and pesticides applied to cropland may end up in drinking water supplies, again exposing consumers to a risk of dietary exposure to potentially hazardous chemicals.

Consumers make choices about the food products they purchase based on a number of factors. In addition to the price of the product, such factors as appearance, convenience, texture, smell and perceived quality all influence the choices made in the marketplace. In an ideal world, consumers make consumption decisions with full information about product attributes, and so choose the selection of food products which maximizes their well-being.

In the real world, however, there are numerous information problems which complicate the consumer's decision as far as food safety is concerned. All raw meat and poultry products contain some level of microorganisms, some of which may be pathogens. Therefore, handling and processing of meat and poultry unavoidably incurs some probability of fostering the growth of these pathogens, which may remain in food products at such a level as to pose a risk of illness to consumers. However, consumers generally are unable to determine the level of risk of foodborne illness posed by their consumption choices, since pathogens are not visible to the naked eye. Aside from some rather obvious indications (unpleasant odor or discoloration, which may be caused by non-pathogenic spoilage microorganisms), there are, in many cases, no clear-cut ways for consumers to determine that the food they buy may provide a health risk from pathogens or other causes (such as pesticide residues).

Just as consumers do not have full information about the safety of the products they buy, producers have no direct incentive to provide this information. Since it is not clear to firms whether consumers can distinguish among food products of different safety levels, they may not wish to incur the extra cost of providing more than the minimum allowable level of safety in the food products they market. In addition, there may be some concern from a consumer protection standpoint about firms making unsubstantiated health-risk claims in labeling or advertising.

This lack of information on the part of consumers about food safety, and the lack of incentives for firms to provide such information, leads to a case of market failure. The workings of a non-regulated market may yield a sub-optimal level of pathogens in the food supply, excessive levels of human health risk, and higher levels of illness and mortality related to foodborne pathogens and pesticide residues. In such a case, the public welfare may be enhanced if society chooses to regulate the food processing industry to reduce the level of foodborne pathogens and increase the knowledge of consumers, so they may take personal action to reduce their risk of exposure to foodborne illness.

The economic issue of concern is how best to achieve the goal of a safer food supply. Although regulations governing the production, processing, distribution and marketing of food products may increase the safety level of the nation's food supply and provide benefits of reduced risk and illness, such regulations may also increase costs to producers, and potentially raise the costs of food to all consumers. The task is to ensure that the regulations maximize the net benefits of increasing food safety, while minimizing the costs these regulations impose on producers and consumers.

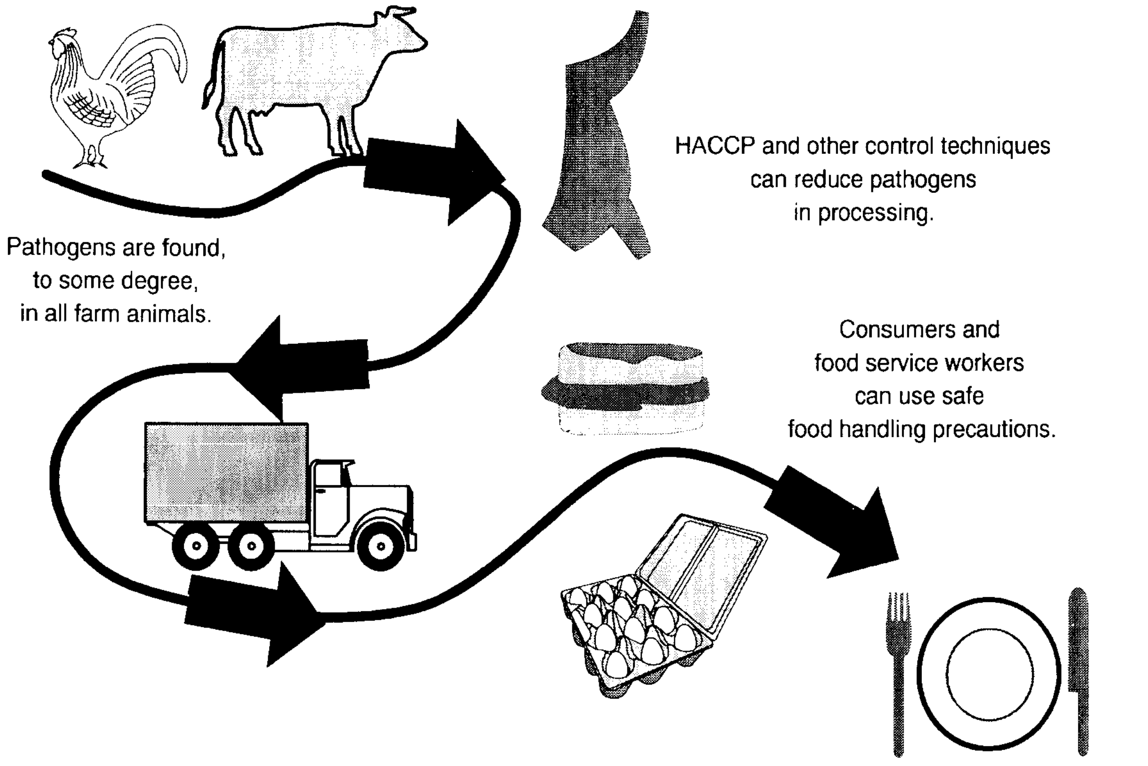
The next two sections show how some of the economic costs of food safety can be determined. We first present a baseline estimate of the extent of foodborne illness related to microbial pathogens. We then present some of the costs associated with these illnesses.

