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VALUING INDIRECT EFFECTS FROM ENVIRONMENTAL HAZARDS ON A CHILD'S LIFE CHANCES*

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Abstract: This paper discusses indirect child welfare effects associated with environmental health. It considers the economic value of reducing the indirect risk to a child's life chances from environmental threats to (a) caregiver health, (b) sibling health or the child's health, and (c) the health of the surrounding natural environment and the consequent caregiver's choices. Each of these effects can reduce the healthy child's chance to be productive, to complement the work of others, and to contribute to the common good. In addition, this paper considers what evidence exists in the current literature that might quantify these effects, and whether these effects may be important to policy makers both for child health-related regulations and for regulations involving adult health effects. Finally, this paper also considers whether these indirect effects can be linked to existing models to value children's health effects.

Subject Areas: 57. Benefit-Cost Analysis, 62. Valuation, 63. Children's Health

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1.   INTRODUCTION

In April 1997, President Clinton issued Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks," which instructs the federal government to safeguard children from environmental threats.[1] The main motivation for the EO is that intuition and evidence indicate children deserve more attention when designing environmental policy. Indeed, a growing body of research suggests that children face disproportionate health risks from environmental hazards; e.g., although still unproved, increased cancer rates due to exposure of children to chemical pollutants are of significant concern.[2] These unbalanced perceived risks stem from basic differences in the physiology and activities of children and adults. A child's digestive, nerve, and immune systems are more susceptible to pollutants and other environmental hazards. They breathe, eat, and drink more for their weight, and spend more time outside, potentially exposing them to greater amounts of pollution for their weight than adults. Children are also less able to recognize and to protect themselves from risk.

Environmental threats that reduce the health of their adult caregivers (often parents), their siblings, or the natural environment can also affect a child, even if he or she remains healthy. In a perfect world within a perfect family unit, a healthy child's chances to succeed in life should be outstanding. Household resources, human resource investment prices and levels, endowments, preferences, labor market opportunities, marriage market, and natural environment define his or her primary opportunity set — the basic material needed for attainment in life. But when environmental hazards affect the health of the adult, siblings, or the natural environment, the child's opportunities can be restricted. These risks indirectly modify a child's life chances by reducing and

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reallocating household resources or by constraining his or her choices or both. For instance, wealth that could have been invested in his or her human capital now must go toward health care for the sick family member. Caregivers may shift resources toward a sick child and away from a healthy child. Perhaps, due to pollution, a child might have to forego the life experience of fishing the same river as his or her parents. Faced with these consequences, adults might be willing to pay to prevent risks that restrict children's opportunities to grow into productive members of society.

This issue paper discusses indirect child welfare effects associated with environmental health. We consider the economic value of reducing the indirect risk to a child's life chances from environmental threats to (a) caregiver health, (b) sibling health or the child's health, and (c) the health of the surrounding natural environment and the consequent caregiver's choices.   Each of these effects can reduce the healthy child's chance to be productive, to complement the work of others, and to contribute to the common good. We then consider what evidence exists in the current literature that might quantify these effects, and whether these effects may be important to policy makers both for child health-related regulations and for regulations involving adult health effects.

The paper also considers whether these indirect effects can be linked to existing models to value children's health effects. For the most part, the valuation question is one of defining a situation in which a caregiver makes decisions that attempt to reduce the risk to a child's opportunity set. Accounting for these decisions will require the specification of a new adult-oriented valuation model that focuses on the value of maintaining the child's opportunity set so as to maximize his or her life chances. This will require much more attention to:

- decisions of intrahousehold resource allocation;

- theories of caregiver motives, e.g., self-interest, altruism, justice;

- links between social and private risk reduction strategies;

- revealing accurate values from existing insurance markets given the known problems of moral hazard (hidden actions) and adverse selection (hidden endowments); and

- overcoming data limitations.

