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Economic Uncertainties in Valuating Reductions in Children's Environmental Health Risks

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The recognition that environmental hazards can affect children differently and more severely than adults has provoked growing concern in industrialized nations about the impact of environmental pollution on children's health. That concern has reinforced the commitment of governments to ensure that environmental policies take into account the special vulnerability of children. Among the indications of that commitment are the creation in 1997 of a special office for children's health in the U.S. Environmental Protection Agency (EPA)[1] and work on a children's environment and health action plan for Europe at the WHO Fourth Ministerial Conference on Environment and Health in Budapest in June 2004.[2]

Governments in many countries are also expanding their use of regulatory impact assessment, including valuation of the benefits of environmental policy (OECD 1997; Pearce 1998; *c.f.* Grasso and Pareglio 2002). The greater reliance on regulatory impact assessment means that benefits to children's health from environmental policies need to be valued. Yet it is far from clear how best to do this, given uncertainties associated with the methods used to value children's health improvements and the economic uncertainties inherent in valuing children's health.

What Is "Economic Uncertainty"?

This paper focuses on the effect of economic uncertainty on valuation of children's benefits from environmental health programs. By *economic uncertainty*, we mean uncertainties in any of the factors that influence individuals' behavior and preferences, as well as uncertainty about the physical and financial effects of environmental hazards on children. Failing to account

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[1] http://yosemite.epa.gov/ochp/ochpweb.nsf/homepage (accessed June 2005).

[2] http://www.who.dk/childhealthenv/Policy/20030625_1 (accessed June 2005).

for important economic uncertainties can result in poor measures of the effectiveness of environmental policy, inappropriate policy priorities, or poorly targeted policy instruments.

To economists, the benefit of a public program is the change in social welfare resulting from that program. *Social welfare* is defined as an aggregation of the utility of all individuals in society. Individual utility associated with environmental health policies is determined by the change in health risks resulting from the policy and by the consumption of other goods and services as constrained by income. Exogenous changes in the underlying structure of the economy and social institutions will affect the level of program benefits actually experienced. Any one of these factors can be a source of uncertainty in measuring program benefits.

The formal denotation of the change in social welfare with and without the program,

$$W(\mathbf{U}(\mathbf{x}^{w})) - W(\mathbf{U}(\mathbf{x}^{w/o})) \qquad (1)$$

highlights two types of economic uncertainty: uncertainty about physical factors that affect the level of benefits from the program, **x**, and uncertainty about how to represent and measure preferences, U(•). The first is associated with measurement error and forecasting uncertainty; the second with modeling uncertainty.

In the next section we identify sources of both types of uncertainty in estimates of the value of reducing risk to children's health. We then go on to examine how economic uncertainty affects the use of standard economic and noneconomic approaches to the valuation of health benefits and the implications of economic uncertainty for operationalizing those measures. The approaches include willingness-to-pay measures, cost-of-illness and human-capital measures, and quality-adjusted life years (QALYs) and related noneconomic measures. We end the paper by suggesting some ways to improve valuation of the benefits of reducing children's health risks from environmental hazards by accounting for critical sources of economic uncertainty.

Identifying Sources of Economic Uncertainty

In this section we explore how economic uncertainty can influence measurement of the benefits of environmental health policy (measurement error and forecasting uncertainty) and how it affects modeling of preferences or economic choice.

Measurement Error and Forecasting Uncertainty

Error in measurement—of both baseline conditions and expected change in those conditions—is always a fundamental concern in benefits analysis. That we expect children to live longer, on average, than adults suggests that the passage of time may influence outcomes more for children than for adults. Economists concerned with economic forecasting have given considerable thought to the ways in which the passage of time may influence economic projections or forecasts, but we are aware of very little work relating the more general research on economic forecasting to the problem of measuring baselines for environmental health valuation. Some of this research on forecasting, such as projections of change in the labor markets, may be of very direct interest to health valuation. Other parts of the literature may be a source of ideas for issues that may be important in environmental health valuation but that have not yet been addressed. Because of children's long lifespan and concerns about the impact of environmental hazards on child development, these issues may be of critical importance in valuing benefits to children's health.

