Journal of Agricultural and Applied Economics, 30,1(July 1998):95–107

A Distributional Analysis of the Costs of Foodborne Illness: Who Ultimately Pays?

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ABSTRACT

This paper traces the economic impact of the costs of foodborne illness on the U.S. economy using a Social Accounting Matrix (SAM) framework. Previous estimates of the costs of seven foodborne pathogens are disaggregated by type, and distributed across the population using data from the National Health Interview Survey. Initial income losses resulting from premature death cause a decrease in economic activity. Medical costs, in contrast, result in economic growth, though this growth does not outweigh the total costs of premature death. A SAM accounting of how the costs of illness are diffused through the economy provides useful information for policy makers.

Key Words: cost of illness, foodborne illness, Social Accounting Matrix.

The annual cost of foodborne illness is estimated at $5.6 to $9.4 billion (Buzby and Roberts). These costs have economic ramifications that percolate throughout the economy, extending past the most directly affected individuals and industries. The objective of this paper is to trace the economic flows resulting from foodborne illness and measure their impact on the level and distribution of production and income. A Social Accounting Matrix (SAM) framework is used to provide a full accounting of the impact of these economic flows.

The Costs of Foodborne Illness

The most thorough and widely cited study on the cost of foodborne illness (Buzby et al.) estimated the economic costs associated with six bacterial foodborne pathogens: *Salmonella* (non-typhoid), *Campylobacter jejuni* or *coli, Escherichia coli* O157:H7, *Listeria monocytogenes, Staphylococcus aureus,* and *Clostridium perfringens.* These estimates were updated to 1993 and expanded to include the parasite *Toxoplasma gondii* (Buzby and Roberts). Buzby and Roberts estimated that the cost of illness from these seven pathogens from food sources was between $5.6 and $9.4 billion in 1993. The Buzby and Roberts; Buzby et al.; and Roberts, Murrel, and Marks studies and cost estimates are hereafter referred to as the "baseline" studies and estimates.

The baseline cost estimates are restricted to the two types of costs included in most cost-of-illness studies: direct medical expenses and human capital costs. The direct medical costs of illness are expenditures for medical goods and services such as doctor visits, hospital and nursing home care, and medications. Human capital costs of illness are the present value of labor productivity foregone as a result of an adverse health outcome. If labor compensation

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The authors thank Ken Hanson and Steve Vogel for their assistance with the SAM model. The views expressed here are solely those of the authors and do not necessarily reflect the views of the ERS or the USDA.

(wages plus nonwage benefits) is assumed to equal the marginal value of labor, then the human capital costs of illness are equal to the present value of foregone labor compensation. Both the time spent sick and premature death are valued in terms of foregone compensation. Productivity losses due to long-term or permanent disability are calculated as the difference between the individual's earnings with and without the disability.

In order to trace the impact on the economy of foodborne illnesses due to the seven pathogens, the different types of costs embedded in the baseline estimates must be disaggregated into their component parts: productivity costs of work-loss days, medical expenses, and productivity costs of premature death. Extrapolating from the baseline studies, the productivity costs due to time lost from work from illness not resulting in death (hereafter referred to as "work-loss days") are estimated to be $2.9–$3.6 billion, and include productivity losses due to chronic *E. coli* O157:H7 infections and long-term disability resulting from listeriosis and congenital toxoplasmosis.

Again using baseline extrapolations, the cost estimates for premature death are $1.3–$3.1 billion. Buzby et al. based their estimates of productivity losses due to premature death on the human capital measures developed by Landefeld and Seskin. Buzby et al. adjusted the Landefeld and Seskin measures of lifetime after-tax income by averaging across gender, interpolating between age groups, and updating to 1993 dollars. For each of the pathogens considered in their study, Buzby et al. then calculated the cost of premature death according to the age distribution of death for each pathogen. Due to the different age distribution of illness for the seven pathogens, the average cost per premature death varied substantially among the pathogens, ranging from $274,246 for *Listeria monocytogenes* to $1,208,488 for *E. coli* O157:H7. In the case of infant and fetal deaths from *Toxoplasma gondii* and *Listeria monocytogenes,* the baseline studies assumed there were no productivity losses for the 60% of deaths replaced by a subsequent birth.

Based on extrapolations from the baseline studies, the total medical costs of illness are estimated at $1.4–$2.7 billion. Medical costs for foodborne illness include expenditures on physician visits, hospital and nursing home care, drugs, and medical tests and procedures.