The paper proceeds as follows. It first describes the three indirect effects and how they may affect a child's well-being, provides evidence of each effect from the current literature, and discusses the links to economic valuation. It then outlines the implications of this information and offers recommendations for future work on valuing indirect effects on children's life chances. Appendix A outlines a framework that could be further refined and then used to frame how a caregiver values a reduction in the risk to family health, and the related impact on a child's current welfare and his or her future opportunities in life. Note that this paper does not discuss how sick children affect caregiver's utility—Agee and Crocker embed this topic in their discussion paper.

FRAMING VALUATION OF INDIRECT
EFFECTS ON CHILDREN'S LIFE CHANCES

Let us now consider the three indirect effect scenarios in more detail: caregiver's poor health; a sibling's or child's poor health; and environmental hazards that prompt caregiver restrictions on a child's choices. The three effects have a common thread — each can constrict the healthy child's opportunity set and thus potentially affect his or her attainments in life. For our purposes, let us assume that children's opportunity sets

increase as more *income* is invested in them, more *time* is spent with them, and less *stress* is placed upon them (Haveman and Wolfe, 1995).

The key valuation question is whether adults are willing to pay to maintain or increase the size of the child's opportunity set. Valuation takes the adult perspective for one simple reason — for the most part, children have no economic standing. And without standing, the prudent choice is to first address the tangled question of how a caregiver values the maintenance or enhancement of the opportunity set that supports his or her children's life chances.

Caregiver Health

Effects. Economists usually model the process of children's attainments as part of the theory of the family (e.g., Becker and Tomes, 1976; Bergstrom, 1997). Parents (or caregivers) choose how to invest their assets in the family production function. They have preferences over how to use the earnings and the created opportunity sets of their children. These adults invest some of their real inputs into either their own or their children's human capital so as to create welfare for the family members. The amount, nature, and timing of the resources invested in children directly affect their attainments in life, given their initial genetic endowment. How parents choose to invest resources in themselves, their home, their neighborhood, and community also impacts children.

The poor health of a caregiver due to exposure to an environmental threat might have three main consequences for children — less wealth to invest in them, less time to spend with them, and more stress placed upon them. Sick adults can have less access to high wage employment, and thus might be poorer and have less ability to provide resources to their children. The implication of this is lower income and poorer families.

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A sick caregiver might be more likely to have fewer opportunities to create wealth, and might have to reallocate existing wealth and time to medical care and away from children. A decline in monetary and non-monetary assets to invest in a child's human capital is feared to reduce his or her attainments in life as measured by school achievement, occupation, level of earnings or income, and behavioral choices or life situations (e.g., teen pregnancy). Less household wealth influences the opportunities a child has for such things as education, culture, and quality of life.

In a household with more than one child, the negative impact on a child may be reinforced, compensated, or neutralized by an additional intrahousehold reallocation of resources. A sick caregiver might also choose to reallocate household resources between siblings. A caregiver might choose to increase inequalities by reallocating resources to reinforce endowment differences between their children. Alternatively, the caregiver might attempt to reduce inequalities by reallocating resources to compensate the children with lower initial endowments and equalize potential opportunities. The direction of this reallocation, if any occurs, depends on the caregiver's preferences for equity versus productivity in future earnings potential (see Behrman, 1997). Just how a reallocation affects a child's life chances depends on his or her gender, age, and birth order.

A sick caregiver might also have relatively less time, quality or otherwise, to spend with his or her child. If a caregiver must reallocate time to self-care or to receive medical attention, the child's opportunity to develop successfully can be diminished. In the extreme, time is removed completely from the child if the caregiver dies. Death or illness also increases the level of stress in the household. And if the caregiver must undergo intense treatment, the household might have to move closer to the medical center. Geographic moves can be stressful.

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Evidence. The empirical evidence provides mixed support for the proposition that family incomes are associated with child well-being. The underlying presumption behind the desire to understand the indirect effects is that poor caregivers will generate lower odds that their children will succeed in life. Although admittedly not definitive, Haveman and Wolfe (1995) summarize the key findings from the vast empirical literature on the determinants of children's success.   Consider three results most relevant to our concerns—wealth, time, and stress. First, children from a poor family tend to have less success in education and the labor market relative to children from a rich family. This suggests that parental choices that resulted in lower income increased the odds of low attainment by their children. One might be tempted to interpret this as saying that if an environmental hazard affects parental ability to generate income, this effect spills over to their children.

