PARENTAL ALTRUISM AND THE VALUE OF AVOIDING ACUTE ILLNESS: ARE KIDS WORTH MORE THAN PARENTS?

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Abstract

A model describing parents' preferences to relieve their own and their children's acute illnesses is estimated using stated-preference survey data. Estimated marginal rates of substitution (MRS) between child and parent illness are about two, indicating that parents value children's illness attributes twice as highly as their own. The MRS is larger for younger children, falls toward unity as the child approaches adulthood, and appears to reflect parental altruism rather than parent-child differences in initial health or illness costs. Intra-family allocations may compensate for chronic health impairments. Parents' willingness to pay (WTP) to avoid own or child illness increases with income, declines with fertility, increases at a decreasing rate with duration and number of symptoms, and depends on perceived discomfort and activity restrictions. Current methods of assessing morbidity benefits of environmental regulations may understate substantially the value of children's health, particularly in African-American families.

Key Words: altruism, benefit-cost analysis, children's health, environmental justice, environmental policy, family economics, health valuation, morbidity valuation, willingness to pay.

1. INTRODUCTION

Recent executive [17] and legislative [15] decisions in the U.S. have emphasized protecting children's health from environmental threats, partly because children may be at greater risk than adults from some environmental hazards. Although a variety of policies might help protect children's health, information on parents' preferences is useful in evaluating the effectiveness and economic efficiency of virtually any policy that affects children. Parental preferences, along with income and fertility, influence family investments in children [25], and these investments may offset or reinforce effects of public policy [5]. Parental preferences also provide a basis for assessing benefits of improving children's health.

This paper investigates parents' preferences over acute health outcomes affecting themselves and their children. The health outcomes include common short-term effects of exposure to ambient air pollution. A model of family decision-making, presented in Section 2, is used to derive equivalent surplus functions describing parents' willingness to pay to relieve their own and their children's acute illnesses. The model is estimated using data from a stated-preference survey described in Section 3. A key parameter of the model is the marginal rate of substitution between health outcomes experienced by the child and parent. This rate of substitution serves as an index of parents' altruism or selfishness toward their children. Parental preferences are "neutral" if the marginal rate of substitution equals unity when the child and parent experience equivalent health outcomes. In this case, a small decrement in illness attributes experienced by the child just offsets, in the sense of holding parental utility constant, an equal increment in illness attributes experienced by the parent. A larger rate of substitution indicates more altruism, while a smaller rate indicates less altruistic (more selfish) preferences.

Results presented in Section 4 imply rejection of the hypothesis of neutral preferences in favor of substantial parental altruism toward children. The estimated marginal rate of substitution (MRS) is about two for a nine-year-old child, implying that parents value their children's acute illnesses twice as highly as their own. The MRS is higher for younger children and falls toward unity as the child reaches adult age. It remains significantly greater than unity after accounting for many socioeconomic factors and for possible differences between parents and children in costs of illness and initial health status. Thus, the conclusion that parents value their children's health outcomes more highly than their own seems more

likely to reflect parental preferences than household constraints. Parents' valuations of avoiding child and parent illness increase with family income, reflect a quantity-quality tradeoff by declining with fertility, and appear closely related to the opportunity cost of parental time. Fathers and mothers make similar family health decisions, and parents show no favoritism between sons and daughters. Family resource allocations compensate for, rather than reinforce, chronic health impairments among family members.

Estimates of parents' median willingness to pay (WTP) to avoid acute illness are presented in Section 5. Estimated WTP to relieve parental illness is broadly consistent with results of prior research on adults, but parents are willing to pay significantly more to relieve their children's acute illnesses. Parents' WTP depends on perceived discomfort and activity limitations, and increases at a decreasing rate with the number of symptoms experienced and the duration of illness. Black parents are willing to pay more than white parents.

These results have at least three implications for analysis of environmental policies affecting health. First, the current practice of valuing children's illnesses using WTP estimates computed for adults [43,45] apparently understates benefits substantially. Second, unit values used by the U.S. EPA to estimate benefits of reduced acute morbidity are much lower than estimates presented here and in previous research. Third, applying an overall average WTP to all households would understate benefits of reducing acute illnesses for African-American families.

Although previous studies have investigated how parental behavior, family resources and public programs affect child health [30,38], the research has been conducted mainly in developing countries and has not examined key preference parameters such as willingness-to-pay or the marginal rate of substitution between child and parent illness. Few researchers have estimated WTP to reduce adult and child morbidity or mortality in a common framework. Viscusi *et al.* [46] found that parents were willing to pay more to reduce injury risks to their children than to themselves, but the children's injuries considered were more severe than the adult injuries. Liu *et al.* [31] conclude that a typical Taiwanese mother's WTP to prevent her child from having a cold is about twice her WTP to avoid a cold herself. But these two studies did not specify an explicit model of family decision-making, did not account for

key determinants of parental expenditures such as fertility and child age, and did not estimate a theoretically consistent index of parental altruism like the marginal rate of substitution.

2. A CONSENSUS MODEL OF HEALTH CHOICES IN THE FAMILY

A parent or adult decision-maker is assumed to maximize utility subject to a budget determined by the pooled income of all family members. In this "consensus" approach, developed by Becker [4] and commonly used for analysis of resource allocation within families [5], utility depends on consumption of market goods, the "quantity" or number of children (fertility), and the "quality" of children. Quality often is defined as the wealth, earnings, academic achievement, or health of a child.

In the dual problem of minimizing expenditures subject to a given level of utility, let $m(h_p, h_c, z, n, p, u, \tilde{e})$ denote the expenditure function. The h_i represent measures of health outcomes experienced by the parent ($i = p$) and one child ($i = c$), while health outcomes experienced by other family members are assumed constant and suppressed; z denotes a vector of characteristics of the parent, child, and household, such as age and indicators of chronic health status; n represents fertility, or the number of children in the family; p is a vector of prices; u is the given utility level, and $\tilde{e}$ is the stochastic part of the random expenditure function, reflecting heterogeneity between households.

In the empirical analysis the health variables h_i are scalar measures of acute illness, such as symptom-days experienced, or vectors of illness attributes, such as symptoms experienced and duration of illness. Parents are asked whether they would pay a dollar amount t for a treatment that would relieve various combinations of illness attributes. If the illness affects the child, a parent would be willing to pay the stated amount provided that

$$m(h_p, h_c^1, z, n, p, u^0, \tilde{e}^1) - m(h_p, h_c^0, z, n, p, u^0, \tilde{e}^0) > t, \tag{1}$$

where h_c^1 and h_c^0 respectively denote the vector of child health attributes with and without the illness, $\tilde{e}^1$ and $\tilde{e}^0$ denote the stochastic component with and without the illness, and u^0 equals the maximum utility attainable without the illness. Then $u^0 = v(h_p, h_c, z, n, p, y)$, where $v(\cdot)$ represents the indirect

utility function and y denotes pooled family income. Assuming additive random errors, letting $e = \tilde{e}^1 - \tilde{e}^0$, and substituting the indirect utility function for u^0 (see McConnell [33]), the parent would be willing to pay the amount t to relieve the child's illness if

$$s(h_p, h_c^1, h_c^0, z, n, p, y, e) > t, \tag{2}$$

where the equivalent surplus function $s(\cdot)$ equals the difference in expenditure functions. Of course, a similar equation applies to the WTP to relieve an acute illness affecting the parent.

The marginal WTP to reduce illness attribute k affecting family member i, such as the WTP to avoid a day of fever experienced by the child, is given by $\partial s / \partial h_{ik} = \partial m / \partial h_{ik}$. The ratio of any two marginal valuations in turn equals the marginal rate of substitution between the corresponding two attributes in the household utility function.[1] For example, the MRS between illness attribute k experienced by the child and the parent is

$$MRS = (\partial s / \partial h_{ck}) \Big/ (\partial s / \partial h_{pk}). \tag{3}$$

This rate of substitution is a useful index of parental altruism because it measures the parent's marginal valuation of her child's acute illness *relative to* her own. An MRS of unity implies that parental preferences are neutral in the sense that the parent experiences an equal reduction in utility from a given health condition, no matter whether she or her child experiences it. In this case, adults' WTP to avoid the condition would apply equally well to children. Conversely, the MRS would be greater or less than unity as the parent placed a higher or lower value on avoiding a given health condition when the child, rather than the parent, is affected. An MRS different from unity would imply that a parent's WTP differs depending on whether the child or the parent is ill.

Unless acute health outcomes affecting the parent and child are perfect substitutes in the parental utility function, the MRS will vary with the outcomes. The MRS thus should be estimated while holding the vector of illness attributes constant between parent and child. To illustrate, suppose there is one illness attribute per person, h_i, measured as the number of days a particular combination of symptoms is experienced. If there were T days per period, then days free of symptoms, $T - h_i$, $i = p, c$, would enter

the parental utility function as goods rather than bads. Indifference curves then would have the conventional convex shape shown in Figure 1. The hypothesis of neutral parental preferences should be tested at a point like E, where the parent and child consume equal amounts of the illness attribute considered. If the hypothesis were tested at point A, preferences would appear altruistic because the MRS exceeds unity, even though the $MRS = 1$ at point E.

