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THE VALUATION OF ENVIRONMENTAL HEALTH RISKS TO CHILDREN: METHODOLOGICAL AND POLICY ISSUES

For more information, please contact Pascale Scapecchi. Email: pascale.scapecchi@oecd.org.
Tel.: +33 1 45241487.

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FOREWORD

This synthesis report was prepared as part of the OECD programme on the "Social and Environment Interface". It is based on the findings and discussions arising out of the OECD Workshop on "The Valuation of Environmental Health Risks to Children", held in September 2003. The proceedings of the Workshop will be published separately by 2005. As a follow-up work, a series of pilot valuation studies will be carried out in selected OECD countries in order to estimate values differentiated across factors such as age, latency and risk factor. The report was written by Pascale Scapecchi under the supervision of the OECD Working Party on National Environmental Policy (WPNEP). It benefited from comments from Nick Johnstone (OECD Secretariat) as well as delegates to the WPNEP. This report is published under the responsibility of the Secretary-General of the OECD.

THE VALUATION OF ENVIRONMENTAL HEALTH RISKS TO CHILDREN: METHODOLOGICAL AND POLICY ISSUES

EXECUTIVE SUMMARY

The relationship between environment and children's health has been the subject of increasing interest.

There are a growing number of epidemiological studies attempting to establish a link between environmental pollution and impacts on the health of children. However, there have been few economic studies estimating the benefits of reducing environmental health risks to children.

A better understanding of the conceptual and practical problems associated with undertaking such studies would help policymakers evaluate environment-related health risks that largely affect children, and would contribute to the development of guidelines for the valuation of children's environmental health risk. To this end, a technical workshop was held at the OECD in September 2003, to take stock of the issues and the methodological "state-of-the-art". This report summarises the discussions and main findings arising from the workshop.

It is more difficult to estimate benefits value for children than for adults.

One of the most important issues of valuing children's health relates to the special link that has been established between the natural environment and children's health, and more particularly the epidemiological and economic valuation differences between adults and children. Children are not just little adults and should therefore not be treated as such in policy-making.

Valuation differences between adults and children may be particularly problematic and should be adequately addressed in order to obtain reliable estimates of the economic value of children's health. The most important valuation difference is related to the elicitation of children's preferences. While revealing adults' preferences is relatively problematic, children's preferences are even more difficult to obtain because, according to standard economic theory, children are not reliable decision makers. Economists therefore have to rely on a proxy to elicit children's preferences. Parents are the most intuitively appealing proxy and are therefore usually asked to reveal the value they place on their children's health.

This, in turn, has an effect on the context in which the valuation process takes place. When asking for adults' preferences for a reduction of a specific environmental risk, individuals are asked to reveal the value they place on their own risk reduction. When revealing children's preferences through parents (or caregivers), individuals are asked to state the value they place on a reduction of a risk that affects another member of their household. The context of valuation shifts from an "individual" context to a "household" context. This is associated with some difficulties, such as the choice of the type of welfare model and the influence of household-related factors (*e.g.* household structure, household composition, household preferences, etc.) on the estimates of the benefits of a risk reduction.

Differences in age between adults and children, the existence of long latency periods between the exposure and the onset of an illness, and discounting also raise some additional difficulties that should be accounted for when evaluating the social benefits of the reduction of environmental health risks to children.

Empirical evidence on the valuation of children's environmental health is limited. The question of what valuation method or what health outcome measure is the most appropriate in this context remains open. One can choose to use either "stated preferences" techniques or "revealed preferences" techniques to obtain "willingness-to-pay" (WTP) values to reduce environmental health risks to children, or to measure "quality-adjusted life years" (QALYs) associated with a specific intervention. Further empirical work is necessary, both in the epidemiological and the economic fields, in order to provide meaningful recommendations.

This lack of empirical evidence may have serious policy implications.

Policymakers have had to make decisions and set priorities on the basis of very limited evidence and insufficient information. However, inadequate consideration of epidemiological and valuation differences between adults and children could lead to inefficient policy decisions. On the one hand, ignoring risk differences between adults and children could lead to setting wrong standards, concerning for example the maximum allowable level of air pollution emissions. On the other hand, ignoring the valuation differences between adults and children could lead to wrong policy priorities being set within the health and environment fields. In the long run, this could generate an important social welfare loss. This also raises questions concerning the validity of policies currently in place: Do they reflect the differences between adults and children? Are they (still) appropriate?

In the light of previous considerations on valuing children's health, further research would be necessary to determine the most relevant measure of health benefit and the most appropriate valuation technique. Valuation differences may affect both WTP and QALYs measures, but the order of magnitude is still to be determined. In addition, it would be necessary to better understand how the estimates differ with the characteristics of individuals. Finally, given regional disparities, comparative economic studies carried out in different countries would contribute to the generation of more credible values.

For more information about **The Valuation of Environmental Health Risks to Children: Methodological and Policy Issues**, contact: **Pascale Scapecchi,** National Policy Division, Empirical Policy Analysis Unit**,** Environment Directorate, OECD.
Email : Pascale.Scapecchi@oecd.oeg; Fax : +33 1 44 30 61 79
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THE VALUATION OF ENVIRONMENTAL HEALTH RISKS TO CHILDREN: METHODOLOGICAL AND POLICY ISSUES

Introduction

The examination of the environmental health impacts on children and adolescents is an area receiving increasing attention in OECD Member countries, and many policies and programmes targeted specifically at children are being introduced and undertaken by international organisations, such as the OECD or the WHO, and Environment and Health Ministries. As an example, the Fourth Ministerial Conference on Environment and Health in Budapest in June 2004 focused on *The Future for Our Children* (see WHO, 2004).

Reliable estimates of environmental impacts on a child's health are important in order to help policymakers to evaluate the economic efficiency of policies aimed at reducing children's health impacts. More particularly, such measures contribute in the assessment of the effectiveness of environmental policy and social programmes currently in place. They also provide valuable input to policy design in determining environmental health priorities and vulnerable population groups, and setting optimal targets in order to improve environmental policy design.

However, there have been few economic studies with the objective of estimating the value of reducing environmental health risks to children. This is due in part to the various conceptual and practical problems associated with such studies. Efforts to value the health impacts for children also have important implications with respect to the applicability of the underlying assumptions of the methodologies used. Thus, it is not clear which is the best methodology to adopt in this particular context. Further work is therefore required in order to obtain children-specific economic values.

A research project, undertaken by the OECD, concerning the valuation of environmental health risks to children has been developed in order to help policymakers evaluate environment-related health risks that largely affect children, and to develop guidelines for the valuation of children's health environmental risk. To this end, a technical workshop was held at the OECD in September 2003, to take stock of the issues and the methodological "state-of-the-art".

The main lessons of the workshop have highlighted six main themes of high relevance and importance that should be addressed when estimating the social value of a reduction in risk to children. The first relates to the special link that has been established between **the environment and children's health,** and more particularly focuses on the evidence of epidemiological and economic differences between adults and children. More specifically, a number of issues associated with the valuation of children's health need to be resolved. They represent important topics and include the **elicitation of children's preferences** and the issue of **intra-household allocation.** The fourth theme deals with the various **methodologies** commonly used to value children's health, based either on economic grounds or on non-economic considerations. The difficulties related to **age**, **latency** and **discounting** constitutes the sixth important theme to take account for. This set of considerations will allow for the generation of **policy implications** and **recommendations** for the valuation of environmental health risks to children.

1. Children's health and the environment

Findings from existing studies highlight the link between environment and children's health. Some environment-related health effects are unique to children, such as birth defects related to exposure to

environmental pollution. In other cases, both adults and children are affected, but to differing degrees. In many respects, adults and children constitute two largely different populations, and disparities between adults and children can be expected in terms of risks and in terms of valuation.

