SESSION IV

VALUING RISK REDUCTIONS FOR DIFFERENT HAZARDS

Benefits Transfer and the Value of Food Safety

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Resources for the Future

Introduction

We take it as given that cost-benefit analysis (CBA) is a useful tool for choosing among alternative courses of action according to the criterion of social efficiency. It does this by providing a single, money metric that under certain assumptions indexes social welfare. Other things being the same, policies that would increase welfare as indicated by the metric would be preferred to policies that would reduce welfare, and policies that would increase welfare more would be preferred to policies that would increase welfare less.

The application of CBA in the food safety area is challenging for many reasons. Of most importance here, is the fact that benefits of food safety regulations or other interventions are primarily registered in improved health status. One can perform useful policy analyses by comparing the costs of various interventions per unit health improvements across the set of available interventions (a cost-effectiveness analysis), but to be able to aggregate across various types of health effects, and to be able to say something normative about the regulations or interventions being contemplated, requires estimating health benefits, i.e., placing monetary values on these health improvements.

But to successfully apply CBA in the food safety area means valuing an enormous range of possible diseases related to food safety – a task far beyond what the literature on health valuation in a food safety context can currently support. There are only three solutions to this problem. We can wait until the valuation literature catches up – not a very satisfying option; we can "retreat to defensible borders," in the sense of using medical cost information as a placeholder and lower bound for the more appropriate "willingness to pay" measures of value; or we can use techniques to modify the existing, non-food safety valuation literature to make it more appropriate for use in a food safety context. This last option is called benefits transfer.

In fact, there is a reasonably robust literature for valuing the respiratory effects of air pollution reductions, containing a significant and reasonably accepted number of studies valuing respiratory-related symptom-days and chronic respiratory disease cases. There is also a very large number of studies yielding values of statistical life (VSL) that, while not defining a policy context appropriate to deaths associated with air pollution (a discussion we will take up below), are typically used in CBA studies associated with air pollution regulation performed by the government and others. The question for this paper is: Should and can this literature be used to help value food safety outcomes? A supplementary question is: What research needs are suggested by this analysis?

What is Benefits Transfer?

To be more formal about it, benefits transfer is the application of valuation results from a study performed for one policy context to another policy context (see Desvousges, et al., 1992, for a complete discussion in the context of recreation demand; see AERE, 1992, for many papers on this topic).

There are two types of results that can be used for benefits transfer—unit values and valuation functions. The first is more easily and more widely used. It involves the application of a value, say in terms of the willingness to pay (WTP) for a reduction in a health "unit," such as a symptom-day of a particular kind, being applied, after any needed adjustments, to epidemiological estimates of symptom-day reductions as a result of a food safety intervention.

The second approach allows the analyst to adjust the values for the policy context at the cost of placing a greater burden on the food safety analyst. There is an *ad hoc* approach to do this and one relying on statistical results. The *ad hoc* approach involves developing from information in the literature or the analysts' own judgment, various factors to adjust the WTP estimates from the study context. The statistical approach involves, first, finding an original study where statistical analyses explain variation in the WTP for, in this case, avoiding a symptom-day using a set of explanatory variables, such as severity of the symptom, income, sex, health status, etc. The outcome is a regression equation describing the contribution of each factor to WTP. The food safety analyst then takes the resulting regression equation and substitutes in the values for the factors in the regression that are appropriate to the food safety case. For example, suppose the regression shows that every year of life over age 40 results in a $1 reduction in the WTP to avoid a symptom-day. If the age of those affected by a food safety intervention averages 75 years, then this factor would drop WTP estimated from the other factors by $35.

Why Use Benefits Transfer?

Of course, if simple adjustments like those for age and income were all it took to perform a credible benefit transfer, they would be used much more frequently and with much less controversy. After all, a benefits transfer is far cheaper than performing an original research study. For instance, the cost of an in-person contingent valuation survey is at least $100 per completed survey, with a sample of about 1,000 fairly standard. Add to this the cost of developing the survey and analyzing it, and such a study, on one or at most a few health endpoints, could cost over $200,000. Moreover, a benefits transfer from an established set of unit values or functions carries with it instant professional and institutional legitimacy. The unit values appearing in EPA's recent study of the *Costs and Benefits of the Clean Air Act Amendments of 1990* (USEPA, 1999), for instance, have been reviewed by a special panel of economists and undergone review both inside and outside the Agency.

Unfortunately, the needed adjustments are not simple. The food safety context differs markedly from the air pollution context in several areas, some of which have so far not been very well addressed by researchers.