The importance of this issue increases if the family "produces" symptom-free days. In a static model that might be appropriate for valuing short-term health conditions (where household resource allocations influence the number of symptom-free days but changes in the stock of health capital are ignored [18]), point A would reflect the initial equilibrium, given the nonlinear budget constraint represented by curve B_0. The family produces fewer symptom-free days for the child than for the parent, perhaps because the child has a chronic illness like asthma that raises the marginal cost of producing symptom-free days. The higher valuation of symptom-free days for the child reflects both preferences (the MRS) and constraints (the child-parent ratio of marginal costs). In this case, parents' choices should be examined net of effects of child-parent differences in marginal costs of producing symptom-free days. Similarly, any difference in costs of illness between parent and child should be controlled.[2]

Two steps are taken in an effort to estimate the MRS as an appropriate measure of parental preferences, under the assumption that the stock of health capital enters the utility function separately from, and is unaffected by changes in, short-term symptoms. First, the experimental design used in the survey allows illness attributes to be held constant between parents and children when estimating the MRS. This insures that the MRS is evaluated at points like E if short-term health conditions occur exogenously. If the conditions are home-produced, this design yields estimates at points like E if the relevant time period is short and preferences for avoiding the conditions are independent across periods (*e.g.*, the value of avoiding acute bronchitis in November is independent of whether it was experienced in March). Second, the MRS is estimated while controlling for socioeconomic factors likely to affect the slope or position of the budget constraint, or reflecting costs or consequences of acute illness, such as parental employment and earnings, medical prices, and presence of chronic illness.

3. SURVEY DESIGN AND DATA

The model is estimated using survey data collected in Hattiesburg, Mississippi, during June - July 2000. African-Americans comprise 26 percent of the 115,000 persons living in the metropolitan statistical area, double their share nationally, while few residents are classified as members of racial or ethnic groups other than black or white [42]. African-American households were sampled in proportion to their share of the local population to support tests for racial differences in preferences for avoiding illness. Some researchers have found racial differences in family health valuation, behavior or outcomes [20,28], and environmental health risks may disproportionately affect children who live in low-income or minority households [34,44].

Respondents were recruited by dialing local telephone numbers at random during daytime and evenings on weekdays and weekends. Adults contacted were informed of the study about how health, health care and health costs affect families. Parents or guardians of at least one child aged 3 to 17 years living at home were asked to schedule a convenient time to complete the survey on a local university campus, and would receive $20 for participating. Two-parent households could volunteer either parent to complete the survey; callers asked only that the responding parent be knowledgeable about family health and health costs. Response rates were broadly consistent with other health surveys using telephone recruitment and in-person interviews at a central location [3,27].[3] The survey was administered in-person to 295 parents and required 25 minutes on average to complete; empirical analysis is based on the 284 respondents who reported their income. In developing the survey, two focus groups with six parents each were conducted, followed by four rounds of pre-tests with a total of 12 subjects.

Background Data

The survey collected general information about the household and more detailed data about the responding parent and one child. Detailed information was not collected about other children in the household to limit the length of the interview and to avoid repetitive questioning. The “sample child” was selected at random from households with more than one eligible child, although asthmatic children were over-sampled to support tests for differences between children with and without asthma.[4]

The interview began with questions about household composition and continued with standard economic and demographic questions about the respondent, a spouse or partner, if any, and the sample child. Data were collected on experiences with acute illnesses during the past 12 months and on the chronic health status of the respondent and sample child.[5] Information was obtained about health insurance coverage, money and time costs of medical care, paid sick leave, and family income.

Table I lists summary statistics on household data used as well as on variables from the valuation component of the survey (described below). The sample closely resembles the local population with respect to race, age, single-parent status, and family size [42], but nearly half of respondents were college graduates. Almost 80 percent were employed, and family incomes more closely match national than local statistics. Sample median and mean family incomes are about $47,000 and $68,000, respectively, relative to $51,000 and $66,000 nationally for families with children at home [41]. As in most surveys that inquire extensively about children, the majority of respondents (75 percent) were female.

Health Valuation

The survey included an "attribute-based, stated-preference choice experiment" to assess parents' preferences for avoiding acute illness. Respondents were given descriptions of illness episodes, and asked whether they would pay stated amounts for treatment to relieve the conditions described. These descriptions or "profiles" differed in four attributes: (1) symptoms (cough with phlegm, shortness of breath with wheezing, chest pain on deep inspiration, and/or fever with muscle pain and fatigue); (2) duration (two days or one week); (3) person affected (parent or child); and (4) price of treatment. The symptoms were chosen because exposure to air pollution appears to increase incidence of upper respiratory symptoms and acute bronchitis among children, and existing valuations of these effects in the U.S. are based on decades-old studies of adults [43, Tables 10 and 13].[6] Also, focusing on acute rather than chronic illness avoids complications from potential differences between parents and children in latency, life expectancy or discounting, and allows comparison with several previous studies of adults.

After asking whether the respondent or child had experienced each of the four symptoms during the past year, interviewers indicated that the survey would next inquire, "How your family would be

affected if you or your child had an illness or condition that caused some of these symptoms." Interviewers explained that the respondent would be given descriptions of four separate illnesses and would be asked some questions about each, including "whether you would buy a hypothetical medication to treat the condition." Respondents were told that drug companies were working on treatments for illnesses causing respiratory symptoms and fever [37]. The influenza drugs released the previous autumn were used as examples, although respondents were advised that these were examples only because the survey was not about influenza or drugs currently available.[7] The medication would be taken on the first day of symptoms and would prevent any remaining days of symptoms that otherwise would have occurred. It would be available in liquid, tablet or capsule form and would be FDA-approved, safe and effective for adults and children three years of age and older. Immediately following this introduction, each respondent would evaluate four profiles in sequence.

Each profile assigned symptoms and duration to the parent or child but asked respondents to rate subjectively the resulting degree of discomfort and interference with usual activities. The final section of the profile reminded the respondent about the hypothetical medication and budget constraint, and asked whether she would be willing to pay a given price out-of-pocket for the medicine. Although it was not shown on the description viewed by respondents, a follow-up question assigned a higher or lower price according to whether the respondent would or would not buy the drug at the initial price.[8]

Four features of the valuation procedure warrant comparison to previous research. First, respondents value illnesses assigned to them [8,27,39], not illnesses they have recently experienced [2,10,11,31,35]. Symptoms were assigned so that tradeoffs between parent and child health would reflect identical health outcomes (to estimate the MRS at points like E in Figure 1). A disadvantage of this approach is that respondents may not have enough information or experience to value the assigned health outcomes. But the symptoms considered here are common, and data were collected to assess whether familiarity affects responses. Second, a key goal of the research is to estimate ratios and differences in valuations between parents and children. Effects of hypothetical bias, inadequate information, or other potential problems with stated preference data would be mitigated to the extent that these factors are constant between parents and children.

Third, previous acute health valuation surveys often have not specified concretely how payment of money would prevent adverse health effects. Instead, respondents may be reminded in general terms of tradeoffs between money and health, for example that expenditures on medical treatment may improve health. This approach proved unsuccessful in pre-tests and consequently the valuation scenario involves a specific hypothetical medication.[9] Fourth, respondents valued four illness episodes in the "double-bound," discrete-choice with follow-up framework. This approach aimed to balance gains from additional questioning against respondent burden. In other research, respondents may value only one illness in a triple-bound framework [2] or as many as eight to 16 illnesses at a single price for each [27].

A limitation of the survey is the absence of "debriefing" questions to assess respondents' motivations for valuation responses or acceptance of information provided. Separate debriefing questions for each profile would be repetitive and lengthen the survey, while a single set of questions following the last profile would be ambiguous if motivations or acceptance of information varied between profiles. Nonetheless, the absence of debriefing questions makes it difficult to assess whether respondents doubted the effectiveness of the hypothetical medication, were concerned about side effects, or responded strategically if they believed drug companies were sponsoring the study. However, debriefing of pretest respondents suggests that these factors may not be important determinants of responses.[10]

The overall design, exclusive of follow-up prices, can be described as a 2^7 factorial, with 128 profiles. All profiles include cough with phlegm and most include one or more of the three other symptoms. Each symptom has two levels (present or absent), as does duration (two or seven days without treatment) and person affected (parent or child). There are four prices for the initial discrete choice question ($40, $200, $400, $600).

Table II summarizes the 16 profiles used in the orthogonal and balanced design. Profiles one through eight represent a 1/16 fraction of the full factorial and by themselves would make a standard "main effects," 2^{7-4} design. Main effects plans, the most commonly used experimental designs, support estimation of partial effects of each attribute, but do not identify interactive effects. For example, a main effects plan would allow estimation of the divergence in WTP between parent and child, but would constrain any divergence to be equal for each symptom. To allow the child-parent WTP differential, if

any, to vary over illness attributes, a second 1/16 fraction was constructed such that the two fractions together allow estimation of interactions between child status and all other attributes [9].

