PRELIMINARY AND INCOMPLETE: Comments welcome

Marginal rates of substitution between discounted health-state years in a utility-theoretic model of preferences over latent health risks

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ABSTRACT

BACKGROUND: The time-tradeoff (TTO) method typically describes some period of years in an adverse health state and asks respondents how many (fewer) years in "full health" they would accept to avoid the longer time period in the adverse health state. TTO studies have produced many useful insights, such as the finding that tradeoffs willingly made depend upon the age and gender of the respondent. In contrast to surveys that focus specifically on time tradeoffs, we use a large general-population conjoint choice survey in the U.S. that was designed to permit estimation of willingness to pay (WTP) by different types of respondents to reduce their risks of suffering illnesses with specified time profiles of future symptoms and outcomes. These WTP functions were intended to serve as monetized benefits estimates for benefit-cost analysis of public policies to reduce both morbidity and mortality risks.

OBJECTIVES: Our current analysis uses the same basic utility-theoretic choice model as for our WTP analyses, but focuses instead on the estimated marginal rate of substitution between discounted time in different pairs of health-states drawn from the set that includes pre-illness status quo health, sick time, recovered/remission time and lost life-years.

METHODS: A representative U.S. sample aged 25+ completed a computerized conjoint-analysis (discrete-choice experiment) survey. Each choice task involved two different health risk reductions for specific health threats described in terms of their future age-at-onset, duration, prognosis, and reduction in life expectancy. The pattern of future adverse health state durations—sick-years, recovered-years, and lost life-years—was randomly assigned for each age and gender (subject to basic plausibility exclusions). Respondents were provided with extensive tutorial material before being asked to choose their most preferred risk reduction program, where each program was described as a pin-prick diagnostic test that would provide their physician with information that would permit medication or other measures to reduce the health risk in question—at a specified annual cost. Respondents could also choose the status quo. Our utility-theoretic model to explain risk-reduction program choices employs a flexible second-order translog-type approximation for its discounted expected utility-differences, and permits marginal utility parameters associated with different health states to vary systematically (in general, quadratically) with respondent age and other characteristics.

RESULTS: Just as there is considerable heterogeneity across individuals and across health risks in WTP to reduce the risk of specific illness profiles, there is also considerable estimated heterogeneity in time-tradeoffs. Our initial models imply some very interesting heterogeneity across respondents of different ages, and we also plan extensions to explore differences by type of illness.

CONCLUSIONS: WTP estimates based on these data have been demonstrated to be consistent with the findings of wage-risk studies in the special case of sudden death in the current period, yet our model expands greatly the continuum of illness profiles for which monetized WTP amounts can be calculated. The current analysis permits us also to determine the extent to which respondent preferences elicited in our study imply time tradeoffs similar to those measured by more conventional TTO studies reported in the literature.

Introduction

Health economists have long been concerned with patients' subjective utilities in different health states. Cost-effectiveness in the allocation of scarce health-care resources across different types of patients implies that these resources should be moved around among patients until the marginal cost of an additional unit of "health" is equalized across patients. This requires, however, that health be measured in standardized units, on a one-dimensional cardinal scale. Unfortunately, different types of illnesses and injuries vary along an almost infinite number of dimensions, especially when one includes the heterogeneity stemming from differences in patient age and baseline health status.

The practical response to this problem has been the development of the concept of a quality adjusted life year (QALY). A year in perfect health is defined as one QALY. Being dead is defined as zero QALYs. States perceived as being worse than death are denoted as negative on the QALY scale. For the allocation of health-care resources, the relevant marginal costs are defined (roughly) as the number of dollars per QALY across alternative uses of scarce funding. Cost-effectiveness can be improved by withdrawing funding from high cost-per-QALY treatments and directing it, instead, towards treatments for which the cost per QALY is lower.