Available Unit Values

Above, we noted that the health unit values for the air pollution context are drawn from the most robust literature. Table 1 provides a small sample of the midpoint values typically used by practitioners of health benefits analyses in the air quality area, as well as ranges of these values. We picked the unit values for health endpoints chosen by four major studies or models in the United States, Canada, and Europe, ordered from highest to lowest based on the first of these studies--the U.S. study on the Costs and Benefits of the 1990 Clean Air Act Amendments (USEPA, 1999) --and put them in common currency and constant dollars.

The willingness to pay for reducing risks of mortality and chronic morbidity is expressed, for convenience, in terms of the value of a statistical life (VSL) and the value of a statistical case of chronic disease (VSC).[1] The table shows quite close agreement on the size of the best or midpoint VSL's and VSC's. The differences that do exist may be explained partly by currency conversions and partly by researchers' not always adjusting such values over time for inflation. Also, the rank ordering of values is found to be very similar across the studies, although not every study considers the same set of health endpoints. The low VSL's for the Tracking and Analysis Framework (TAF) (Bloyd, et al., 1996, which came from Lee et al., 1995) and the Air Quality Valuation Model (AQVM) (Stratus Consulting, 1999) result from adjustments to the VSL for the older age of those affected by air pollution relative to those included in the studies underlying the VSL estimates. ExternE (ExternE, 1999, originally from ExternE, 1996) makes a similar adjustment by converting the VSL to a value of a life-year for subsequent analysis. In other analyses, EPA (USEPA, 1999) and TAF have done the same thing.[2] These efforts have yielded values ranging from \$50,000 to \$300,000 per life year.[3]

In our judgment, this close agreement among the studies is the result of several factors, including replicability of findings in original studies in different locations (i.e., independent choices made

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[1] It is important to note that these terms are merely a shorthand for the WTP for a given risk reduction divided by that risk reduction. This relationship is convenient because the VSL's or VSC's can be multiplied by estimates of the "lives saved" or "chronic cases saved" to obtain benefits.

[2] Other adjustments to VSL's have been made (or suggested) for latency (ExternE, 1999), for health status (basically the "harvesting" issue) (UKDH, 1999) and for a range of attributes, such as dread and voluntariness (USEPA, 2000).

[3] The ranges around these estimates are all somewhat different, seemingly without pattern. This result perhaps could be expected since there is no treatment of uncertainty that is universally accepted. The EPA mortality results are based on one standard deviation from the distribution (the Weibull) that best fits the mean WTP estimates from 26 studies. The Canada results are based on a representation of uncertainty as a three-point probability distribution, which includes expert judgment. The TAF distributions are Monte Carlo-based, assuming, unless otherwise indicated by the original studies, that errors about mean estimates are normally distributed, with variances given in the concentration-response and valuation studies relied upon for the underlying estimates. Bounds are defined as 5th and 95th percentile. Error bounds in the latest ExternE report (1999) are established as one-half (low) and twice (high) the geometric mean.

by different research teams), and the consensus reached by research teams on a common pool of studies, results, and interpretations. We believe that the social cost of electricity studies in the United States and the ExternE effort in Europe have something to do with this commonality. In addition, the Canadian studies have been informed by the AQVM model developed by Hagler Bailly (now Stratus Consulting) and others who have been active participants in the U.S. debate over the social cost of electricity as well (Hagler Bailly, 1995). Many U.S. studies pre-date and presage these efforts.

It is worth noting that the endpoints being valued are not all comparable to one another. The unit values for mortality risk, chronic lung disease risk, and acute symptoms all are derived from a willingness-to-pay approach that may be thought of as capturing, however imperfectly, the full value to the individual of reducing the risk or the symptom. The other values are only partial, mainly relying on cost of illness techniques. They are meant to capture the more severe manifestations of either acute events or chronic states and may, without proper adjustments, double-count WTP benefits or provide significant underestimates of the WTP to reduce such effects. Indeed, it is fairly common practice to adjust such cost of illness (COI) estimates by a factor to bring them up to a WTP estimate, so as to eliminate such underestimation. AQVM, for instance, recommends using a factor of 2-3 to make this adjustment. The evidentiary basis for the generality of this adjustment across endpoints is weak.

Example of Ad Hoc Adjustment of Unit Values

A recent attempt to adjust the VSL used by EPA in its cost-benefit analyses for the context of death from cancer (Revesz, 1999) is illustrative of an ad hoc approach to benefits transfer and the critique it received by the EPA's own Science Advisory Board is illustrative of its problems.