The four profiles assigned to a respondent were selected randomly from the set of 16, and assigned in random order, subject to two constraints. First, each respondent received two profiles describing an illness she would experience, and two describing an illness her child would experience. Second, to mitigate any tendency of respondents to try to appear altruistic to their children, the parent and child illness profiles assigned to a given respondent were never identical. For example, a respondent receiving the first profile, describing a seven-day cough experienced by the parent, would not be assigned profile nine, describing the same illness experienced by the child.

4. EMPIRICAL ANALYSIS OF HEALTH CHOICES IN THE FAMILY

Table II summarizes responses to the initial discrete-choice valuation question, showing the proportion of parents who would purchase treatment for the illnesses considered. For each of the eight pairs of profiles, parents are more likely to purchase treatment when the illness affects the child rather than the parent. Seven of the eight pairwise differences in proportions are statistically significant at the 10 percent level in two-tail tests (including five that are significant at one percent). Overall, the odds of purchasing treatment are twice as high (odds ratio = 2.12) for the child as for the parent.

Table II also presents non-parametric, lower bound estimates of mean WTP for each combination of illness attributes administered in the survey. These Turnbull-type estimates use information only on the initial prices for the hypothetical medication, and the proportion of parents who would purchase the drug at the initial price [21]. For each illness, the lower bound estimate of mean WTP is larger for children than for parents. Again, seven of eight pairwise differences are significant at the 10 percent level in two-tail tests (including five that are significant at one percent). Taking the ratio of lower bound, mean WTP for the child relative to the parent for each illness, and then computing the geometric mean of these eight ratios, yields 1.86. This suggests that the typical parent is willing to pay almost twice as much to relieve an acute illness affecting her child as to relieve an equivalent illness affecting herself.

Inferences drawn from information in Table II do not depend on any assumption about the distribution of WTP, or about the functional form of equivalent surplus functions. Continuing in a similar vein, the last row of the table presents Turnbull estimates of WTP per symptom-day avoided. Considering WTP per symptom-day gives a simple way of pooling data over profiles without specifying a parametric model. The Turnbull estimation procedure [21] is applied after defining the price of treatment as the initial price, divided by the number of symptom-days avoided. The number of avoided symptom-days is computed as the number of symptoms times the reduction in the number of days ill associated with use of the new medication. The lower bound estimates of mean WTP per symptom-day are about $86 for children and $35 for parents. The estimate is 2.47 times larger for children than for parents, and the child-parent difference is significant at one percent in a two-tail test.

Tables III and IV present parametric estimates of the equivalent surplus function (inequality (2)) and associated MRS (equation (3)) between child and parent illness. Table III focuses on how illness attributes affect WTP, while estimates in Table IV account for effects of individual and household characteristics. Estimates are computed by maximizing the log-likelihood function of the interval estimator for double bound, discrete-choice with follow-up data, assuming that WTP is lognormally distributed [2,31]. The log-likelihood function for the i^{th} observation is

$$\ln L_i = \ln\left[\Phi\left(\frac{\ln(s_i^U) - x_i'b}{s}\right) - \Phi\left(\frac{\ln(s_i^L) - x_i'b}{s}\right)\right], \tag{4}$$

where s_i^U and s_i^L denote upper and lower bounds on the equivalent surplus, x_i and b represent conformable vectors of explanatory variables and coefficients, s denotes the standard deviation of $\ln(e)$, and Φ denotes the standard normal cumulative distribution function. Results based on an alternative (Weibull) distribution for WTP are available on request.

Illness Attributes

The specification in column (1) of Table III defines illness according to the number of symptom-days avoided. Column (2) and all remaining columns include indicators for the degree of discomfort and

activity restriction that the respondent associates with the illness. Column (3) follows Alberini *et al.* [2] and separately enters the number of symptoms and days of illness avoided, while column (4) follows Johnson *et al.* [27], using days of separate symptoms as illness attributes. The final column of Table III addresses effects of familiarity or recent experience with symptoms. Each specification includes a constant term and a dummy variable indicating whether the illness affects the child or parent, with the implied MRS between child and parent illness reported in the last row.

As shown in column (1), WTP to avoid acute illness increases at a decreasing rate with symptom-days and is significantly higher for children than for parents. The estimated MRS of 2.12 differs significantly from unity at less than the one percent level in a two-tail test. This result implies that the average parent values relieving her child's acute illness about twice as highly as relieving her own.

Results presented in column (2) indicate that subjectively perceived discomfort and activity restriction are important determinants of the value of avoiding acute illness. The estimated symptom-days elasticity falls when these factors are accounted for, because illnesses with more symptoms and/or longer duration are associated with greater discomfort and activity restriction. Evidently, about 10 percent of the premium that parents are willing to pay to relieve the child's illness reflects their belief that the same symptoms and duration cause more discomfort and interference with activities when the child, rather than the parent, is ill.

In column (3) the elasticities of WTP with respect to number of symptoms and duration are each significantly greater than zero and less than one, but they are statistically indistinguishable from one another ($p = 0.41$). This indicates that the combined symptom-days measure adequately captures effects of both duration and symptoms. Similarly, duration elasticities reported by Alberini *et al.* [2] (0.31 to 0.46) are quite close to their elasticities with respect to the number of symptoms (0.34 to 0.44). Duration elasticities in Johnson *et al.* [26] range from 0.44 to 0.51 and in Liu *et al.* [31] from 0.16 to 0.21.

Researchers estimating hedonic wage equations similarly report elasticities of wages with respect to duration of injury, holding risk of injury constant, significantly less than unity. Estimated duration elasticities are 0.05 to 0.32 [14,22]. Thus, stated-preference methods applied to acute illness and

revealed-preference methods applied to workplace injuries both indicate diminishing marginal valuation of duration. Although workplace injuries and acute illnesses are different health outcomes, this result is consistent with the idea that the concavity of estimated WTP in symptoms and duration reflects diminishing marginal utility of symptom-free days [18:351], rather than insensitivity to scope in hypothetical valuation responses.

As shown in columns (4) and (5), accounting for the separate symptoms experienced and for recent experience with the symptoms has little impact on coefficients of other variables, the log-likelihood value, or the MRS. Comparing column (4) to previous columns suggests that people care less about which specific symptoms they experience than about the number and duration of symptoms, an inference which echoes results obtained by Alberini *et al.* [2] and Johnson *et al.* [27]. In column (5), coefficients of three of four dummy variables indicating recent experience with a symptom are statistically insignificant at 10 percent. It seems that stated preferences for avoiding common symptoms are not unduly sensitive to experience.[11]

The coefficient of the "child" indicator gives the main effect of a child illness relative to a parent illness. As discussed in Section 3, the research design would allow the child-parent differential to vary over illness attributes, and Liu *et al.* [31] found significant differences in slopes of valuation functions between mothers and children. Table III reports outcomes of two likelihood-ratio tests for interactive effects. As shown, slopes and variances of equivalent surplus functions appear identical between parents and children, implying that the MRS is constant over the illness attributes considered here.[12]

Individual and Household Characteristics

Table IV shows effects of characteristics of the parent, child and household on WTP to avoid acute illness. The main purpose of these regressions is to test the robustness of the MRS estimates in Table III and their interpretation as measures of parental altruism. As discussed in Section 2, if parents value relieving their children's illnesses more highly than their own because children's illnesses are more costly, or because of a difference in baseline health status between parents and children, then the parent-child tradeoffs in Table III confound preferences with constraints. Table IV regressions also account for

specific features of the sample, such as the over-sampling of blacks relative to the national population, and would be useful in transferring benefits to populations with different characteristics.

Family Characteristics. All regressions in Table IV show effects of variables identified in family economics as key determinants of parental investments in children – income, marital status, fertility – and control for race and for the sex of the responding parent. Estimated income elasticities of 0.08 to 0.22 are lower than those obtained in previous research [2,31,32], which lie between 0.2 and 0.6. Greater fertility is associated with lower WTP. This outcome partly reflects the well-established quantity-quality tradeoff [24], in which a larger number of children implies reduced spending on each child. Here, however, a larger number of children implies a lower WTP for both the child's *and* the parent's health conditions.[13]

Health choices made by fathers and mothers are indistinguishable, but married parents may be willing to pay less than single parents. This effect, significant at ten percent in two of the four regressions, may indicate that acute illness is a relatively greater burden in a single-parent household. Whites are willing to pay less than blacks, as would be expected if African-Americans have fewer or worse options for responding to acute illness.[14] Alberini *et al.* [3] found that blacks are willing to pay more than whites for reduced adult mortality risk, and Joyce *et al.* [28] found that blacks mothers are willing to pay more than white mothers for improved infant health. Other researchers have not found significantly higher WTP among blacks [8,39], while many have not controlled for race [2,10,11,27,29,31,32,46].