We find as a helpful guide a framework developed by econometricians for examining how time-series analysis can be used to conduct economic forecasts. In this framework, forecasting uncertainty is reflected in the dispersion of actual outcomes relative to those forecasted (Hendry and Ericsson 2001). Clements and Hendry (1998, 168, modified) identify six broad sources of economic uncertainty in time-series analysis:

- changes in the underlying structure of the economy,
- uncertainty and therefore misspecification of the relationships modeled,
- mismeasurement of the data in the base period from which forecasting begins,
- inaccuracies in estimation of the model's parameters,
- changes in variances of errors over time, and
- the accumulation of future errors (or shocks) to the economy.

We address issues about model misspecification in a later section. The remaining sources are primarily relevant to the measurement of program benefits, which, for simplicity, we refer to as forecasting uncertainty. The sources of forecasting uncertainty can be either deterministic (for example, trends and shocks) or stochastic (for example, randomness in income). Theoretical research on time-series forecasts suggests that the behavior of deterministic model terms has a greater influence on forecasting uncertainty than that of stochastic terms (Hendry and Ericsson 2001).

Because environmental policy focuses on the differential impacts of environmental hazards on subpopulations, in this case children, it is important to ask whether forecasting uncertainty is different for the subpopulation than for the population as a whole. Let us first be clear about what is *not* at issue here. It is easy to slip into thinking that because the life outcomes—for example, future income—of a given child are more uncertain than those of a given adult, there is a greater uncertainty in forecasting lost income of children than adults. This is not what is at issue. The lifespan of any individual is highly uncertain at his or her birth, yet the average age at death of that individual's birth cohort is highly predictable—in fact, an entire industry is based on the ability to make this prediction. What is at issue, then, is uncertainty about predicting the average outcomes for the subpopulation as a whole.

Error in Measurement of Baseline Conditions

All health valuation starts with an estimate of the physical impacts of the environmental program. Errors in the measurement of those impacts can be propagated through the rest of the valuation exercise. There are reasons to believe that error in measuring the physical impacts of environmental programs is greater for children than for adults. For example, there is often a long latency period between exposure to environmental toxins and the resulting adverse health outcome. Even with adults this latency creates great difficulty in directly measuring the effect of environmental toxins using epidemiological studies. As a result, estimates of incidence often rely instead on projections based on animal models. Where long latency periods are involved, children's greater average longevity has several implications. First, children will be exposed to environmental hazards over a longer period of time, with potentially more complex interactions among hazards. This suggests greater difficulty in measuring health effects using epidemiological studies. Second, differences between children's and adults' biological response to environmental hazards mean that animal models that seem appropriate for assessing adult sensitivity to hazards may not accurately represent children's responses. Use of those models to assess children's rather than adults' benefits from environmental programs may therefore entail additional measurement error.

Irreversibility and Uncertainty in Estimates of Change in Health Risks

The irreversible—or potentially irreversible—effects of many children's health problems make it still more difficult to understand health states and risks, thereby making valuation more uncertain. A particularly important case is that of developmental effects in childhood that raise the risks of developing multiple future conditions, many of which are irreversible. The possibility of a premium on valuation of children's health associated with the likelihood of irreversible effects means that the use of adult values may understate the benefits of protecting children's health. To our knowledge, this premium has not been measured. We expect it to account for a large proportion of the willingness to pay to reduce risks that involve irreversible harm.