Some researchers challenge this conclusion. Mayer (1997), for instance, argues that whereas higher income yields better living conditions, better living conditions do not improve children's attainment that much. This occurs because public programs have already provided a safety net such that most of the basic material needs are covered for the great majority of children. In the United States, relatively few children suffer from the material deprivation that causes serious harm. As such, conventional models overstate the importance of income to children's outcomes. One could interpret this as saying that the spillover effect from an environmental hazard that reduces parental health and hence income is not as great as one might have expected. Society has already stepped in between in many cases, and has buffered the indirect effects on children's attainment.

The evidence on whether sick caregivers would reallocate wealth to reinforce or to compensate human capital endowment differences between children is unknown at this time. The existing empirical evidence seems to support the view that caregivers have equal concern about their children such that they make investments to compensate for endowment differences (see Behrman et al., 1982, 1986, 1994; Pitt et al., 1990). If the child has a smaller endowment, and a sick caregiver reallocates resources toward this child, his or her losses might be minimal. It remains an open empirical question as to the loss of a child's opportunity set from less wealth given the potential for intrahousehold reallocation of wealth.

Second, evidence suggests that growing up in a family in which the mother works during early childhood adversely impacts educational attainment, suggesting that a loss of child care time has a negative effect on a child's life chances (see Haveman and Wolfe's literature review, 1995). The evidence also suggests that children who grow up in a single-parent family have lower educational attainment (Haveman and Wolfe, 1995). Third, evidence indicates that stress during childhood seems to have a substantial negative impact on children's attainment (Haveman and Wolfe, 1995). Stress from moving, for example, reduces attainment levels. But the link from environmental threat to stress to reduced attainment deserves more research and requires more evidence before strong conclusions can be drawn. For a concrete valuation exercise on these indirect effects one must establish a link between environmental threats and reallocation decisions.

Valuation Link. The valuation question is whether caregivers would be willing to pay to increase the odds that their children would still have a complete opportunity set in the event that a caregiver got sick. Adults may value the opportunities that a higher

family income can provide for children. For example, their children may suffer the longer term consequences of inadequate education (lost future income), or may have to begin work at an earlier age to supplement the family income, thereby losing out on recreational and peer-related activities. In addition, parents may not benefit from as much care from their children at an old age if their child (as an adult) is not able to earn money sufficient to support an extended family. This would entail taking actions to ensure that income, time, and stress were maintained at pre-sickness levels.

Here the answer seems relatively straightforward — many people already buy health and life insurance that suggests that they do value the maintenance of their child's opportunity set. One might question whether capital markets allow people to purchase enough life insurance relative to their value, and would have to disentangle which proportion of this value goes to the spouse and the children, if it could be done.

Caregiver Responses To Any Child's Poor Health Within The Family

Effects. Having a sick child in a family will likely change the behavior and decisions of the caregivers. The life changes that the caregiver experiences as a result of having a sick child in the home may have long-term consequences for the household and for the quality of life that the child in the household experiences. Similar to a sick caregiver, the effects on the child's opportunity set are threefold — less income to invest in the child, less time to spend with the child, and more stress on the child.

The added time for medical care might force a caregiver to find employment that trades off more flexible hours for less pay. Some caregivers may have to forego increased wealth from career and job opportunities, as sick children sometimes need to be located near special care facilities. Again, a reduced family income may influence the

opportunities a child has for such things as education, culture, and quality of life. More likely is that the caregiver with several children will choose to reallocate household resources, so as to compensate the child with lower human capital endowments, which could be the sick or healthy child.

Alternatively, the added financial requirements might force a caregiver to find a higher paying or second job, and as a consequence sacrifice time at home in exchange for income. A sick child can push a caregiver to reallocate his or her time to the workplace from the home to earn more resources to support the needed health care for the child, e.g., chelation for children affected by lead (Agee and Crocker, 1998). More time working to support the sick child leaves less time for the healthy child, which might lessen his or her life chances.