The relative size of the three types of costs (work-loss days, premature death, and medical expenses) varied substantially across the different pathogens, with the combined estimated costs of illness totaling between $5.6 and $9.4 billion. Medical expenditures accounted for 30–50% of total costs of illness in the cases of *Salmonella* (non-typhoid), *Campylobacter jejuni* or *coli, Staphylococcus aureus, Clostridium perfringens,* and *Listeria monocytogenes*; 12% for *E. coli* O157:H7; and only 3% in the case of *Toxoplasma gondii.* The distribution of costs between medical and productivity loss depends on the death and disability rate for each pathogen. In general, the relative share of total costs due to medical expenses was lower for pathogens that were more likely to cause deaths or disability.

The SAM Framework and Initial Distribution of Costs of Foodborne Illness

Once the costs associated with the seven pathogens have been disaggregated into their component parts, it is possible to investigate their impact on the economy. A shock of $5.6 to $9.4 billion, the estimated cost of foodborne illness due to the seven pathogens, is potentially large enough to have significant economic ramifications. This shock could result in measurable changes in the level and distribution of production, consumption, and income. To provide an accurate analysis of the full economic impact of these costs requires a general equilibrium approach such as a Social Accounting Matrix.

A SAM is a form of double-entry accounting in which national income and product accounts and input-output production accounts are represented as debits (expenditures) and credits (receipts) in balance sheets of activities and institutions. Activities are industries and services, and institutions are households, firms, government, and the rest of the world. Entries in the SAM include intermediate input demand among production sectors, income

Table 1. Population Distribution by Household Type (in 000s)

	Household Type					
Description	Dual-Parent	Single-Parent	Single-Adult	Multi-Adult	Elderly Head	Total
No. of Households	25,246 (24%)	10,577 (10%)	28,012 (26%)	21,412 (20%)	21,189 (20%)	106,436 (100%)
No. of Persons	106,126 (41%)	32,902 (13%)	28,012 (11%)	52,476 (21%)	37,038 (14%)	256,554 (100%)
No. of Adults	57,351 (36%)	14,222 (9%)	28,012 (18%)	51,042 (32%)	7,186 (5%)	157,813 (100%)
No. of Children	48,291 (71%)	18,504 (27%)	0	0	1,211 (2%)	68,006 (100%)
No. of Elderly	484 (2%)	177 (1%)	0	1,434 (4%)	28,640 (93%)	30,735 (100%)
Poverty Rate (% persons within household type)	10	46	27	6	17	16
Health Insurance (% persons within household type)[a]						
Public Coverage	15	49	8	15	97	30
Private Coverage	74	38	73	75	3	60
Uninsured	11	13	20	10	1	10

Sources: Hanson, Vogel, and Golan; and NHIS pooled survey data for 1992–94.
Note: Percentages may not total to 100 due to rounding.
[a] The classification by health insurance excludes households that could not be classified by coverage due to missing information.

(value added) paid by production sectors to different types of labor or capital, the distribution of wages across different household groups, and the distribution of household expenditures across savings, consumption of domestically produced goods and services, and imports. Unlike the input-output framework, the SAM framework endogenizes income and consumption, thereby permitting an accurate appraisal of the full effects of specific changes to the economy.

In addition to providing a snapshot view of the circular flow of accounts of an economy, a SAM also provides the basis for a SAM multiplier model. The SAM multiplier model is a linear, general equilibrium model of the economy that traces the impact of exogenous change on every endogenous account in the economy. For this analysis, we used a 1993 SAM derived from a computable general equilibrium (CGE) model of the U.S. economy developed by the U.S. Department of Agriculture, Economic Research Service (USDA/ERS) (Hanson, Vogel, and Golan). The underlying data for the CGE model and our "foodborne-illness" SAM are the 1977 input-output accounts prepared by the U.S. Department of Commerce, Bureau of Economic Analysis.

The foodborne-illness SAM classifies households into five categories to capture differences in the risks of foodborne illness and access to medical care. The household classification is based on age of household head, presence of minor children, and number of adult members. Households with elderly heads and households with children were distinguished because some pathogens are more likely to affect children or the elderly. Dual-parent and single-parent households were distinguished because eligibility for Medicaid health benefits depends on whether both parents are present, as well as on poverty status.

Table 1 presents the population distribution by household category. The five household category types are: (*a*) households headed by persons aged 65 or older (denoted "elderly head"), (*b*) dual-parent households with heads under age 65 and one or more children under age 18 (denoted "dual-parent"), (*c*) single-parent households with heads under age 65 and one or more children under age 18 (denoted "single-parent"), (*d*) childless households with heads under age 65 and two or more adult members (denoted "multi-adult"), and (*e*) individuals under age 65 living alone or without relatives (denoted "single-adult"). Dual-parent households accounted for the largest share of the population (41%), followed by multi-adult households (21%).

