Paper presented at the annual meeting of the AAEA, to be published in the December 2007 *American Journal of Agricultural Economics.*

WTP Estimates of the Societal Costs of U.S. Foodborne Illness

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Introduction

The U. S. Federal government has a prominent role in regulating food safety. Estimates of the societal costs of foodborne illness are an important input for regulators. For example, ERS' estimates of the cost of foodborne illness for selected pathogens were used in USDA's Benefit/Cost Analysis of Food Safety and Inspection Service's (FSIS) proposed Pathogen Reduction /Hazard Analysis and Critical Control Point regulations (1995, p. 6781). A key question is how much food safety is society demanding? Estimation of the societal costs of missing food safety information and of information as a public good is critical for government priority setting and decision making about food safety (Unnevehr 2007). I highlight the vanishingly small probability of a company's product being linked to a human illness, reinforcing the importance of the Federal government in assuring food safety.

Next I examine advances in valuation methods and use Willingness to Pay (WTP) estimates for foodborne illnesses. WTP is endorsed in the literature as the valuation method most consistent with economic theory (Viscusi and Aldy 2003, Haninger and Hammitt 2007). Hammitt and Haninger (2007) have surveyed consumers on their WTP for a "safer" meal. This paper uses the Hammitt and Haninger estimates of WTP for safer food and FoodNet data on the age distribution for various severities of illness to provide preliminary estimates of the societal WTP for acute foodborne illnesses. Different values are used for children, adults, and the elderly in either the morbidity and/or mortality estimates. Because these cost estimates include all 76 million foodborne illnesses (Mead at al. 1999) and use different valuation techniques, the values are higher than previous cost of foodborne illness estimates by ERS and FDA based on only a handful of pathogens[1].

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*Tanya Roberts is an economist, Economic Research Service, United States Department of Agriculture. I thank James K. Hammitt, Harvard University, Jason F. Shogren, University of Wyoming, and Joseph Cooper, Economic Research Service, for insightful discussions and access to the literature on valuation. David Zorn, Food and Drug Administration, and Chris Dockins and Kelly Maguire, Environmental Protection Agency, provided useful information on valuation methods used for morbidity and mortality in their agencies. The views expressed in this paper are those of the author and do not reflect the views of the Economic Research Service or the U.S. Department of Agriculture.

Pathogen information and victim compensation

The occasional settlement in court cases associated with a well-publicized outbreak sends the signal that foodborne illness victims are compensated. Because bacterial and viral pathogens cannot be seen by the purchaser, however, information hurdles remain. I examine the evidence on the extent of these information hurdles and the transactions costs for compensating victims.

To overcome the first information hurdle, FoodNet started an active surveillance of laboratories to increase the recording of pathogen test results (figure 1). Mead et al. (1999) find that **0.04%** of all estimated foodborne illnesses can be linked, via a test, to the specific pathogen causing the illness[2]. The remaining illnesses are identified by symptoms in the gastrointestinal tract[3], as reported by physicians or the patients in two FoodNet surveys (figure 1).

The next information hurdle is to identify a link between the pathogen and the food, which is most likely to happen in a foodborne disease outbreak. Illnesses identified in an outbreak average 5,800 cases a year, or **0.008%** of the total 76 million U.S. foodborne illnesses (Mead et al. 1999). Illnesses not part of an outbreak have higher information hurdles of identifying the causative pathogen, the food containing the pathogen, and the company producing the food.

Suing and winning compensation for a foodborne illness are even lower probability events with high transactions costs, such as time invested, cost of hiring a lawyer, and emotional costs of revisiting the illness. Buzby, Frenzen, and Rasco (2001) found that very few foodborne illnesses end up in court, on average 18 jury trials a year, or **0.000024%** of all illnesses. Only 30% of the cases win in a jury trial. For the winners, the median award is $25,600 and increases to $55,000 if the pathogen can be identified. Other cases are settled out of court and require that the award be kept secret. This secrecy decreases the probability that other ill persons will take legal action against the company and suppresses news stories associating foodborne illness with the company and its products. The out of court settlement is partly an agreement to keep information from others who might be ill and be able to build on this court case, partly savings on legal fees by all parties, and partly compensation for the illness. In sum, the probabilities of a positive pathogen test, of identifying the food contaminated with the pathogen, and of winning compensation are vanishingly small[4].