The added effort and resources needed to care for a sick child often increase the stress in household relationships. For example, couples may have more disagreements, or marriages may end in divorce or separation. Caregiver stress may result in less patience or tolerance with their children. Sibling relationships may also be affected. Having a sick child in the house may limit the mobility of the family. Children and caregivers may miss out on the chance to relax through vacation, recreational or other family-oriented opportunities. Each of these situations may potentially affect the quality of life for the child.

Evidence. What do we know about how a child's life chances are affected by the health of a sibling?   Evidence on the consequences of sibling illness for healthy children is hard to find. As a proxy, the first place to look is the evidence just considered for how a sick caregiver affects a child's opportunity set.   Another related set of evidence is the work on gender and birth-order effects in the intrahousehold literature (e.g., Deaton,

1994; Pitt and Rosenzweig, 1990; Pechman, 1987). Data limitations and econometric problems related to measurement error, however, limit the persuasiveness of findings that suggest little evidence of gender discrimination (see Behrman's review, 1997).

Valuation Link. The valuation issue is again whether the caregiver would be willing to pay to maintain a child's opportunity set in the event that a sibling or the child becomes sick. A caregiver would value reducing the risk to the child's life chances that arise from less income, less time, and more stress.   As with the sick caregiver, insurance markets already exist that allow the caregiver to reveal some of his or her preferences for reducing this risk. Caregivers often purchase medical insurance for all members of the family to help smooth out income in a bad state of the world, regardless of which family member becomes ill.   But these markets are also subject to issues of hidden lifestyle (moral hazard) and hidden endowments (adverse selection) that hinder the market's ability to set efficient prices.

Poor Environmental Health and Caregiver Choices to Reduce a Child's Risk

Effects. Caregivers routinely make decisions that restrict the life experiences of a child. The caregiver might well prefer that children have fewer opportunities for certain actions, e.g., the caregiver chooses not to let a child swim alone in a lake or play in traffic. Such decisions to restrict are voluntary. In the case of voluntary restrictions given the caregiver's preferences, there are no efficiency losses involved. The valuation question from the caregiver's perspective for indirect effects is moot.[3]

But in some cases the restrictions on a child's opportunity set imposed by the caregiver's decision to restrict are involuntary — the child would be allowed to swim in the lake except for the fact that it is polluted to unsafe levels. The caregiver may not have

undertaken these involuntary restrictions in the absence of poor, or high risk,

environmental conditions.   For example, parents would prefer an increase in the health

of the natural environment so as to allow their child to swim in a previously

contaminated lake, or prefer the ability to let their asthmatic children outside during high

smog days. In the case of the involuntary restriction, the caregiver would probably be

willing to pay to remove that restriction on the child's opportunity set. Caregivers may be

willing to pay to increase the child's well-being by making every available environmental

opportunities accessible to him. For example, a child may be better off if he can keep

and eat a fish he has caught instead of having to throw it back, or if he can have more

opportunities to play outside with his friends.

Evidence. The past three decades of nonmarket valuation research has revealed

that caregivers are willing to pay for a cleaner environment. All the work on "total

values" suggests that people will invest resources both to use the environmental asset and

preserve the asset for future generations. These non-use values, such as bequest,

existence, and option values, have been estimated numerous times over the years.[4] The

valuation literature is filled with studies estimating the value of a clean environment.

While few studies have explicitly made the maintenance of a child's opportunity set the

central or explicit valuation question, one can speculate that some portion of these values

is to maintain a child's life chances (Viscusi et al., 1994).

Valuation Link. The question is whether it is worth the effort to try to disentangle

the total value of preserving the environment into various sub-values, such as the value of

maintaining a child's opportunity set. Many researchers have abandoned the attempt to

separate out values because the insight gained was not worth the cost. Whether this is

also the case for the indirect effects of interest here is unclear. It might be enough for

adult valuation to know the total value of an improvement in environmental quality. Perhaps the values that the adult reveals through his or her expenditures reflects a household value, children are already included. Asking the caregiver to them break apart this value into its sub-components of personal values, spouse values, child #1 values, child #2 values, and so on, might not be worth the effort.

