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MORBIDITY VALUE TRANSFER

1. INTRODUCTION

In many environmental regulation contexts, an important category of impacts from regulation is impacts on public health. These can include impacts on both rates of mortality and rates of morbidity in the affected population. Indeed, for regulations aimed at improving air or water quality, health benefits can be the dominant category of impacts in a regulatory impact analysis. For example, in a prospective cost-benefit analysis of the 1990 Clean Air Act Amendments (US EPA 1999), decreases in mortality and morbidity from improved air quality constituted over 95% of the total estimated benefit.

When compared to valuation of other environmental goods such as outdoor recreation, scenic quality, wilderness, and wildlife populations, the approach typically used to value improvements in health resulting from improved environmental quality is somewhat unique, in that it relies heavily on unit values and value transfer.[1] The typical approach when valuing environmental health improvements from a proposed action is to follow the damage function approach, which is discussed in the first chapter of this volume. First, projected changes in exposure to pollutants are combined with established exposure-response relationships. This type of analysis gives predictions of how many ill health outcomes would be avoided as a result of the action.[2] These improvements in public health are then valued by multiplying the number of each type of ill health outcome avoided by a constant value specific to each outcome.[3]

The focus of this chapter is on the third step in this approach, multiplication of the number of ill health outcomes to be avoided by an outcome-specific unit value per incidence. Three categories of value are generally considered: (1) the social costs of providing medical treatment to the victim of the ill health outcome; (2) lost labor productivity resulting from the ill health outcome; and (3) the pain, discomfort, and inconvenience suffered by the victim. Per-incidence estimates of the first category of these costs are assembled from hospital records, records of visits to doctors' offices, records of prescription medication use, and surveys of victims of their out-of-pocket health care costs. Per-incidence estimates of lost productivity are usually based on the hourly wages paid to the victim, relying on the theoretical assertion that wages should reflect the marginal value of the victim's labor to his or her employer.

Estimation of the third category of value, the pain, discomfort, and inconvenience suffered by the victim, is more problematic, because there are few market prices or financial records that will reveal this value. Instead, the usual approach is to use stated preference techniques such as contingent valuation or stated choice

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approaches to estimate the victim's willingness to pay (WTP) to avoid an ill health outcome.[4]

What makes public health valuation unique among situations where nonmarket valuation techniques are applied is the implicit assumption that all cases of an ill health episode have the same value. In particular, it is usually assumed that the value of an ill health outcome does not depend on (1) the cause of that ill health outcome (so that, for example, a day suffering from itchy eyes and a stuffy nose caused by air pollution is valued the same as a similar episode caused by contaminated water at a swimming beach, (2) whether individuals in the population will avoid at most one incidence of an ill health outcome, or whether some individuals will avoid more than one (so that, for example, the value to an individual of avoiding 7 incidences of ill health is 7 times the value of avoiding one incidence), and (3) the health status of the individuals who will enjoy improved health (so that the value of avoiding an incidence of ill health to a person with chronic health problems is the same as the value to a person who rarely experiences ill health).

In contrast, for most other environmental goods, it is generally believed that the context of the good is critically important in determining its value. The marginal value of improving water quality in a lake depends on how many lakes will be protected. Oil pollution from a tanker spill is valued differently from oil pollution originating from natural seeps. In public health valuation, the issues of context and scale are typically assumed away.

The purpose of this chapter is to review available evidence on the validity of using constant per-episode and per-case values when valuing changes in public health due to changes in environmental quality. A second issue that will be explored is the validity of transferring health values estimated in one geographic region to an analysis conducted in another region. Relatively few environmental health valuation studies have been conducted, especially outside the U.S. Health values are routinely transferred between countries, with little guidance on how values might differ due to differences in health status, socioeconomic conditions, or culture.