Differences in terms of risk

There are many reasons to believe that there are likely to be differences between children and adults in terms of health risk. Exposure is likely to be different for children and adults. Children's activity patterns differ from adults and as a consequence some exposure scenarios that apply to one group may not apply to the other. For example, occupational exposure for adults would not apply to children. Conversely, exposure due to activities such as crawling on the ground, or excessive "hand-to-mouth" behaviour and lower comprehension of basic risk information typically does not apply to adults.

As presented in Tamburlini (2003), differences in terms of risk comprise exposure and susceptibility differences. Exposure differences refer to the total intake of pollutants per unit of body weight, while susceptibility represents the likelihood, the nature and amount of damage subsequent to exposure to pollutants.

Exposure differences can be explained by the disparities between adults' and children's activities, and, in many ways, this may result in greater levels of risk and a relatively greater exposure for children. Given their lack of full understanding of the risks around them, children's activity pattern exposes them to high levels of risk more often than adults. Moreover, metabolic activity is higher for children than for adults, which implies higher daily requirements for food, water, and oxygen per unit of body weight for children than for adults. Children can thus experience a larger effective dose than adults for equal exposure.

Conversely, children are less exposed to high level of substances that cause observable harmful effects than adults, such as potential exposure to nuclear radiation experienced when working in a nuclear plant. Therefore some exposure scenarios or conditions that apply to one of the two groups (children or adults) might not apply to the other one. For such reasons, children's exposure to environmental risk is expected to be different from that of adults.

In addition to differences in exposure, in recent years, it has become clear that children differ substantially from adults in the nature and severity of their responses to environmental exposures (Tamburlini, 2003). Susceptibility differences between adults and children can be explained in terms of outcome (qualitative difference) and in terms of severity (quantitative difference). Children's bodies are still developing and can respond differently than adults to the same apparent levels of exposure; they are less able to metabolise, detoxify or remove pollutants. For instance, it has been shown that for environmental factors which affect the nervous, respiratory, endocrine, reproductive, and immune systems, there can be critical windows of susceptibility, in which adverse impacts will be particularly significant. Thus, the timing of exposure can be significant, and in many (but not all) cases, children are particularly susceptible.

As suggested in Tamburlini (2003), a great number of uncertainties affect the epidemiological side of the valuation process. This particularly concerns the likelihood and the magnitude of health effects, mainly related to the multi-factorial nature of environment-related health outcomes, limit the ability to quantify the risk differences between adults and children This also affects the correct quantification of acute and chronic impacts of environmental exposure on children's health. This may have serious implications more specifically on the approaches used in the risk assessment process. The current knowledge of children's vulnerability is not sufficient. More epidemiological research is then required.

Differences in terms of valuation

For reasons mentioned above, large disparities in the estimates of health benefits for children and for adults are to be expected. These differences in terms of values – or valuation differences – could be distinguished into at least four main categories: age, risk preferences, context of valuation and perspectives[1].

- Difference in age: The obvious difference between adults and children is related to the difference of age. There is empirical evidence that age matters within the adult population: young adults do not have the same WTP values to reduce fatal risks than middle-aged or older adults[2]. Therefore, we could reasonably expect that age would matter more greatly for children relative to adults. Although empirical evidence is weak, some economists have concluded that VSL for children is probably equal or greater than that for adults (Blomquist, 2003). Further research would be necessary to better understand how the VSL differs with the characteristics of individuals.

- Difference in risk preferences: Society and parents are known to be more risk averse to risks experienced by children than to those experienced by adults. The factors driving this are not clear, but could include risk aversion. Other factors that may have substantial impacts on the value include involuntariness of risk experienced by children and uncertainty associated with the risk itself. Some empirical studies have also shown that people believe that, *ceteris paribus*, a programme that protects young people is preferable to one that protects the elderly, because it delivers greater benefits related to the difference in time/age existing between these two populations (larger benefits for young adults given their larger expected lifespan). Examples include Lewis and Charny (1989), Cropper et al. (1994), Johannesson and Johansson (1997). A comparable result between the two latter studies is that the age of the respondent has no effect on his choice, which means that both young and old adults give priority in saving the life of the youngest. There is also empirical evidence that parents are willing to pay more to reduce health risks to their children than to themselves (Liu et al. (2000), Van der Pligt (1998), Blomquist et al. (1996))[3].

- Different context of valuation: In the context of valuation of children's health, people are asked to evaluate the health benefits of a risk reduction experienced by another population (not their own risk), which is quite different from the traditional context of valuation where people are asked their WTP to reduce their own health risk. As parents appear as the most relevant party to value children's health, several factors associated with that particular context may affect children's health estimates. Some factors related to the household structure and composition, such as age structure, presence or absence of the father, may be of high importance (Dickie and Ulery, 2001). Differences within and between households exist and may be associated with age, gender or health status of the child (Pitt and Rosenzweig (1990), Hanushek (1992), Liu et al. (2000)). Finally, as most studies are based upon the parental perspective, altruism from parents toward their children may significantly affect the estimates and be a source of disparity between adults' values and children's values (Dickie and Ulery, 2001).

- Different perspectives: while the relative value we are looking for is the measure of social welfare associated with a risk reduction, different perspectives to obtain this value can be considered: society, children and parental perspective. The difference between these alternatives will be further developed (See Section 3 below).

Although few case studies focusing on the valuation of environmental health risks to children have been implemented, empirical evidence suggests that valuation differences may have a large impact on WTP estimates for reduced risks to children's health. These factors should be taken into account in order to obtain reliable estimates of health benefits used in political decision-making.

2. Elicitation of children's preferences

Which perspective to adopt?

While the relative value we are looking for is the measure of a change in social welfare associated with a risk reduction for children, different perspectives to obtain this value can be considered: that of society[4], that of children and that of parents. All three provide potentially valid avenues for research, but face their own unique challenges.

The elicitation of children's preferences raises a unique challenge and implicitly requires a trade-off between the benefits of a being as close as possible to the person affected (the perspective) and the costs of under or overestimation due to altruism, at the two extremes: either you adopt the closest perspective (i.e. consisting in asking directly children about their WTP to reduce a risk in their own health) in which you avoid any altruism effects, or you choose to adopt a much more distant perspective (i.e. in asking a sample representing the whole population) in which the presence of altruism will significantly affect the WTP estimates.

The theoretical measure of a change in social welfare is measured in aggregating the change in welfare of all individuals in the society. Societal perspective (i.e. asking a sample representing the whole population – all adults, both parents and non-parents) is the best perspective from a public policy point of view, but it is not appropriate for revealing children's preferences because of the difficulty in distinguishing between paternalistic and non-paternalistic altruism. Obtaining a WTP based upon responses from representatives of society as a whole would potentially present problems of double-counting due to altruism (Jones-Lee, 1991 and 1992). Therefore, given the substantial problems associated with altruism, an alternative perspective will have to be adopted from which to elicit children's preferences.

As a second best, welfare economics suggest that, in order to estimate the value of a reduction in a given health risk, the best-placed people to know the value they place in a reduction of their health risk are those who are directly affected by the considered health outcome[5]. Therefore, in the context of valuing a

[1] The perspective makes reference to the person from whom we should elicit values for reducing environmental health risks to children.

[2] Results are clearly mixed. Examples could include the following studies. On the one side, Johannesson and Johansson (1996) report age-differentiated WTP estimates obtained from a contingent valuation survey in Sweden. The results suggest that the WTP increases with age: on the standard basis, 8000 SEK for the 18-34 age group, 10000 SEK for the 35-51 age group and 11700 SEK for the 51-69 age group. Johannesson et al. (1997) also report a positive relationship between age and WTP. On the other side, Hammitt and Graham (1999) determine that WTP declines with age. Chilton et al. (2004) also report a negative relationship between WTP and age.

[3] The difficulties associated with potential altruism from parents, and more generally adults, toward children are examined below.

[4] With "society", we mean all adults in the population, i.e. parents and non-parents.