Cost-effectiveness calculations, however, take the total amount of resources allocated to health care as given. These calculations address the question of how to allocate that given amount of resources, but cannot respond to the question of whether the overall allocation of resources to health care is appropriate. Cost-effectiveness analysis cannot be used to determine whether more or fewer of society's resources should be allocated to health care as opposed to using these scarce resources to produce other things that people want and need, such as a cleaner environment, or better education, or more effective homeland security, etc. From an economic

efficiency standpoint, the relevant question is not the cost per QALY, but whether the marginal social benefit from additional resources devoted to particular types of health care exceeds the marginal social opportunity costs stemming from the need to forgo the other goods or services (public or private) that could be produced with those same resources. Benefit-cost analysis of the prevention and/or treatment of illnesses and injuries, however, requires monetized estimates of the benefits from reductions in illnesses and injuries, as well as the costs of prevention and/or treatment.

A further complication is that many decisions about the allocation of resources to the prevention of illnesses and/or injuries requires decisions to be made ex ante, in advance of anyone actually suffering these adverse health states. This contrasts with the situation when the question concerns the allocation of resources to alternative treatments, or across different illnesses or injuries. For treatments, it is appropriate to take into account some measure of the subjective disutilities of individuals who are already suffering from the illness or injury in question. Much of the QALY literature is devoted to measures of the time tradeoffs that people are willing to make, where they are asked how many years in their current health state they would give up to enjoy one year of perfect health. (Alternatively, they are asked how many years of perfect health are equivalent to one year in their current adverse health state.) All of these estimates, however, take the individual's current compromised health state as the status quo, from which they are asked to consider the alternative of "perfect health," which represents a "gain" in health status, relative to their current state.

For decisions about how to allocate resources across different times of prevention measures, however, the status quo is the individual's current health status, rather than the future prospective adverse health state. This current health status may not amount to perfect health, but

it is not the "sick" state. In deciding how much they are willing to give up to avoid suffering one year in a specific future adverse health state, they are being asked to contemplate a "loss." Economists are familiar with the notion of "loss aversion." Thus it can be expected that that willing tradeoffs when contemplating a loss will be less than tradeoffs expressed when contemplating a similar gain.

QALY information is also important to medical decision-making because alternative therapies can pose the need to make trade-offs between time spent in different health states. The canonical example concerns how to choose between one therapy that will increase a patient's life expectancy but provide a lower quality of life in the interim than an alternative therapy which will improve quality of life but will not extend life expectancy to the same extent. Which is "better"? The answer to this question depends upon the extent that patients are willing to make tradeoffs between sick-time and lost life-years. This will depend upon the individual's marginal rate of substitution between sick-time and lost life-years, which is determined by the ratio of the marginal (dis)utility of sick-time to the marginal (dis)utility of lost life-years (both of which can be expected to be negative).

Similar trade-offs between different adverse future health states must be contemplated when the goal is to evaluate different *preventative* health measures. These different preventive measures, for example, may increase the latency period before symptoms appear, but at the cost of exacerbating the illness when it does become apparent and perhaps shortening the lifespan of the patient. Other such measures may have the effect of reducing lost life-years, for example, by extending time in a recovered/remission state prior to death (for example, by extending the life-span of cancer survivors).

To understand tradeoffs from the perspective of decision-makers who are not yet afflicted with the illness in question, we require *ex ante* preferences defined over different spells of time in prospective future health states, preferably differentiated by disease. In a large stated-preference survey study, we surveyed roughly 2000 subjects from a representative population sample of the U.S. for people between 25 and 93 years old. From each individual, we elicited choices over a wide variety of health-risk reduction programs. Each respondent considered five independent choice scenarios, where each choice consisted of two different risk reduction programs and a "neither program" option. Each program was defined in terms of its annual cost and the original and reduced risk levels for suffering a specific illness. The illness was described in terms of the time profile of latency-years, sick-years, recovered/remission years, and lost life-years, and each illness profile was also given a name. These names were drawn randomly from a list that included heart disease, heart attack, breast cancer (for women), prostate cancer (for men), colon cancer, lung cancer, skin cancer, stroke, respiratory disease, traffic accidents, diabetes, and Alzheimer's disease. These random assignments were limited only by implausible matches, such as recovery from diabetes or Alzheimer's.