2. VALUING ONE EPISODE VERSUS MANY EPISODES

At least for less-serious ill health outcomes, it is common practice in stated preference studies valuing health to value a discrete, marginal change in the number of episodes or cases of ill health that the respondent will experience, rather than valuing a change in risk of ill health. This approach is clearly unrealistic – future health cannot be guaranteed. Further, a risk-free treatment that focuses on health outcomes, rather than on risks, does not allow consideration of potential changes in defensive actions that the respondent might take, such as limiting activity during periods of poor air quality. On the other hand, valuing changes in risk imposes difficulties on both the respondent and the researcher. For this reason, most morbidity valuation studies have measured WTP to avoid, with certainty, one or more specific episodes or cases of ill health.

While exposure-response studies may tell us how many fewer hospital admissions and minor symptom days will occur as a result of an improvement in environmental quality, they usually do not predict how these avoided outcomes will be distributed within the affected population. For many environmental health issues, there is an at-risk subpopulation that suffers a disproportionate share of the total number of ill health outcomes. For example, asthma attacks are concentrated among those who have asthma. The health improvement that results from an improvement in environmental quality will likewise be concentrated within the susceptible subpopulation. Individual sufferers who benefit may avoid more than one episode or case as a result of the policy action. Does the value of avoiding a single episode of ill health depend on how many episodes the individual will avoid?

The evidence is that it does. Tolley et al. (1994) valued avoidance of one additional day of suffering from seven different symptoms that can be caused by pollution, and avoidance of 30 days of suffering from the same symptoms. While WTP to avoid 30 additional days was uniformly higher than WTP to avoid one day, the ratio of the two was only between 7 and 10 to 1. Similarly, Navrud (2001) found that avoidance of WTP to avoid 14 additional days of minor symptoms was 3 to 5 times as large as WTP to avoid 1 additional day. These results would seem to suggest that the marginal benefit from avoiding a symptom day decreases as the number of symptom days avoided increases. Johnson et al (2000), in a study that used paired comparison and stated preference techniques, apply a transformation to duration of illness that assumes diminishing marginal value. However, in a second pair of surveys, Tolley et al. found that WTP to avoid 20 days of severe angina was over three times as large as WTP to avoid 10 days, implying increasing marginal value of duration (or, equivalently, decreasing marginal value of health).

It is not clear, from theoretical grounds, whether WTP to avoid additional symptom days should increase at a less than or greater than proportional rate as the number of additional days to be avoided increases. If health, measured as the number of days in a year the individual does not experience symptoms, is a normal good with decreasing marginal utility, then marginal WTP to avoid an ill health outcome should increase as the number of ill health outcomes the individual will experience increases. However, if health is viewed as something that you either have or do not have, then the marginal disutility of additional ill health may be low, once health status drops below some threshold.

To date, the empirical evidence on whether marginal WTP to avoid ill health increases or decreases as the duration of the ill health increases is mixed, though results consistent with declining marginal disutility of ill health are more common than results consistent with declining marginal utility of good health. Complicating these results is the possibility that the elicitation methods used may be unable to reliably measure how value changes as the scope of the health improvement changes. At a minimum, the evidence to date suggests that it is inappropriate to assume that marginal WTP per outcome avoided is constant regardless of the number of outcomes avoided by each individual.

3. DO PEOPLE WITH POOR HEALTH VALUE HEALTH DIFFERENTLY?

Related to the issue of how many outcomes an individual avoids, is the issue of who in the population avoids the ill health outcomes. If it tends to be persons with poorer health who benefit most from improvements in environmental quality, then it is of interest to know whether marginal WTP to avoid one ill health outcome varies with the individual's health status.

Tolley et al. report conflicting results as to whether health status affects WTP to avoid days of ill health. WTP to avoid one day of minor symptoms was generally positively related to the number of days the respondent experienced those symptoms within the past 12 months, and was negatively related to overall indicators of health. However, WTP to avoid 30 days of minor symptoms or to avoid 10 or 20 days of angina were not related to health status.

Dickie et al. (1987) found that WTP to avoid one day of nine different symptoms that can be caused by ozone exposure was not sensitive to how often respondents experienced the symptoms, or whether respondents were respiratory impaired.