Revesz sought to develop a VSL for cancer for use in addressing alternative policies to control emissions of carcinogenic pollutants. He proposed to adjust the standard VSL used by EPA ($4.8 million in 1996 dollars, based on hedonic wage studies) for involuntariness of exposure, the lack of controllability of that exposure, and for the dread cancer causes in those facing it. Relying on some studies in the literature, Revesz suggested that the first two factors would lead to a doubling of the VSL, while the third would lead to another doubling.

The EPS's Science Advisory Board (2000) carefully reviewed the paper and concluded that the literature relied upon was not robust enough to justify adjusting the standard VSL.

Elements of the Policy Context

It is helpful to develop a taxonomy of the elements of the policy context. If a function were available that related each of these elements to WTP, then one could do a confident benefits transfer. Even though such a function is not available, we can use the taxonomy to compare the study context to the policy context to make judgments about how credible a benefits transfer would be.

There is no universally accepted list of all the elements of a policy context one needs to address for a conceptually complete benefits transfer. Table 2 gives one such list, listing four elements and various features for each element. This list does not attempt to distinguish what elements or features *should* affect values, only those that have been shown or speculated to affect values. The nature of the risk refers to whether the risk refers to death or morbidity (either chronic or acute), the features of morbidity that might be relevant, and the qualities of both mortality and morbidity that might be relevant, such as dread and controllability (Slovic, 1987). While it might seem strange that morbidity and mortality are valued separately, in fact the health valuation literature is bifurcated in this way, probably more due to the difficulties of obtaining values on this more complex combined commodity than any other reason.

Referring back to table 2, the risk change element has three features. One is baseline risk, which refers to the risk of death or morbidity faced by the individual in the absence of a policy intervention. The timing refers to whether the intervention will have an immediate effect on risk or a latent effect. Size is the size of the risk change.

The only other element that needs clarification is "Other." Whether the good is provided privately, through markets or through an individual's actions, or publicly, say through the government to an entire class of individuals, may affect valuations directly. In addition, particularly in the public good setting, individuals may hold values for health improvements to other individuals, i.e., they may be altruistic. Whether altruistic WTP should be counted in addition to individual WTP depends on the type of altruism individuals hold. Paternalistic altruism is defined as one person's caring about another's health, to the exclusion of caring about other facets of the person's life, facets that might be affected by their wealth. In this case, there is reasonable agreement that the altruistic portion of WTP can be counted. If the altruism is non-paternalistic, however, in the sense that one individual cares about another's utility, then the cost of the policy to the other person should enter into the altruistic person's WTP. In this case, altruism would not be counted.

Avoidance behavior means the ability of at-risk individuals to reduce their health risks. A health intervention may reduce the need for avoidance behavior taken by an individual, without necessarily changing health risks. While this benefit is not strictly speaking a health benefit, it should be counted in a benefits analysis, and individuals would count such improvements as a benefit of an intervention. Looked at in another way, individuals may not be willing to pay much for an intervention that would reduce their chance of a headache where taking an aspirin (the averting behavior) costs 2 cents and it works immediately and without side effects. As a food safety example, WTP to reduce the risk of health effects from an outbreak of giardiasis would be limited by the cost of avoiding the contaminated water. Where avoidance behavior options are limited, this factor would not have to (or need to) be taken into account.

Finally, some researchers have speculated that the willingness to pay to reduce risks may be affected by the agent causing the health effect, e.g., that the WTP to reduce risks of a named disease (e.g., listeriosis) may be different than the WTP for avoiding a disease solely described by its symptoms. This effect may overlap with the disease quality feature discussed above.

Mortality Risk Valuation and Benefits Transfer

Table 3 provides the elements of the study context for the main literature used to value mortality risk reductions in governmental environmental cost-benefit analyses and compares them to the elements for the policy context for air pollution and health.

We have identified five approaches to estimating preferences for reducing mortality risks and expressing these preferences in monetary terms: the human capital approach, various revealed preference approaches (most importantly the hedonic labor market approach, but also the consumer products approach), and stated preference techniques that address health and those that do not.

The human capital approach is not a WTP measure. It seeks to estimate the productivity lost when a person dies prematurely. This approach is utilitized as part of the cost-of-illness methodology employed by ERS, for instance (Buzby et al., 1996). Without special adjustments, it ignores losses to society of nonworkers.