The random assignment of disease labels makes it possible to abstract from this attribute of the alternative health risks when modeling preferences over risk reductions that involve illnesses or injuries with specified future time periods in different health states. In other work Cameron and DeShazo (forthcoming), we have considered the evidence concerning respondents' willingness to pay (WTP) for reductions in their risks of experiencing different illness profiles. WTP is simply the marginal rate of substitution between money (wealth) and risk. Preliminary analysis of the systematic effects on WTP of the name of the illness or injury is described in Cameron et al. (2011). To date, however, we have yet to explore the other margins at which

people may trade off: between different health states when income and risk levels are held constant.

Review of Time-Tradeoff (TTO) Approaches in Health Economics

QALY measures standardize the health-related quality of life associated with different health conditions into a single univariate metric by weighting each life-year with a scale ranging from zero to one, where zero denotes a health status valued equivalent to death and one indicates full health. To calculate the QALY weights for quality of life in different health states, the TTO method relies on the tradeoffs that individuals might be willing to make between living longer in a less-than-perfect health state and living in a better health state, but for a shorter period.

The traditional TTO methodology involves eliciting the amount lifetime in full health (or in current health), x, that the individual considers equivalent to a given amount of time, y, in a specified health condition. The QALY weight for that health condition would then be the ratio x/y. For conditions stated to be worse-than dead, some studies adopt the adjustment procedure developed by Torrance et al. (1982) where the respondents choose between immediate death and living in full health for a given amount of time, x, followed by a period, y-x, in worse-than-dead condition. Here y is fixed and x is varied until the respondent is indifferent between the two alternatives. In this case, the utility value for that condition is –x/y-x.

One approach to elicit such preferences involves asking the respondents how much of their given remaining lifetime (e.g. remaining 20 years of life expectancy) they would be willing to trade off to avoid a certain health condition. Some examples of the exact wording from literature are given in Panel A of Table 1.

A more widely used approach parallel to the above-mentioned procedure is to ask the respondents to make a choice between living a fixed amount of time, y, in a given health state

and living a shorter amount of time, x, in full health (or current health). (See Panel B in Table 1) The value of x is changed in a series of questions iteratively (usually using a ping-pong method) until the respondent is indifferent between the two alternatives. Again, the health preference for the given condition is calculated to be x/y.

The health states presented in these TTO elicitations can be specific diseases often at a described severity with given symptoms. The respondents in these disease-specific studies are usually the patients who are already suffering from the given health condition. The idea is to obtain a value for the condition by eliciting the patient's valuation for their current health, as well as for the symptoms, complications and treatment options of the disease. In some studies, on the other hand, more generic health state description systems are used, and the EQ-5D health states appears to be the most widely used system. The EQ-5D system characterizes health in five dimensions (mobility, self-care, usual activities, pain/discomfort and anxiety/depression) where for each dimension there are three possible levels (no problems, some problem and extreme problems). For instance, the health state coded as 22111 in EQ-5D system indicates a health state where the individual has some problems in the first two dimensions, mobility and self-care, but no problems in the remaining three dimensions.

The studies using EQ-5D find the time in healthy state (defined as 11111) that the individuals consider equivalent to a given time in different EQ-5D states. Some of them, following the disease-specific studies mentioned above, define TTO as the ratio of the two time periods. However, some studies (e.g. Williams (1995); Craig and Busschbach (2011)) calculate the quality of life weights for each dimension at every possible level, and calculate the weight for a specific health state combination by subtracting relevant weights from one (i.e. perfect health). Similar multi-attribute approach is adopted for calculating quality of life weight for specific

complications or phases associated with different illnesses such as diabetes (e.g. Huang et al. (2007)) and breast cancer (e.g. Milne et al. (2006)). The idea is to build a standard measure that accommodates quality of life calculations for a unique combination of symptoms for a given disease.

More recently, discrete choice experiments (DCEs) has become one of the methods used in eliciting health utilities. In general, in DCEs, the respondents are asked to make a choice between hypothetical options where each option contains a set of attributes in varying levels. Given the utility of the respondent is a function of these attributes, the choices made can be used in estimating the relative importance of these attributes for the individual. The traditional choice TTO approach discussed above seems similar to DCE, the main distinction being that in traditional TTO, one of the options is always anchored to the same alternative (perfect health), and the time spent in the given health condition is not treated as an attribute.