Health Status. Prevalence of asthma is higher among children, especially African-American children, than among adults. Episodes of asthma exacerbation, often involving some of the symptoms valued here, are associated with air pollution. As shown in column (1) of Table IV, physician-diagnosed asthma is associated with a significantly higher demand to avoid acute illness. Estimating the MRS separately by asthma status yields 2.28 when the child but not the parent has asthma, and 1.51 when the parent but not the child has asthma (the separate estimates are not shown in the table).

These results suggest that acute health tradeoffs within a family depend on the chronic health status of family members. The shift of resources toward the person with asthma implies compensating rather than reinforcing allocations; incremental health spending shifts toward the person in poor health.

Still, the MRS remains significantly greater than unity even when the parent, not the child, has asthma. The conclusion that parents value avoiding their children's illnesses more highly than their own is not an artifact of over-sampling asthmatic children. More generally, the finding that parents are willing to pay more to protect their children than themselves from acute illness cannot be attributed to measured differences in baseline health status between parents and children.[15]

Costs and Consequences of Illness. Columns (2) and (3) of Table IV include variables associated with costs of illness, marginal costs of reducing acute illness, and additional indicators of the parent's human capital. WTP increases with illness costs. It is higher when the parent is employed, and increases with wages and medical prices. The effect of medical price suggests that the hypothetical medication and existing treatments are viewed as substitutes. The time required for medical care, paid sick leave, and parental schooling appear unrelated to WTP. Measures of schooling, employment and wages are entered separately for mothers and fathers in column (3). The additional detail contributes little to the explanatory power of the regression. In any event, the conclusion that the MRS significantly exceeds unity cannot be attributed to measured differences in costs or consequences of illness.[16]

Children's Characteristics. Apart from asthma, the only individual or household characteristic affecting the MRS seems to be the age of the child, as shown in column (4). Figure 2 plots the estimated MRS as the child ages, including extrapolation beyond the sample range of 3 to 17 years of age. The MRS declines as the child ages and is no longer significantly greater than unity at the five percent level beyond age 18. As shown in column (4), the effect of child age is estimated net of the effect of attending school. This regression also indicates that parents have no preference between acute health conditions affecting sons and daughters; in contrast, Liu *et al.* [31] found that Taiwanese mothers favor sons.

Some results above suggest that the opportunity cost of parental time is closely tied to the value of avoiding acute illness. Models that explicitly incorporate the loss of time from market and non-market activities induced by acute illness (*e.g.*, [18]) would predict that WTP increases with the opportunity cost of time and the amount of time lost. This perspective would account for the increase in WTP with the responding parent's employment and wage, and might explain the declining MRS as the child ages, if more time is needed to care for a sick child who is younger.[17]

Discussion of MRS Estimates

The estimated MRS significantly exceeds unity after accounting for many socioeconomic factors and for potential differences between parents and children in initial health status and illness costs. Thus, the hypothesis of neutral preferences is rejected in favor of parental altruism toward children. The degree of altruism is difficult to reconcile with a purely genetic basis for parental preferences. Hamilton's rule, in which altruism is proportional to shared genes [6], suggests that an individual parent would value her child's health outcomes half as highly as her own. Of course, motivations other than altruism could cause the MRS to exceed unity. For example, the declining MRS with the child's age may reflect an ethic of guardianship in which a parent's sense of responsibility diminishes as the child matures.

Whatever the explanation for MRS estimates obtained, parents' apparent altruism has implications for public policy. In view of parents' legal authority over children, parental preferences are an important determinant of child health outcomes and of the effectiveness of policies designed to improve child health. Children of selfish parents would be more likely to experience poor health outcomes, and policies designed to benefit these children could be neutralized as parents re-allocated family resources in response to policy changes. But results presented above are inconsistent with the idea that parental selfishness or lack of concern is a major impediment to improving child health.

This conclusion in turn bears on whether parental WTP is an adequate and politically acceptable benefit measure. Dockins *et al.* [12] conclude that parental preferences provide the best basis for benefit-cost analysis of policies affecting children. Politically, however, policy-makers might be reluctant to accept parental WTP as a measure of child health benefits if the MRS were less than unity.

5. WILLINGNESS TO PAY TO AVOID ACUTE ILLNESS

Parametric estimates of median parental willingness to pay to relieve acute illness episodes are shown in Tables V and VI. Estimates in Table V are based on regressions in Table III and show WTP to avoid illnesses with varying symptoms and duration, accounting for severity or for recent experience with symptoms. Throughout Table V, estimated WTP is about twice as high for illnesses affecting children as

for equivalent illnesses affecting parents, reflecting the underlying MRS of about two. All child-parent differences are statistically significant at the one percent level in two-tail tests.

The top panel in Table V shows WTP to avoid symptom-days at the sample minimum (one) and maximum (24) number of symptom-days avoided. Severity is defined by subjective perceptions: "mild" cases involve low discomfort and activity restriction, while "severe" cases involve high discomfort and activity restriction. Estimated WTP is about two-thirds higher for severe than for mild cases.

The bottom panel of Table V shows WTP to avoid days of separate symptoms at the sample maximum number of days avoided (six). This duration shows the largest within-sample differences between valuations of separate symptoms, since gaps between symptom valuations widen with duration. Yet the coefficient of variation of WTP for the separate symptoms is only 0.13, implying that separate symptom values deviate from the value of the average symptom by less than 15 percent on average. This variation, like the effect of recent experience with symptoms, is quite modest relative to the impact of severity or of the family member affected. Experiencing all of the symptoms for 7 days, or 28 symptom-days altogether, is roughly equivalent to a case of acute bronchitis, an important health endpoint associated with children's exposure to air pollution. WTP to avoid all but the first day of all four symptoms, shown in the last row of Table V, is about $320 for children and $170 for parents.

Table VI presents median WTP estimates, based on regressions in Table IV, for avoiding one symptom-day applicable to specific sub-populations. Comparisons in Table VI represent partial effects of variables taken one at a time, holding other explanatory variables at sample means. Results underline the importance of family composition, race, chronic health status, and child age in determining WTP.[18]

Estimates of mean WTP (not presented) are almost twice as large as median WTP estimates. Additionally, all estimates in Tables III through VI were re-computed assuming a Weibull, rather than a lognormal, distribution for WTP, with no effect on any substantive conclusions.[19]

Implications of WTP Estimates and Comparison to Previous Research

The WTP estimates imply that the practice of valuing children's acute illnesses using WTP estimates computed for adults [43,45] substantially understates benefits. A similar conclusion would be

drawn from two other studies of acute morbidity [1,31]. Also, Dickie and Gerking [12] report that parents are willing to pay more to reduce skin cancer risks to their children than to themselves, while Blomquist [7] indicates that the value of a statistical life is no lower for children than for adults.[20]

The relationship of WTP with income, family composition and race bears on environmental-justice implications of evaluating policies with benefit-cost analysis. While concerns for environmental justice encompass income and minority status [16], economists often address the potential for a WTP criterion to favor the rich at the expense of the poor [36]. Concerns for equity may be countered by the argument that policy analysts usually apply the same WTP value to all persons affected by a policy, but that practice weakens the link to individual preferences [23]. Results presented here, however, indicate that an overall average WTP would understate benefits to disadvantaged families.

To illustrate, the regression in Table IV, column (1), is used to estimate median WTP for three types of families, with each assigned US mean income for its type: white, married-couple families (mean income $74,913); black, married-couple families ($62,454); and black, single-parent families with no husband present ($26,863). Estimated median WTP is 50 percent higher for married-couple black families, and 57 percent higher for single-parent black families, than for white, married-couple families. Thus, applying an overall median (or mean) WTP to all households would substantially underestimate benefits to African-American families.[21]

Finally, results obtained here may be compared to earlier research. Table VII presents results from seven previous efforts to value similar symptoms. Three of the studies [10,11,32,39,40] were early, "first-generation" efforts to value symptoms. The fourth [26] was a meta-analysis of the morbidity valuation literature, based partly on the three first-generation studies. The final three studies are much more recent but were conducted outside the U.S., in Taiwan [2,31] or Canada [27]. Only one [31] of the seven studies estimated WTP for children as well as adults.

Each of the prior studies estimated WTP to avoid entirely one or more days of symptoms, while respondents in the present study would avoid all but the first day of symptoms. The difference in methodology would tend to yield lower WTP estimates here than in previous research, because of concavity of WTP in duration. Also, WTP may include fixed and variable components, reflecting

preferences for avoiding illness entirely and for reducing its duration. Previous estimates would include both components, while estimates in Tables V and VI would include only the variable component.