The hedonic labor market studies statistically relate wage differentials to mortality or morbidity risk differences across occupations and industrial/commercial sectors, under the theory that in competitive labor markets, workers in risky jobs should receive wage premiums equal to the value they place on avoiding increased mortality or morbidity risks. One study asks workers their perception of the death risks they face in order to address the issue of whether their behavior would be consistent with perceived risks rather than actual risks and that these two types of risks might diverge. These studies are numerous and form the foundation for most VSL estimates.

The stated preference approaches, of which contingent valuation and conjoint analysis are the two most prominent, are survey approaches that set up choice situations. These methods ask individuals to chose among various hypothetical choices. For instance, they ask whether individuals are willing to pay some amount, or to vote yes on a referendum, or to prefer one package of attributes over another, in order to acquire reductions in mortality risk. The ability of conjoint analysis to recover preferences is a matter of debate. Also, both of these approaches may suffer from a variety of their own biases, and their results have been shown to be very sensitive to question wording and ordering. They are capable of being molded to whatever population and context are appropriate, however. And respondents can be tested for their cognition and understanding of the issues being examined in the survey (see Hammitt (2000) for a detailed discussion of the CV-mortality risk valuation literature). Some of the best known CV studies for mortality risks (Jones-Lee et al., 1985; Hammitt and Graham, 1999) look at traffic fatalities.

The comparison between the study and air pollution policy context reveals that there is already a benefits transfer underlying valuation of mortality in the air pollution context and that there is a serious disconnect between the study context and this policy context. The main body of literature is the hedonic labor market studies and contingent valuation studies based on accidental fatality risk in mainly a transportation context. This literature focuses primarily on prime age, healthy individuals (mostly men) and involves “private” labor market or transportation choices, while the air pollution context involves a very different at-risk population and affects more the nature of a public good. The sizes of the risk reductions match fairly well, although some air pollutants may have latent effects on health, which the literature has not captured.

Is a benefits transfer from this literature to the food safety context any more credible than its use in an air pollution context? To answer this question, we first must define the "food safety context" For the purpose of this paper, we focus simply on the top four foodborne diseases identified by the ERS/USDA/CDC: salmonellosis, campylobacteriosis, *Escherichia coli* diseases, and listeriosis. Box 1 provides summarizes key features of these diseases.

Turning to the last column of table 3 for food safety, we find that the diseases have a number of characteristics that are distinct from one another, making them difficult to classify according to table 2's taxonomy. Nevertheless, they do have in common that the unconditional mortality risks are very small, on the order of 1 in 100,000 or lower. And, they have conditional death risks that are considerably larger than those in the study context—anywhere from 1 in 1,000 to 1 in 5 annually. The latter is for listeriosis—a disease hard to contract but remarkably easy to die from. As estimated VSL's appear to be very sensitive to the size of the risk change (larger for smaller risk changes) and communicating conditional risk continues to be problematic in the literature, these differences are serious.

In addition, as in the air pollution context, but unlike the study context, effects are concentrated on the ill. Somewhat unique for the food safety context is that children, particularly very young children, are a significant fraction of the population at risk and that averting behavior after an outbreak is announced is a significant component of the behavioral response to risk. The upshot of this comparison is that benefits transfers for mortality valuation are probably more problematic for the food safety context than for the air pollution context.

Theory and Empirical Evidence for VSL

How important are the distinctions being made in the above section? If the differences in context do not amount to much empirically, perhaps such differences can be ignored. In fact, some differences matter more than others.

Table 4 (based partly on Hammitt, 1999) attempts to summarize both the theoretical and empirical literature to answer this question. Neoclassical welfare economics, in particular the life-cycle utility model, lies at the heart of the theoretical modeling. Its predictions about the effects of various factors on WTP are provided in the first row of the table. WTP should clearly increase with the size of the risk change; indeed, subject to some minor caveats, the life cycle model predicts a proportional relationship. This implies that the VSL would be constant for any risk change. The model also implies that the further in time any risk change begins, the lower WTP should be. The effect on WTP of baseline risk was studied by Pratt and Zeckhauser (1996), who show that those facing higher baseline risks should be willing to pay more for a given risk reduction (the "dead anyway" effect). Higher incomes or wealth should be related to higher WTP. The age effect varies depending on whether the individual can borrow against future earnings. With borrowing, the predicted relationship is an inverted U-shape, peaking, according to these studies, at around 40. Finally, the models do not make a prediction on health status.