The strong utility theoretic foundation of DCE makes it an appealing method for valuation of health outcomes. It has been argued that DCE gives more realistic quality of life indicators for especially chronic conditions where death is not a likely outcome, as people find it difficult to trade off life years for those conditions (Burr et al. (2007)). Also, there are concerns about the way traditional TTO elicitation is modeled to handle worse-than-dead scenarios (Craig and Busschbach (2011)). DCE is more flexible in allowing for worse-than-dead preferences. That is, in DCE setting the valuation of worse-than-dead conditions do not require special treatment,

Another advantage that DCE is claimed to have over traditional TTO methods is that DCE is easier to complete compared to traditional TTO. Bansback et al. (2012) point out that DCE simply requires the respondents to indicate the alternative they prefer, without going

through an iterative process of identifying the point where the respondent is indifferent between the two options, which potentially eliminates the need for an interviewer. They find that it takes much less time for the respondents to complete DCE tasks compared to TTO tasks, and unlike TTO, 'irrational' respondents have little influence on the results with DCE.

Considering these advantages DCE methods might be a valuable tool in estimation of QALY weights. In fact, Lancsar and Louviere (2008) point out:

> "…DCEs potentially can be used to derive utility weights for calculating QALYs. This requires further research and comparison to more standard methods such as time trade-off, standard gamble and the visual analogue scale and would require a large-scale study to investigate population values."

The recent studies in this direction mostly focus on using DCE in estimating weights for condition-specific symptoms (e.g. Burr et al. (2007); Ryan et al. (2006), Brazier et al. (2011)). In these studies, the respondents are given choice scenarios in which the attributes specific to a disease are varied, and time spent in given condition is not included as an attribute in choices. In a recent study, Bansback et al. (2012) calculate QALY weights for EQ-5D states using DCE. They include time spent in the given state as an attribute in choices. But they still estimate the weights for each dimension of health in every possible level, and use these in calculating TTO for a given state.

One important aspects of DCE relevant to TTO elicitations and QALY weight estimations is that it allows for the estimation of marginal rate of substitution (MRS) between any two attributes. This is useful in comparing the value of one dimension in any given health state relative to another. But what one further can do is to calculate TTO using the MRS between life years spent in a particular health state and healthy years.

I think this is a good place to talk about why the MRS calculations are superior in having stronger utility theoretic foundation, and in incorporating other things like age and utility of income in TTO calculations.

To facilitate comparison, some QALY weight estimates from the literature are presented in Table 2. It noted that only the conditions relevant to this study are included, and the studies presented in the table all use traditional TTO methods. It is possible to see that there is high variation in TTO estimates across studies for certain conditions such as stroke.

Overview of our Survey Data

We use data from a stated preference survey that elicits *WTP* for health risk reductions described more fully in a related paper Cameron and DeShazo (forthcoming). The survey was administered by Knowledge Networks, Inc. to a random general-population sample of respondents in the United States. Respondents are members of households selected by random-digit dialing techniques from the population of the United States. They are offered free internet access, and WebTV technology if necessary, in return for completing a few surveys every month. Since these respondents are part of a standing consumer panel, a large quantity of demographic and background information, such as health status and health history, is available for every member of the panel.[1]

The survey has five parts. The first part asks respondents to think about some of their own health habits and their subjective risks of suffering from the different classes of illness which will be the subject of the survey. The second part is a risk tutorial for the survey, where risks are displayed in three different ways and respondents are required to answer successfully a

[1] For a thorough description of the development of the survey and a single instance of the randomized survey instrument, see the compilation of Supplementary Materials that supports all papers in this series.

risk comprehension question. After 24 screens of preparation and training material, the third part of the survey asks the respondent to consider five different three-alternative conjoint choice sets.[2] In each choice scenario, respondents choose between Program A, Program B, and the status quo ("Neither Program") as seen in the example of a choice summary table in Figure 1. Each program reduces the risk that the individual will suffer a particular illness profile. The health risk reduction programs, as described to respondents, consist of a diagnostic pin-prick blood test given by the individual's doctor once per year that indicates whether the individual is at risk for the illness. If the blood test indicates the individual is at risk, then the doctor would prescribe medication and life-style changes (such as diet and exercise) and continue to monitor the individual.[3] Each illness profile consists of a brief description which includes the approximate age of the individual when the illness starts, the duration of the illness, the symptoms and treatments, and its anticipated effects on life expectancy. The risk reduction programs are characterized in terms of the expected risk reduction achieved by the program, and the cost of the program (expressed in both monthly and annual terms). All of the attributes are independently randomized, including the name of the illness, subject only to some basic plausibility constraints. Any more-efficient blocked design for the mixes of attributes in these experiments is precluded by the fact that eligible illness profiles are dictated by the gender and current age of the individual respondent (because illness profiles must be expressed relative to the individual's status quo life expectancy).[4]