Historically, pathogen information first became a problem with the export of U.S. hog bellies to Europe. In the 1860s, some European countries began using the trichinae scope to detect the parasite, *Trichinella*. When countries found the parasite in U.S. hog bellies, they closed their markets in the 1870s and 1880s. U. S. companies exporting to Europe lobbied the Federal government for meat inspection to regain access to overseas markets. In 1890, voluntary Federal inspection became available for exporting companies. In 1891, U.S. companies could request inspection for the domestic market. In 1906, Federal inspection was mandated for beef and pork transported across state lines. In 1957, poultry was added. These examples illustrate the increased Federal involvement in regulating and assuring food safety.

In 1996, a new system, called the Pathogen Reduction/Hazard Analysis Critical Control Point system was implemented. Federal inspection of final products by FSIS was

replaced by Federal inspection of meat and poultry companies' systems to control foodborne hazards. The most serious hazards are bacteria, viruses, parasites, and prions that may enter the food supply chain from the farm to the kitchen. Federal intervention leads to the question of how costly is the current level of U. S. foodborne illness? The next section develops estimates of the societal cost of human foodborne illness using results from consumer surveys to estimate WTP for safer food.

Societal costs of acute foodborne illness

ERS funded two consumer surveys to update valuation methods for morbidity and mortality risks attributed to foodborne pathogens. The first two papers in this session report the WTP findings from these consumer surveys. Hammitt and Haninger (2007) conduct a stated-preference survey of WTP to reduce risk of foodborne illness. I use their values for children and adults for morbidity valuation in four categories: hospitalized cases, those who see a physician and have a test positive for a pathogen, those who see a physician but do not have a sample taken for a test, and those who do not seek medical care (table 1).

FoodNet uses four survey instruments to collect data on age for three severities of illness: persons who visited a physician and had a positive test for a pathogen, patients who were hospitalized, and patients who died (figure 1). In table 2, the distribution of cases by disease severity is shown for three age groups: children (0-14), adults (15-69), and elderly (70+). The age groups are based on WTP studies in the labor market, environmental, and foodborne pathogen literature that show differing values, depending on the age of the ill person.

Mortality risk valuation has a long history examining risk premiums in labor markets, while valuation of mortality risk is more recent in the environmental literature. Typically, researchers compare small differences in mortality risk in different occupations or in different industries with the accompanying differences in wages, after adjustment for skill level and other factors. The mortality risk and associated risk premium in wages is used to estimate the Value of a Statistical Life (VSL). Blomquist's review of studies finds that VSLs are generally greater for children than adults, while VSLs for those over 70 years of age are about 30% lower than other adults (2004). Viscusi and Aldy's review of the labor market literature and finds estimates of $4 million to $9 million per VSL (2003).

Foodborne illnesses by severity

Mead et al. (1999) estimate there are 76 million U.S. foodborne illnesses each year, that 325,000 result in hospitalization, and that 5,200 result in death from the acute illness. Subtraction of the hospitalizations and deaths leaves 75,669,800 remaining milder cases. These cases can be parsed into subgroups of differing severity. Mead et al.'s estimates were based on cases that tested positive for a pathogen. Salmonellosis, the most studied foodborne pathogen, was the source of the estimate that for each positive test there are 38 milder cases. To estimate the number of patients who test positive for a pathogen, I reverse the calculation and divide 75,669,800 cases by 38, which results in an estimate of

1,991,311 patients with a positive test result. For example, Scallan et al. (2006) find that physicians only ask for pathogen tests if the patient has bloody diarrhea or is quite ill.