## The Extent of Pathogen-Related Foodborne Disease

Bacteria and parasites exist, to some degree, in all farm animals. Most microbes which are pathogenic to animals do not cause human illness. However, some pathogens which remain in meat and poultry products after slaughter may cause human illness under certain conditions. Pathogens may also be introduced to meat and poultry products in slaughter plants, in processing plants, in grocery stores or food service establishments, and at home (see fig. 1). Examples of where pathogens can enter the food chain are through feed, manure management, processing procedures, or equipment and facility sanitation. Improper operating procedures at the processing level, and food handling practices in the home or restaurant, may cause pathogens to survive and grow, which in turn increases the risk of foodborne illness. Among the most frequent problems are inadequate cooking, inadequate cooling and improper personal hygiene.

The Centers for Disease Control and Prevention (CDCP) and the Food and Drug Administration (FDA) estimate that, each year, between six and 33 million people become ill from microbial pathogens in their food. Of these, an estimated 6,000 to 9,000 die (CAST, 1994). These figures are estimates based on reported outbreaks and other epidemiological data, and

FIGURE 1 - SOURCES OF PATHOGENS IN THE FOOD CHAIN



are subject to some uncertainty. First, many foodborne illnesses have symptoms which are similar to other gastro-enteric illnesses, and may not be reported by physicians as foodborne. Second, in some cases, there is a delay of days or weeks between exposure to a foodborne pathogen and the resultant illness; many illnesses that are reported may not be linked to specific foods or pathogens.

Table 1 presents illness and death estimates for seven pathogens for which we have the most reliable information: These include *Salmonella*, *Campylobacter jejuni/coli*, *Staphylococcus aureus*, *E. coli* O157:H7, *Clostridium perfingens*, *Listeria monocytogenes*, and *Toxoplasma gondii*. Illness caused by *Salmonella* is frequently associated with chicken and egg consumption. Symptoms generally occur six to 48 hours after eating contaminated food, and can last from days to weeks. Acute symptoms include abdominal pain, nausea, stomach ache, vomiting, cold chills, fever, exhaustion and bloody stools. Endocarditis (infection of the heart), meningitis (infection of the brain tissues), and pneumonia may follow the acute stage. The pathogen can also cause chronic consequences such as rheumatoid symptoms, reactive arthritis and Reiters' syndrome. Death may result from the illness. A new strain, *Salmonella enteritidis*, can be passed to eggs before the shell forms, if the hen is infected. Fresh shell eggs and their products can be contaminated with *Salmonella enteritidis*. Homemade foods containing fresh eggs, such as ice cream, egg nog, mayonnaise, and Caesar salad, are potentially risky. A recent outbreak of *Salmonella enteritidis*-related illness in the Midwest was traced to ice cream which was transported in containers that previously carried unpasteurized eggs.

Illness caused by *Campylobacter* has been linked to chicken consumption. Symptoms usually begin in one to seven days after exposure to contaminated food, and can last for days. These symptoms include malaise, diarrhea, abdominal pain, bleeding and fever. Other complications may follow, such as meningitis, arthritis, cholecystitis, urinary tract infection, appendicitis, septicemia, Reiters' syndrome, and Guillain-Barre syndrome (GBS)— a major cause of non-trauma related paralysis in the United States. A small proportion of patients die.