The column of Table VII labeled "Study WTP" gives WTP estimates in U.S. dollars of the year 2000. The final two columns adjust the earlier WTP estimates for differences in income. Mean income levels in previous studies were converted to USD 2000 and then adjusted to the mean income in the present sample. The effect of the change in income on WTP then was estimated by applying income elasticities of 0.15 (the median of the three statistically significant values in Table IV) and 0.4 (representative of estimated elasticities in earlier work).[22]

WTP estimates for parents avoiding one symptom-day in Table V are somewhat higher than the median of values from previous studies, after adjusting for effects of income, of about $30 (mild) or $90 (severe). On the other hand, estimates of WTP to avoid six days of single symptoms in Table V are much lower than income-adjusted multi-day, single-symptom values in previous research, of $250 to $385. Valuations for avoiding acute bronchitis in Table V are larger than values for avoiding multiple-day, multiple-symptom episodes from Alberini *et al.* [2] and Liu *et al.* [31]. However, acute bronchitis lasts longer and involves more symptoms than the acute illnesses considered in the two Taiwan studies.[23] In summary, the values obtained here for parents' own illnesses are broadly consistent with results of previous research, but values for children's illnesses are larger than most previous estimates for adults.

In any case, the unit values used by the U.S. EPA to estimate benefits of reduced acute morbidity are much lower than relevant estimates from existing valuation research. In the retrospective cost-benefit analysis of the Clean Air Act [43], for example, unit values inflated to USD 2000 are $7/day for shortness of breath, $15/case for lower respiratory symptoms, and $56/case for acute bronchitis. These values are lower than adult valuations in existing research, but EPA identifies children as the affected population for air-pollution induced episodes of these endpoints. Morbidity benefits comprise 18 percent of total health benefits attributed to the Clean Air Act over the period 1970-1990. Aggregate benefits of avoided shortness of breath, acute bronchitis, and upper and lower respiratory symptoms in children, and of any acute symptom in adults, sum to $75 billion ($2000). Replacing EPA's unit values with those obtained in this research would boost this total by a factor of six to $465 billion, increasing the share of these

symptoms in total morbidity benefits from 1.5 to 8.6 percent.[24] In any event, EPA estimates may substantially understate benefits of reduced acute morbidity.

6. CONCLUSIONS

Information on parents' preferences for their own and their children's acute health outcomes is useful for evaluating the likely effectiveness and economic efficiency of policies affecting acute illness. Results presented here indicate substantial parental altruism toward children. Future research should examine parents' preferences for other health outcomes affecting children, test alternative models of family decision-making, and consider further whether parental WTP is an adequate measure of benefits of children's health. Results obtained here may or may not extend to chronic, latent or fatal health effects, where age-related differences in cumulative exposures, latency periods or remaining lifetimes may influence parent-child health tradeoffs. Other models of family decision-making should be explored to determine whether the model of consensus parental preferences is appropriate for valuing children's health. Researchers should investigate whether people display "paternalistic altruism" toward children outside their own families, and whether these preferences should be considered in benefit-cost analysis.

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Table I. Sample Means (and Standard Deviations) or Proportions.

Household Characteristics		Individual Characteristics		
			Responding Parent	Sample Child
Family Income ($/year)	68441	Age (years)	36.98	9.25
	(63196)		(8.55)	(4.36)
Married Parent Family	0.68	Physician-Diagnosed Asthma	0.10	0.18
Number of Children	1.78			
	(0.90)	Female	0.75	0.52
		Price of Doctor Visit ($/visit)	52.54	44.66
Race is White	0.73		(84.89)	(93.23)
Responding Parent is			2.05	2.09
College Graduate	0.49	Hours Required for Doctor Visit	(1.03)	(1.10)
Responding Parent is				
Employed	0.79	Cough with Phlegm in Past Year	0.46	0.54
Responding Parent's	17.37	Shortness of Breath with Wheezing in		
Wage if Employed	(24.59)	Past Year	0.13	0.21
Responding Parent Has		Chest Pain when Cough or Breathe		
Paid Sick Leave	0.45	Deep in Past Year	0.25	0.28
Mother is Present and				
College Graduate	0.45	Fever in Past Year	0.46	0.61
Mother is Present and				
Employed	0.68	Data from Health Valuation Profiles		
Mother's Wage if	14.62	Symptom Days Avoided	8.66	8.73
Present and Employed	(24.93)		(7.81)	(7.80)
Father is Present and		Number of Symptoms	2.51	2.49
College Graduate	0.38		(0.87)	(0.86)
Father is Present and		Days of Illness Avoided	3.48	3.51
Employed	0.69		(2.50)	(2.50)
Father's Wage if Present	20.00	Cough Days	4.48	4.51
and Employed	(24.23)		(2.50)	(2.50)
Sample Child is in		Shortness of Breath with Wheezing	2.74	2.74
School	0.92	Days	(2.47)	(2.48)
		Chest Pain Days	2.72	2.74
			(2.48)	(2.48)
		Fever Days	2.73	2.74
			(2.47)	(2.48)
		High Discomfort (=1 if Rating>6)	0.46	0.65
		High Activity Restriction (=1 if		
		Rating>6)	0.40	0.62
		Initial Price, New Drug	307.57	307.18
			(209.95)	(209.10)
		Buy New Drug at Initial Price (=1)	0.34	0.53
		Number of Observations	563[a]	568[a]

[a] Eleven of 295 responding parents did not report income and are excluded. Each of the remaining 284 respondents received four profiles, two for a parent illness and two for a child illness. Five of the resulting 568 parent profiles are deleted because the follow-up question was mistakenly deleted from the interviewers' packets.

Table II. Profiles and Initial Responses

(*z*-statistics in parentheses)

Profiles	*Symptoms: Cough/phlegm AND…*	*Untreated Duration (Days)*	*Treatment Cost*[a] ($)	*Proportions Buying Treatment*[b]			*Non-parametric Lower Bound Mean WTP*[c]			*Follow-up Cost*[d] *($)*
				Child	*Parent*	*Difference*	*Child*	*Parent*	*Difference*	
1, 9	No other symptoms	7	40	0.96	0.74	0.22	38.31	29.44	8.87	10,
						(3.67)	(40.12)	(14.17)	(3.88)	400
2,10	Chest pain	2	200	0.49	0.24	0.25	97.22	47.06	50.16	10,
						(3.08)	(8.25)	(4.57)	(3.21)	400
3,11	Shortness of breath/wheeze	7	200	0.58	0.35	0.23	115.07	69.57	45.5	40,
						(2.72)	(9.95)	(6.07)	(2.79)	600
4,12	Shortness of breath/wheeze	2	40	0.87	0.83	0.04	34.93	33.33	1.596	10,
	Chest pain					(0.67)	(22.12)	(18.97)	(0.68)	200
5,13	Fever	2	600	0.19	0.09	0.10	113.04	53.73	59.31	40,
						(1.66)	(4.00)	(2.57)	(1.69)	750
6,14	Fever	7	400	0.51	0.19	0.32	202.74	75.36	127.38	200,
	Chest pain					(3.97)	(8.66)	(4.00)	(4.24)	750
7,15	Fever	2	400	0.34	0.17	0.17	135.21	67.53	67.68	40,
	Shortness of breath/wheeze					(2.38)	(6.02)	(3.96)	(2.40)	600
8,16	Fever	7	600	0.28	0.10	0.18	167.65	60.87	106.78	200,
	Shortness of breath/wheeze					(2.66)	(5.14)	(2.79)	(2.72)	750
	Chest pain									
	Overall			0.53	0.34	0.19				
						(6.35)				
	WTP per Symptom-Day Avoided						86.03	34.85	51.18	
							(8.66)	(3.62)	(3.70)	

[a] Initial price for new drug.

[b] Proportion of parents who would purchase the new drug at the initial price.

[c] Turnbull estimate of the lowest possible mean WTP for any distribution defined over non-negative values [21:74]. WTP to reduce duration of illness to one day for each profile (first 8 rows); WTP per symptom-day avoided (last row.) US dollars of year 2000.

[d] Price for new drug in follow-up question; the higher or lower of the pair of follow-up prices was assigned depending on whether the respondent would or would not buy the drug at the initial price.

Table III. Logarithmic Surplus Function: Illness Attributes and Symptom Experiences.[a]
(Asymptotic *z* statistics in parentheses).