Johnson et al (2000) found that WTP to avoid episodes of respiratory and cardiac ill health was higher for respondents who had been diagnosed with cardiovascular or respiratory conditions, or other serious illness.

Ready et al (2004a) found that WTP to avoid five different episodes of respiratory ill health was significantly positively related to frequency of respiratory symptoms in 6 of 19 regressions, while a significant negative relationship was found in only 1 of the 19 regressions. Further, WTP to avoid the episodes was significantly higher among respondents diagnosed with either asthma or respiratory allergies in 6 of 20 regressions, while no significant negative relationships were found.

To summarize, there are several instances where WTP to avoid ill health outcomes was higher for respondents who suffered from that type of outcome more frequently, or respondents with poorer health measured more generally, while there are very few results that showed the opposite result. We conclude that a weak negative relationship probably exists between health status and WTP to avoid ill health for most ill health outcomes.

4. DOES THE CAUSE OF THE ILL HEALTH MATTER?

Many ill health outcomes that are caused by one type of pollution could also be caused by other types of pollution as well. Nausea, for example, can be caused by air pollution, contaminated drinking water, contaminated swimming beaches, food-borne disease, or by person-to-person transmission of disease. Does the value of avoiding an ill health outcome depend on the cause of that outcome?

Few studies have examined this issue directly. Most environmental health valuation studies are deliberately vague about the cause of the prospective ill health, or the mechanism by which their health would be improved. The fear is that if respondents were told that the health improvement would be delivered by an improvement in environmental quality, they would include in their WTP values the co-benefits (improvements in visibility, ecological services, etc.) that would logically result from the environmental quality improvement, making determination of a value-per-day or a value-per-episode difficult. Indeed, when WTP values measured without reference to the cause of the ill health are compared to WTP values for the same health improvement brought about by an improvement in environmental quality, the latter are found to be larger than the former (Rozan and Willinger 1998).

Ready et al. (2004a) attempted to isolate the impact of the cause of ill health on its value, without confounding the value with consideration of how the improved health would be delivered.[5] In five European countries, WTP to avoid six specific episodes of ill health was measured. Some of these episodes could be caused either by poor air quality or by swimming at contaminated beaches. A split sample design was used, where some respondents were told the cause of the prospective ill health (air pollution or contaminated water) and others were not told the cause. Neither group was told how the ill health would be avoided. Rather, as is common in this literature, respondents were told that by paying a specified sum, they could avoid one episode with certainty. Out of 11 possible tests, none showed a significant difference (at the 10% level) in WTP between the two samples. This result gives some comfort that the common practice of applying per-incidence values, without consideration of the specific cause of the ill health outcome, is valid.

5. TESTING MORBIDITY VALUE TRANSFER AMONG COUNTRIES

Most environmental health valuation studies done to date have been conducted in the United States, though several European studies have been completed more recently. Is it valid to take WTP values for avoided ill health outcomes estimated in one country and use them to value health improvements in a different country (so called unit value transfer)? What types of adjustments should one make when making inter-country value transfers?

The issue that has received the most attention when making inter-country transfers is differences in wealth. If health is a normal good, then WTP for improvements in health should increase with wealth. Indeed, most empirical studies find that within samples of respondents, WTP is positively related to the respondent's income. When using health values estimated in one country (the study country) in a policy analysis in a second country (the target or policy country), it is logical, then, to suppose that WTP should be adjusted to reflect differences in mean income between the two countries. This is of particular importance when transferring unit values estimated in a developed country to a policy analysis in a less-developed country.

There are two common approaches to adjusting WTP values to account for differences in income. First, unit values (WTP to avoid a single incidence of a specific health outcome) from the study country can be adjusted by assuming a constant income elasticity of WTP. A constant income elasticity of 1 would mean that the ratio of WTP to income is the same in the two countries. While an assumed income elasticity of 1 may be intuitive, empirical evidence is that the income elasticity of WTP tends to be positive, but less than one. The second approach is to use value functions estimated in the study country to predict WTP in the target country. This approach, called value function transfer, accounts for differences in not only income, but any other characteristic that was measured for each respondent in the original study, and is measurable in the target country. The value function transfer approach relies on the assumption that the two countries share a common value function.