Framing of Policy Analysis and Inaccurate Estimates of Model Parameters

Sources of measurement error are compounded by the way program benefits are usually assessed—and, in particular, by methods of accounting for the influence of social and economic factors on physical outcomes experienced by children. In general, benefits are often viewed as "snapshots" of program impact (U.S. EPA 2003). The use of such a static model assumes that conditions affecting model parameters remain unchanged into the future and that modeling error is constant from period to period (U.S. EPA 2003). This is appropriate for programs with short-lived effects or where discounting significantly reduces contributions of future program impacts. But in periods of rapid technical, scientific, or social change, or in situations where program benefits are experienced over a long period, this assumption will lead to inaccurate estimates of model parameters.

Structural Change, Trends, and Cohort Effects

Certain problems are unique to the time-series setting: accounting for structural change, changes in variances of errors over time, and the accumulation of future errors (or shocks) to the economy.

The economic forecasting literature teaches us that time matters—not only because one is measuring an inherently dynamic process (for example, a child's development), but also because the process will differ depending on when it starts. Demographers and economic forecasters recognize this fact in the use of birth cohort analysis (Mason and Fienberg 1985; H. Becker 1992). Cohort effects may be important to children's health valuation for several reasons: recognizable trends may affect health and the economy over the expected program's life; structural interactions between birth cohorts may result in forecast error if ignored; and unanticipated shocks may affect health and life outcomes. It is beyond the scope of this paper to comprehensively review how cohort effects can introduce uncertainty into children's health valuation. Instead, we provide a few examples and discuss what can be done to address the concerns they illustrate.

Over the past century, medical technology has improved steadily and rapidly. There is ample evidence that this trend continues to increase longevity in OECD countries. But there is also evidence that it may be leading to increased heterogeneity in the robustness or frailty of the population (Vaupel 1998). Although this is particularly true for the elderly, it is also true for the very young. For example, significant advances have been made in the past 20 to 30 years in neonatal care. As a result, infant mortality rates are decreasing in industrialized countries, but morbidity is increasing (Draper et al. 1999). Currently, even infants weighing less than a kilo can survive, given extensive intervention. However, there is some indication that infants with very low birth weight may experience serious and chronic lung and neurodevelopmental problems (Nuntnarumit et al. 2002; McIntire et al. 1999; Anderson and Doyle 2003; Weiler et al. 2002).

This trend contributes to uncertainty in valuing benefits from children's environmental health programs in several ways. First, it may result in systematic changes in the susceptibility of the population to environmental hazards. To the extent that more infants start life with poorly developed lungs, air pollution is likely to have more widespread and serious effects. Uncertainty about the trend, coupled with modeling misspecification if the trend is ignored (as current approaches to cost-of-illness analyses are likely to do), increases forecasting uncertainty. Second, any illness—but neurodevelopmental problems in particular—can reduce the effectiveness of human capital investments in childhood, and this, in turn, can affect the cohort's expected income. Finally, the underlying trend of improvement in medical technology will affect other health treatment options as the cohort ages. It will also affect the cost of treatment, so the same disease is likely to have both different outcomes and different treatment costs at different times.

The relationship between cohorts cannot always be modeled as a simple trend. Failure to account for more complex relationships may result in model misspecification and increased forecasting uncertainty. There may be interactions between health trends. For example, if better neonatal care increases the number of children with neurodevelopmental problems associated with premature birth, it may compound the effects of childhood exposure to environmental neurotoxins. Health trends may also interact with economic trends. In the United States, as in other OECD countries, the economic return to different levels of education has grown more dispersed over the past 25 years (Cheeseman and Newburger 2002). As a result, lower educational attainment associated with exposure to environmental neurotoxins has different consequences in terms of lost income in 2003 than it had in 1980. Or the relationship between sequential birth cohorts may be nonlinear. Labor economists have long recognized that the relative size of sequential birth cohorts affects each cohort's educational and employment opportunities and, therefore, their earnings. Members of a birth cohort that is large relative to the preceding one can expect to fare worse in the labor market because of the excess supply of labor (Welch 1979; Macunovich 1998). This uncertainty about income introduces increased uncertainty into the estimation of cost-of-illness and even willingness-to-pay measures (working through the income elasticity of willingness to pay).