[2] The "conjoint choice" terminology emerged from the marketing literature to describe choice tasks involving multiple alternatives each with multiple attributes.

[3] For traffic accidents, the program is described as "new airbag, braking, and impact reduction technologies that are becoming available. These will reduce your chance of injury or death due to auto accidents. These technologies can be built into new vehicles, or added to existing vehicles. You will probably pay the cost of these technologies all at once when you buy a new car or have the equipment installed in an older one. When we describe costs, we will convert them to monthly costs and also annual costs to make them easier to compare across programs."

[4] For a thorough description of the attributes used in the choice sets in this survey, see Section 3 of the Supplementary Materials (Details of the Choice Set Design).

The fourth part of the survey consists of debriefing questions which follow up on each conjoint choice task. The fifth part of the survey was taken separately by all panelists and gathers socio-demographic information that can be readily merged with the data collected expressly for this study.

The survey was administered to 2,439 respondents with a 79% response rate among invited panelists.

Overview of Random Utility Specification

[This section can be skipped if the reader is familiar with the derivations in Cameron and DeShazo (forthcoming).] Let the superscript *A* denote "under Program *A*" while *N* denotes "with no program". Let the superscript *H* denote "if the respondent remains healthy," while *S* denotes "if the respondent gets sick from this health threat." We suppress the i subscripts for individuals and write indirect utility levels as a function of net income and health status in each future period (already denoted *relative* to their current health) as follows.

(1)

$$
\begin{aligned}
V_t^{AH} &= f\left(netY_t\right) + \varepsilon_t^{AH} \\
V_t^{AS} &= f\left(netY_t\right) + \alpha_0 1\left(pre\text{-}illness_t\right) + \alpha_1 1\left(illness_t\right) + \alpha_2 1\left(recovered_t\right) + \alpha_3 1\left(lost\ life\text{-}year_t\right) + \varepsilon_t^{AS} \\
V_t^{NH} &= f\left(netY_t\right) + \varepsilon_t^{NH} \\
V_t^{NS} &= f\left(netY_t\right) + \alpha_0 1\left(pre\text{-}illness_t\right) + \alpha_1 1\left(illness_t\right) + \alpha_2 1\left(recovered_t\right) + \alpha_3 1\left(lost\ life\text{-}year_t\right) + \varepsilon_t^{NS}
\end{aligned}
$$

For future period t, we can write the difference in expected utility with program *A* and with no program (*N*).

(2)
$$\left[\left(1-\pi^{AS}\right)V_t^{AH} + \left(\pi^{AS}\right)V_t^{AS}\right] - \left[\left(1-\pi^{NS}\right)V_t^{NH} + \left(\pi^{NS}\right)V_t^{NS}\right]$$

To explain a decision taken today, based on the stream of future *differences* in expected indirect utilities across the two alternatives, these future quantities must be discounted back to the present.

The fact that net income and health status are assumed to be approximately level within each of the four different health states permits us to reverse the order of discounting and the taking of expectations. We can work in terms of the present discounted *time* in each health state, and simply multiply this by the utility of net income in that interval and by the (dis)utility of health status in that interval. We assume simple exponential discounting where the discount factor is $\delta^t = (1+r)^{-t}$. Each summation in the following terms runs from the present to the end of the individual's nominal lifespan.

$$
\begin{aligned}
pdve &= \sum \delta^t 1(\, pre\text{-}illness_t) \\
pdvi &= \sum \delta^t 1(illness_t) \\
pdvr &= \sum \delta^t 1(recovered_t) \\
pdvl &= \sum \delta^t 1(lost\ \ life\text{-}year_t)
\end{aligned}
\tag{3}
$$

For convenience, we define two other types of present discounted time intervals, $pdvp = pdve + pdvr$, which captures just the time where the individual is neither sick nor dead, and $pdvc = pdve + pdvi + pdvr + pdvl$, which corresponds to the entire remainder of the individual's nominal lifespan.