Each household category was further divided into households above and below the official poverty level, because income affects both the propensity to spend on health care and eligibility for Medicaid. The poverty rate was much higher for members of single-parent households (46%) and single-adult households (27%) than for the rest of the population.[1]

The household categories were used to examine the distribution of the costs of foodborne illness in the economy. The initial distribution of costs was established by the incidence and severity of illness in each household category. To measure the distribution of illness, we relied on respondent reports of foodborne illness and acute health conditions resembling foodborne illness derived from the National Health Interview Survey (NHIS). Other sources of data on foodborne illness based on medical records underestimate the incidence of illness because most cases are never seen by physicians. In addition, other data sources provide little or no information about the socioeconomic characteristics of the persons who became ill.[2]

The NHIS is a nationally representative survey of the U.S. civilian noninstitutional population that inquires about health conditions in a sample of approximately 49,000 households (Benson and Marano). Respondents are asked to report about the health of other household members as well as their own health during the two weeks preceding the interview, yielding information on approximately 120,000 persons. The NHIS also collects information about family size and composition, income, employment, health insurance coverage, and the impact of illness on daily activities. The 1992, 1993, and 1994 NHIS annual samples were pooled for this analysis in order to obtain more stable estimates of the incidence of acute conditions for small groups. The pooled sample includes information on 354,000 persons, representing nearly 14,000 person-years of exposure to the risk of foodborne illness.

The NHIS estimates indicate that there were approximately 13.5 million cases of foodborne illness and other acute conditions potentially due to foodborne pathogens each year in the U.S. civilian noninstitutional population during 1992–94. This estimate is similar to the baseline estimate of 12–15 million annual cases due to the seven pathogens from all sources. However, the two estimates are not comparable for three reasons. First, the NHIS counts only those cases severe enough to require at least half a day of restricted activity or a physician visit, whereas the baseline estimate includes all clinically detectable cases regardless of severity. This difference suggests that the cases identified by the NHIS are likely to be more severe on average than the cases examined by the baseline estimates. In fact, 35% of all cases of foodborne illness and other acute conditions potentially due to foodborne pathogens identified by the NHIS were severe enough to require a visit to a physician, in

[1] The income calculations for this classification excluded all in-kind assistance, Earned Income Tax Credits (EITCs), Supplemental Security Income (SSI), Aid for Families with Dependent Children (AFDC), and general assistance payments in order to focus on the household's ability to achieve an adequate income without government assistance.

[2] The detailed study of the incidence of foodborne illness by Steahr does not examine variations by income or employment sector. Other studies of foodborne illness based on mortality data reveal little about socioeconomic variations because only a small proportion of cases result in death, and because death certificates provide little information about socioeconomic characteristics. Although epidemiological studies of foodborne illness collect socioeconomic information, this information generally is used only for assessing risk exposure factors.

contrast to only 15–27% of the cases examined by the baseline estimates.

The second reason the NHIS and baseline estimates are not exactly comparable is that NHIS respondent reports of acute health conditions tend to represent symptoms rather than medically diagnosed diseases unless respondents visited a physician who diagnosed the condition. NHIS medical coders classify these reports using a "short index" relating symptoms to specific diseases [National Center for Health Statistics (NCHS)]. Preliminary analysis of the NHIS data suggests that the medical coders placed most symptoms potentially due to foodborne pathogens into four general disease categories: (*a*) "intestinal infections due to other organisms, not elsewhere classified"; (*b*) "food poisoning, unspecified"; (*c*) "infectious colitis, enteritis, and gastroenteritis"; and (*d*) "infectious diarrhea." Therefore, in our analysis, we examined all acute conditions classified in these general categories, as well as those classified in the specific categories corresponding to the seven pathogens included in the baseline estimates.[3] As a result, our definition of illness due to the seven pathogens is broader than the definition adopted in the baseline estimates, and undoubtedly includes some illnesses due to other pathogens.

The final reason why the NHIS and baseline estimates are not exactly comparable is that the NHIS does not cover the institutionalized population. The NHIS estimates consequently omit all cases of foodborne illness occurring among persons in institutions, notably nursing homes, whereas the baseline estimates include such cases.