Scallan et al. (2006) estimate that 80% of all FoodNet cases do not visit a physician. Multiplication of the 76 million cases by .8 = 60,800,000 cases that never seek medical care, primarily because they have a mild case of illness. The rest of the cases are persons who do see a physician, but the physician does not request a pathogen test, or 75,669,800 – (1,991,311 + 60,800,000 **)** = 12,878,489 cases.

In summary, the estimated annual 76 million cases of foodborne illness are now separated into five mutually exclusive severity categories:

1. 5,200 deaths,
2. 325,000 cases who average 5.8 days in the hospital (Voetsch et al. 2004),
3. 1,991,311 cases who visit a physician and test positive for a specific pathogen,
4. 12,878,489 cases who visit a physician but have no test, and
5. 60,800,000 cases who do not seek medical care.

Valuation of severity categories

For the four categories of morbidity, I use Hammitt and Haninger's values in table 2, with adjustments for moderate cases. The survey instrument was designed to elicit separate adult and child values, namely what the parent is willing to pay to protect his or her child from a foodborne illness. WTP survey results often are not very sensitive to differences in severity or duration of illness and Hammitt and Haninger's estimates are no exception. To overcome this hurdle and make the valuation differ with the days of illness for moderate cases, I force the values to be linearly related. I start with the seven day value for moderate cases and divide it by seven days to arrive at a daily value for both the child and adult estimates. The result is a reduction in the WTP estimate for the moderate cases of 3 days and 1 day of illness. For example, the adult one day value of illness becomes $2,100, and the child one day value of illness becomes $3,800 (both rounded to the nearest $100).

The WTP estimate becomes $170 billion for those with one day of moderate illness and not seeking medical care (Table 3). For those with moderate illness who visit a physician but have no test, the three days of illness are now valued at $6,300 per adult and $11,400 per child, and total $108 billion for this severity category. Those with moderate illness who visit a physician and test positive for a pathogen, the seven days of illness are valued at Hammitt and Haninger's WTP result of $14,400 per adult and $26,500 per child, for a total cost of $39 billion. Hospitalized cases with seven days of illness are valued at Hammitt and Haninger's WTP result of $16,100 per adult and $26,700 per child, for a total cost of $6 billion.

For mortality values, I use different values for adults, children, and the elderly. Adults are valued at $7 million each, based on Viscusi and Aldy's 2003 review of the VSL literature where the range is $4 million to $9 million. The midpoint, accounting for some inflation, is roughly $7 million today. The elderly, 70+, are valued at 30% less, or $5 million, based on Blomquist's review (2004) and Krupnick et al. (2002). Children are valued more highly. The closest severity category to mortality that Hammitt and Haninger have is the hospitalized cases. Here the child value is around 70% higher than

the adult value, or $26,700 divided by $16,100. Consequently, the death of a child from a foodborne illness is valued at $12 million.

Mead et al. estimate that there are 5,200 acute foodborne illness deaths annually (1999). I use the age breakdown of foodborne illness deaths, based on the FoodNet data from 2001-2005 (table 2). Children (0-14) are ten percent of the deaths, adults (15-69) are 43%, and the elderly (70+) are 47% of the deaths. The total value for all deaths is $34 million: $6.2 million for children, $15.7 million for adults, and $12.2 million for the elderly (table 3).

The societal cost contribution of each of the five severity categories is markedly different from ERS traditional estimates for two reasons, the valuation method and the number of cases considered. In table 3, WTP estimates are used for both deaths and milder cases. Traditionally, ERS has used WTP only for deaths and has valued less severe cases with the Cost of Illness (COI) method, grounded in medical costs and productivity losses. ERS' use of the COI method omits values for lost leisure time, pain and suffering, and disruption of daily life that are captured in WTP values. In the traditional ERS estimates, deaths and chronic complications are the largest contributors to the costs of human illness. In contrast, the leading cost component in the WTP estimates is cases where no medical care is received. This severity category contains 80% of the illness cases and contributes $170 billion (48%) to the societal WTP cost estimate.