We will now develop, separately, the "present discounted expected" form of the three parts of the indirect utility function: the net income terms, the health status terms, and the error term. Fortunately, we find no strong evidence that the marginal utility of net income depends on these probabilistic future health states (or vice versa) in any of the models explored in the main

paper. In other work, we find some evidence of the dependence of the marginal utility of net income on current health, but this is the numeraire health state in the main paper.

Development of the net income term

Table 1 shows the pattern of income and program costs over the individual's future life-years, as a function of whether the program is selected and whether he/she gets sick. The net income level, $netY_t$, will differ according to the type of health state, whether the program is currently being paid for, and whether the individual gets sick or stays healthy:

We can make use of our notation for discounted future time intervals, plus the pattern of net income amounts under the four different outcomes as displayed in Table 1, to specify the discounted future expected utility from net income (noting that $pdve + pdvi + pdvr = pdvc - pdvl$). [5]

The discounted future expected utility from net income and future health states can then be written as follows:

$$\begin{bmatrix} \left(1-\pi^{AS}\right) f\left(Y-c\right) pdvc \\ +\left(\pi^{AS}\right)\left[f\left(Y-c\right) pdve + f\left(\gamma_1 Y-\gamma_3 c\right) pdvi + f\left(Y-c\right) pdvr + f\left(\gamma_2 Y-\gamma_4 c\right) pdvl \right] \end{bmatrix} \quad (4)$$
$$-\begin{bmatrix} \left(1-\pi^{NS}\right) f\left(Y\right) pdvc \\ +\left(\pi^{NS}\right)\left[f\left(Y\right) pdve + f\left(\gamma_1 Y\right) pdvi + f\left(Y\right) pdvr + f\left(\gamma_2 Y\right) pdvl \right] \end{bmatrix}$$

Distribute the probabilities and rearrange to get:

---

[5] The parameters γ_1 and γ_2 allow different assumptions about the fraction of the respondent's current income that would be received if they are sick or dead from the illness in question. The parameters γ_3 and γ_4 allow varying assumptions about what fraction of risk reduction costs the respondent would be obliged to pay when sick or dead. Note that in any model wherein indirect utility is not a linear function of net income, it appears to be necessary (to make it straightforward to solve for c) to limit the coefficients γ_3 (the fraction of program costs paid while sick) and γ_4 (the fraction of program costs paid after death) to take on only the values 0 or 1. Otherwise, it is prohibitively difficult to solve the utility-difference function for an expression for willingness to pay (WTP).

$$
\begin{aligned}
& f\left(Y-c\right) pdvc-\pi^{AS} f\left(Y-c\right) pdvc+\pi^{AS} f\left(Y-c\right)\left(pdve+ pdvr\right) \\
& \quad +\pi^{AS} f\left(\gamma_1 Y-\gamma_3 c\right) pdvi+\pi^{AS} f\left(\gamma_2 Y-\gamma_4 c\right) pdvl \\
& -f\left(Y\right) pdvc+\pi^{NS} f\left(Y\right) pdvc-\pi^{NS} f\left(Y\right)\left(pdve+ pdvr\right) \\
& \quad -\pi^{NS} f\left(\gamma_1 Y\right) pdvi-\pi^{NS} f\left(\gamma_2 Y\right) pdvl
\end{aligned}
\tag{5}
$$

We have noted that each of γ_3 and γ_4 may take on only the values of 0 or 1. If $\gamma_3 = 1$, then γ_1 must also be 1, so that $\gamma_1 Y - \gamma_3 c = Y - c$ and this term can be grouped with the other terms in $Y - c$. Likewise, if $\gamma_4 = 1$, then we must have $\gamma_2 = 1$ so that this term may also be included in the same group of terms. However, if $\gamma_3 = 0$, then $0 \le \gamma_1 \le 1$ can be accommodated and the term $\gamma_1 Y - \gamma_3 c = \gamma_1 Y$ can be grouped with the other term in $\gamma_1 Y$.