To test whether any of the three transfer methods (unit value transfer, unit value transfer with adjustment for income differences, or value function transfer) is valid, it is necessary to measure WTP for the same health improvement in two different countries. Alberini et al. (1997) measured WTP to avoid an episode of acute respiratory illness in Taiwan, and compared values for specific ill health outcomes to values previously estimated in the U.S. They transferred U.S.-estimated unit values adjusting for income differences between the U.S. and Taiwan, assuming an income elasticity of 1 or of 0.4, and compared the transferred values to WTP values estimated in Taiwan. They also transferred a value function estimated in Taiwan to predict WTP in the U.S., and compared those predictions to values previously estimated in the U.S. They could not conclusively state whether one of the three approaches outperformed the others, in part because variation in estimated U.S. WTP values was about as large as variation between Taiwan and the U.S. A further complication is that the U.S. studies used different survey instruments, and did not value exactly the same episodes of ill health as were valued in Taiwan.

Similarly, Chestnut et al. (1997) compared WTP to avoid one respiratory illness day estimated in Bangkok, Thailand, with estimates from previous studies conducted in the U.S. They found that, even though average income in Bangkok is about one-quarter that in the U.S., mean WTP was roughly equal in the two countries. Again, interpretation of this result is complicated by the fact that the U.S. and Bangkok studies used different survey instruments.

Ideally, a validity test of value transfer between countries should use the same survey instrument, and value the same outcomes, in both countries. Ready et al. (2004b), estimated WTP to avoid episodes of ill health using the same contingent valuation survey instrument in five different European countries, the Netherlands, Norway, England, Portugal and Spain. The six different episodes valued included two different mild symptom days, a minor restricted activity day, a work-loss day, a bed day, an emergency room visit, and a hospital admission. Table 1 presents brief synopses of the six episode descriptions.[6]

The survey instrument was similar in form to that used by Tolley et al (1994). Respondents were first asked questions about their health status, then asked to rank the episodes in order of severity, then asked their WTP to avoid each episode. Split samples in which the episodes were valued in different order showed no evidence of ordering effects (Ready et al 2004a).

One issue when comparing WTP values from several countries is determining the appropriate exchange rate. Ready et al. (2004b) argue that local currencies should be converted to a common currency using a purchasing-power-parity (PPP) adjusted exchange rate. In the context of the contingent valuation survey, improved health

Table 1. Ill-Health Episode Descriptions

Episode name	Epidemiological end point	Description
EYES (E)	1 Mild Symptom Day	One Day with mildly red, watering, itchy eyes. A Runny nose with sneezing spells. Patient is not restricted in their normal activities.
COUGH (Co)	1 Minor Restricted Activity Day	One day with persistent phlegmy cough, some tightness in the chest, and some breathing difficulties. Patient cannot engage in strenuous activity, but can work and do ordinary daily activities.
STOMACH (S)	1 Work-Loss Day	One Day of persistent nausea and headache, with occasional vomiting. Some stomach pain and cramp. Diarrhea at least twice during the day. Patient is unable to go to work or leave the home, but domestic chores are possible.
BED (B)	3 Bed Days	Three days with flu-like symptoms including persistent phlegmy cough with occasional coughing fits, fever, headache and tiredness. Symptoms are serious enough that patient must stay home in bed for the three days.
CASUALTY (Ca)	Emergency Room Visit for COPD and Asthma	A visit to a hospital casualty department, for oxygen and medicines to assist breathing problems caused by respiratory distress. Symptoms include a persistent phlegmy cough with occasional coughing fits, gasping breathing even when at rest, fever, headache and tiredness. Patient spends 4 hours in casualty followed by 5 days at home in bed.
HOSPITAL (H)	Hospital Admission for, COPD, pneumonia, respiratory disease and asthma	Admission to a hospital for treatment of respiratory distress. Symptoms include persistent phlegmy cough, with occasional coughing fits, gasping breath, fever, headache and tiredness. Patient stays in the hospital receiving treatment for three days, followed by 5 days home in bed.