The other difference in these WTP estimates versus traditional ERS estimates is that for the first time all 76 million cases of acute foodborne illness are included. Previous estimates examined only a few, specific pathogens. This estimate of the societal costs totals $357 billion, compared to the last ERS estimate of $6.9 billion for five pathogens causing foodborne illness (Crutchfield and Roberts 2000).

Sensitivity Analyses and Discussion

New data on valuation of deaths suggests that the labor market wage risk premium for VSL could be overestimated. For example, Krupnick et al. (2002) find VSL estimates of $1 to 3 million in 1999 U.S. dollars. Since both these WTP and ERS estimates use VSL estimates from the labor market, both sets of estimates would be reduced. However the WTP estimates in table 3 would not be lowered much, since the morbidity estimates for food-borne illness are dramatically higher that the ERS COI morbidity estimates. A concluding note on the differences in methodology is ERS' "pathogen by pathogen" approach includes chronic complications excluded in the Hammitt and Haninger survey. ERS uses medical data to develop disease outcome trees for assorted chronic complications and then values the medical and productivity costs.

The Hammitt and Haninger WTP estimate for 24 hours of foodborne illness with moderate symptoms is $11,100 for an adult case and $28,000 for a child's case (table 1). Several interpretations are possible for this high value for 24 hours of illness. One possibility is that consumers surveyed are giving one value for prevention of foodborne illness and are not differentiating among the risk categories. A second interpretation could be that consumers are gaming the system and giving high numbers to promote more government protection. A third interpretation is that people are intolerant of becoming ill involuntarily, consider that they are being used as guinea pigs for the food

industry that does not test food for pathogens or exert the high level of control for pathogens in the food supply chain that consumers expect, and hence give high values for these involuntary risks. A fourth interpretation is that the survey questions were not appropriately asked or analyzed, leading to results that do not tease out the different values for the different levels of morbidity risk. A fifth interpretation is the difficulty of conveying information about food safety risks, even in WTP survey. An assessment of which explanations of the high monetary values in the WTP survey are most accurate is not possible until more surveys and results are analyzed.

Support for consumers expecting the government and industry to protect them from foodborne illness can be shown in recent polls. The Food Marketing Institute's annual survey found that food safety outbreaks have led to a decline in the percentage of shoppers confident about the safety of supermarket food from 82% in 2006 to 66% in 2007 (Feedstuffs FoodLink 2007). Consumer confidence in restaurant food is even lower at 43% in 2007. The intensity of current public concern about food safety dates back to the early delegation of food safety inspection to the Federal government. In 1906, public outrage (over slaughterhouse practices chronicled by Upton Sinclair in *The Jungle* and over chemicals added to foods and drugs) pushed Congress and the President to mandate Federal inspection for meat crossing state lines and to create the Food and Drug Administration. However, enforcement remains an issue, which is not unusual for a public good with moral hazard properties. For example, FSIS does not have the authority to order recalls or impose fines on companies producing contaminated product.

Conclusion

The high WTP societal costs estimated $357 billion annually[5] for current levels of foodborne illness and the high level of consumer concern about food safety in supermarkets and restaurants, stand in sharp contrast to the vanishingly low probability of consumers being able to identify the food, pathogen, and company that made them ill and to win compensation. Although food safety has been delegated to the Federal government, enforcement tools are limited, which can hinder achievement of the level of food safety preferred by consumers.

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Endnotes

[1]The first estimate of costs of foodborne illness, for selected bacterial pathogens, was published in the *AJAE* in 1989 (Roberts). The human capital method was used to value mortality and the cost of illness method for morbidity. While USDA's Economic Research Service (ERS) and the Environmental Protection Agency continue to use various cost of illness methods for morbidity, the Food and Drug Administration uses

Quality Adjusted Life Years. Today, all three agencies use the WTP method to value mortality, based on labor market risks.