These predictions have not always been matched by the model results. Table 4 provides some information on findings of empirical studies and rates the robustness of the results, ranging from "high," which means there is a body of literature in basic agreement, to "low," which means either a very thin literature, and/or a new literature, or a literature in disagreement.

Beginning with responsiveness to risk change, a perfectly responsive finding, where WTP moves proportionally with the size of the change, would imply a constant VSL. Rarely have most studies even tested for sensitivity of the WTP for different risk changes provided to separate samples (the external scope test), let alone passed them. The recent CV study by Krupnick et al (2000) passes this test but fails the more stringent proportionality test, showing less than proportional responsiveness, and therefore a VSL that is higher for small risk changes. It is worth noting that the VSL's ranged from $1-$3 million (1999 dollars), still far lower than EPA's choice of $6 million, drawn from labor market studies.

The same study (as noted above) is the only one to test for the WTP for future risk reductions in a survey also testing the WTP for contemporaneous reductions. This study found the former—for average futurity of 15 years, and with an average perceived probability of making it to 70 (when the risk reduction would begin) of about 75 percent—to be about 40 percent of the latter.

The empirical studies have all found income effects as expected but have had difficulty separating baseline risk from age, because the two move together. Also, all studies have had very limited participation of older individuals. An exception is Krupnick et al. (2000) which had one-third of their sample over 60 years old (up to 75), finding no statistical difference in VSL across ages until age 70 and above, the latter VSL being lower than that for the 40-year-olds by a fraction similar to that of Jones-Lee at al. (1985) (about 33 percent) but at a much lower initial VSL. Indeed the VSL for those over 70 was only about $650,000 for a 5-in-10,000 annual risk change. Finally, only the Krupnick et al. study explicitly addresses the effect of health status on WTP, finding no effect of health status on WTP, except for those with cancer, who were WTP about 45 percent more to reduce their annual risks by 5 in 10,000 than their counterparts with the same characteristics who did not have cancer.

Summary of Four Foodborne Bacterial Diseases

The largest rate of food poisonings is from *Salmonella*.[1] Its symptoms range from mild abdominal discomfort to dehydration and vomiting and can cause secondary chronic illnesses, such as septicemia, which can lead to death. The most vulnerable populations are the very young (below age 5), the old (over age 70) and the immunocompromised. The incidence rate has been estimated to be between 1.7 percent and 8.3 percent, with 2 percent of cases resulting in hospitalization and death rates around 6 percent of this or about 1 in 10,000 in the population. *Salmonella* contamination occurs in undercooked poultry, raw eggs and beef, and other dairy products, such as ice cream, and even fruits and vegetables. Avoidance options are easily available in some cases, but not in others. Cost-of-illness estimates, which include medical costs and productivity losses (including losses of human capital from premature death), range from $0.60-$3.5 billion annually.

Campylobacter infections occur through the consumption of poultry and pork, as well as clams, raw milk, and untreated water. The symptoms are mostly diarrhea and at times very strong abdominal pain, and can last from a day to weeks—the latter in about 20 percent of the cases. Chronic conditions can follow in from 2-10 percent of cases, including meningitis, inflammation of the gall bladder, and appendicitis. The very young and people in their twenties seem to have the most cases. Case rates are about 1 percent, with 0.6 percent of these hospitalized and with 2-6 percent of these resulting in death, or about 1 to 4 in a million in the population. The costs of foodborne campylobacteriosis are $0.6 to $1 billion annually, using the cost-of-illness approach. Improved food handling could reduce cases, particularly in supermarkets.

Escherichia coli infections can be caused by a variety of foods, some cross-contaminated by bovine products. The bacteria can produce symptoms from mild diarrhea to death; some infections can cause hemorrhagic colitis, and some of these cases can result in hemolytic uremic syndrome (HUS), which can lead to death through kidney failure and other complications. There are a small number of cases throughout the U.S., only a rate of 0.004-0.008 percent. Of these, 18 percent are hospitalized, 20 percent of these turn into HUS, and 33-40 percent of these die, or from 5 per 100,000 to 1 in 10,000. The very young are most susceptible, followed by those over age 60. Cost estimates range from $0.2-$0.6 billion

Infection from *Listeria monocytogenes* (listeriosis) has a "bimodal distribution of severity, with most cases either mild or severe." Even the "mild" cases are characterized by fever, severe headache, and vomiting. Severe cases, which are experienced *in utero*, by infants, and some immunocompromised or pregnant adults can involve delirium, coma, and death. It survives refrigeration and can be present in high doses on underheated hot dogs, cheese, and pate. The reported number of cases is tiny, only 1,800 in 250 million. But all are hospitalized and of these about a quarter die, or 2 per million. The severity of this disease pushes costs to $0.2-$0.3 billion annually.