Trends and shocks also affect social institutions. For example, the structure of public support for disabled people affects the consequences of having a developmental disability. That structure is affected both by discrete policy changes and by trends in or evolution of social norms over time. Temporal changes in household structure operate in a similar way. Heterogeneity in household structure in developed countries was greater in 2000 than in 1950. To the extent that household structure influences investment in children's health or education, it will interact with the influence of environmental hazards to affect children's life outcomes.

In macroeconomic forecasting, the most damaging sources of forecasting uncertainty are exogenous shifts in model parameters (Clements and Hendry 1998, 168–71), with change in policy regimes an important cause of such shifts (Hendry and Ericsson 2001, 185–91). In health valuation, policy regimes affect the severity of disease outcomes and the opportunity sets in which choices are made. For example, a change in educational policy may result in a shift in marginal productivity losses from early childhood neurotoxin exposure. Natural exogenous shocks can also have significant impacts on valuation. The emergence of new immunosuppressive diseases, such as AIDS, has shifted the dose response curve for waterborne bacteria and therefore, its damage function.

We are not suggesting that program evaluation should be conducted using dynamic models. The data and analytical burden of such an approach would likely not be justified by any improvements in analysis. Rather, we are suggesting that lessons from forecasting can be applied within a static analysis. The implications of lessons from time-series analysis for static analysis of program benefits are considered in the third section of the paper. We now turn to the task of identifying ways in which uncertainty about how to measure and represent preferences affects valuation of environmental policy benefits to children.

Uncertainty about Model Specification

In general, very young children cannot provide information on their health preferences. One must therefore find a proxy for the utility children derive from programs designed to protect their health. Many suggested proxies are measures of the benefits of the programs to people other than children. It would be easy in these circumstances to undercount benefits by including a measure of an adult's benefit both as a direct measure of the adults' benefit and as a proxy for children's direct benefits. Keeping a formal model of social welfare in mind can help identify this kind of modeling error by maintaining a consistent accounting framework.

Three groups of people are potentially affected by children's health programs: children themselves, their parents, and others. Let children's own utility from their own safety be denoted $\mathbf{U}_c(\mathbf{x}_c)$. Parents' direct benefits from the impact of investment in children's health on parents' own consumption are denoted $\mathbf{U}_p(\mathbf{C}_p(\mathbf{x}_c))$, where $\mathbf{C}_p$ is parents' total consumption. Parents' benefits due to paternalistic and nonpaternalistic altruism are denoted $\mathbf{U}_p(\mathbf{x}_c)$ and $\mathbf{U}_p(\mathbf{U}_c(\mathbf{x}_c))$, respectively. Paternalistic altruism is utility derived from another's consumption. Non-paternalistic altruism is utility derived from another's own utility. Direct benefits to others in society who are not parents is denoted $\mathbf{U}_o(\mathbf{C}_o(\mathbf{x}_c))$, and benefits due to their paternalistic and nonpaternalistic altruism toward children's health are denoted $\mathbf{U}_o(\mathbf{x}_c)$ and $\mathbf{U}_o(\mathbf{U}_c(\mathbf{x}_c))$, respectively. Total social welfare from children's safety then can be denoted as

$$W = W(\mathbf{U}_c(\mathbf{x}_c), \mathbf{U}_p(\mathbf{C}_p(\mathbf{x}_c)), \mathbf{U}_p(\mathbf{x}_c), \mathbf{U}_p(\mathbf{U}_c(\mathbf{x}_c)), \mathbf{U}_o(\mathbf{C}_o(\mathbf{x}_c)), \mathbf{U}_o(\mathbf{x}_c), \mathbf{U}_o(\mathbf{U}_c(\mathbf{x}_c))) \quad (2)$$

It is possible that the model is actually even more complex. For example, older children's concern about their own health may include altruistic concerns about the impact of their health on their parents and others.