[5] Welfare economics rests on the assumption that decisions are made by rational individuals. The suggestion is that individuals are the best judges of the values they place on goods and services (Randall, 1987).

risk reduction to children, children should be directly asked about the value they place in a reduction of their health risk – referred to as "the children perspective". This approach would, however, clearly present difficulties in the case of children, as children have neither the cognitive capacities to have clearly defined preferences for health outcomes, nor the command over financial resources to make their preferences effective. As such, they could be considered as unreliable decision-makers. As a consequence, the basic tenets of welfare economics cannot reasonably be assumed to represent children. The children's perspective being inappropriate, another perspective has to be adopted. The natural alternative to children's perspective is the parental perspective, which consists in asking parents (or caregivers) about the value they place on their children's health.

The theoretical justification of the use of the parental perspective (or that of the caregiver) is based on various theoretical economic models, suggesting that parents' choice are the appropriate proxy for children's preferences and constitute a reliable source of information (Viscusi et al., 1987). As such, the few existing studies that have estimated a measure for a reduction in health risks to children have elicited parents' or caregivers' preferences. However, altruism remains a major concern, as for the societal perspective. Indeed, the WTP of parents may be significantly affected by altruism towards their own children as well as towards children in general. So, why is the parental perspective a better approach than the societal perspective? A first advantage of the parental perspective over the societal perspective is that it reveals preferences of individuals which are as close as possible to the population at risk – the children. Moreover, even though altruism is likely to be important in this approach, it is felt that the benefits associated with asking the persons who are actually directly affected by a reduction in the health risk of (their) children would outweigh the costs associated with a misestimation due to potential altruism.

Concerns related to altruism have encouraged the consideration of alternative parental perspectives. One of them requires adults to place themselves in the position of children, thinking back to their own childhood and the risks they were facing at that time. Although this approach allows for obtaining estimates of WTP for a risk reduction from "rational" individuals considering themselves (and not another member of their household), it makes the design of the questionnaire more complex and increases the cognitive burden of completing the questionnaire. Further research could help determine the usefulness and robustness of this approach[6].

Relatively to societal and children's perspective, the parental perspective has the advantage that literature is available – albeit sparse. A few of these studies have examined possible differences of values between adults and children, but their findings have been mixed. Some studies find that the value of children's health benefits is higher than those of adults (Lewis and Charny, 1989; Busschbach et al., 1993; Cropper et al., 1994; Liu et al., 2000; Dickie and Ulery, 2001). Other research has generated estimates of WTP for child and adult health that are similar (Blomquist, 2003; Mount et al., 2000). One study estimates the value of statistical life for a child that is lower than the value of a statistical life for an adult (Jenkins et al. 2001).

Moreover, these studies could potentially be affected by a number of limitations that suggest that careful, primary research must be undertaken in this line of inquiry. For example, in a recent study (Dickie and Gerking, 2003), the risk reduction for a child was valued by the parent within the same survey as a risk reduction for the parent. This may have created order biases in WTP, or have implicitly obliged respondent to report values for the child at least as large as those reported for himself/herself. In addition, this adds the issue that a third party is involved in the valuation. This is not the case with the adult-as-child perspective. However, there has been little research on this approach.

[6] For further details on various parental perspectives, see Dockins et al. (2002).

The choice of the perspective is crucial since different perspectives lead to different estimates of the health benefits. As an example, society and, to a greater extent, parents are known to be more risk averse to risks experienced by children than to those experienced by adults. Empirical studies[7] as well as programmes and policies undertaken in some countries[8] have highlighted that (i) health benefits to children should be considered separately from the general population and (ii) the willingness to protect children from environmental threats to a greater extent than protecting adults facing similar risks.

The choice of the perspective will probably also have methodological implications for valuation approaches (Hanemann, 2003; Nord, 2003). While several valuation techniques can be used to estimate the health benefits from a risk reduction, these are often based on economic considerations (i.e. stated preferences, revealed preferences) which are methodologically problematic for children. Therefore, changes in the conception of traditional economic valuation methodologies have to be made before being applied to the valuation of children's health.

And finally, there is also an endogeneity problem in distinguishing between public investments in programmes benefiting children, and the WTP for these programmes. Motivation for public investments in children may be due to direct benefits derived from children's future contribution to wealth production process but also to altruistic preferences. This raises issues associated with the inclusion of altruistic preferences in measures of social welfare.

Associated difficulties

Other issues related to the valuation of children's environmental health risks appear to be of high importance and require more attention from analysts. They include:

- Economic uncertainties: there may be good reasons to believe that there is greater inherent uncertainty in risk for children. For instance, while the general scientific understanding of the risks associated with exposure to pollutants is subject to a great deal of uncertainty, this may be particularly important when considering children's health. Uncertainty in general may be a greater problem for children. Knowing those uncertainties is important on the one hand because they have impacts on the significance and the validity of the values, and on the other hand, because they represent an important element in the decision-making process. This may significantly affect some of the traditional economic methodologies, as well as non-economic-based techniques of valuation of health.

- Assumptions about cognitive capacities: Some assumptions about cognitive capacities in the neo-classical theory are likely to be violated when considering children's health valuation. Therefore, the foundations of neo-classical theory may not be a good representation of children's decision-making. This generates problems, for instance, for the integration of WTP or COI estimates in the framework of a cost-benefit analysis.

- Autonomy of the decision-maker: Most important decisions concerning children are taken by their parents or their caregivers, and not by the children themselves. As noted, the few existing studies that have estimated a measure for a reduction in health risks to children have

[7] Examples include Lewis and Charny (1989), Cropper et al. (1994), Johannesson and Johansson (1997).

[8] Environmental policies that explicitly address children's health are limited at the moment. Most of them, implemented in the United-States, focus on specific substances. For example, in the Clean Air Act, standards for permissible levels of toxins in air should be set in order to protect "the most vulnerable members of society", i.e. mainly children. In addition, the Declaration of the Fourth Ministerial Conference on Environment and Health (WHO, 2004) is promising and more regulations specifically aimed at reducing environmental risks to children's health should be proposed in the following years.

elicited parents' preferences[9]. Unfortunately this parental perspective violates the theoretical assumption underpinning many methodologies that everyone is able to behave in a manner which is consistent with their perception of their own welfare. Thus, even when there are no assured problems of cognitive capacity, children are not always able to express their preferences through their own behaviour. This has serious implications for some valuation methodologies, and more generally for any study relying on a decision-maker.

- Issues associated with altruism and discounting: When parents are asked about children's health improvements, the obtained values reflect both parents' preferences to reduce risks towards their own children, and altruistic concerns for children more generally. The difficulty lies in estimating the degree and type of altruism in the values for the health of others. Some empirical studies have highlighted that altruism toward children may largely affect the WTP for reducing environmental health risks to children, which results in a greater VSL for children than for adults (Dickie and Gerking, 2003). In addition to differences in the valuation of the benefits, during the valuation exercise, it might be expected that people do not use the same discount rate when they are asked to value a reduced latent health risk for their own children, than when they are personally concerned (Dickie and Gerking, 2003).

There is little empirical evidence of the impacts of those problems on the valuation methodologies traditionally used to assess health benefits subsequent to a risk reduction. Some may have more serious consequences than others, but ignoring those issues could generate misleading values that should not be used within a cost-benefit (or cost-effectiveness) analysis framework.

The potential issues related with the valuation of health risks to children may not satisfy the main hypotheses of neo-classical consumer theory. In this case, we cannot rely on children's own evaluation of a change in their own welfare and we have to rely on the most sensible proxy: their parents or their caregivers. However, this implies a shift in the context of valuation: we move from an individual context toward a household context.