Previous ERS morbidity estimates use the Cost of Illness method, along with disease outcome trees for each pathogen laboriously built from medical data to indicate the probability of different acute illness and chronic disease outcomes over a lifetime. The limitation, however, was that only a handful of diseases were included in the ERS foodborne illness cost estimates. The WTP approach used in this paper has the benefit of including all acute foodborne illnesses, but excludes costly chronic complications that can last a lifetime, such as kidney failure, paralysis, arthritis, and mental retardation.

[2]Mead et al. (1999) lists that 19% of foodborne illnesses are identified by pathogen. This number is based on two multiplication factors. First, FoodNet sites where more active surveillance is done represented only 7.5% of the U.S. population at that time. Hence, a population adjustment is made. Second, most cases with a positive pathogen test were multiplied by 38 to adjust for the other cases where the ill person did not seek medical care, where the physician did not ask for a stool sample, where the test did not give a positive result even though the patient was positive, and where the positive test was reported to CDC. The 0.04% result of actual, known positive test results is Mead's 0.19 multiplied times the population adjustment of 0.075 and divided by 38 = 0.04%.

[3] FoodNet survey instruments for physicians and the general population define an illness as "…≥3 loose stools in 24 hours with impairment of daily activities or duration of diarrhea of more than a day" (Jones et al. 2006).

[4] The information problem is illustrated by salmonellosis, an infection with a bacterium called *Salmonella.* This bacterium lives in the gastrointestinal tracts of mammals, birds, and reptiles. It is one of the most common causes of human foodborne illness and results in diarrhea, fever, and abdominal cramps 12 to 72 hours after food consumption (CDC 2007). Many different kinds of illnesses can cause diarrhea, fever, or abdominal cramps. Determining that *Salmonella* is the cause of the illness depends on laboratory tests that identify *Salmonella* in the stools of an infected person. The diversity of foods contaminated and the delay before illness strikes makes linking the pathogen to the food difficult, unless there is a well-documented outbreak where people are surveyed about what they ate in the days before the illness. Human salmonellosis illnesses usually last 4 to 7 days, and most persons recover without treatment. Sometimes the diarrhea is so severe that the patient needs to be hospitalized. In these patients, the *Salmonella* infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness. Source: CDC's Salmonellosis page accessed 4/13/2007 www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis_g.htm

[5] Another method for forcing linearization is to assume the one-day values are the most accurate and multiply the one-day value by the number of days in each severity category. This method will dramatically increase the estimate. If I were to use the original Hammitt and Haninger values listed in Table 2, the estimated U.S. societal costs of foodborne illness would be $1.4 trillion annually. A third sensitivity analysis, based

on Hammitt and Haninger's concluding statement: "Our stated-preference estimates suggest that WTP to reduce risk of short-term morbidity from foodborne pathogens is on the order of $10,000 per statistical case avoided for adults and twice as large for children," results in an estimate of $1.2 trillion annually.