[1] All the information in this box is taken from Buzby et al. (1996).

Morbidity Valuation and Benefits Transfer

Table 5 takes the same format as table 3, but describes the study, air pollution, and food safety contexts for morbidity. The key studies here vary for whether the morbidity is chronic or acute. In general, the cost of illness approach breaks down the consequences of illness into its component parts and attempts to place values on each part. The ideal WTP measures would capture all the medical costs, pain and suffering, time loss, productivity loss and fear of an illness (see Harrington and Portney (1987) for the basic model). This approach has a welfare theoretic basis but is basically a stop-gap to use when other approaches fail. For instance, Hartunian (1985) uses a model of the progress of cancer and (separately) of respiratory disease to estimate the medical costs of these diseases over one's lifetime. Cropper and Krupnick (2000) have estimated the consequences of various chronic diseases on wages and labor force participation. Ultimately, such measures founder on their inability to capture the pain and suffering that are likely to arise from chronic illness. The approach has fared better with acute illness.

Considering the valuation of chronic illness, conjoint analysis has been used by two studies to value the WTP to reduce risks of developing chronic respiratory disease, and several studies have addressed the WTP to reduce cancer morbidity risks. Viscusi, Magat, and Huber (1991) and Krupnick and Cropper (1992) used conjoint analysis to examine the WTP to reduce the risks of chronic respiratory disease.

Considering acute health valuation, three contingent-valuation studies (Loehman et al., 1979; Tolley et al., 1986; Dickie et al., 1987) are the original studies of this type. They used bidding procedures to elicit estimated values for respiratory-symptom days, with average estimates ranging from $5 to $25, depending on the symptom, its severity, and whether a complex of symptoms is experienced.

All those studies have drawbacks, related mainly to their methodology--the CV studies were performed before many of the most important advances in CV techniques. But they offer consistent ranges of estimates for WTP to avoid a particular type of symptom.

Differences in the study and air pollution contexts are not very large because many studies have been designed with the air pollution context in mind. However, differences between these and the food safety context are more pronounced than those for mortality risks. Many foodborne illnesses have strange and serious symptoms, making reliance on studies of respiratory disease for benefits transfer questionable. In addition, some of these symptoms may be unfamiliar and dreaded, adding additional dimensions to the WTP. Furthermore, baseline risks are different. The foodborne disease risks may be in the 1 per 100 range—very large compared to the chronic disease in the air pollution context and smaller than respiratory symptom probabilities. And again, the ill and very young are at risk, and avoidance behavior is perhaps a major element of the behavioral response.

Conclusions and Recommendations

In comparing the study and policy contexts for valuing food safety, the clear conclusion emerges that reliable health values for food safety are not going to be found in the health valuation literature used in air pollution benefit-cost analyses. That literature has its own problems of credibility and reliability. But, more important, at least in the case of valuing mortality risks of air pollution, there is a serious disconnect between the study and policy contexts. While far from a consensus has been reached, agreement is growing that there should not be one VSL for use in all cases. Where different groups are affected in different contexts, whether they differ by age, sex, race, health status, or other characteristics, it is their WTP that matters for valuation. *A priori,* there is no reason that each of these groups should hold the same willingness to pay for an equivalent risk, although Krupnick et al.'s findings on the lack of sensitivity of WTP to age (below 70) and physical health suggest that not all these characteristics may matter. In the context of food safety, where some diseases affect children, those with AIDS, and the elderly, these considerations suggest not only that benefit transfers would be unreliable but that VSL's will differ in different food safety contexts.

Moreover, as empirical evidence mounts that WTP changes less than proportionally with risk reductions (this in spite of the conceptual support for proportionality from the lifecycle model literature), the possibility grows that different VSL's would be used for different size risk reductions *experienced by the same groups.* Again, in the food safety context, risk reductions are either relatively smaller or relatively larger than the air pollution or labor market contexts, suggesting, again, that transfers are unlikely to be reliable and that more than one VSL may be appropriate, depending on the food safety context.

For morbidity valuation, the case against useful benefit transfers is clearer still. The symptoms associated with the major foodborne illnesses are specialized and varied far beyond the simple respiratory effects or diarrheal effects that have been valued in the health literature. Also, the high prevalence of foodborne diarrheal disease among children means that WTP estimates appropriate for this group are necessary; however, the state of the literature for deriving these values is embryonic.