Despite these differences, the NHIS provides information about the socioeconomic distribution of foodborne illness unavailable from any other data source. For this study, we assumed that the distribution of cases among households revealed by the NHIS is similar to the distribution of cases of foodborne illness due to the seven pathogens examined by the baseline studies. In the absence of more comprehensive data on socioeconomic variations in foodborne illness rates, this seems a reasonable assumption.

The NHIS data indicate that the distribution of foodborne illness and other acute conditions potentially due to foodborne pathogens varies by household type (table 2). The average annual number of cases per 1,000 persons during 1992–94 was highest in single-parent and dual-parent households (87.4 and 65.9, respectively), a result probably due to the concentration of children in these households and the higher incidence of foodborne illnesses among young children. In contrast, the annual incidence rate was lowest in households with elderly heads (15.3 per 1,000 persons). The reason for the low incidence rate in this household category is not entirely clear, although one factor may be the exclusion of institutionalized persons from the NHIS sample. Elderly persons in nursing homes are likely to be in poorer health and therefore at greater risk of foodborne illness than the noninstitutionalized elderly, so the exclusion of the institutionalized elderly from the NHIS probably leads to an underestimation of the incidence rate of foodborne illness among the elderly.

The NHIS data also show that the average annual incidence of foodborne illness and other acute conditions potentially due to foodborne pathogens was slightly higher among the poor (60.1 per 1,000 persons) than the nonpoor (53 per 1,000 persons). However, this difference was not significant (table 2).

In contrast to the incidence of illness, there was little difference in the proportion of cases seen by physicians by either household type or poverty level (table 2). One explanation for this pattern is that there may have been little difference in the degree of severity of illness. Alternatively, the propensity to visit a physician after becoming ill may have varied within

[3] The NHIS classifies diseases using the ICD-9 system (Benson and Marano). The specific ICD-9 categories included in our analysis were 003.0, 003.1, 003.2, 003.8, 003.9, 005.0, 005.2, 005.9, 008.0, 008.41, 008.43, 008.8, 009.0, 009.2, 27.0, and 130.0–130.9. The Council for Agricultural Science and Technology (CAST) reports that there are 40 known foodborne pathogens. Garthright, Archer, and Kvemberg discuss some of the issues involved in using NHIS respondent reports of illness to measure the incidence of intestinal infectious diseases.

Table 2. Incidence of Foodborne Illness and Other Acute Conditions Potentially Due to Foodborne Pathogens, 1992–94

Household Characteristic	Avg. Annual No. of Conditions per 1,000 Persons		Percent of Conditions Medically Attended	
	No.	Std. Dev.	%	Std. Dev.
Household Type				
Dual-Parent	65.9	4.0	33.6	2.8
Single-Parent	87.4	9.4	41.5	5.4
Single-Adult	37.7	4.2	32.4	5.2
Multi-Adult	46.8	7.6	36.2	7.7
Elderly Head	15.3	3.3	41.5	10.4
Income				
Above Poverty	53.0	2.7	35.1	2.4
Below Poverty	60.1	7.2	36.5	5.8
Health Insurance				
Public Coverage	38.1	4.6	44.3	5.4
Private Coverage	60.7	3.8	33.7	3.4
Uninsured	44.0	7.7	27.2	9.5
Total	52.9	2.4	35.3	2.1

Notes: Data compiled from pooled 1992–94 NHIS annual samples. Standard errors for individual years were calculated using the approximation method developed by NCHS (Benson and Marano). Standard errors for the three-year pooled estimates assume that the correlation between annual estimates of acute conditions was equal to the mean correlation coefficient for the total population in 1982–84, the only period for which covariances between years have been reported (Bean and Hoffman). The standard errors are likely to be larger than the true standard errors because neither the NCHS approximation method nor the assumed correlation between annual estimates reflects the oversampling of Hispanics that began in 1992.

the population in a way that masked differences in the severity of illness.

The NHIS estimates provide a detailed picture of the distribution of foodborne illness and other acute conditions potentially due to foodborne pathogens that are severe enough to require physician care. However, the NHIS does not reveal which cases resulted in hospitalization or death. Since hospitalizations and deaths account for a substantial proportion of the total costs of foodborne illness, assumptions about the distribution of hospitalizations and illness within the population will have a major impact on conclusions about the share of costs borne by different groups.