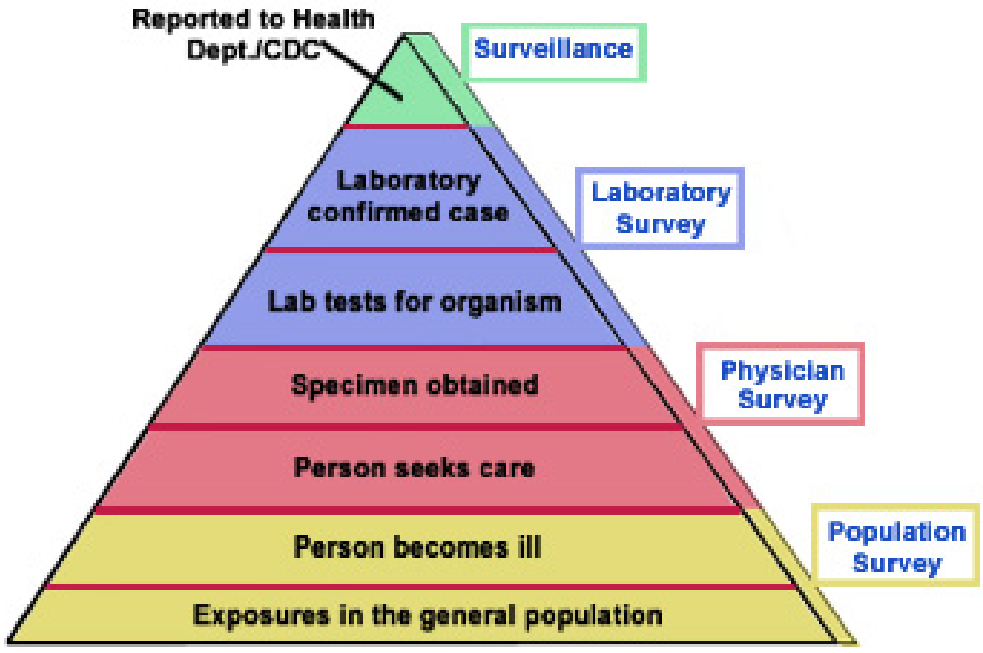

Figure 1. U. S. foodborne disease databases from CDC

Source: Centers for Disease Control and Prevention (CDC)

Table 1. Hammitt and Haninger's willingness to pay values for safer food[a]

Severity of symptoms[b]	Duration of illness	Value per child case	Value per adult case[c]
Moderate/no medical care	1 day	$3,800	$2,100
Moderate/see physician, no test	3 days	$11,400	$6,300
Moderate/see physician, +test	7 days	$26,500	$14,400
Severe/hospitalized cases	7 days	$26,700	$16,100

Source: Hammitt and Haninger 2007. [a]Estimates are median WTP values to avoid morbidity caused by foodborne pathogens. The moderate cases are based on a daily value rounded to the nearest $100. The seven day value for moderate cases is the starting point, and it is divided by seven days to arrive at a daily value for both the child and adult estimates. [b]Moderate Symptoms – You will have an upset stomach, fever, and will need to lie down most of the time. You will be tired and will not feel like eating or drinking much. Occasionally, you will have painful cramps in your stomach. In addition, you will have some **diarrhea** and will need to stay close to a bathroom. While you are sick, you will not be able to go to work or do most of your regular activities. Severe Symptoms – You will have to be admitted to a **hospital**. You will have painful cramps in your stomach, fever, and will need to spend most of your time lying in bed. You will need to vomit and will have severe diarrhea that will leave you seriously dehydrated. Because you will be unable to eat or drink much, you will need to have intravenous tubes put in your arm to provide nourishment. [c]Adult values are those for the more numerous category of "households without children."

Table 2. Illnesses, hospitalizations, and deaths in FoodNet, by age, 2001-2005

Case severity/Age	0-14		15-69		70+		Total
	#	%	#	%	#	%	cases
Illness confirmed by pathogen test	25,821	41%	35,263	55%	2,338	4%	63,422
Cases that require hospitalization	4,828	31%	8,444	55%	2,148	14%	15,420
Foodborne illness caused deaths	36	10%	158	43%	174	47%	368

The illness severity categories are mutually exclusive.

Source: Data from FoodNet, Ida Rosenblum, April 2007 email.

Table 3. U.S. societal annual costs of acute foodborne illness: willingness to pay method

Severity/Age	Adult cases[a]		Child Cases (0-14)		Total cases/costs	
	#	$/case	#	$/case	#	$(billion)
No medical care	35,800,000	$2,100	25,000,000	$3,800	60,800,000	170
See physician, no test	7,600,000	$6,300	5,280,000	$11,400	12,878,489	108
See physician, +test	1,175,000	$14,400	816,000	$26,500	1,991,311	39
Hospitalized	220,000	$16,100	105,000	$26,700	325,000	6
Death	4,680	$7 million	520	$12 million	5,200	34
TOTAL					76 million	$357 billion

[a]Elderly, defined as 70+, are valued with other adults in the morbidity valuations. Elderly are valued separately for deaths, at 70% of the other adult value, or $5 million.