Gathering the terms in $f\left(Y-c\right)$, $f\left(Y\right)$, $f\left(\gamma_1 Y\right)$ and $f\left(\gamma_2 Y\right)$ and simplifying allows equation (5) to be written as follows. (Note that the fact that γ_3 and γ_4 can take on only the values of zero or one means that they can be used as indictors to switch on and off the presence of terms in $pdvi$ and $pdvl$.)

$$
\begin{aligned}
& f\left(Y-c\right)\left[\left(1-\pi^{AS}\right) pdvc+\pi^{AS}\left(pdve+\gamma_3 pdvi+ pdvr+\gamma_4 pdvl\right)\right] \\
& \quad + f\left(Y\right)\left[(-1)\left\{\left(1-\pi^{NS}\right) pdvc+\pi^{NS}\left(pdve+ pdvr\right)\right\}\right] \\
& + f\left(\gamma_1 Y\right)\left[\left((1-\gamma_3)\pi^{AS}-\pi^{NS}\right) pdvi\right] \\
& + f\left(\gamma_2 Y\right)\left[\left((1-\gamma_4)\pi^{AS}-\pi^{NS}\right) pdvl\right]
\end{aligned}
\tag{6}
$$

To permit the use of further abbreviations for the terms which multiply the function $f\left(\cdot\right)$ in each of its four forms, we denote the four terms in square brackets in equation (6) as:

$$
\begin{aligned}
cterm &= \left(1-\pi^{AS}\right) pdvc + \pi^{AS}\left(pdve + \gamma_3 pdvi + pdvr + \gamma_4 pdvl\right) \\
yterm1 &= (-1)\left\{\left(1-\pi^{NS}\right) pdvc + \pi^{NS}\left(pdve + pdvr\right)\right\} \\
yterm2 &= \left((1-\gamma_3)\pi^{AS} - \pi^{NS}\right) pdvi \\
yterm3 &= \left((1-\gamma_4)\pi^{AS} - \pi^{NS}\right) pdvl
\end{aligned}
\tag{7}
$$

In the definitions in (7), it should be clear that depending upon whether γ_3 and γ_4 are either 0 or 1, two terms in $cterm$ and one term each in $yterm2$ and $yterm3$ will be switched either on or off, accordingly.

For estimation of the parameters of the model, we use these components to construct the net-income-related variable in the formula for the discounted expected utility difference:

$$
bXterm = f\left(Y-c\right) cterm + f\left(Y\right) yterm1 + f\left(\gamma_1 Y\right) yterm2 + f\left(\gamma_2 Y\right) yterm3 \tag{8}
$$

where $bXterm$ uses the indicator X to signify models with different functions $f(\cdot)$. The estimated coefficient on this variable can be interpreted as the marginal indirect utility associated with transformed net income, $f(Y)$, which has been factored out of each term involving $f(\cdot)$ on the right-hand-side of equation _.

Development of the health-state-related term

Table 2 lays out the pattern of *utility* levels as a function of health states over the individual's remaining life-years, according to whether he/she suffers the illness profile in question. We assume that our subjects view future health states, when "healthy" or "sick," as being unaffected by whether Program *A* or No Program is selected (given that there is merely a *lesser* chance of getting sick if the risk reduction program is selected, not a *zero* chance). All that is affected by Program *A* is the *risk* of suffering this illness profile, not the illness profile itself. Unlike the net

income profiles, therefore, the "net health" profile over time depends only on whether the individual gets sick.

Written in its extensive form the difference in discounted expected health states between Program *A* and no program is given by:

$$(9)\qquad \begin{bmatrix} \left(1-\pi^{AS}\right)\left[\alpha_0 pdve+\alpha_0 pdvi+\alpha_0 pdvr+\alpha_0 pdvl\right] \\ +\left(\pi^{AS}\right)\left[\alpha_0 pdve+\alpha_1 pdvi+\alpha_2 pdvr+\alpha_3 pdvl\right] \end{bmatrix} - \begin{bmatrix} \left(1-\pi^{NS}\right)\left[\alpha_0 pdve+\alpha_0 pdvi+\alpha_0 pdvr+\alpha_0 pdvl\right] \\ +\left(\pi^{NS}\right)\left[\alpha_0 pdve+\alpha_1 pdvi+\alpha_2 pdvr+\alpha_3 pdvl\right] \end{bmatrix}$$