Illnesses caused by *E. coli* O157:H7 are less widespread, but have received considerable publicity following recent outbreaks in the Pacific Northwest attributed to undercooked hamburgers in a fast-food restaurant chain. The pathogen is also found in raw milk, unpasteurized apple cider, processed sausage, and home-prepared hamburgers. The latter present a particular risk; the bacteria lives on the surface of meat products and is normally destroyed by cooking. However, when meat is ground to make hamburger or sausage, the organism is distributed throughout the product.

**TABLE 1**
**Cases of Foodborne Illness for Selected Pathogens - 1993 (Estimated)**

| | Cases | Deaths |
|---|---|---|
| **Bacteria** | | |
| *Salmonella* | 696,000-3,840,000 | 696-3,840 |
| *Campylobacter jejuni/coli* | 1,375,000-1,750,000 | 110-511 |
| *Staphylococcus aureus* | 1,513,000 | 1,210 |
| *E. coli* O157:H7 | 8,000-16,000 | 160-400 |
| *Clostridium perfingens* | 10,000 | 100 |
| *Listeria monocytogenes* | 1,526-1,767 | 378-485 |
| **Parasite** | | |
| *Toxoplasma gondii* | 2,056 | 41 |
| **Total** | 3,605,582-7,132,823 | 2,695-6,587 |

Source: Buzby and Roberts, 1995

**TABLE 2**
**Populations Susceptible to Foodborne Illness**

| Category | Number of Individuals |
|---|---|
| Elderly | 29,400,000 |
| Pregnant women | 5,657,900 |
| Neonates | 4,002,000 |
| Cancer patients | 2,411,000 |
| Nursing home residents | 1,553,000 |
| Organ transplant patients | 110,370 |
| AIDS patients | 135,000 |

Source: US Dept. of Health and Human Services, 1993

If the sausage or hamburger is undercooked or eaten rare, the bacteria in the center of the meat may not be killed. It takes three to seven days before symptoms occur after eating contaminated foods. Acute symptoms, lasting six to eight days, are diarrhea, abdominal pain, vomiting and neurologic complications. Chronic consequences include hemolytic uremic syndrome (HUS), which is characterized by kidney failure and strikes mostly children under the age of five. Some proportion of patients will die.

Not all segments of the population are equally at risk from microbial foodborne disease. Much of this risk comes through impairment of the immune system; organisms which a healthy immune system may successfully combat may pose a greater risk to some population subgroups than others. These include the elderly, pregnant women, children under the age of one, nursing home patients, and people with compromised immune systems, such as cancer patients, organ transplant patients, and people with Human Immunodeficiency Virus or Acquired Immune Deficiency Syndrome (HIV/AIDS) (Table 2).

Elderly individuals undergo a decrease in immune function as they age. The immune system of neonates and young children is not fully developed. Pregnancy puts a woman and her fetus at special risk of foodborne illness caused by pathogens such as *Listeria monocytogenes* and *Toxoplasma gondii*; miscarriage, stillbirth or fetal abnormality may occur. Since, by definition, the immune systems of people with Acquired Immune Deficiency Syndrome or who have been infected by the Human Immunodeficiency Virus are damaged or destroyed, these patients are also at greater risk of foodborne disease.

Foodborne illness trends, over time, are not consistent across pathogens. Some illnesses may be decreasing over time. Others may be increasing. However, it seems clear that, as the population ages and the number of AIDS/HIV cases grows, the pool of people susceptible to microbial foodborne illness seems certain to increase. Other factors may cause an increase in overall risk as well. One factor, which is critical to preventing foodborne illness, is correct handling of food, and cooking to appropriate temperatures. The USDA, in 1994, required all fresh meat and poultry products to carry warning labels alerting consumers to foodborne health risks, and advising safe handling and proper cooking precautions. Consumers may not be able to take precautions to prevent foodborne illness, however, when food is consumed in restaurants or institutional settings. According to USDA food consumption and expenditure data, between 1970 and 1993, the proportion of food consumed away from home rose from 34 percent of total food expenditures to 41 percent. As more and more food is consumed away from home, consumers will have less control over the safety of their food intake.