To determine the distribution of hospitalizations and deaths within the population, we first assumed that the actual risks of hospitalization and death for persons who became sick enough to visit a physician were the same throughout the population. Then we assumed that these risks were equal to the national-level risks implied by the estimates of physician-attended cases, hospitalizations, and deaths reported by the baseline studies. Using these assumptions, we allocated the total hospitalizations and deaths reported by the baseline studies by household category, and then distributed the initial costs of illness according to this allocation, as shown in table 3. The first two numeric columns of table 3 present the distribution of human capital costs. In keeping with the theoretical basis of the human capital approach, the costs of both work-loss days and premature death were distributed only among households headed by a working-age adult.[4] The costs of direct medical expenses (numeric

[4] This distribution rests on the assumption that all labor force participants are aged 18–64, and that all members of elderly-headed households are out of the labor force. This is a simplifying assumption. A small proportion of labor force participants aged 18–64 were members of elderly-headed households (4% in 1992–94). In addition, some persons over age 64 remain in the labor force.

Table 3. Initial Distribution of Impact of Foodborne Costs on Household Income by Household Type ($ bil.)

Household Type	Human Capital Costs: Premature Death	Human Capital Costs: Work-Loss Days	Medical Expenditures	Total Cost of Illness
Dual-Parent				
Above Poverty	1.61	1.09	0.96	3.66
Below Poverty	0.17	0.12	0.11	0.40
Subtotal	1.78 (55%)	1.21 (55%)	1.07 (52%)	4.06 (54%)
Single-Parent				
Above Poverty	0.40	0.27	0.24	0.91
Below Poverty	0.28	0.19	0.17	0.64
Subtotal	0.68 (21%)	0.46 (21%)	0.41 (20%)	1.55 (21%)
Single-Adult				
Above Poverty	0.23	0.15	0.14	0.52
Below Poverty	0.03	0.03	0.02	0.08
Subtotal	0.26 (8%)	0.18 (8%)	0.16 (8%)	0.60 (8%)
Multi-Adult				
Above Poverty	0.47	0.32	0.28	1.07
Below Poverty	0.06	0.03	0.03	0.12
Subtotal	0.53 (16%)	0.35 (16%)	0.31 (15%)	1.19 (16%)
Elderly Head				
Above Poverty	0	0	0.09	0.09
Below Poverty	0	0	0.01	0.01
Subtotal	0	0	0.10 (5%)	0.10 (1%)
Total	3.25 (100%)	2.20 (100%)	2.05 (100%)	7.50 (100%)

Note: Percentages may not total to 100 due to rounding.

column 3) were distributed across all household categories.

The final distribution of costs depends on households' economic reaction to the initial costs and households' linkages with the rest of the economy. In the following section, we examine the economic reactions to this initial distribution of the costs of foodborne illness.

Economic Impacts of Foodborne Illness

The different types of costs of illness included in the baseline estimates (i.e., direct medical costs and human capital costs) have different kinds of impacts on the economy. Medical expenditures have direct and immediate impacts. These expenditures circulate throughout the economy, triggering economic activity and growth in some sectors of the economy and reductions in others. Unlike direct medical costs, human capital costs do not entail economic flows that can be traced from one sector of the economy to another. Instead, these costs mark a pure drop in economic activity.

In this section, we use the foodborne-illness SAM to trace the impact of human capital costs and medical costs.[5] For both types of costs, we attempt to uncover the final distribution of costs, identifying those sectors of the economy that ultimately pay the costs of foodborne illness.

Economic Impacts of Human Capital Costs

It is difficult to determine who pays the human capital cost of illness. At first glance, it appears obvious that the persons who are sick

[5] The flows recorded in the foodborne-illness SAM already incorporate the costs of foodborne illness, and the structure of the SAM reflects the influence of these costs. As a result, our experiments effectively examine the impact of additional costs of illness. We report only the changes in production, factor payments, and income due to these assumed additional costs.

must bear the brunt of human capital costs, since they are the ones who suffer the pain and inconvenience of the disease. They are the ones who must forego their usual activities. However, human capital costs do not measure the pain and suffering of the individual; rather, they measure the productivity losses of *society* due to illness, disability, and premature death. The human capital approach is based on the notion that the cost to society of adverse health outcomes is the impact of such outcomes on social welfare as measured by national income. Social welfare is diminished by illness, disability, and premature death to the extent that these outcomes diminish national income.

According to the human capital approach, the overall drop in productivity resulting from illness decreases societal prosperity, diffusing the costs of illness throughout the economy. However, these costs are not diffused equally. For example, a premature death that decreases the total productive capacity of the economy is likely to have greater economic consequences for the dependents of the deceased than for other persons. Societal well-being consequently depends on the distribution of the costs of illness, as well as their magnitude. The economic ramifications of premature death and time lost from work are examined in turn below. It will become apparent that these two types of human capital costs are distributed and absorbed by the economy in very different ways.