The question is whether the indirect effects are more important for children than adults. The answer is ambiguous in general. But conditions might exist under which these indirect effects are more important for children, and it is worth the effort to try and reveal the actual degree. These conditions might include situations in which children's immediate pain and suffering is so great and extensive, and is so likely to be carried as a burden his or her entire life to warrant trying to understand the nature of these indirect effects. This might well be the case for children who are less able to cope with the stress and rebound from the loss of time and resources. This might be true for very young children between ages of 0 and 3, in which development potential is the greatest. But then some children turn out fine in the long term despite short term adversity. Identifying which child is likely to be less resilient over the long haul will be a challenge.

And as the model sketched out in the Appendix suggests, the caregiver's value of reduced risk depends on how he or she chooses to reallocate resources and time, overall wealth, number of children, personal benefit from private consumption, the child's potential pain and suffering in the short term, the affect on the child's opportunity set in the long term, the child's ability to cope, another child's inability to cope, the spillover benefits from one child to another, the price of self-protection and self-insurance, the net damages after insurance, and the preferences for good or bad states of nature. The data requirements to identify these various factors will be a challenge.

But if we do decide that indirect effects are crucial to our understanding of environmental risks, then we also have to address the indirect effects to children whose caregiver's business is impacted by the regulation. The loss of wealth or time will also impact these children's opportunity set, and their subsequent life's chances.

IMPLICATIONS

Over the long run, the indirect effects that arise from exposure to an environmental hazard — whether they stem from poor caregiver health, poor sibling or child health, or poor environmental health — can reduce a child's opportunity set. Indirect effects that restrict opportunities can cause the same potential consequences as poor child health itself — less education, less time spent as a family, reduced life chances, parental empathy. And if we maintain the adult viewpoint, we do not need to completely revise our parent-based valuation model to accommodate the valuation of these indirect effects. Economic models already exist that can be adjusted to focus on these indirect effects to children (e.g., Behrman, 1997).

In addition, there are real-world markets in which adults buy private health or life insurance (or self-insure) to spread or reduce the risk that a child's opportunity set will be restricted if a caregiver or sibling becomes ill. Researchers should be able to work through the details of how to adjust current models to account for environmental threats and behavioral responses, and to use current market data to reveal some crude estimates of the willingness to pay to maintain a child's life chances given the chance for poor caregiver and sibling or child health.

The critical question is how to estimate the value of the indirect effects accurately, given that one must clearly understand:

- The measurement and specification errors that most likely exist in the cause and effect links between an environmental threat, a reduced opportunity set, and lower attainments;

- The level of adverse selection and moral hazard that probably exists in imperfect health and life insurance markets;

- How to account for the realizable utility of the children who eventually gain economic standing; and

- The value that adults place on preserving the natural environmental in a state that they perceive does not unduly restrict a healthy child's opportunity set.

In this light, the following recommendations are offered:

Pay more attention to how decisions of intrahousehold resource allocation and distribution are made by caregivers. Most valuation models that might address the investment in human capital usually treat children as a homogenous lot with identical endowments. While this restriction simplifies the valuation exercise, it does not capture the caregiver's decisions on how to allocate resources between children. It seems worthwhile to explore the integration of health valuation models with models of intrahousehold distribution. One starting point is to tease out the valuation implications from the separable earnings-transfer model of Behrman et al. (1982), which assumes endowment differentials among children. This approach addresses the equal concern-earnings productivity trade-off that drives the intrahousehold distribution of resources, which in turn drives a child's opportunity set.

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Begin efforts to construct a systematic framework to help organize how we think about the interaction of environmental threats and the behavioral choices of society, caregiver, and children. Both environmental and behavioral factors determine the success of a child. The key behavioral choices are those made by society, by parents and caregivers given the rules of society, and choices made by children themselves given their parents choices (Haveman and Wolfe, 1995). All three of these choices are conditioned by the quantity and quality of the underlying natural environment that set the opportunities for wealth creation and the constraints on ability. Exactly how different levels of environmental quantity and quality affect the choices of society, parents, and children is an area of research worthy of much more attention. No study listed in the Haveman and Wolfe survey used environmental quality as an explanatory variable. The closest physical proxy was neighborhood location in the city, which might capture exposure to some ambient concentration of an environmental hazard. More attention should be given to how these systems interact with the natural environment to influence a child's life chances (see Agee and Crocker, 1998).