## Economic Costs of Foodborne Disease

When these people we've just described become ill or die, then society pays a cost for that illness. These costs include those of treating the illness, either outpatient or in a hospital, the costs of long-term care or rehabilitation, and the wages lost when workers are unable to perform their jobs. ERS has examined the costs of illnesses associated with seven pathogens in food. We started with the estimated numbers of illnesses just presented, and examined the nature and severity of the illness. Then, we calculated the medical costs, based on the typical treatment needed for each type of illness. When the illness implied long-term disability or long-term care, we also included the cost of that long-term care, as well as the lost wages the disabled worker could have earned and reduced wages due to lower productivity. Our estimates also took into account the age at time of illness.

Table 3 shows how some of the medical costs add up. For each pathogen we studied, we include both the short-term medical costs, and the long-term costs. These two add up to between $4 billion and $8 billion in medical costs each year for these seven pathogens. We include a "high" and a "low" estimate, since some of our cost or illness numbers were only available as estimated ranges.

These estimates include both the inpatient costs, outpatient costs and up-front doctor's charges for foodborne illness. They also include estimates of the lost productivity associated with those made ill or who die prematurely from foodborne diseases. We took a conservative approach to the issue of placing a dollar value on lost lives, using published estimates of lost wages (and implicit value of homemaking) when a person dies prematurely (see Landefeld and Seskin). Essentially, a death from foodborne illness is given a value equal to the present discounted value of lost wages of an average worker at time of death, or value of housework, which yields values of $694 million to $1.4 billion for the lost productivity due to illness and deaths associated from the pathogens in question.

It should also be noted that this total medical cost estimate of $4 to $8 billion is quite probably an understatement of the true cost. For one thing, many foodborne illnesses go unreported, and the medical costs are based on a 'best guess' at the total number of illnesses. The actual cases of illness may be higher (or lower) than this 'best guess.' Second, these costs are only costs associated with actual illness. Those *not* made ill, however, may place a value on reduction of risk as well. This willingness to pay for safer food is not reflected in these cost estimates either.

In principle, non-market valuation techniques, such as contingent valuation, could be used to enhance our cost estimates by measuring the value to consumers of safer food, even when they are not made ill. The contingent valuation method involves what Smith calls "structured conversations," where interviewees are provided information about a particular issue, such as safer food, and then are asked to indicate their willingness to pay for one or more alternatives, compared to some status quo. This valuation technique has been used to place values on a variety of non-market goods and services, and has been given qualified endorsement for valuing natural resource damages, such as oil spills. ERS has conducted research using the contingent valuation method to identify consumers' willingness to pay for drinking water free of nitrate contamination, for example. Research is underway at ERS to extend this valuation technique to valuing decreases in the risk of foodborne illness.

## Benefits of Safer Food

The role of economic analysis in addressing food safety issues goes beyond calculating the costs of foodborne disease. The cost estimates presented above may also be used to evaluate the cost-effectiveness of public policies designed to alter the status quo and decrease microbial contamination of the food supply.

As an illustration, consider the recent proposals put forth by the USDA to revamp the meat and poultry inspection system. The department is proposing to replace the current 'carcass by carcass' inspection system with one that identifies food safety risks throughout the production process, and creates interventions to prevent contamination. The current system, which relies on sight, touch and smell to identify unsafe food, does not detect the presence of microbial pathogens. The new approach, called Hazard Analysis and Critical Control Point (HACCP), uses a science-based approach to identify points in the production process where pathogens may be controlled ('hazard analysis'), and then determines the best approach at that 'critical control point' to eliminate microbial contamination. (The Food Safety and Inspection Service of the USDA has proposed the HACCP regulations for meat and poultry inspection. The FDA has proposed similar regulations for seafood inspection.)

A detailed study of the proposed HACCP regulations was recently published in the *Federal Register*. The Food Safety and Inspection Service (the agency responsible for meat/poultry inspection) used as a baseline current estimates of foodborne illness presented above. It was assumed that, when fully implemented over a five-year period, the HACCP rules would lead to a 90 percent reduction in pathogen levels across the board. Using this assumption, our analysts at ERS made a further assumption that a 90 percent reduction in pathogen levels would result in an equivalent decrease in