We first used the foodborne-illness SAM to trace the economic ramifications of productivity losses due to premature deaths. In this experiment, \$3.25 billion (the mid-point of the baseline estimates of the costs of premature death) was deducted from household income according to the cost distribution reported in the first numeric column of table 3. In other words, in keeping with the theoretical underpinnings of the human capital approach, these productivity costs were simply deducted from national income. However, the initial drop in national income does not incorporate the full impact of the productivity losses due to premature death because the households of deceased persons respond to the initial drop in income by reducing consumption and savings. These reductions trigger decreases in economic activity extending far beyond the households of deceased persons.

The SAM traced the impact of the initial decrease in household income to its dampening effect on consumer demand, industrial output, and factor payments. After the SAM accounted for the general equilibrium impacts, the decrease in household income due to premature death resulted in an \$8.86 billion decrease in industrial output, a \$4.21 billion decrease in factor payments, and a total decrease of \$6.24 billion in household income. Thus, every dollar of income foregone due to premature death resulted in an economywide income *loss* of \$1.92. These results demonstrate that premature death imposes substantial costs on society as a whole, with a final reduction in household income nearly double the size of the initial reduction derived from the baseline studies.

There were also important differences between the initial and final distribution of the costs of premature death by household category. In the final cost distribution, dual-parent and single-parent households absorbed a smaller percentage of costs than in the initial distribution, while multi-adult, single-adult, and elderly-headed households absorbed a higher percentage (table 4). The change was most dramatic in the case of single-parent and elderly-headed households. Single-parent households absorbed 21% of the initial costs of premature death (table 3), but only 13% of the final costs (table 4). In contrast, elderly-headed households were not allocated any of the initial costs of premature death (table 3), but bore 6% of the final costs (table 4). These differences arise because, unlike the initial distribution of cost, the final distribution does not mirror disease incidence; it depends instead on the linkages between households and the economy. Single-parent households, a large number of whom are below poverty, have smaller factor-payment linkages with the economy and are not immediately affected by economic declines. Conversely, upper-income households with strong factor-payment linkages are directly affected by changes in the returns to labor and capital.

Table 4. Final Distribution of Impact of Foodborne Costs on Household Income by Household Type ($ bil.)

Household Type	Human Capital Costs of Premature Death	Medical Expenses Paid by Households	Medical Expenses Paid by Insurance and Government
Dual-Parent			
Above Poverty	−2.55	0.32	0.25
Below Poverty	−0.20	0.01	0.01
Subtotal	−2.75 (44%)	0.33 (37%)	0.26 (40%)
Single-Parent			
Above Poverty	−0.53	0.04	0.04
Below Poverty	−0.28	0.01	0.01
Subtotal	−0.81 (13%)	0.05 (6%)	0.05 (7%)
Single-Adult			
Above Poverty	−0.83	0.17	0.13
Below Poverty	−0.04	0.01	—[a]
Subtotal	−0.87 (14%)	0.18 (20%)	0.13 (20%)
Multi-Adult			
Above Poverty	−1.39	0.27	0.20
Below Poverty	−0.05	0.01	—
Subtotal	−1.44 (23%)	0.28 (31%)	0.20 (31%)
Elderly Head			
Above Poverty	−0.37	0.05	0.01
Below Poverty	—	—	—
Subtotal	−0.37 (6%)	0.05 (6%)	0.01 (2%)
Total	−6.24 (100%)	0.89 (100%)	0.65 (100%)

Note: Percentages may not total to 100 due to rounding.
[a] Denotes a quantity more than zero, but less than $0.01 billion.

The same results appear when households above and below poverty are compared. Poor households absorbed 17% of the initial decrease in income due to premature death, but only 9% of the final costs. Again, this is understandable since lower income households have weaker factor-payment linkages to industrial production than do other households.

The economic impact of time lost from work due to illness is more complex and difficult to interpret than the impact of premature deaths. Numeric column 2 of table 3 shows the initial distribution of costs based on incidence rates, but clearly, many employees do not lose all of their daily compensation when they miss work due to illness. Some of the loss in productivity is absorbed by industries because employers with sick-leave policies continue to pay compensation to ill workers, and because employers incur productivity losses when ill workers who remain at work are too ill to work efficiently. In other cases, if the employee has no sick-leave benefits or has exhausted these benefits, households experience reductions in income.