Explore the existing health and life insurance markets conditional on the assumed behavioral link between the caregiver and child. Through insurance markets, both private and collective, caregivers can shift resources from good to bad states of nature to reduce the impacts of poor family health on a child. Researchers might be able to work with this market data to estimate the proportion of insurance expenditures attributable to the maintenance of children's life chances versus caregiver self-interest. Therefore, it seems important to understand the assumed behavioral motive that links caregiver and child. Three motives dominate economic theory — children as an incentive system, parental altruism, and parents with strategic interests in their children. Children as an

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incentive system for the adult male is perhaps the oldest behavior rule (see Malthus, 1803 [1992]; Persky, 1997). A father understands parental care as his duty, and when the basic necessities are covered by society a caregiver does not have an incentive to work or to take care of the remaining risks for his children. The second frame is that of the parent as altruist, in which the parental utility function explicitly incorporates the utility of their children (Becker, 1991; Barro and Becker, 1989; Chami, 1991; Stark, 1993; Zhang and Zhang, 1997). These models presume the parent is altruistic and the child is egoistic. The third idea draws a rather dark picture of the relationship between parents and their children, a picture in which altruism or duty as motives are missing. Instead, the caregiver has strategic self-interests in his or her children (see Logan and Spitze 1995; Richter and Ritzberger, 1995; Zweifel and Strüwe, 1996), in which the caregiver is concerned with whether the child can deliver long-term care.

Address how the link between social policy and caregiver choice affects the ex ante value to maintain a child's life chances. Public investment in children is significant. Annual expenditures on children are estimated to be about 15 percent of GDP, one-third of which is public investment (Haveman and Wolfe, 1995). These public choices affect the private choices that parents make when deciding how to allocate resources between themselves and children. As a consequence, indirect effects will likely spillover between child and adult. Most importantly, the fact that a child's life chances are affected by both private and public investments suggests that the risks to children are functions of both natural science parameters and behavioral components.[5] This occurs because the relative marginal effectiveness of private and public investments most likely differs. So even in the case in which the environmental hazard that triggers these actions applies equally to everyone, the effect on children might well differ across individuals and

situations (Shogren and Crocker, 1991). Additional research into how collective and private choices affect efforts to maintain a child's life chances through the interaction of natural science information and systematic variation in relative prices, incomes, and other economic and social parameters in needed.

Address the severe limitations in data on household behavior. Behrman (1997) identifies six serious limitations to the data needed for intrahousehold resource allocation decisions. These limits apply equally well if not more strongly to the question of disentangling adult values for reducing the risk of indirect environmental effects on children's life chances. First, individual human capital endowments are often not observed in most socioeconomic data sets, making it nearly impossible to directly estimate how different endowments affect behavior. There is an assignability problem in deducing individual choices from aggregate household choices. Second, we rarely observe the intrahousehold allocation and distribution of transfers and investments such as self-protection, non-labor market time, non-school time, food, exercise, and the quantity and quality of caregiver-child contact. Third, available data usually covers a short window of behavior, whereas many questions of interest are over a lifetime. Fourth, data do not link children with adult siblings who live outside the household. Fifth, many key outcomes that are influenced by household allocation and distribution decisions are either unobservable or inestimable, i.e., the rate of return on human capital investments. Finally, measurement error in most observable variables is a challenge to assess and correct.