Note: COPD = Chronic Obstructive Pulmonary Disease

is a market good – it is something that gives positive utility that the respondent can choose to buy at a price. The choice whether to purchase the good depends on the respondent's income, the price of improved health, and on the price of other market goods available to the respondent. If two people have identical underlying preferences, but one faces prices that are uniformly α percent higher than those faced by the other, then their behavior will be identical only if their incomes and the price of improved health also differ by the same proportion.[7] Following this reasoning, all income and WTP values were converted to British Pounds using PPP-adjusted exchange rates.

Mean WTP values for each episode for each country, converted to British Pounds, are shown in Figure 1. As would be expected, WTP is higher for the episodes that are more serious and last longer. The three episodes that only last one day, COUGH, EYES, and STOMACH, have the lowest mean WTP values in every country. Comparing results across countries, Norway and Spain have consistently high WTP compared to the other three countries, while England and the Netherlands have consistently low WTP. Portugal tends to have intermediate WTP values, except for EYES, where it has the highest. These apparent differences are in many cases statistically significant. Pairwise tests of equality show that England has significantly lower WTP than other countries in 14 out of 21 tests, while Spain has significantly higher WTP than other countries in 10 out of 20 tests.

These results are somewhat counterintuitive, given differences in income among the countries. Spain and Portugal have much lower mean real incomes than the three Northern European countries, yet these two countries generally have intermediate to high WTP values relative to the other countries. However, several other differences exist among the countries that have relevance for health valuation (education, family size, current health status). To control for these differences, value functions were

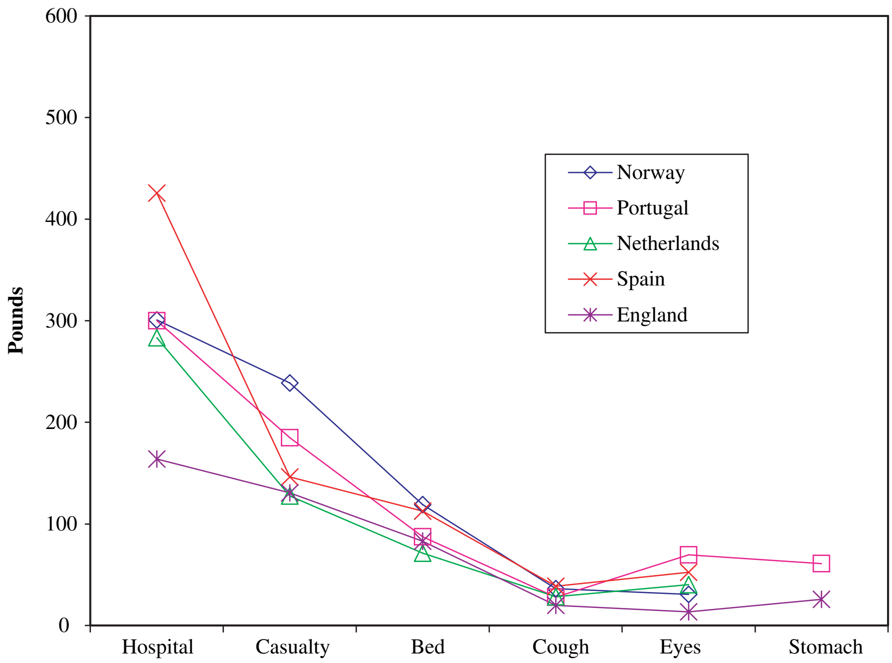

Figure 1. WTP to avoid illness episodes (value per episode).

estimated for each country, for each episode (for regression results, see CSERGE, 1998). Explanatory variables used in the regressions included respondent's income, education level, sex, age, whether there are children in the household, and measures of the respondent's health status and recent experience with symptoms included in the episode descriptions.