Conceptual models of the impact of programs that protect adult health or produce exclusively ecological benefits on social welfare may be equally complex, although the complexity is often ignored in measuring program benefits. Is complexity more critical in obtaining a decent first-order approximation of the benefits of programs that protect children's health than it is for other environmental programs or for the protection of other groups? Our sense, as we explain in the rest of this section, is that it is.

Uncertainty about When Children Can Be Considered "Sovereign"

It is clear from the social welfare function (eq. 2) that children's own health benefits from environmental programs need to be included in a measure of the benefits of those programs. The question is how the benefits should be represented. In social welfare terms, benefits are defined in terms of changes in utility.

Fundamental to any economic approach to program evaluation is acceptance of *consumer sovereignty*. The normative appeal of consumer sovereignty relies on individuals' ability to make informed, rational judgments about the choices they confront. The central problem here is that childhood is defined by the process of gaining the experience and developing the judgment necessary to make just such choices. This is often cast as a question of *whether* children's preferences should be counted, and the answer is assumed to be no. But more precisely, the question reveals uncertainty about *when* children's preferences should be counted. When children are deemed unable to represent their own utility gains or losses, the question then turns to what proxies are available. Although these are, in part, methodological questions, their answers are informed by underlying uncertainty about child development, social institutions, and others' behavior or preferences—that is, by economic uncertainty.

Childhood is characterized by physical, cognitive, emotional, and social development. There is a small but growing literature on children's risk perception and judgment under uncertainty (Davies 1996; Whalen et al. 1994; Hillier and Morrongiello 1998; Schlottmann 2001), and a relatively large body of literature on adolescent risk behavior and perception (for recent discussions see Millstein and Halpern-Felsher 2001 and Fischhoff and Parker 2000). Schlottmann (2001) found functional understanding of probability and expected value in children as young as five or six years of age. Yet Juniper et al. (1997) showed that children as old as 11 had trouble comprehending the standard gamble used to develop QALYs. Harbaugh et al. (2002) found that children give low-probability events too little weight and high-probability events too much weight, a tendency that diminishes with age. Fischhoff and Parker (2000) found that not only do adolescents underestimate the risk of accidents, they also greatly overestimate their likelihood of dying in the near future (contributing to a "so why not take risks, I'm going to die soon anyway" attitude). These are the types of errors in judgment that conventionally are viewed as constituting immaturity. Yet it is too early to draw generalizations from this literature.

Experience plays a significant role in children's understanding of outcomes. Concepts of death, which at some level are quite abstract, are acquired relatively slowly over time. Carey (1985), reviewing literature on children's conceptual understanding of death, finds that children under five typically view death as like sleep; elementary school children understand the finality of death but not its inevitability; by the age of nine or ten, children seem to understand death as both terminal and inevitable. As will be discussed below, in QALY studies, children seem as able as adults to convey the severity of the symptoms they are currently experiencing (Petrou 2003).

Although emerging research suggests that children develop competencies in evaluating risk and managing hazards earlier than previously thought (see, for example, Schlottmann 2001; Hargreaves and Davies 1996), none of the research challenges the position that children are developing and that their understanding of hazards and perception of risk stabilizes in early adulthood. A series of studies in the 1970s and 1980s examined the inefficiencies that arise in markets characterized by this kind of changing and incorrect risk perception (Starr 1973; Harris 1978; Hammond 1998). Hammond (1981) showed that when consumers' subjective probabilities diverge from the true probability of events or exhibit socially unacceptable levels of risk tolerance or aversion, and when the uncertainty is resolved over time, then Arrow-Debreau–contingent commodity markets lead to intertemporally inefficient allocations. Harbaugh (1999) argues that children's own immature appreciation of risk of illness and death and children's future own adult risk aversion are forms of market failure that lead children to "demand" too little safety. So, clearly, reliance on the "immature" preferences and risk perceptions of children has economic as well as ethical consequences.