The food safety context also has some unique elements affecting valuation relative to that of the air pollution context. Most important, for many foodborne illnesses there is a pre-outbreak period where damage is being done before people are aware of the cause and the need for averting action. This is followed by a post-outbreak period where averting activities can be taken. Values are needed that are associated with both periods, because WTP in the second period is conditioned on the cost of averting behavior while WTP for the first period is not.

Implications

If the conclusions of this paper are accepted, then, aside from the thin literature directly addressing valuation of foodborne health effects, there is not much of a literature available to use in estimating the benefits of food safety policy. What should the agencies with regulatory responsibilities in this area do in the mean time?

The first option is to do what the ERS in particular has been doing—use cost-of-illness estimates instead of WTP estimates. This may be viewed as a "retreat to defensible borders" because the COI approach has a long history in food safety, is transparent, and can be thought of as a lower bound on WTP. Another option is to use cost-effectiveness analysis rather than attempting to value health effects. Here the key decision is the health measure. Where one type of physical effect dominates, a measure of the reduction in this effect could be used—something like a health index measure. However, if the analysis is meant to compare cost-effectiveness measures across diseases, there probably will not be a single "index" symptom to use. This obvious problem has led to the creation of various indexes for physical symptoms—the Quality of Well Being scale (Torrance), the Quality-Adjusted Life Year (QALY) (Neumann et al., 1997), and others.

This paper is not the place for an examination of the problems of these various measures as compared with one another and as compared with WTP measures. Suffice it so say that the assumptions needed for their equivalency as measures of utility in alternative health states are many, the empirical literature testing these assumptions shows that they are unrealistic, and the empirical literature shows a fairly consistent lack of association between these measures (O'Brien, 2000) within the same sample of individuals.

A third option is for the longer run and requires a sustained research effort: develop a literature based on food safety valuation and suitable to be used in benefit transfer exercises across the myriad food safety contexts. The idea would be to develop functional relationships applicable to a wide variety of food safety contexts. Such an approach would be less expensive than developing a catalogue of values for different risks and different populations, as suggested by Kuchler and Golan (1999), although it would be less accurate as well.

Beyond this broad agenda for research, our discussion of the food safety context brings out some more specific research priorities. These include:

- WTP applicable to children and household WTP. Research is beginning on building conceptual and testing empirical models appropriate to the valuation of children's health changes. None of the conventional approaches to valuation are applicable because (very young) children are not capable of valuing their own health in hypothetical situations and are not in situations to reveal it. Parent WTP is obviously a key element here. The prominence of children as a sensitive group to foodborne disease makes such research imperative.

  Equally important is research on the WTP of the household as a unit. Altruism within the household is a fact of human existence and economic decisions are often made as a household unit. Most valuation literature looks at *individual* WTP and tries hard to eliminate considerations of family. In the air pollution context, where averting behavior opportunities are minimal and contagion is not a serious issue, the individual valuation paradigm may be sensible. But for food safety, the above concerns loom far larger.

- WTP for combined improvements in mortality risk and morbidity. The health valuation literature is almost entirely bifurcated into studies of the WTP for mortality risks and the WTP for reductions in morbidity. This split is probably not defensible for the air pollution context any more than it is for food safety. Yet the problems in valuing lifetime, integrated health risk changes are so formidable that progress will be slow.

- Improving communication about small probabilities/conditional probabilities. The mortality risk valuation literature continues to struggle with how to communicate small probabilities effectively and to obtain sensitivity to scope. A smaller literature (Smith and Desvousges, 1987) has also tried to communicate conditional probabilities. In the food safety context, where unconditional probabilities are very small (1 in 100,000 or less) but conditional probabilities can be startlingly large (1 in 5 for listeriosis!), progress will be needed.

- Altruism and WTP. The conceptual literature is reasonably in agreement about the conditions under which altruism (outside the family) can be counted and alternatively, results in double-counting. What is not known is the prevalence of these conditions and when one set or the other might apply. There is also only the smallest literature on how large altruistic values might be and no information on such values in a food safety context, where private actions can do so much to limit exposure that people may not hold significant altruistic values.

- Qualitative risk attributes and WTP. The ERS and CDC funded projects recently to examine whether attributes, such as the cause of the health effect (bacteria vs. virus vs. something else), the type of carrier (e.g., foodborne), the name of the disease, and dread, voluntariness, controllability, etc., have any independent effect on WTP for reduced health risks. More of this type of research will be needed if initial results show such sensitivity. Perhaps the results might be appropriately transferred to the air quality valuation literature, where virtually no information of this nature is available!