Using these value functions, it is possible to construct a WTP estimate for each country for a "standardized" respondent – one who is identical in all measurable characteristics. Figure 2 shows this predicted WTP for each episode for each country, for a respondent with characteristics equal to the mean level of all five countries. Here, the pattern of results is more clear. WTP for the standardized respondent is consistently higher in Spain and Portugal than in the Northern European countries. WTP for episodes in Portugal and Spain is significantly higher than WTP in the Netherlands, Norway and England in 23 of 31 possible pairwise tests. Differences within each of the two groups were small. WTP in Spain differed significantly from WTP in Portugal in only 1 of 5 tests, while WTP differed among the Netherlands, Norway, and England in only 1 of 15 tests.

Even though these results show that unit value transfer and value function transfer are not *statistically* valid between pairs of countries, it is still of interest to know the size of potential transfer errors that might result if transfers were conducted. This can be explored by looking at the percent transfer error resulting from a transfer,

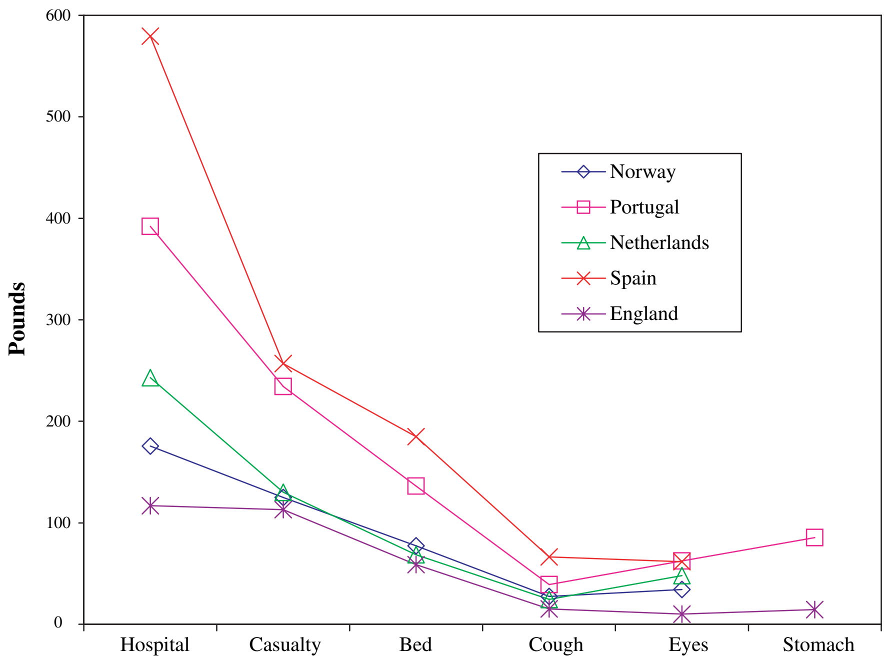

Figure 2. WTP for a "standardized" individual

defined as the absolute value of the difference between the transferred value estimate and the estimate measured in the target country, divided by the estimate measured in the target country. For each target country, for each episode, mean WTP and a value function were estimated from the pooled data set including all other countries. These were then used to conduct a unit value transfer, a unit value transfer adjusted for differences in mean income (assuming an income elasticity of 1), and two value function transfers. In the first value function transfer, the explanatory variables in the transferred value function were set equal to the sample mean for the target country. In the second value function transfer, the transferred value function was used to estimate a WTP for each respondent in the target country sample, and the WTP estimates were averaged.[8]

Table 2 shows average absolute percent transfer error resulting from each transfer approach, averaged over 20 transfer exercises. Interestingly, the performance of the transfer was not substantially improved by taking into account differences between the source countries and the target country. Adjustment for differences in real income gave a slight improvement in performance, over a simple unit value transfer. Value function transfer, with the supposed advantage that it accounts for all measurable differences between the source countries and the target country, actual performed worse than the two unit value transfer approaches.