This leaves open the question of how to determine when a person is deemed mature enough to be considered an adult for purposes of health valuation. At least two options suggest themselves. One is to rely on social institutions as indicators of an age at which people are assumed to have formed the capacity for judgment on which consumer sovereignty is based. The other, in a survey context, is to develop some developmental criteria based on relevant scientific studies that would allow the researcher to test whether to include a particular age group.

In democracies, an argument can be made for not including a person's preferences until she has reached voting age. One rationale—that the valuations of benefits are informing choices over public provision of health protection—is consistent with the use of a referendum format in contingent valuation studies. But voting age is also usually the age of majority for many other actions. It is usually the age at which one can be held responsible for criminal acts, enter contracts, marry, and so forth. In short, it marks a social judgment that on average, individuals of this age have the experience and maturity to make adult judgments and will no longer be protected from the consequences of their decisions.

Voting age provides a convenient cutoff. Yet, arguably, this approach is not fully compatible with social welfare theory because the class of people whose preferences "count" are not directly affected by the social decision. Ideally, one would want to count the benefits and costs to all who are affected in society. Children's preferences are not being included because they are considered incompetent to access the outcomes of their decisions. One alternative might be to look at the nature of the protection being provided. One could then look for a social rule that defines an age threshold in terms of the capacity to evaluate risks similar to those at issue. For example, one might use the legal driving age as a cutoff rather than voting age.[3]

Alternatively, a developmental criterion could be used to determine when respondents are likely to have the cognitive ability and prudential judgment to understand the outcomes of the decision. One might use an average developmental age or, in a survey format, include a test of respondents' ability to understand the problem and the consequences that will result. This kind of front matter is already included in surveys eliciting adult willingness to pay. Given normal adult difficulties in understanding uncertainty, considerable attention is often given in survey-based valuation studies to ensuring that the respondent understands the nature and magnitude of the risk at issue (Krupnick et al. 2002).

A more appropriate criterion might be the age at which children have developed an adequate experiential basis for evaluating the consequences of physical risks to their lives and

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[3] Another source of information on competence is cultural norms and legal rules that reflect experience with the capacity of children to make judgments. Legal rules pose two related questions: first, when and why are children allowed to take on adult privileges and, second, when and why are they required to assume adult responsibilities. Obviously, these are not new questions, nor are the answers immutable. They change with time and societies. So, for example, there are religious norms about assumption of responsibility. The civil parallels to these religious norms are perhaps more instructive for thinking about when children's judgments could be included in cost-benefit analysis of programs designed to reduce their health risks. Every country has a set of rules about when people have generally acquired adequate judgment about risks to be allowed to accept responsibility for risky activities. In many states in the United States, the long-standing rule has been that with a "learners' permit," a youth between the ages of 14 and 16 may drive a car with an adult present. At the age of 16 or 17, a youth may obtain a license to drive that is the same as that of any other adult. In light of high accident rates among teenagers, particularly teenage boys, many states have implemented or are considering rules that would create a more gradual transition to adult driving privileges. Similarly, jurisdictions have rules about legal drinking ages.

All legal systems have rules about the age and circumstances under which contracts entered into by children can be enforced. The ages are usually different depending on whether the contract is to be enforced against the minor or against the party contracting with the minor. Similarly, legal systems have rules about when civil actions can be maintained against minors for injuries they have caused. Many societies have debated juvenile justice systems and when and how minors should be held responsible for criminal action. The lesson from all of these rules is that there is no single age of majority, but rather, a gradual transfer of responsibility to the minor.

health and the cognitive and prudential capacity to make judgments that they are not likely to regret in adulthood. Scientifically, one might ask at what point do minors' judgments about risk begin to look like those of adults. One source of information on this issue is comparative studies of adult and child decision making under uncertainty (Hermand et al. 1999).

The question of when to include children's own evaluations likely depends on the valuation method used. Children's inexperience with financial responsibilities argues for use of adult choice in willingness-to-pay studies. Because experience with a meaningful budget constraint is central to such studies, a strong argument could be made for excluding even young adults until they are financially independent.