Rethink the valuation question to account for the realizable utility of children who secure economic standing in the future. It is most likely insufficient from either an economic or ethical viewpoint to simply rely on the preferences of today's adults to value

the indirect effects on children's life chances. Researchers will have to address whether

and how to account for the fact that children today will have economic standing

tomorrow. The size and nature of a child's opportunity will set the boundaries for his or

her realizable utility as an adult. Accounting for this notion of the child-to-adult

realizable utility will give weight to the view that the child's vision of life chances

matters too. If the goal is to monetize informed choice, who is better informed about the

opportunities provided and denied that the adult looking back on his or her life. The

transition from legal to economic standing implies that the adult should have a say on just

how his or her life was impacted directly or indirectly by environmental threats or by

environmental regulations, both of which could have had positive and negative impacts

on future success. Exactly how to do address this notion of realized utility remains an

open question.

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APPENDIX A—A BRIEF MODEL TO EVALUATE THE INDIRECT EFFECTS TO CHILDREN

Below we sketch out a representative caregiver's ex ante economic problem. The simple model reflects the view that the caregiver must split his or her time between working and family life, and then must decide how to allocate resources and time within the family. Resources spent within the family can be allocated to either generic or member-specific consumption, investment in human capital, investment in self-protection to reduce risk from bad states of nature (e.g., illness of family member), and investments in self-insurance and market insurance to spread risk from bad states to good states. These intra-family distributional decisions are motivated by relative prices, productivity, human capital, a child's ability to cope with stress and adversity, and time allocation choices.

The caregiver derives utility from his or her personal consumption and investment, and from the current utility and future utility from the opportunity set of all children under his or her care. The caregiver must decide how to invest current wealth among competing interests so as to maximize his or her utility. Let the caregiver's utility function in period t be represented by

$$u_{care}(x_{care}(t), \sum_{i=1}^{n}[u_{it_0}(\phi_i) + \beta_i \sum_{t=t_0+1}^{T} Eu_{it}(\phi_i)], z(t))$$

where $u_{care}(\cdot)$ represents the utility of the caregiver, $x_{care}(t_0)$ the consumption/investment of the caregiver in period t_0, $u_{it0}(\cdot)$ is the immediately realized utility of child i in period t_0, ϕ_i child i's opportunity set (defined below), β_i the discount factor, Eu_{it} the expected

utility of child *i* in periods t_0+1 and beyond, and z(t) represents the variable that reflects the state of health in the family—the impact of illness of one or more of the family.

Assume the parameter, z(t), that represents the state of family health is unknown, and the distribution of family health is represent by F(z; s, α) defined over the support [a,b]. Assume a high realized z implies high overall family health; a low realized z implies lower family health. The caregivers investment in generic self-protection, s, affects the likelihood that high and low health states will be realized. More self-protection implies greater likelihood in high family health being realized. Also let α represent the degree of riskiness imposed by the environmental hazard on family health. Assume that as the riskiness index α increases the odds increase that family health declines.

Define child *i*'s opportunity set in time t by five elements: x_{it}—the wealth directly invested in his consumption and human capital, $\rho_{it}x_{kt}$ the spillover benefits from the remain share of wealth spent on other siblings' consumption and human capital, τ_{it}—the share of time directly spent with him (alone or in a group), ψ_{it}—the stress in the family, and $\gamma_{it}(z)$—the child's ability to cope with adversity.

$$\phi_{it} = f_{it}(x_{it}, \rho_{it}x_{kt}, \tau_{it}, \psi_{it}, \gamma_{it}(z))$$

Assume income is derived from initial exogenous endowments and assets, *A*, and by the wage earned per hour spent at work, wT_w. These resources are then spend in four main categories—expenditures on oneself/spouse including consumption and human capital, investment in children's consumption and human capital and consumption, general or specific investments in risk reduction actions such as self-protection that

reduces the odds of bad events occurring and self-insurance to reduce the severity of a

bad event if it does occur, and in market insurance to reduce the shock of a bad event.

We also have to account for the financial damages net of insurance, D(.), due to a

realized state of family health, conditioned on the caregiver's self-insurance

expenditures.

$$A + wT_w = p_x(x_{care} + x_1 + x_2 + \ldots + x_n) + p_s s + p_r r + p_I I - D(z; r)$$

Let p_x, p_s, p_r, and p_I represent the per unit prices of consumption/investment, self-

protection, self-insurance, and market insurance.