The average transfer errors in Table 2 include not only the error due to transfer between countries, but also error due to sampling variation both in the study countries and the target country. To give some perspective, a Monte Carlo simulation showed that if the same study was done twice in the same country, the two resulting values would differ by, on average, 16%. The 38% expected transfer error from the unit value transfer approach should be assessed relative to this background level of random sampling error.

Two consistent results emerge from the three studies examined here. First, despite expectations based on economic theory, adjustment of values for differences in measurable characteristics does not necessarily improve value transfer. Second, while value transfer and value function transfer may be statistically invalid, they may generate transferred estimates that are reliable enough for policy analyses. Indeed, the errors associated with value transfer may not be much larger than the

Table 2. Performance of value transfer methods

Transfer method	Mean transfer error
Unit Value Transfer	0.382
Unit Value Transfer with adjustment for income differences	0.377
Value Function Transfer – evaluated for mean individual in target country	0.384
Value Function Transfer – evaluated for all individuals in target country, then averaged	0.419

sampling errors that would result if a new study was conducted in the target country, or than differences in values that result from using different survey instruments in the same country.

6. CONCLUSIONS

A review of the health valuation literature examined the assumptions, commonly relied upon in environmental policy analyses, that the value of avoiding an ill health outcome is independent of (1) the individual's health state, (2) how many fewer such outcomes the individual will experience, and (3) the cause of the outcome. The evidence is that the health state of the individual that will experience the improvement does matter. Respondents with poorer health state are often willing to pay more to avoid a specific ill health outcome than respondents with better health. How many ill health outcomes an individual will avoid also matters. In most studies, marginal WTP to avoid an ill health outcome decreases as the number of ill health outcomes being valued increases. However, if the ill health outcome is well defined to the respondent, it appears that WTP to avoid the outcome is not dependent on the cause of the ill health outcome.

These results suggest that a increased attention to the distribution of health benefits within the affected population is warranted. If the health benefits from improved environmental quality accrue to a subpopulation that is in poorer health, then we need to measure health values that are specific to that subpopulation. If an individual in that subpopulation will experience several fewer ill health outcomes (rather than several individuals each experiencing one fewer outcome) then we need measure WTP to avoid multiple outcomes, rather than rely on values to avoid individual outcomes.

Studies that have investigated the validity of health value transfer and value function transfer between countries show that unit value transfer, while not statistically valid, may provide value estimates that are "good enough" for many policy analyses. A somewhat surprising result is that value function transfer is not necessarily preferred to unit value transfer. Finally, when considering the validity of inter-country value transfer, the potential transfer error should be viewed in the context of the sampling error that would occur if a new study were conducted in the target country. While a new study will usually generate estimates that are more valid than a value transfer, the difference in reliability is not great as might be thought.

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7. NOTES

[1] Current practice in valuing early deaths is the focus of the preceding chapter in this book. This chapter focuses on valuation of morbidity outcomes.

[2] Ill health outcomes (called endpoints in the environmental epidemiology literature) might be an episode of ill health such as a minor symptom day or a hospital admission, or it might be a case of a disease, such as chronic bronchitis or asthma.

[3] For a more in-depth discussion of the use of exposure-response functions to value morbidity, see Desvousges et al. (1998), Chapter 5.

[4] For a review of empirical estimates of ill health caused by pollution, see US EPA 1999, Appendix H.

[5] See also CSERGE (1998).

[6] STOMACH was valued only in England and Portugal. In Spain, the CASUALTY episode lasted only 3 days, and the HOSPITAL episode lasted only 6 days.

[7] This follows from the homogeneity properties of the indirect utility function and the expenditure function.

[8] Data and WTP values for Spain were not included in this exercise, because of differences in the descriptions of the episodes, and differences in how health experience variables were measured. Because responses are available for only two countries, transfer tests were not conducted for STOMACH.

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