The economywide impact of productivity losses from time lost from work depends on the ultimate allocation of these costs between industry and households. This allocation in turn depends on a myriad of industry-specific characteristics. The task of modeling the relationship between industry and labor is too ambitious for a SAM. However, it is likely that the impacts of the initial distribution of costs will be diffused and amplified once the general equilibrium effects of these productivity losses are included, just as in the case of premature death.

Economic Impacts of Direct Medical Expenses

We next used the foodborne-illness SAM to trace the economywide impact of medical expenditures due to foodborne illness. In this experiment, medical expenses were diverted from general consumption and savings activities at the household level and redistributed to the "medical supply" sectors of the economy. Specifically, $2.05 billion (the mid-point of the baseline estimates of the costs of medical goods and services) was diverted from households according to the distribution of medical costs reported in numeric column 3 of table 3. These households then reduced their normal expenditure and savings activities based on the consumption coefficients embedded in the SAM, and increased their payments to the medical supply sectors. The allocation of payments across medical supply sectors was based on information reported in the baseline studies, and included $0.62 billion paid to the medical services sector for medical care, $0.12 billion paid to the chemicals sector for pharmaceuticals, $0.18 billion paid to the general manufacturing sector for medical equipment, and $1.13 billion paid to the residential services sector for long-term care for disabled persons.

After the SAM accounted for the general equilibrium effects of the increase in medical expenditures, there were net *increases* of $2.19 billion in industry output, $1.08 billion in factor payments, and $0.89 billion in household income. Thus, every dollar of medical expenses resulted in an economywide income *gain* of $0.43. The consumption of medical goods and services due to illness triggered growth in the economy that outweighed the economic decrease due to reduced household spending on nonmedical goods and services. The medical expenditures precipitated by foodborne illness led to an increase in economic activity. The most likely explanation for this result could be the fact that, in general, medical goods and services have a high proportion of domestically produced inputs.

The seemingly perverse effect of defensive expenditures on national accounts has been well documented by environmental economists (Lutz). The increase in income did not necessarily make households better off, because medical costs increased more than income. This result points out the fundamental difference between the human capital costs and the medical costs of foodborne illness, and highlights the need for refinements in methodology to account for changes in well-being that are not captured by income measures alone.

The increase in household income triggered by medical expenditures was distributed differently than the initial distribution of medical expenses. Higher income households with stronger factor-payment links to the economy enjoyed more of the benefits of economic growth than lower income households with weaker links. In fact, households with incomes below the poverty level received only 2% of the increase in household income triggered by increased medical expenditures, although they represented 16% of all households.

For many households, direct medical expenses are paid through medical insurance, thus softening the effects outlined above. In order to examine the economic impact of medical expenses when they are paid through private or public medical insurance, we used additional information from the NHIS to classify households by health insurance status. More specifically, we classified each household into one of three health insurance categories based on the coverage of individual household members. This classification distinguished households whose health care costs were wholly or partially subsidized by public programs from households protected by private insurers and households lacking any kind of coverage. Public coverage took precedence in the classification in order to identify all households receiving public funds. The three household categories were:

(*a*) *Households with Public Coverage.* One or more household members had Medicaid, Medicare, or other public health coverage, regardless of whether any members had private coverage.
(*b*) *Households with Private Coverage.* At least one household member was covered by a private health plan, and all other members were uninsured.
(*c*) *Households without Coverage.* No house-

hold member had either public or private coverage.

Medicare was considered public coverage because most Medicare beneficiaries elect optional Part B coverage, which is subsidized by the federal government. This approach differs from the classification developed by Paulin and Weber, which treats Medicare as private coverage. Military health coverage was treated as private coverage because military dependents and retirees included in the NHIS sample received coverage as an employment benefit. Single-purpose hospitalization plans covering only hospital charges also were counted as private coverage, following Bloom et al. The focus on health insurance reduced the size of the NHIS sample available for analysis by approximately one-sixth because the survey questions about health insurance coverage were not administered during the first half of 1993.

Most members of elderly-headed households (97%) and nearly half of the members of single-parent households (49%) depended to some extent on public health insurance coverage, reflecting the distribution of Medicare benefits for the elderly and Medicaid benefits for the poor (table 1). In contrast, about three-fourths of the members of dual-parent, single-adult, and multi-adult households were protected to some extent by private health plans. One-fifth (20%) of the single-adult household members lacked health insurance, a higher proportion than in the rest of the population.