**TABLE 3**
**Medical and Productivity Costs for Selected Foodborne Pathogens - 1993 (Estimated)**

| **Bacteria** | **All Foods** $ billion (1993) | **Pct. Meat/Poultry** % | **Meat/Poultry** $ billion (1993) |
|---|---|---|---|
| *Salmonella* | 0.6 - 3.5 | 50-70 | 0.3 - 2.6 |
| *Campylobacter jejuni/coli* | 0.6 - 1.0 | 75 | 0.5 - 0.8 |
| *E. coli* O157:H7 | 0.2 - 0.6 | 75 | 0.2 - 0.5 |
| *Listeria monocytogenes* | 0.2 - 0.3 | 50 | 0.1 - 0.2 |
| *Staphylococcus aureus* | 1.2 | 50 | 0.6 |
| *Clostridium perfingens* | 0.1 | 50 | 0.1 |
| **Parasite** | | | |
| *Toxoplasma gondii* | 2.7 | 100 | 2.7 |
| **Total** | 5.6 - 9.4 | n/a | 4.5 - 7.5 |

Source: USDA Economic Research Service, 1995

**TABLE 4**
**Benefit/Cost Assessment of Proposed HACCP Rules for Meat and Poultry Inspection ($1,000)**

| | **Costs** |
|---|---|
| Near Term: | |
| Micro testing | $131.9 |
| Sanitation SOP | 88.6 |
| Time/temperature requirements | 45.5 |
| Antimicrobial treatments | 49.7 |
| Subtotal | $315.7 |
| HACCP Implementation: | |
| Plan development | $37.2 |
| Micro testing | 1,262.5 |
| Recordkeeping | 456.4 |
| HACCP training | 24.2 |
| Aseptic training | 1.9 |
| Fed. TQC overtime | 20.9 |
| Agency training | 0.4 |
| SOP under HACCP | 181.2 |
| Total | $1,983.2 |
| **Total Costs** | $2,298.9 |

| **Benefits** — Foodborne illness avoided: | Low | High |
|---|---|---|
| *Campylobacter jejuni/coli* | $2,191 | $4,670 |
| *E. coli* O157:H7 | 1,168 | 2,419 |
| *Lysteria monocytogenese* | 854 | 1,168 |
| *Salmonella* | 1,751 | 15,178 |
| **Total Benefits** | $6,422 | $23,935 |

Source: Federal Register, Vol. 60, No. 23, February 3, 1995, Pg. 6872.

Benefits and costs represent present value over 20 years, discounted at OMB suggested rate of 7%. Cost data from USDA Food Safety and Inspection Service. Benefits data are based on figures in Table 3, assuming that HACCP results in a 90% decrease in costs of illness. Benefits were assumed to begin in five years after the adoption of the final HACCP rule.

foodborne diseases and costs of illness associated with four of the seven pathogens described above. When spread over 20 years and converted to present values using a seven percent discount rate, the total annualized benefits are between $6.4 and $23.9 billion dollars (see Table 4).

Of course, these benefits must be compared to the costs of achieving this pathogen reduction. USDA's Food Safety and Inspection Service has estimated the annualized costs of the proposed rule at $1.9 billion over the same 20-year time horizon. Clearly, then, the proposed rule passes a 'cost-benefit analysis' test, in that the benefits of the rule (reduced costs of illness) exceed the costs. This analysis is not complete, of course. A more extensive analysis would compare alternatives to the HACCP rules, and rank these alternatives on the basis of their cost-effectiveness. In addition, there are distributive consequences which may be of interest to public policy officials; there is come concern that the HACCP rules, for example, may affect small processing operations more than large firms.

## Conclusions

This paper has given an overview of some of the economic issues associated with food safety. It has been necessarily brief, outlining the economic reasons for food safety problems, and has only dealt in detail with one specific issue, microbial pathogens in meat and poultry.

Much more work needs to be done in this area. First, our estimates of the incidence of foodborne illness are incomplete; for reasons given above, there is much uncertainty about the incidence and prevalence of illnesses related to microbial pathogens. Second, we need more comprehensive and detailed estimates of the benefits of safer food. Finally, more work needs to be done on the economic consequences to producers and consumers of alternative food safety regulations and policy options.

We expect that economics will continue to play a role in public policy decisions in the future. Recent executive branch policies have required accounting for costs and benefits in all regulatory decisions. Recent moves in the Congress to require that all regulations undergo risk assessment and cost-benefit analysis also means that economics will play a larger role in public policy making in this area. Given the uncertainty economists face in measuring the "Ps" (costs of illness) and "Qs" (number of illnesses), doing cost-benefit analysis of food safety programs will require creativity and willingness to make simplifying assumptions. It will also mean that the decision makers seeking information must have a clear understanding of the inherent uncertainty in the information economists supply.

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