3. Household allocation models

Irrespective of the group from which children's preferences are elicited (whether the parents of the children or other caregivers, or other members of society), seeking to obtain values of WTP for a reduction in health risk to children does not take place in the traditional individual context (where someone is asked to state a WTP for his/her own risk reduction), but rather in a household (i.e. collective) context where someone (e.g. a parent) is asked to evaluate a risk reduction for another member of his/her household (e.g. his/her child). Accepting the parental WTP as a good proxy of the WTP for reducing health risks to children then raises the issue of how decisions are made within the household, thus necessitating the consideration of intra-household allocation. While all WTP studies (even for adults) should reflect the nature of household decision-making, since the risks which children face are due in part to decisions taken by their parents (or their caregivers), it is particularly important to account for the decision-making process within the household. Thus, the focus on children necessitates considering the individual as a member of a household and not as an autonomous actor, which complicates the modelling and the estimation of the WTP value.

[9] For more details on the difficulties associated with the use of the parental perspective, see Dickie and Gerking (2003).

Unitary and collective models

Two alternative models have been proposed in the economics of the household (Dickie and Gerking, 2003). The first class of model is the unitary model in which the household is treated as a unit: it has a single utility function, and decision-making is derived directly. It also assumes that the contribution of a particular member to household income does not matter: financial resources are pooled. This is the method applied in almost all existing studies of children's health because of its attractive assumptions and ease of application (the single utility function implies the household WTP is a relevant measure of welfare). The alternative class proposes collective models in which the individual utility functions of each household member (at least the adults) are pooled to obtain a collective decision, taking account of the differences in household members' preferences. The household decisions are modelled as the outcome of a bargaining process (cooperative or non-cooperative), or as Pareto-efficient allocation of resources (Chiappori, 1988). It also includes models where each spouse is responsible for decisions and expenditures on different goods (separate sphere models)[10].

These two types of household allocation models differ in two criteria: whether children are treated as independent decision makers, and whether the family is assumed to maximise a single utility function. Generally, children are passive participants in family decision-making. However, alternative approaches that could fit better this particular context should also be considered and examined[11].

Associated difficulties

Some difficulties are associated with using intra-household allocation models to derive parents' WTP to reduce a given health risk to their children. They include the fundamental choice of the type of model (unitary or collective) and the influence of household-related factors on the WTP.

Choice of the model: unitary or collective?

The choice of the model is practically important since different environmental-health impacts can have very different implications for household decision-making and will therefore necessitate the use of one particular model (for example the unitary model) instead of another (the collective model). For instance, a recent study has looked at the valuation of the health impacts of environmental tobacco smoke for children (Agee and Crocker, 2001). This is clearly a good example of the need to introduce and understand intra-household externalities. In this case, the utility of some household members (for instance, the parents/adults) enter the health function of the other members of the household (the children). A collective approach appears to be a good way to examine the problem, since in this case, the household could not be considered as one decision-maker. The intra-household allocation model applied will have a significant impact on the WTP estimated.

The degree of rivalry of the good within the household could also influence the choice of the model of intra-household decision-making applied. Let's consider the example of lead – contained either in wall paint or in water pipes. The lead level contained in wall paint clearly refers to a pure public bad at the household level. In this case, both models would *a priori* lead to similar results since household could be considered as one decision-maker. On the contrary, lead contained in water pipes is potentially excludable insofar as there is a private substitute good (bottled water). Some (or all) household members can thus protect themselves from adverse health impacts through personal behaviour. In this case, the choice of the household allocation model is crucial and will affect WTP estimates. In other words, the degree of

[10] For further details on unitary and collective models, see Dickie and Gerking (2003).

[11] For further details, see Dickie and Gerking (2003).

excludability may affect the appropriateness of the choice of household model, and unitary and collective models would lead to different WTP estimates.

Finally, the choice of the parental perspective may also introduce additional uncertainty in the valuation exercise. As pointed out by Hoffmann et al. (2003), there is also uncertainty about how to measure parents' benefits and about the appropriate way to model parents' benefits from children's health. The parental perspective appears as a commonsense solution, since they are personally affected in many ways when their children are ill, bearing both the tangible and intangible costs of illness. However, we do not precisely know what lies behind the parents' preferences and empirical evidence highlights preference differences within the household, i.e. mothers are more risk averse than fathers and thus more willing to pay to reduce health risks to their children (Scapecchi, 2003). Moreover, there is significant heterogeneity in the way that households structure resource allocation among the members. All these considerations may suggest that the household allocation unitary model may not be appropriate to formulate children's preferences. Further work is required to provide clear recommendations on the most appropriate household model – when the parental perspective is adopted to elicit children's preferences.

Thus factors such as the presence of intra-household externalities, the degree of excludability, and the degree of intra-household rivalry are also key factors, in which the nature of household decision-making assumed is likely to have important effects on the results. Depending upon the degree to which an impact is "public" within the household and the extent to which externalities arise, the choice of household allocation model applied can have significant consequences for estimates obtained.

Influence of household-related factors

As parents appear to be the most relevant third party to value children's health, several factors associated with that particular context may affect children's health estimates.

Some factors related to the household structure and composition, such as age structure, presence or absence of the father, may be of high importance. Differences within and between households exist and may be associated with age, gender or health status of the child. Finally, as most studies are based upon the parental perspective, altruism from parents toward their children may significantly affect the estimates and be a source of disparity between adults' values and children's values. The main empirical results suggest that parents may value their children's health more highly than their own[12].

There are empirical similarities among the few economic studies that have considered the valuation of children's health (Dickie and Gerking, 2003). First, the family structure and composition affect resource allocation and health outcomes experienced. Second, parents do not equally treat the health of all family members, but instead may allocate resources differently according to health status, gender or age. These results suggest that applying a unique value for all children would lead to unreliable estimates of children's health.

In addition, double-counting issues could arise when using the parental perspective. As suggested by Hoffmann et al. (2003), children's preferences may likely already be included in parents' preferences through non-paternalistic altruism. This may have serious consequences on the selection of efficient policies designed to reduce health risks for the whole population (i.e. adults and children). In this context, it is recommended to aggregate the WTP for a risk reduction of all individuals in society, i.e. aggregate the WTP for adults and the WTP for children. However, if the WTP for adults already includes a WTP for children, then this could lead to double-counting and thus to an overestimation of the health benefits of the policy. In contrast, assuming that the WTP of parents includes the WTP for children, considering solely the

[12] For further details and a review of this literature, see Scapecchi (2003).

WTP for adults as a proxy of WTP for children could lead to an underestimation of the health benefits for children[13].

4. Valuation methodologies

Very few economic studies have considered the valuation of environmental health risks to children. However, *some* empirical evidence set in the adult-related literature highlights the valuation of health benefits associated with environmental risk reductions for children.

Based on the adult valuation literature, two types of approaches are commonly used to capture the benefit of policy interventions aimed at reducing environmental impacts on health[14]. The first one is the traditional economic framework of cost-benefit analysis (CBA), based on economic consumer theory, which can provide a monetary measure of the efficiency of a given policy/programme/intervention, and the multi-criteria analysis (MCA)[15] framework which relies on non-monetary considerations to provide information about the cost-efficiency of a given policy/programme/intervention.

The overall advantage of monetary valuation and of CBA on MCA and CEA is that it allows costs and benefits to be compared in the same unit of measure (a monetary unit) within a theoretical-founded framework. It is then possible to compare across different policies, to evaluate whether a given policy is economically efficient and to state which one is the most efficient, in order to implement it. In contrast, CEA does not allow for the assignment of a monetary value to health improvements: different health effects are assessed in the same unit of measure (a HRQOL measure) but not in monetary terms. As a consequence, costs and benefits are not commensurable. Therefore, one cannot know from the obtained values whether or not the health benefits related to an intervention exceed the corresponding costs. Since none of those multi-criteria techniques estimate the net benefits of a public policy, they cannot identify an economically efficient policy. CEA can only state which policy is the most cost-effective, i.e. which policy can achieve the objective (find a treatment for a given health problem) at least costs.