Parameter	(1)	(2)	(3)	(4)	(5)
ln(Symptom Days Avoided)	0.262 (5.965)	0.195 (4.436)			
ln (Number of Symptoms)			0.273 (2.589)		
ln (Days of Illness Avoided)			0.186 (4.104)		
ln (Days of Cough with Phlegm)				0.147 (1.961)	0.155 (2.077)
ln (Days of Shortness of Breath/Wheezing)				0.0895 (1.645)	0.0868 (1.594)
ln(Days of Chest Pain)				-0.0459 (-0.533)	-0.0398 (-0.462)
ln(Days of Fever)				0.146 (1.667)	0.142 (1.620)
High Discomfort		0.321 (3.121)	0.315 (3.064)	0.315 (3.034)	0.312 (3.020)
High Activity Restriction		0.209 (2.059)	0.203 (1.992)	0.207 (2.035)	0.205 (2.021)
Child rather than Parent is Ill	0.753 (9.314)	0.643 (7.965)	0.645 (7.991)	0.645 (7.962)	0.665 (8.173)
Had Cough/Phlegm in Past Year					-0.129 (-1.532)
Had Shrt Brth/Wheeze, Past Year					0.0449 (0.353)
Had Chest Pain, Past Year					-0.222 (-1.957)
Had Fever Past Year					-0.0301 (-0.362)
Constant	4.321 (45.152)	4.209 (43.270)	4.157 (35.952)	4.234 (39.867)	4.349 (37.826)
s	1.187 (33.794)	1.160 (33.129)	1.159 (33.047)	1.159 (33.027)	1.152 (32.956)
Log-likelihood[b]	-1184.42	-1168.27	-1167.92	-1168.04	-1162.40
Test for interactions with Child (*p*-value)[c]	.55 .46	.74 .70	.65 .60	.75 .73	.44 .54
MRS	2.12 (12.37)	1.90 (12.39)	1.91 (12.40)	1.91 (12.35)	1.94 (12.29)

[a] Maximum likelihood estimates. The latent dependent variable is the natural logarithm of the equivalent surplus in dollars.

[b] The log-likelihood value with all parameters except the constant and s set equal to zero is 1243.96. Thus, the null hypothesis of zero slope coefficients would be rejected at less than one percent significance for each specification in the table.

[c] Likelihood ratio test of null hypothesis of equal slopes (top entry) or equal slopes and variances (bottom entry) between parent and child, allowing for different intercepts.

Table IV. Logarithmic Surplus Function: Household Characteristics.[a]
(Asymptotic z-statistics in parentheses).

Parameter	(1)	(2)	(3)	(4)
ln(Symptom Days	0.187	0.190	0.193	0.199
Avoided)	(4.271)	(4.353)	(4.435)	(4.592)
High Discomfort	0.359	0.328	0.344	0.335
	(3.455)	(3.148)	(3.314)	(3.209)
High Activity	0.187	0.214	0.203	0.178
Restriction	(1.808)	(2.059)	(1.972)	(1.709)
Child rather than	0.618	0.648	0.638	1.636
Parent is Ill	(7.741)	(8.087)	(7.934)	(6.099)
ln (Annual Family	0.154	0.0773	0.217	0.141
Income)	(3.441)	(1.279)	(3.547)	(3.096)
Married Parent Family	-0.179	-0.0524	-0.0230	-0.182
	(-1.761)	(-0.481)	(-0.144)	(-1.770)
ln (Number of Children)	-0.288	-0.295	-0.270	-0.281
	(-3.150)	(-3.229)	(-2.939)	(-3.092)
Responding Parent is	-0.0904	-0.0249	0.343	0.00324
Female	(-0.963)	(-0.251)	(1.289)	(0.033)
Race is White	-0.432	-0.448	-0.448	-0.478
	(-4.415)	(-4.462)	(-4.519)	(-4.805)
Have Physician-	0.239			
Diagnosed Asthma	(2.102)			
*ln(*Parent Age)		0.0649		0.518
		(0.372)		(2.705)
Responding Parent is		-0.0531		
College Graduate		(-0.578)		
Responding Parent is		0.390		0.207
Employed		(2.378)		(1.982)
*ln(*Responding Parent		0.124		
Wage)		(2.235)		
*ln(*Price of Doctor's		0.121		
Visit)		(2.659)		
*ln(*Hours Required for		0.0279		
Doctor Visit)		(0.361)		
Responding Parent has		-0.0163		
Paid Sick Leave		(-0.179)		
Mother is College			-0.0588	
Graduate			(-0.613)	
Mother is Employed			0.0974	
			(0.946)	
*ln(*Mother's Wage)			0.0332	
			(0.998)	
Father is College			0.0263	
Graduate			(0.248)	
Father is Employed			-0.0689	
			(-0.347)	
*ln(*Father's Wage)			-0.0948	
			(-1.755)	

Table IV. (Continued).

Parameter	(1)	(2)	(3)	(4)
(Child Ill) x (Child Female)				-0.0114 (-0.105)
Child in School				-0.262 (-1.750)
(Child Ill) x *ln(*Child Age)				-0.471 (-3.846)
Constant	3.183 (6.785)	3.676 (4.405)	2.196 (3.040)	1.522 (1.975)
s	1.131 (32.816)	1.125 (32.974)	1.128 (32.872)	1.119 (32.956)
Log-likelihood[b]	-1146.77	-1141.68	-1143.69	-1136.82
Test for equal slopes and variances, Parent and Child (p-value)[c]	.33	.60	.79	.94
MRS at Means	1.86 (12.53)	1.91 (12.48)	1.89 (12.44)	1.79 (11.75)

[a] Maximum likelihood estimates. The latent dependent variable is the natural logarithm of the equivalent surplus in dollars.

[b] The log-likelihood value with all parameters except the constant and s set equal to zero is 1243.96. Thus, the null hypothesis of zero slope coefficients would be rejected at less than one percent significance for each specification in the table.

[c] Likelihood ratio test of null hypothesis of equal slopes and variances between parent and child, allowing for different intercepts.

Table V. Parents' Median Willingness-to-Pay to Relieve Acute Illness.[a]

(Asymptotic z -statistics in parentheses. Standard errors estimated using delta method.)

Illness	*Col (1)*[b]			*Col (2)*[b] *– Mild Symptoms*			*Col (2)*[b] *– Severe Symptoms*		
Symptom Days Avoided:	*Child*	*Parent*	*Difference*[c]	*Child*	*Parent*	*Difference*[c]	*Child*	*Parent*	*Difference*[c]
One Symptom Day[d]	160 (10.8)	75 (10.5)	85 (7.2)	128 (10.0)	67 (10.3)	61 (6.2)	217 (9.5)	114 (8.7)	103 (6.5)
24 Symptom Days[e]	367 (11.7)	173 (11.5)	194 (7.4)	238 (9.2)	125 (9.9)	113 (5.9)	404 (11.7)	212 (10.8)	191 (6.9)

Illness	*Col (4)*[b]			*Col (5)*[b] *– Have Had Symptom*			*Col (5)*[b] *– Have Not Had Symptom*		
Days of Symptoms Avoided:	*Child*	*Parent*	*Difference*[c]	*Child*	*Parent*	*Difference*[c]	*Child*	*Parent*	*Difference*[c]
Six Days Cough[d]	226 (10.2)	119 (10.3)	108 (6.3)	215 (9.7)	111 (9.6)	105 (6.4)	245 (9.1)	126 (9.3)	119 (6.1)
Six Days SB[d]	204 (7.3)	107 (7.0)	97 (5.5)	211 (5.9)	109 (5.6)	102 (4.9)	202 (7.2)	104 (7.0)	98 (5.6)
Six Days Chest Pain[d]	160 (5.4)	84 (5.1)	76 (4.6)	138 (4.9)	71 (4.7)	67 (4.4)	172 (5.3)	88 (5.1)	84 (4.6)
Six Days Fever[d]	226 (5.6)	119 (5.7)	107 (4.5)	221 (5.4)	114 (5.4)	107 (4.5)	228 (5.5)	117 (5.6)	111 (4.5)
Six Days, All Symptoms[d]	318 (10.1)	167 (10.0)	151 (6.4)	---[f]	---[f]	---[f]	---[f]	---[f]	---[f]

[a] Estimates of median WTP in U.S. dollars of the year 2000 based on equivalent surplus functions in Table III.

[b] Identifies the Table III regression used to estimate WTP. Mild (severe) cases involve low (high) discomfort and interference with activities

[c] WTP for child minus WTP for parent. [d] One day of symptom still experienced. [e] Four symptom days still experienced.

[f] Not estimated because "experience" could be defined arbitrarily to mean experience with one, two, three or all four symptoms.

Table VI. Individual and Household Characteristics and Median Parental Willingness-to-Pay.[a]
(Asymptotic z -statistics in parentheses. Standard errors estimated using delta method.)

	Total Willingness to Pay to Avoid One Symptom Day	
Characteristic	*Child*	*Parent*
Married	161 (10.4)	87 (9.9)
Not Married	192 (8.7)	104 (8.3)
One Child	195 (9.7)	105 (9.3)
Two Children	159 (10.9)	86 (10.2)
Three Children	142 (9.6)	76 (9.1)
Four or More Children	129 (8.2)	70 (7.9)
Have Asthma	209 (7.4)	113 (7.0)
Do Not Have Asthma	165 (10.9)	89 (10.3)
White	151 (10.7)	82 (9.9)
Black	233 (8.5)	126 (8.3)
Child Age=3	271 (6.7)	---[b]
Child Age=6	196 (10.1)	---[b]
Child Age=9.25 (Sample Mean)	160 (10.2)	89 (10.4)
Child Age=12	141 (9.1)	---[b]
Child Age=17	120 (7.3)	---[b]

[a] Estimates of median WTP in U.S. dollars of the year 2000 based on equivalent surplus functions in Table IV. Shows effect of changing one characteristic while holding all others at sample means. Computations for child age are based on column (4) of Table IV while all others are based on column (1).