It is important to note that the three health insurance categories capture only some of the differences in sources of payment for health care. Many households with public coverage also have private coverage, notably "medigap" policies for costs not covered by Medicare. Some households with private coverage pay less out-of-pocket costs for health care than others because they have more comprehensive policies, or because their employers pay a larger share of the premium. Finally, some uninsured households may have better access than others to health care providers who reduce their fees for low-income patients, and then shift the unreimbursed cost to public payers (through government subsidies or charitable deductions) or private payers (through higher charges).

We used the information from the NHIS on the distribution of illness by household insurance category (table 2) to distribute the $2.05 billion dollars in medical costs. Households with private coverage accounted for a much larger share of the total costs ($1.33 billion) than households with public coverage ($0.58 billion) or households without coverage ($0.14 billion). The availability of health insurance changes the linkages examined in the earlier SAM experiment. Most importantly, the fact that nearly one-third of medical expenses were incurred by households with public coverage or no coverage links these expenses to taxpayers.

We used the foodborne-illness SAM to trace the impact of direct medical costs when "third-party payers" (private insurance or the government) pay the bills. The initial impact of public coverage was represented by a $0.72 billion increase in taxes to pay the medical expenses of publicly insured and uninsured households. The tax increase was obtained from households above poverty, who adjusted their consumption and saving accordingly. The increased tax revenue was immediately allocated to medical sectors to pay the medical expenses of publicly insured and uninsured households. The initial impact of private coverage was represented by a $1.33 billion rise in costs for the insurance sector to pay the medical expenses of privately insured households. The rise in costs for the insurance sector was modeled by diverting sector expenditures to the purchase of medical goods and services.

The final impact of third-party payments of medical expenses was again an increase in economic activity. In fact, the increase in output was larger when medical expenses were paid by third-party payers ($4.17 billion) than when they were paid out of household income ($2.19 billion). However, this larger increase in production did not translate into larger factor payments or household income. When medical expenses were paid by third-party payers, the increases in factor payments and total household income were $0.70 and $0.65

billion, respectively. In contrast, these increases were $1.08 and $0.89 billion, respectively, when expenses were paid out of household income. Every dollar of medical expenses paid by third-party payers resulted in an economywide income gain of $0.32 as opposed to a gain of $0.43 when households paid expenses out of pocket.

The final distribution of the increase in household income resulting from third-party payments of medical expenses differed from the initial distribution of foodborne illness for two reasons. First, the increase in economic activity resulting from higher medical expenditures was distributed back to households through factor payments, thus diffusing the increase in income throughout the economy. Second, initial medical expenses were paid by insurance companies and taxpayers rather than households, thereby diffusing the initial costs throughout the economy. This diffusion would continue if insurance companies raised premiums to cover increased costs.

When medical expenses were paid by third-party payers, the link between the initial distribution of illness and the distribution of the economic impacts was broken because both the initial and final impacts of foodborne illness were diffused throughout the economy. As a result of the greater diffusion, the final distribution of economic impacts differed from that when expenses were paid out of household income (table 4). In the case of third-party payers, this is a result of the fact that taxpayers and households receiving factor payments from the insurance sector paid proportionately more of the medical costs of illness.

The final impact of medical expenses on the economy probably falls between the two cases we examined using the foodborne-illness SAM model: neither households nor third-party payers pay all medical expenses. However, regardless of the exact mix between household payments and insurance and government payments, the SAM experiments found that the ultimate impact of medical expenses will be an increase in economic activity.

Conclusion

The cost-of-illness approach to measuring the cost of foodborne illness provides an *accounting* of the dollars spent on medical expenses and the earnings that are foregone as a result of illness, disability, or premature death due to foodborne illness. Such an accounting describes the initial economic impact of these costs. In this paper, we used a SAM model to trace the ultimate impact of these costs on the economy. We found that the economic impact of human capital costs differs fundamentally from the impact of direct medical costs. The results of the SAM experiments indicate that every dollar of income foregone due to premature death results in an economywide income *loss* of $1.92, every dollar of medical expenses paid out of household income results in an economywide income *gain* of $0.43, and every dollar of medical expenses paid by private and public insurance results in an economywide income *gain* of $0.32. The economywide loss from premature death outweighs the gain due to increased medical expenditures.

The SAM accounting of the final impact of costs of illness provides useful information for economists and policy makers by indicating the direction and magnitude of the economic flows resulting from health shocks to the economy. Such an accounting identifies who ultimately pays for adverse health outcomes. In this analysis, economic feedback effects and private and public insurance diffused the costs of foodborne illness throughout the economy, far beyond the persons who actually became ill.

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