Another difference between CEA and CBA is that CEA provides useful information on the relative values of reducing risk but it does not address the question whether a particular risk reduction is worth its costs, while CBA allows for the estimation of the economic value of reduced health risk benefits[16].

A brief presentation of the valuation methodologies associated with each framework is proposed in what follows.

Monetary valuation[17]

Two economic approaches are commonly used to measure a change in utility, e.g. in estimating the willingness to pay for a reduction in the mortality risk: the techniques based on revealed preferences and those based on stated preferences.

[13] Another issue being how to assess the value of the WTP for children included in the WTP for parents.

[14] For further details, see Scapecchi (2003) and Hammitt (2003).

[15] Alternatives to CBA include cost-effectiveness analysis (CEA), risk-risk analysis and health-health analysis. For further details, see Kuchler and Golan (1999).

[16] For further details on the disparities between CBA and CEA, readers are referred to Dolan and Edlin (2002), Hubbell (2002), Brent (2003) and Hammitt (2003).

[17] For further details on monetary valuation, readers are referred to Pearce et al. (2005).

Revealed-preferences techniques

Revealed preference studies rely on actual behaviour, analysing the trade-offs people actually make. They could include compensating wage studies, consumer behaviour studies, and hedonic pricing approaches. They rely on the assumption that individuals know exactly the risks implied by their choices of residential location, occupation, automobile, and use of risk-reducing products. They include the hedonic method, based on the underlying idea that goods are characterised by a set of attributes, and that utility comes from the value of each attribute.

Averting behaviour models (ABM), particularly associated with safety product markets, use existing data on risk reducing behaviours or on actions taken to mitigate the effects of exposure to a given health risk to determine the individual WTP for a reduction in the specified risk. Individuals' consumption choices associated with products of different safety attributes and different prices reveal the value individuals place on avoiding some bad outcome, a proxy of the WTP to avoid this outcome. In other words, health-related (directly or indirectly) consumption choices reveal the value people place in their own health or in the health of other members of the household (e.g. their children). Ultimately, the perspective underlying ABM is that of the parent. In the context of the valuation of environmental health risks to children, one must rely on risk reducing actions/behaviours parents make on behalf of their children. Three modelling approaches have been developed to incorporate these decisions: the household production model, the intra-household allocation model, and the safety product market models[18].

Cost-of-illness (COI) measure can be associated with revealed preference techniques, though it does not rely on the same assumptions and principles. The method consists in accounting for the different expenditures caused by a health-specific damage. In its most elaborate form, this method takes account for all the direct costs related to a specific illness, i.e. the direct components of the health costs (such as cost of treatment, cost of consulting, cost of hospitalisation, cost of death…) and usually the associated productive losses as well. However, COI measures do not take account of all the intangible costs associated with ill health or death, such as pain and suffering (from the ill person as well as from his/her relatives). The COI approach does not involve the estimation of the WTP to avoid illness or to reduce health risk. It only accounts for direct economic impacts, such as medical costs and productive loss associated with being ill[19]. COI measures do not take into account the change and the loss of utility related to ill health. On the contrary, revealed preference methods (and stated preference techniques as well, as we will discuss below) capture the full impact of ill health by measuring the WTP for a reduction in the health risk. In this context, the COI approach underestimates the full social costs of ill health and for this reason, COI measures are sometimes considered as the lower bound of WTP estimates. Thus, WTP values are thought to be better estimates of the health benefits associated with a reduction in a given health risk, and are most widely used in the context of valuation of health benefits.

Stated-preferences techniques

Stated preference studies[20] attempt to elicit trade-offs individuals make between health and wealth by presenting them with hypothetical choices, thus gathering their preferences. In a stated preference study, people are asked to state decisions they would take under hypothetical circumstances. In principle, they can be designed to cater to any population and any risk of interest. They include the contingent valuation

[18] For further details, see Agee and Crocker (2002).

[19] The COI approach is usually classified with the human capital approach since it can be considered as measuring the loss in productivity associated with ill health.

[20] See Bateman et al. (2002) for a recent review.

method, which has undergone extensive development and now has several variants, such as choice modelling.

The contingent valuation method (CVM) usually involves the *ex ante* valuation of individual variation of welfare related to the variation of the status of individuals exposed to a particular health risk. It consists in presenting people with a hypothetical scenario (*via* telephone, postal or in person survey), and asking them about their maximum WTP to compensate for a variation in their well-being. It estimates WTP values for a reduction in health risk, or analogously, willingness-to-accept (WTA) values for an increase of health risk[21]. This information then allows for the construction of monetary indicators on the value people attribute to different elements of their health or to any good having no market price *per se* (pain, suffering, time loss etc.). Despite underlying biases[22], the CVM is the method most frequently used to value non-market goods, in particular health benefits associated with an environmental degradation or pollution.

Choice modelling (CM) has been developed as a response to the problems of CVM, particularly in the context of environmental policy. CM is composed by a set of SP techniques that includes: choice experiments; contingent ranking; contingent rating; and, paired comparisons. CM is based on the idea that any good can be described in terms of its attributes, or characteristics, and the levels that these take. For example, a river can be described in terms of the chemical composition of the water, the quality and quantity of biodiversity, and the appearance of the water. By changing attribute levels, CM allows for the determination of the value of such changes in attributes, i.e. the WTP for each attribute. By including price (or cost) in the attributes list of the good, WTP can be indirectly recovered from individual rankings, ratings or choices.

As CVM, CM is based on hypothetical surveys and can measure all forms of value, including non-use values. The main difference between CVM and CM is that CM WTP values are relative while CV WTP values are absolute. Empirically, CM has been formerly widely used in the market research and the transport literatures (where it is referred to as "conjoint analysis"), and has been recently applied to other fields such as the environment.

Preference scales

The non-economic methodologies are based upon non-economic and non-monetary considerations. There are five main methodologies for measuring individual's quality of life, distinguished by the manner in which they are derived: the generic health utility scales, such as the Health Utility Index Mark III (Furlong et al., 1998); the rating scale or visual analog scale (also referred to as the feeling thermometer); the standard gamble; the time trade-off measurement; and, the person trade-off methodology.

The most common measure – referred to as health-related quality of life (HRQOL) measures[23] – yielded by those methods is the Quality-Adjusted Life Year (QALY), represented by an ordinal or interval-scale measure for various health states. In general, the QALY index assigns numeric values to various health states so that morbidity effects (such as severity and types of illness) can be combined with mortality effects (or likelihood of death) to develop an aggregated measure of health outcomes. Death is represented by a score of zero, whereas perfect health is represented by a score of one. QALYs are based on multiplying the duration of a health state by a score reflecting the quality of a health state. Life years are

[21] In practice, WTA measures are rarely used, particularly in the health context, because they do not have an upper limit: WTA values can be extremely large, while more reasonable values can be obtained through the WTP approach.

[22] For further details, see Mitchell and Carson (1989) and Hausmann (1993).

[23] For further details on preference scales and HRQOL measures, see Chapter Nord (2003).

generally treated equally for all individuals, so a single healthy year is weighted the same regardless of age or income.

QALYs can be applied to the analysis of public interventions in a cost-utility analysis framework in order to determine the most effective option within a given set of alternatives. QALYs can also be converted . to dollars (referred to as "value of QALY changes"), generally using a single $/QALY factor and then can be integrated either in a cost-benefit analysis framework to calculate net benefits, or in cost-utility analysis framework to calculate cost-utility ratios. However, the values used in such studies are based upon very limited evidence. There are very few studies which have attempted to develop estimates of the monetary value of a QALY (Mauskopf and French, 1991; Gyrd-Hansen, 2003) for conducting cost-benefit analysis. The requirements needed for meaningful $/QALY conversions are very restrictive, and the simplistic conversions that are often used (e.g., from the value-of-life-year or value of statistical life year) are inconsistent with welfare economics. Thus, further research is required to better appreciate the usefulness of such an approach.