A caregiver's total time is divided between time at work, time with children, and

time ill.

$$T = T_w + T_c + T_{ill}(z)$$

Total time spent with children can be divided further into time spent individually with

each child, or time spent in groups of children. Separating this time element will be a

challenge, but might be helpful in understanding intra-household allocation decisions.

$$T_c = \tau_1 + \tau_2 + \ldots + \tau_n + \tau_{1,2} + \tau_{1,3} + \ldots + \tau_{1,2,\ldots,n}$$

Given these assumptions, the caregiver's objective function can be written as

$$\int_a^b \int_0^T [u_{care}(x_{care}(t), \sum_{i=1}^n [u_{it_0}(\phi_i) + \beta \sum_{t=t_0+1}^T Eu_{it}(\phi_i)], z(t))] dt dF(z; s, \alpha)$$

subject to (suppressing time sub-script)

$$A + w[T - (\tau_1 + \tau_2 + \ldots + \tau_n + \tau_{1,2} + \tau_{1,3} + \ldots + \tau_{1,2,\ldots,n}) - ET_{ill}(z)]$$

$$= p_x(x_{care} + \mathrm{x}_1 + \mathrm{x}_2 + \ldots + \mathrm{x}_n) + p_s s \; + p_r r \; + p_I I - \mathrm{E}D(z; r, I)$$

Within this framework, a caregiver will maximize his or her expected utility given his resource and time constraints.   Depending on the expected risk posed by exposure to the environmental hazard, the caregiver might be willing to pay something to reduce the potential indirect effect on child i given an exogenous public policy that reduces the index of riskiness on his or her family's current health status. Solving for the exact form of the valuation functions will require additional work (see for example, Shogren and Crocker, 1991). In general, we can say at this time that the ex ante willingness to pay of the caregiver today to reduce risks to children's pain and suffering today and reductions in their opportunities for tomorrow will depend on how he or she chooses to reallocate resources and time, overall wealth, number of children, personal benefit from private consumption, the child's potential pain and suffering in the short term, the affect on the child's opportunity set in the long term, the child's ability to cope, another child's inability to cope, the spillover benefits from one child to another, the price of self-protection and self-insurance, the net damages after insurance, and the preferences for good or bad states of nature.

1. Federal Register: April 23, 1997 (Volume 62, Number 78, 19883). The EO directs the federal government to safeguard children from environmental risks through three actions: policy, research coordination, and federal regulatory analysis. Section 1 requires all agencies to make the protection of children a high priority in implementing their statutory responsibilities and fulfilling their overall missions. Section 3 creates an interagency task force to identify research and other initiatives the Administration could take to protect children, and to enlist public input for these efforts. Section 5 requires, for the first time, that agencies examine and explain the effects of their rules on children. Agencies promulgating major regulations that may have a disproportionate impact on children now must (a) evaluate the environmental health or safety effects of the planned regulation on children, and (b) explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the agency. The idea is to link policy decisions to the health science on children, to ensure accountability to the public, and to force agencies to refocus their research agendas. Section 5 is the key to the order and, potentially, the most controversial — it has been called the "kick me" provision, given the need to explain why actions beneficial to children were passed over. Supporters argue that without Section 5 the order will be merely hortatory and symbolic.

2. See Wargo, 1996 *Our Children's Toxic Legacy. How Science and Law Fail to Protect Us from Pesticides.*   New Haven: Yale University Press, and the cites therein.   Also see the 1997 report "The First Three Years: Investments That Pay," by the Council of Economic Advisers, which stresses the importance of the first three years in the development of a child, and the corresponding costs of neglect.

3. The child might have a different perspective when he or she achieves economic standing, however; this is currently not addressed in our standard valuation model.

4. See Freeman (1993) for the research details.

5. Crocker, Thomas D. and Jason F. Shogren. 1997. Endogenous Risk and Environmental Program Evaluation. *Environmental Program Evaluation. A Primer* (G. Knaap and T.J. Kim, eds.) Urbana, IL: University of Illinois Press, pp. 255-269.