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Table 1. Comparison of unit values used in several major studies or models

Values	US EPA[1]			US TAF[2]			Canada AQVM[3]			Europe ExternE[4]
	Low	Central	High	Low	Central	High	Low	Central	High	Central
					1990 dollars					
Mortality	1560000	4800000	8040000	1584000	3100000	6148000	1680000	2870000	5740000	3031000
Chronic bronchitis	-	260000	-	59400	260000	523100	122500	186200	325500	102700
Cardiac hospital admissions	-	9500	-	-	9300	-	2940	5880	8820	7696
Resp. hospital admissions	-	6900	-	-	6647	-	2310	4620	6860	7696
ER visits	144	194	269	-	188	-	203	399	602	218
Work loss days	-	83	-	-	-	-	-	-	-	-
Acute bronchitis	13	45	77	-	-	-	-	-	-	-
Restricted activity days	16	38	61	-	54	-	26	51	77	73
Respiratory symptoms	5	15	33	-	12	-	5	11	15	7
Shortness of breath	0	5.3	10.60	-	-	-	-	-	-	7
Asthma	12	32	54	-	33	-	12	32	53	36
Child bronchitis	-	-	-	-	45	-	105	217	322	-

[1]The Costs and Benefits of the Clean Air Act Amendments of 1990. Low and high estimates are estimated to be 1 standard deviation below and above the -mean of the Weibull distribution for mortality. For other health outcomes they are the minimums and maximums of a judgmental uniform distribution.
[2]Tracking and Analysis Framework, developed by a consortium of U.S. institutions, including RFF. Low and high estimates are the 5% and 95% tails of the distribution.
[3]Air Quality Valuation Model Documentation, Stratus Consulting for Health Canada. Low, central, and high estimates are given respective probabilities of 33%, 34%, and 33%.
[4]ExternE report, 1999. Uncertainty bounds are set by dividing (low) and multiplying (high) the mean by the geometric standard deviation (2).

Table 2. Elements of the Policy Context

Elements	Features
Nature of risk	Mortality/morbidity
	For morbidity:
	Symptom type
	Severity
	Frequency
	Jointness
	Disease qualities
	Dread
	Controllability
	Etc.
Risk change	Baseline
	Timing
	Size
Population characteristics	Health status
	Age
	Income
	Education
	Race
Other	Public vs. private good
	Altruism
	Avoidance possibilities
	Causal agent

Table 3. Mortality Valuation and Benefit Transfers

Elements	Primary studies (hedonic wage/CV accident)	Conventional air pollution context	Food safety context
Nature of risk	Familiar, voluntary (?)	Familiar, involuntary	Varies
Timing	Contemporaneous	Contemporaneous and future	Contemporaneous and future
Size	X in 10,000	X in 10,000	X in 100,000 or smaller*
Affected population	Healthy (males); no young, few old	Ill, very old, very young (?)	Ill, very young, other
Public/private	Private	Mostly public	Mostly private
Averting behavior		Minor	Major

* Unconditional probability; conditional ~ 1 in 1,000 (salmonellosis); 1 in 4-5 (listeriosis)

Table 4. Theory and Empirical Evidence for WTP for Mortality Risk Reduction

	Risk change	Latency	Baseline risk	Income	Age	Health status	Dread
Life cycle model	+ proportional.	–	+	+	-, + then -	?	+
Wage compensation	+		_	+	+ then -		
CVM	+; not prop.	–	varies	+	varies	0, cancer +	+

Hammitt and Graham (1999) and author

Table 5. Morbidity Valuation and Benefit Transfers

Elements	Primary studies (primarily CV; context free)	Conventional air pollution context	Food safety context
Nature of risk	Acute: Mostly respiratory Chronic: respiratory; Familiar	Acute: Respiratory and cardiovascular (CA), Chronic: respiratory and CA; Familiar	Wide variety (GI), complex mixture of symptoms; Unfamiliar/dread
Timing	Contemporaneous	Contemporaneous and future	Contemporaneous and future
Size	Acute: Certain Chronic: x in 10,000	Acute: high Chronic: small	Varies: e.g., ~1 in 100
Affected population	Adults	Adults, asthmatics	Ill, very young
Public/Private	Private	Public	Private
Averting Behavior	Few	Minor	Major