Comparison of methodologies

Valuations obtained from economic valuation methods are likely to differ from non-monetary estimates of children's health given the differences between those two approaches in terms of theoretical foundations. The comparison between economic and non-economic measures of health outcomes constitutes a major element of the assessment of the merits of those respective approaches and could significantly contribute to the recommendations on the valuation of environmental health risks to children.

Revealed-preference vs. stated-preference techniques

Revealed-preference (RP) and stated-preference (SP) techniques allow for the estimation of the WTP for a reduction in a specified (health) risk. However, each has advantages and drawbacks in comparison with the other. On the one hand, RP methods are based on the observation of actual choices and thus need a large number of observations, as well as well documented and (rather) exhaustive information. Data are thus difficult to collect and to validate. Moreover, RP models may require the definition of the choice set. Finally, correlation problems often arise between time and cost, two important characteristics of the models used in RP methods.

On the other hand, SP techniques also require a large number of observations to get reliable results[24]. However, as SP techniques do not rely on actual choices, they can be used in contexts in which it is not possible to observe real behaviours either for lack of data or because the alternative to be analysed is not yet used or available for use. Therefore, SP methods can design a market for non-marketed goods instead of relying on "proxy" markets. Moreover, SP techniques – more particularly contingent valuation surveys – are (relatively) easier to implement and computations needed to estimate the WTP are (relatively) less time-consuming than when applying a HP model or an ABM model.

Hanemann (2003) proposes a comparison of stated-preference techniques and revealed-preference techniques used to derive individual WTP. When examining the links between the natural environment and public health, revealed preference methodologies may derive only lower-bound estimates on WTP. If environmental factors enter directly into the household's utility function, and not just indirectly through the marketed good which is being examined, the direct loss of utility will go unaccounted for in the estimation of WTP. Since many types of environmental impact will have both direct and indirect effects on utility this

[24] It is often recommended to have a sample of 1,000 observations as a minimum (see Mitchell and Carson, 1989, for more details on the design of a contingent valuation survey).

is important. This leads to the conclusion that, when the household production model is employed, it is difficult to estimate valid and useful welfare measures for changes in environmental quality, based solely on the estimation of the health production function without also estimating the household's preferences, especially if environmental quality enters the household utility function directly. As such, the stated-preference techniques appear as more appropriate than the revealed-preferences techniques when valuing health risks, whether they concern adults or children (Hanemann, 2003).

However, traditional economic valuation methodologies are rarely used in health economics. Analysts in this field tend to prefer using health-related quality of life measures (HRQOL) instead of traditional WTP measures. Given the increasing use and demand at the policy making level of these non-monetary measures, a comparison of the various approaches is necessary in order to assess the most appropriate approach.

Comparison of health-related quality of life measures

Health-related quality of life (HRQOL) measures are used in a cost-effectiveness analysis framework. Because of their apparent simplicity and ease of implementation, those measures could appear as a good alternative to traditional WTP estimates. In Chapter IX, Nord reports on these measures and associated non-monetary valuation techniques in the context of children's health valuation in order to assess the different methodologies. Empirical studies tend to show that QALY values obtained from parents and children differ significantly. This suggests that when valuing children's health outcomes using QALYs, children should be asked directly. Otherwise, substantial underestimates of QALYs could arise. Empirical evidence (Apajasalo et al., 1996a and 1996b) tends to justify this assertion in showing that children older than 8 are able to answer multi-attribute utility questionnaires or complete visual analogue scales[25].

The main problem with the HRQOL measures is related to the validity of the value obtained. The weight used in health-related quality of life measures often represents the *ex ante* judgement of people in good health[26], which may explain why low scores are often attributed for moderate states of illness. However, this raises the question of precisely what disutility of that specific health state is being assessed. The weights do not allow for the determination of priorities between different groups, i.e. between adults and children. Confounding factors should also be taken into account because they can have serious consequences on the values attributed to a given health impact.

Further research is therefore required in order to assess the internal and external validity of non-monetary approaches and HRQOL measures when valuing children's health. According to Nord (2003), comparable results (i.e. QALYs measures) would be obtained if parents and children were asked the same questions. Then, combining these values with the WTP estimates of parents could provide sound estimates of the social value of a risk reduction for children. However, limited cognitive capacities and little control over financial resources may restrict the number of cases where it could be done.

To summarise, two types of measure can be used when valuing health benefits subsequent to (environmental) risk reduction: WTP and QALYs. The case of children is, as we have seen, more complex than the adult context. Empirical evidence is limited and is not able at the moment to recommend one approach instead of another. Therefore, a theoretical comparison of those two measures of welfare (WTP

[25] For children of 8 years of age, support is, nonetheless, necessary to help children correctly understand the questionnaire and to formulate sensible answers.

[26] "Community preferences" have been recommended to derive the weights used in health-related quality of life measures (Gold et al., 1996), i.e. preferences of people generally in good health, thus *ex ante* judgements. However, these weights can – of course – be elicited from any subgroup of the population.

and QALYs) could provide a good starting point in order to know which approach would be the most appropriate when assessing the social value of a reduction in risk to children.

WTP vs. QALYS

Hammitt (2003) analyses the differences between QALYs and WTP values. On the one hand, QALYs impose restrictions on the structure of individual preferences and depend only on health[27]. They also rely on several conditions, which are quite plausible but frequently violated at the individual level. On the other hand, WTP impose less restrictions on the structure of individual preferences than QALYs, but they are much more sensitive to the individual's state of mind. WTP can also incorporate other effects, including issues such as the degree of voluntariness of risk exposure.

In addition, WTP and QALYs do not represent the same type of preferences. When QALYs are determined, people are asked to consider the best treatment for affected people (i.e. for people in general, not specifically for them). In this context, QALY measures represent social preferences. However, when WTP are assessed, people are asked to evaluate a reduction of their own health risk. In this context, WTP represent individual preferences.

The comparison of WTP and QALYs does not depend on the context of valuation. With children, the perspective issues are similar. Therefore, any standard chosen is arbitrary, and the use of an approach instead of another will only depend on the setting. Any approach has pros and cons. For example, in practice, the same WTP values are often used whether it concerns a child or an adult, although large disparities exist between those populations. Concerning QALYs, the assumption of neutral risk aversion over life-span is not empirically verified, which may undermine this approach (Hammitt, 2003).

However, the non-comparability between WTP and QALY values at the aggregate level does not necessarily mean that the two methodologies cannot produce mutually consistent results for the relative importance of different factors within the health context. As such it is important to examine how the two methodologies address important issues associated with the valuation of children's health, such as age, latency, the choice of perspective, etc.

5. Difficulties related to age, latency and discounting

A number of issues when valuing children's health have been identified. They include difficulties related to age, latency and discounting. They affect the valuation of adults' health but it is reasonable to expect these concerns to be greater when considering the case of children given the differences between adults and children.

Age

Empirical evidence from the literature related to adults' health valuation highlights the large influence of age on WTP values: young adults do not have the same WTP values to reduce fatal risks than middle-aged or older adults (Johannesson et al., 1997). Therefore, we could in general reasonably expect that age would matter more for children relative to adults. Empirical evidence is mixed but many economic studies based on a unitary household allocation model have found that the VSL for children is at least as great as the VSL for adults (Scapecchi, 2003; Dickie and Gerking, 2003). Further research would be necessary to better understand how the VSL differs with the characteristics of individuals.

[27] With the QALY measures, there are no trade-offs between health and the other goods.

Empirical evidence from recent studies is mixed: while Johannesson et al. (1997), and Persson et al. (2001) report results compatible with the inverted-U relationship theory[28], Krupnick et al. (2002) and Alberini et al. (2004), in studies in the US and Canada, find that WTP is lower only for persons of 70 years of age and older. Without further documentation there is no reason to believe that older persons should be willing to pay less for a reduction in their own risk of dying.