Even if one does not seek to have a valuation reflect a child's own evaluation of risks, hazards, and financial trade-offs, there may be situations in which it is desirable to capture their preferences about outcomes. The psychometric literature presents strong arguments for using the child's preferences when it is the child's own experience of the current condition that matters (Petrou 2003). Children have a perspective on their own condition that is distinct from the adult perspective. Furthermore, adults may not have access to this information because children may censor information they share with adults. If the purpose is to value the benefit of reducing acute illness, there is much to be said for capturing children's preferences. One could use children's own evaluation of the discomfort of their symptoms, for example, to improve parents' choices about protecting their children's health.

Clearly, no one would suggest relying on very young children's own revealed or stated preferences. Yet infants and fetuses are most susceptible to environmental toxins because the brain and other organ systems are particularly vulnerable at early stages of development; thus they are precisely those most likely to benefit from environmental health policies targeted at protecting children.

Uncertainty about an Appropriate Proxy for Children's Utility

Even if it is agreed that a child's preferences should not be counted directly, there remains uncertainty about whose judgments should stand in their place. In the United States, economists have focused on use of parents' preferences as representing children's own benefit from environmental programs. Parents have legal responsibility for their children's welfare, and children's preferences are likely included in their parents' preferences through nonpaternalistic altruism. Going back to the social welfare function as an accounting framework, however, one sees that parents' utility should be counted as representing parents' benefit from protecting children's health. Thus, using measures of parents' utility from environmental programs to count for both their own utility *and* children's utility could underestimate program benefits.

Yet an imperfect world may allow only for an imperfect measure. It would be helpful to know how large the underestimation might be, but there is considerable statistical uncertainty. From a purely theoretical perspective, nonpaternalistic altruistic preferences for children's benefits, $\mathbf{U}_p(\mathbf{U}_c(\mathbf{x}_c))$, are a transformation of children's own preferences, $\mathbf{U}_c(\mathbf{x}_c)$. If we could measure this transformation, we might have an idea of the relative magnitude of the error imposed by using measures of parental utility to account for both parents' and children's benefits. But we are aware of no studies that have estimated the relationship between the preferences of the target of the altruism (here the child) and of the altruistic party whose preferences are being measured. There is some literature comparing children's perception of risks and their parents' perception of the same children's risks (Soori 2000). The intrahousehold allocation literature has focused in only limited ways on separating children's and parents' consumption (see Gronau 1991, for example). None of this provides much insight into how to empirically measure the relationship between $\mathbf{U}_p(\mathbf{U}_c(\mathbf{x}_c))$ and $\mathbf{U}_c(\mathbf{x}_c)$.

It is difficult to conceive of a study that could measure parents' or nonparents' utility (in the form of nonpaternalistic altruism) from programs protecting children. Perhaps the best that can be said is that unlike the usual situation, where we are concerned that including nonpaternalistic altruistic preference leads to double counting, use of parents' preferences to stand both for their own benefits from children's health programs and as a proxy for their children's benefits may lead to undercounting. It might be worth considering the use of various proxies for $\mathbf{U}_c(\mathbf{x}_c)$. One possibility might be to use parental preferences alone as a lower bound on combined parents' and children's benefits and parental willingness to pay plus adults' retrospective assessment of their willingness to pay to reduce risk in their own childhood as an upper bound on public valuation of reduction of environmental risks to children's health.

Another alternative might be Harbaugh's (1999) recommendation to use adults' willingness to pay for safety as a proxy for children's. This is a way of resolving inconsistency between a person's own ex ante childhood allocation and their adult ex post allocation in favor of the ex post allocation (Harris and Olewiler 1979; Ulph 1982). Given changing medical technology, this kind of inconsistency between ex ante and ex post valuation cannot be entirely avoided, but use of adult willingness to pay as a proxy for children's, when children are deemed unable to appreciate risk or alternative health outcomes, would appear to be an improvement over present practice.