[b] Does not vary with child age.

Table VII. Acute Morbidity Values from Previous Research. [a]

Symptom	*Days*	*Severity*	*Age Group*	*Study*	*Study WTP*[b]	*Income-Adjusted Using Elasticity of:*[c] *0.15*	*0.40*
			One-Day Episodes of One Symptom				
Cough	1	-	Adults	Dickie *et al.*	17	17	16
	1	-	Adults	Tolley *et al.*	40	42	42
	1	Mild	Adults	Johnson *et al.* [26]	27	28	30
	1	Severe	Adults	Johnson *et al.* [26]	49	51	53
Shortness of Breath	1	-	Adults	Dickie *et al.*	10	10	10
	1	Mild	Adults	Loehman *et al.*	80	91	110
	1	Severe	Adults	Loehman *et al.*	98	112	135
	1	Mild	Adults	Johnson *et al.* [26]	27	28	30
	1	Severe	Adults	Johnson *et al.* [26]	84	87	92
	1	Mild	Adults	Johnson *et al.* [27]	0	0	0
Fever/Ache	1	Mild	Adults	Johnson *et al.* [27]	23	25	28
			Multiple-Day Episodes of One Symptom				
Shortness of Breath	5	Mild	Adults	Johnson *et al.* [27]	235	252	282
	7	Mild	Adults	Loehman *et al.*	239	273	329
	7	Severe	Adults	Loehman *et al.*	266	304	367
Fever/Ache	5	Mild	Adults	Johnson *et al.* [27]	319	343	384
			Multiple-Day, Multiple-Symptom Episodes				
Cold	5	-	Adults	Alberini *et al.* [2]	40	47	58
	6	-	Mothers	Liu *et al.*	34	44	59
	6	-	Children	Liu *et al.*	71	90	121
Not Cold	5	-	Adults	Alberini *et al.* [2]	61	71	87

[a] Sources of values are as follows. Dickie *et al.*, Loehman *et al.* and Tolley *et al.*: taken from Johnson *et al.* [26], Table 1. Johnson *et al.* [26]: their Table 4, "Predicted WTP." Alberini *et al.* [2]: their Table IV. Johnson *et al.* [27]: their Table 6. Liu *et al.*: *p.* 324, averaged over severity levels. Alberini *et al.* [2] and Liu *et al.* presented their results in USD (converted from Taiwanese currency using exchange rates). Johnson *et al.* [27] values converted from Canadian dollars using purchasing power parity for the survey year (U.S.$ 1 = CAN$ 1.19).

[b] All values inflated to USD 2000 using the implicit GDP Deflator.

[c] Shows effect of changing mean income level in original study to mean income of present sample using alternative income elasticities of WTP. Income in the Johnson *et al.* [26] study assumed to be average of mean incomes in Dickie *et al.*, Loehman *et al.* and Tolley *et al.*

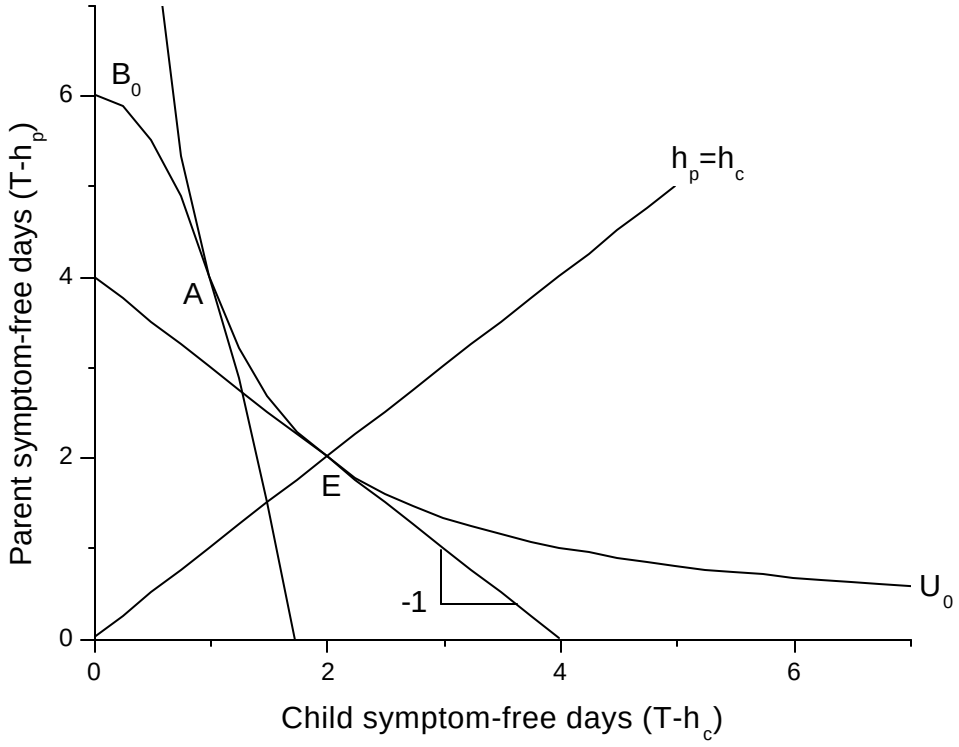

Figure 1: Neutral Parental Preferences. The MRS exceeds unity at point A, where the indifference curve is tangent to the nonlinear budget constraint. Parental preferences are neutral, however, because the MRS equals unity at point E, where parent and child consume equal numbers of symptom-free days.

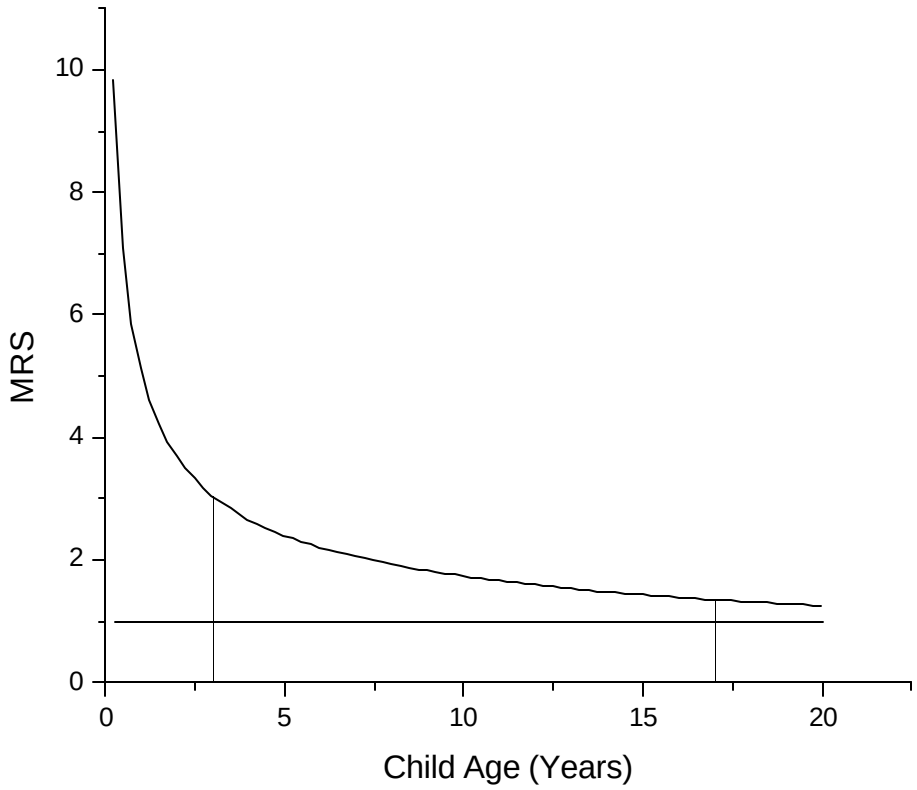

Figure 2: Estimated Marginal Rate of Substitution against Child Age. The convex curve shows how the MRS falls as the child ages, based on column (4) of Table IV. Vertical lines mark the within-sample age range of 3 to 17 years. The estimated MRS significantly differs from unity (shown by the horizontal line) at less than 5 percent for all within-sample ages.

[1] The MRS is defined by the implicit function theorem and rule as $(\partial u / \partial h_c) / (\partial u / \partial h_p)$, where u denotes the direct utility function and $(\partial u / \partial h_p) \neq 0$. Using duality, the ratio of marginal disutility of illness attributes equals the ratio on the right hand side of equation (3).

[2] Benefit estimates for policy, however, should be computed at the household's equilibrium.

[3] Of 11,018 calls to presumed working residential numbers, 19.7% yielded no contact after the maximum of three calls. Of 8,852 adults contacted, 55.9% declared their household ineligible, a reasonable figure since children are present in only about one-third of households. The remaining 3904 adult contacts are assumed eligible, although many refused to participate before eligibility could be verified. Interviews were scheduled with 487 persons, representing 12.5% of assumed eligible contacts, and 295 arrived for the interview. The ratio of completed interviews to adult contacts (295/8852 = 3.3%) is lower than in Alberini *et al.* [3] (930/17841 = 5.2%) or in Johnson *et al.* [27] (399/4517 = 8.8%), who did not have to exclude households without children.