Latency

Many environmental health risks involve a time lag between exposure and the onset of illness or death. For example, exposure to some heavy metals and chemicals (especially in childhood) are known to result in health impairments later in life. A reduction in exposure today, therefore, would result in risk reductions to be experienced later in life. This implies that, in order to value the benefits of policies that, if implemented today, would reduce future risks, it is necessary to ask people to report their WTP now for a risk reduction to be experienced in the future.

For environmental exposures which do not have immediate health consequences, life expectancy of the affected population is clearly an important factor in the determination of the perceived value of policy interventions. Thus, children are more likely to have adverse health consequences arising from equivalent exposures (even if equally susceptible), and these differences increase with the length of latency. Therefore, latency is a major concern for the valuation of environmental health risks to children, because of their particular vulnerability to environmental pollutants and given the longer lifespan of children.

Trade-off decisions that involve latent health effects may be influenced by the perceptions of future health states and preferences, which increases the uncertainty associated with the valuation of children's health. Since health risks to children are not as well understood as those to adults, it is likely that latency issues will be more uncertain for children than for adults (Hoffmann et al., Chapter VI). Also the fact that there is more lifespan over which latent impacts can be realised increases the value of preventing exposure. As an example, there is a higher probability that the impacts of a disease with a 20-year latency period will be realised if a 10 year-old is exposed to a toxic hazard than if a 70 year-old is exposed.

An important determinant of the value of reducing future risks is that there is a chance of dying before the impact of exposure. For example, if a latent impact were uniform across the whole population, with a lag of 20 years, then approximately 25 percent of those affected would die before the damage became evident (Cropper and Portney, 1990). This adds complexity when taking account for latency effects on the valuation of children's health.

In practice, revealed preference approaches do not lend themselves easily to estimating WTP for future risk reductions[29], suggesting that empirical work in this area should employ stated preference methods. Despite the importance of this matter, very little empirical work has been conducted thus far to tackle the issue of latency. Notable exceptions are Johannesson et al. (1997), Alberini et al. (2003), Alberini et al. (2004) for the US and Canada, Krupnick et al. (1999) for Japan, Markandya et al. (2004) and Chilton et al. (2004) for the UK.

[28] Shepard and Zeckhauser (1981) consider the life cycle model and show that, under certain assumptions, the relationship between WTP and age could be modelled as an inverted-U relationship that peaks when the individual is 50 years old.

[29] The applicability of revealed preference techniques to estimate WTP for future risk reductions depends upon the nature of the relationship between the product under consideration and the impact which is to be valued. Examples could include purchases of bottled water (e.g. water quality) or organic foods (e.g. pesticide residues) protect against future (latent) risk reductions.

Discounting

Discounting practices are particularly important when health effects are long-lived such as those concerning children.

The main difficulty in discounting is the determination of the appropriate discount rate. Health gains are generally valued not in monetary terms but rather in "physical" terms (number of years of life gained or QALYs gained). When costs and benefits are valued in monetary terms, a common rate can be used. Otherwise, it is of general practice to discount benefits at a lower rate than that of costs[30].

In a context of discounting children's health, another difficulty makes the task more complex. The theory suggests eliciting preferences from those directly affected by the risk reductions being valued. However, as children's preferences are excluded, we must make recourse to the preferences of adults, possibly the parents of the child in question. But it is not known whether parents discount their own future health benefits at the same rate as they discount future health benefits to their children. Elicitation of time preference over future health events from adults is challenging because of the unfamiliarity with this sort of decision making, the uncertainty associated with future health events, the cognitively demanding task and the meaning of the description of future health events (Cairns, 2003).

Regarding the discount rate, it has been argued that individuals' discount rate will generally be low in the case of a mortality risk as the future disutility of a future risk of death will be fairly constant (Cropper and Portney, 1990). Moore and Viscusi (1990) use wage-risk tradeoffs from the labour market to infer that individuals make employment choices consistent with discount rates that range between 1 and 14 percent. Horowitz and Carson (1990) estimate the discount rate from discrete choice questions that ask individuals to choose between programs that save lives in the future at a cost. The median discount rate is estimated to be 4.5 percent, and a sizable fraction of the sample is found to have a very low discount rate. Alberini et al. (2003), and Markandya et al. (2004) use WTP data reported by individuals in a series of CV surveys conducted in Canada, the US, the UK, Italy and France to estimate the implicit discount rate exhibited by individuals for future risk reductions, finding that such discount rate vary across the studies, ranging from 4.5 percent (the US) to 10 percent (the UK) [31].

It is of common practice to use a constant discount rate over time and across individuals. However, results from recent empirical studies suggest this may not the case: non-constant discount rates and more generally hyperbolic discounting appears as a better model than traditional exponential discounting, which is the standard method in use applying a discount rate that is constant over time (Wietzman, 2001). This also supports direct estimation of discount rates (implicit in WTP values for future risk reduction), supplemented by sensitivity analysis to identify determinants of these discount rates, including age, gender, income, education and other individual characteristics. However, the practical validity of hyperbolic discounting is very much in question given time inconsistency problems[32].

As discussed in Cairns (2003), time preferences over future health states are difficult to elicit from adults, and this is even more challenging in the children's health context given the lack of empirical studies dealing with discounting children's health benefits. A less than satisfactory possibility would consist in

[30] For more details, see Cairns (2003), Department of Health (1996) and National Institute for Clinical Excellence (2001).

[31] These figures do not converge with estimates of discount rates based on surveys and laboratory experiments. For example, Harrison et al. (2002) estimate the discount rate for money to be 28% in a field experiment in Denmark, while Warner and Pleeter (2001) peg the individual discount rates for US military personnel between 10% (for officers) and 54% (for enlists).

[32] For further details, see Cairns (2003).

using the age-discount rate relationship defined over adult populations and apply it to younger age groups to predict discount rates.

Issues, policy implications and recommendations

The impacts of environment on human health have been at the core of economic valuation for the last twenty years. Recently, the focus has shifted to children, and interest in children's environmental health outcomes is increasing. Children are particularly vulnerable to the impact of environmental degradation and/or pollution. However, evidence is still rather limited. In order to reduce environmental risks to children, a better understanding of the major threats, challenges and opportunities that exist in the field of children's health and the environment is required.

Issues associated with the valuation of children's health

As noted above, empirical evidence on the valuation of children's health is limited. Experience from the valuation of adults' health provides significant valuable inputs on how to evaluate children's health. However, a number of specific questions need to be further examined and addressed in order to obtain reliable estimates of health benefits for children. Methodological and data issues are of particular importance and are analysed in what follows.

Methodological issues

An important conclusion from the previous chapters is that children differ from adults in terms of risk and in terms of valuation. Children are neither little adults nor little consumers. Ignoring those differences could lead to biased estimates of health benefits associated with a reduction of environmental risk and therefore to inefficient health/environmental policies. As an example, according to economic studies estimating parental WTP to reduce health risks to their children, mortality and morbidity risk reductions greatly differ. Morbidity and mortality risk reductions should therefore be estimated in a consistent way if policy makers want to be informed about the efficiency of the actual resources allocation between these components from the health field. In order to be able to correctly compare children and adults values of health benefits, estimates should be obtained from a consistent way of valuation.

The literature on the valuation of adults' health is extensive. Given risk differences between adults and children, whether it be in terms of exposure or in terms of dose-response, we can reasonably expect large disparities in estimates of health benefits associated with a given risk reduction between adults and children. The valuation of children's health poses unique challenges to economists. The main difficulties identified relate to differences in age, in risk preferences, in context of valuation and in perspective.