[4] Specifically, if an eligible child with physician-diagnosed asthma lived in the household, he or she was selected as the sample child. Otherwise, the sample child was selected based on the number of eligible children and the last digit of the survey number. For example, if two eligible children were present, the older child was chosen if the last digit of the survey number (surveys were numbered sequentially from 1 to 295) was 1-5; otherwise the younger child was chosen. The algorithm for choosing the sample child is included with the survey, a copy of which may be obtained by request. A child is eligible if the adult respondent is the parent or legal guardian; the child lives with the respondent and is between 3 and 17 years old. The upper age limit was chosen because adulthood legally begins at age 18, and for valuation purposes EPA considers children to be persons under age 18. The lower age limit was chosen in an effort to limit the sample to parents who had accumulated a reasonable amount of experience dealing with the child's acute illness and who would be able to distinguish separate symptoms affecting the child. The parent of a very young child might have relatively little experience, particularly if the child were the oldest or only child. Also, it can be difficult for a parent to ascertain the exact symptoms being experienced by a very young child, and the child may be unable to communicate this information.

[5] Acute illness experiences were measured by: work-loss days for employed respondents, school-loss days for children in school or day-care, restricted activity days for parents not employed or children not in school, and indicators of whether the four symptoms included in the valuation component of the survey had been experienced. Indicators of chronic health status include presence of physician-diagnosed: asthma, COPD, other chronic lung condition, other serious, long-term health condition, allergies; whether

health conditions limit activities; subjectively assessed health status (excellent, very good, good, fair or poor). Also, measures of the child's health in infancy were collected (birth weight, prematurity, whether admitted to neonatal intensive care).

[6] Acute bronchitis typically lasts about a week (a few days to two weeks) and is characterized by lower respiratory symptoms and a fever of less than 101° F. Symptoms include cough with phlegm, possibly chest pain below the breastbone when breathing deeply or coughing, and shortness of breath/wheezing.

[7] Taken soon after symptoms start Relenza or Tamiflu may reduce duration of illness.

[8] Prices used for a study in Taiwan [2] and in Canada [26] were adjusted for differences in price and income levels relative to Mississippi.

[9] Some pretest respondents objected to the idea of "avoiding" an illness. How would one know that an illness had been avoided? How would one know to make a payment to avoid a specific illness, without already experiencing the illness? Others wanted to know the mechanism between payment and illness avoidance, such as whether it was a visit to the doctor or a pill.

[10] Debriefing of pretest subjects included a relatively non-directive assessment of their reactions to the hypothetical medication. No one expressed concern about side effects. One pretest respondent expressed doubts that a real medication would be as effective as the survey description; one indicated she thought the hypothetical drug was similar to a real drug in development; and one asked whether drug companies were funding the study. None of these pretest respondents indicated that their WTP responses had been affected by these thoughts. Alberini *et al.* [3] found that about 1/3 of their sample doubted effectiveness of a hypothetical product reducing fatality risks, while about 1/5 were concerned about side effects. However, these factors had little discernible impact on WTP responses.

[11] In an unreported regression, four additional variables were added to the specification of column (5), constructed as interactions of symptom-experience dummies with the separate symptom-duration variables. None of the interaction terms was statistically significant. Previous findings on effects of experience or familiarity on health valuations pertain mainly to chronic illnesses. Krupnick and Cropper [29] found that relatives of people with chronic lung disease were willing to pay more to reduce risk of chronic bronchitis than persons with less familiarity. In contrast, persons with a chronic condition do not perceive higher losses in quality-adjusted life-years from the condition than the general public [19:100].

[12] The first test, of whether slopes vary between children and parents after allowing for intercept shifts, is based on re-estimating the equations with interaction terms constructed as products of the child indicator variable and all other explanatory variables. The second test, of whether slopes *and* variances differ after allowing for intercept shifts (as might occur if WTP values were more variable for children than parents), is based on re-estimating the equations separately for parents and children.

[13] To further investigate effects of household composition, two unreported regressions allowed the coefficient of the child indicator to vary with birth-order or by first-born status; however, coefficients of these interaction terms were statistically insignificant.

[14]But parents of both races appear to make identical tradeoffs between their own and their children's illnesses. When the child indicator was interacted with the racial indicator, the coefficient of this interaction term was not statistically significant at conventional levels.

[15] In unreported regressions the asthma indicator was interacted with symptom-days, or with the measures of days of individual symptoms, but the interaction terms were statistically insignificant. Also, several unreported regressions investigated further effects of health status. Dummy variables indicating presence of allergies or of health conditions that limit normal activities, or indicating subjectively rated health status (excellent, very good, good, fair or poor) took statistically insignificant coefficients. Dummy variables indicating whether restricted activity days, or work- or school-loss days, had been experienced in the past year had statistically significant, negative coefficients, suggesting that those who recently experienced activity restrictions due to illness are willing to pay less to avoid an incremental episode of acute illness. However, MRS estimates were largely unaffected by these changes in specification.

[16] Several unreported regressions included other variables associated with parental labor supply or with the costs/consequences of illness. Additional variables included indicators of health insurance coverage and measures of hours of work, availability of paid sick leave or family leave, subjective ratings of the extent of problems caused by missing work, and whether work would be missed if the child were ill or were taken to the doctor. Few of these variables had statistically significant coefficients, and accounting for them left the estimated MRS largely unaffected.

[17] The parent's rate of substitution between time spent caring for a sick child relative to another activity would reflect similar utility terms as the MRS for illness attributes, and would be expected to decline as more time is spent with the child. The rate of substitution would equal unity, however, at an interior optimum for a parent who could freely allocate time between activities, to insure that the marginal value of time would be equal across all activities.

[18] WTP estimates assume that those who would not purchase the new drug at either initial or follow-up prices are willing to pay a positive amount less than the lower, follow-up price. Some of these "No, No" responses, however, may reflect a zero WTP or rejection of the valuation scenario. Overall, 15 percent of responses were "No" at both initial and follow-up prices. Given a "No" at the initial price, the proportion of negative responses at the follow-up price is increasing with price, from five percent at $10, to 16 percent at $40, and 56 percent at $200. Two-thirds of "No, No" responses occur at $200, the highest of the "No" follow-up prices. The preponderance of high prices among "No, No" responses is consistent

with the assumption that WTP is less than the follow-up price, though not necessarily zero. These respondents may have been thinking of treatments already available and less expensive than the hypothetical medication. Also, a bivariate probit analysis indicates that the probability of a "No" response to either initial or follow-up questions declines as symptom days avoided increase, is lower when the child rather than the parent is affected, and increases with price. Thus, determinants of "No, No" responses appear consistent with determinants of WTP in Tables III and IV. This outcome, together with the fact that only one respondent answered "No, No" to each of four profiles, suggests that these responses do not reflect rejection of the valuation scenario.

[19] Estimates of mean WTP for the lognormal case, and all results based on the Weibull distribution, are available on request. Weibull-based estimates of the MRS are about five percent smaller than estimates in Tables III and IV, while estimated median WTP is about 20 percent higher for children, and 25 percent higher for adults, than estimates presented in Tables V and VI

[20] A second shortcoming in current benefit assessments is not distinguishing between one-day episodes of one symptom and episodes with more symptoms or days, because valuations increase less than proportionately with duration [2,26,27,31,32,39] or number of symptoms [2,39].

[21] This outcome reflects the relatively modest estimated income elasticity, coupled with higher WTP among black and single-parent families. Estimates were computed by evaluating median WTP for female responding parents with race, marital status and income set appropriately for each family type, and all other explanatory variables at sample means. Mean income figures appear in Table FINC-01 [41], at www.census.gov/hhes/www/income00.html.

[22] The income elasticity Alberini *et al.* [2] use to estimate benefits is 0.41. Liu *et al.* [31] report four income elasticities that average 0.38. Loehman *et al.* [32] report elasticities ranging from about 0.25 to 0.6, with a midpoint of about 0.43. The average of 0.41, 0.38 and 0.43 is about 0.4.

[23] For example, Alberini *et al.* [2] consider five days of illness with about two symptoms, while acute bronchitis as defined here would involve seven days of four symptoms. But cough with phlegm, fever, aching muscles, chest pain, shortness of breath and wheezing would count as six symptoms in Alberini *et al.*'s coding scheme, while these ailments, plus tiredness and chills, count as only four symptoms here.

[24] Unit values are listed in Table 14, p. 44 and aggregate benefits in Table I-3, p. I-17 [43]. Unit values were replaced with the following estimates from the present study: for children, $174 for one shortness of breath day, $160 for any other symptom, and $318 for acute bronchitis; for adults, $75 for any symptom. The first of these values is estimated from the regression in column (4) of Table III but is not reported in the paper while the other three estimates are taken from Table V.