The choice of the perspective is a major concern when valuing children's health. The WTP for environmental health risk reductions cannot be directly elicited from children because of children's limited cognitive abilities, and little or no control over money. As such, they are not reliable decision-makers and it is necessary to rely on proxy perspectives. Commonsense suggests choosing their parents. However, this generates additional difficulties, mainly altruism, and may violate the assumptions made by the economic theory of consumer. For instance, empirical results suggest that parents may value their children's health more highly (twice) than their own. Moreover, we do not precisely what lies behind the parent's WTP: this value may also include the WTP for a risk reduction in their own health. Nevertheless, in the absence of strong evidence, the parental perspective appears as the (second) best solution, even though it may introduce biases.

Another important point concerns the valuation methodology. Empirical evidence is limited and the question of what method is the most appropriate remains open. The contingent valuation method (or other stated preferences techniques) is commonly used to get WTP measures, despite underlying biases.

Empirical studies have shown that estimates obtained from economic valuation methods are likely to differ from non-monetary estimates of children's health, given the differences between those two approaches in terms of theoretical foundations. Standard economic valuation techniques are adapted to measure parents' and/or individuals value (WTP or QALYs) for reducing health risks to children in a household setting. A related question focuses on the choice of the measure of outcomes. When valuing health benefits associated with a risk reduction, different measures may be used, whether it be for mortality risk reduction or morbidity risk reduction. Recent studies seem to indicate that VSL is relevant for acute deaths and for latent deaths while VOLY is relevant for chronic health effects[33].

Data issues

The second type of issues associated with the valuation of children's health is related to the lack of available data. Values for children's environmental health outcomes are not available: there is little information on environment-related health impacts that are unique to children, such as foetal loss and developmental disorders. A few health endpoints have been identified and estimates of a great number of health outcomes relative either to mortality or morbidity are not available. From a more practical point of view, more data are necessary, and more particularly data on specific health endpoints, such as chronic morbidity risk, asthma morbidity and inference of a child's environment-related VSL, as it has been made for adults. Taking account for the latency/delay between exposure and illnesses would also highlight the work on long term effects of environment degradation on health. The lack of data precludes an evaluation of the efficiency of existing environment-related health policies. Therefore**, priority should be given to the collection and measure of epidemiological data to implement strongly founded economic valuation studies to provide efficient policy advice.**

In the meantime, decisions concerning the design and reform of existing policies to reduce risks to children have still to be made. Therefore, in order to examine the economic efficiency of policies aimed at reducing children's health impacts, analysts often have to transfer the results from studies valuing health impacts for adults to children. The problem with the benefit transfer approach is that results may be used (or misused) for different purposes than those originally envisaged. For example, WTP values may be estimated by transferring results from studies or other effects or of other population groups, sometimes by using a "context" factor in order to take into account the difference in the contexts of valuation. In the context of children's health valuation, it has been proposed to adjust adults' values with a factor referred to as the "marginal rate of substitution" (MRS) between child's and adult's health. However, transferring values for adults to children do not appear to be appropriate unless careful and appropriate adjustment of those values by the right MRS is done. As a consequence, it is necessary to estimate MRS between children's and adults' health for multiple endpoints in order to better understand how it varies systematically. This requires additional economic studies.

Key policy issues

Public decision makers require estimates of the effects of policy interventions on social welfare in order to implement new policies or reforms. To quantify the health benefits of environmental policies, estimates of the reduced probability of illness or death are generally required. For that purpose, economic valuation has become a central tool and empirical studies have stressed the need for a better understanding of how to value the environmental health risks faced by children. However, we need to better understand the major threats, challenges and opportunities that exist in the field of children's health and the environment.

[33] For empirical evidence, see Markandya et al. (2004) and Chilton et al. (2004). For further details, see Pearce et al., forthcoming.

The paucity of research in this area, and the conflicting results from what is available, leaves little guidance for policy makers on how to value health risks to children. Due to the lack of empirical research on VSL, most economic analyses rely on adult VSL for children's health effects. However, in the absence of reliable estimates of children's health, inappropriate policy decisions could be undertaken. On the one hand, ignoring risk differences between adults and children could lead to setting wrong standards, concerning for example the maximum allowable level of air pollution emissions. On the other hand, ignoring the valuation differences between adults and children could lead to wrong policy priorities being set within the health and environment fields, which, in the long run, could generate an important social welfare loss.

Policymakers have been forced to make decisions and set priorities on the basis of very limited evidence and limited information. As noted above, children are different from adults. This raises a question on the validity of the policy strategies/actions/instruments/targets currently in place: do they reflect the differences between adults and children? Are they (still) appropriate? Three related "policy failures" can be identified:

- Standards that are set in many countries for specific environmental impacts (i.e. air pollution concentrations) are based on their impacts on adults, which are often quite different from those for children. Proper valuation of impacts on children would result in standards which are different, often (but not always) more stringent.

- Policy priorities across different environmental health impacts are based on adult responses, and so are often inappropriate for children. Governments are often not allocating investments so as to avoid loss of lives or accidents in an optimal manner.

- The allocation of resources between the environmental (ex ante) and the health (ex post) fields may be imbalanced – with too much focus on cleaning up the health concerns generated by environmental problems, rather than on preventing the environmental problems in the first place.

Existing evidence seems to indicate that the resources devoted toward children's health are too low, or at least imbalanced. This could come from two separate aspects: the lack of data (as previously mentioned) or the lack of co-ordination between the environment and health spheres in terms of valuation methodologies. The disparities between the frameworks used in those two fields explain the differences in the estimates, and therefore lack of co-ordination between the environmental and the health policies. In order to obtain sound estimates in both valuation fields, it would be useful to harmonise the valuation process. The analysis of potential co-ordination of those policies, based upon theoretical and empirical findings, would constitute a major input in the valuation of environment-related health risks, more particularly for children. Providing recommendations on a potential manner of methodological harmonisation and policy co-ordination (to obtain sound estimates in both fields and provide more efficient policy advice) would help bridging the gap between environmental and health professionals and ministries; researchers and practitioners; and the general public.

The growing concern for children's health-related issues has encouraged the implementation of a great deal of studies in the United-States as well as in Europe, most of them funded by government or public agencies (such as the United States Environmental Protection Agency (US EPA)[34], the European Commission (EC), etc.) and important international organisations. For example, in Europe, the Pan

[34] See also US EPA (2003).

European Programme (PEP)[35], gathering five European countries (Austria, France, Malta, the Netherlands, Sweden and Switzerland), has been carried out in order to assess the transport-related health impacts and their costs and benefits, with a special emphasis on children, the objective being to contribute to the development of WHO-Guidelines for the economic valuation of transport related health effects. In the United-States, the U.S. Environment Protection Agency (US EPA) has funded a great deal of empirical studies related the valuation of environmental health risks to children. Examples include undertaking surveys to measure the WTP to avoid asthma incidence or to avoid skin cancer for oneself, children and the population as a whole, as well as work on the transfer of adults' values to children's values. A great number of new empirical projects related to children's health focus on latency issues, supporting the importance and relevance of this issue on the valuation of children's health.

While there are specific children's environmental health concerns by country, there are also key global risk factors. A good example is asthma which represents the health impact that has been mostly considered in epidemiological studies and that concerns a great number of OECD Member countries, as well as non member countries. The WHO has implemented cost-effectiveness analyses of interventions that address environmental risk factors. But concerted international efforts are essential to coordinate the resources and needs of the different countries.

All these projects are promising and will probably contribute a great deal to a better understanding of how to correctly value the benefits associated with a reduction of environmental health risks experienced by children. Then, economists could inform policymakers about the environment and health policies they should implement in order to reduce such risks to children. However, the literature on valuation of adults' health highlights risk differences between countries, social and ethnic groups. Given the lack of available data, no such conclusion can be drawn for children's health. More comparative economic studies carried out in different countries would contribute a great deal in policy making. More interestingly, a multi-disciplinary approach (gathering economists, epidemiologists, sociologists, psychologists, etc.) would allow obtaining sound estimates.

[35] The main outcomes and conclusions of THE PEP are covered in the synthesis brochure (see THE PEP, 2004).

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