Distributing the probability terms and simplifying yields:

$$(10)\qquad \left(\pi^{AS}-\pi^{NS}\right)\begin{bmatrix} \left(\alpha_0-\alpha_0\right) pdve \\ +\left(\alpha_1-\alpha_0\right) pdvi \\ +\left(\alpha_2-\alpha_0\right) pdvr \\ +\left(\alpha_3-\alpha_0\right) pdvl \end{bmatrix}$$

If we normalize future health-related utility on the individual's *status quo* health state, equivalent to setting $\alpha_0 = 0$, and express the change in the risk of the illness profile due to Program A as $\Delta\pi^{AS} = \pi^{AS} - \pi^{NS}$, we can write this term more simply as:

$$(11)\qquad \left(\alpha_1 pdvi+\alpha_2 pdvr+\alpha_3 pdvl\right)\Delta\pi^{AS} = \alpha\text{term}\,\Delta\pi^{AS}$$

Here, the estimated α_j parameters are the (dis)utilities from one unit of time in each adverse health state, *relative to* the individual's current pre-illness health status. This normalization is particularly convenient. However, it imposes some strong assumptions which we explore in other work, where we allow these marginal disutilities of adverse future health states to depend upon current morbidities and comorbidities, and upon subjective risks for the health problem in question and other major types of health risks. The marginal disutilities estimated in our basic

models must be interpreted as averages, across the current population distribution of health states and health outlooks, for the U.S. population 25 years and older, across the range of health threats names in our study.

Development of the error term

For completeness, the assumed independent and identically error terms in each of the four variants of indirect utility in each future period are combined in a similar fashion:

$$(12) \qquad \left[\left(1-\pi^{AS}\right)\varepsilon_t^{AH}+\left(\pi^{AS}\right)\varepsilon_t^{AS}\right]-\left[\left(1-\pi^{NS}\right)\varepsilon_t^{NH}+\left(\pi^{NS}\right)\varepsilon_t^{NS}\right]$$

When discounted back to the present, we assume the resulting differences in expected error terms (across the healthy and sick outcomes) are cooperative in being distributed in a manner consistent with the assumptions necessary for the use of McFadden's conditional logit choice model.

The difference in discounted expected utilities that drives choices

We can now assemble the discounted net income terms, the discounted health state terms, and the discounted error terms to yield the difference in discounted expected utilities that is assumed to drive the individual's choice between Program A and "No program."

$$(13) \qquad \Delta PDV\left(E\left[V\right]\right)=\left\{\begin{array}{l} f\left(Y-c\right)cterm \\ \quad +f\left(Y\right)yterm1 \\ +f\left(\gamma_1 Y\right)yterm2 \\ +f\left(\gamma_2 Y\right)yterm3 \end{array}\right\}+\alpha term\,\Delta\pi^{AS}+\varepsilon$$

where $aterm=\left[\alpha_1 pdvi+\alpha_2 pdvr+\alpha_3 pdvl\right]$, to simplify the notation in what follows.[6] This is the basis for the estimating equations used in our papers.

[6] We generalize our specification so that utility is not merely linear in the level of discounted future health-state years, so $\alpha term$ will be more complex than this. It will involve nonlinear and interaction terms, as well as heterogeneity in some of the parameters with respect to respondent age.

Generalization to the case of three alternatives simply means we introduce a second "difference" equation analogous to equation **Error! Reference source not found.**, but for risk reduction Program B, relative to "No Program." Program costs and the size of the risk reduction, as well as the relevant illness profile, will differ between the two programs. For the "Neither program" alternative, of course, the "difference relative to Neither Program" is zero for all variables. There is no difference in net income because program costs are not incurred, and the term involving the health profile is zero because there is no reduction in the risk of experiencing that profile (i.e. $\Delta\pi^{jS} = 0$). The health risk is still present, but since neither program is selected, no reduction in risk is achieved.

All that remains is to choose a specific functional form for $f(\cdot)$ and to decide whether preferences are homogeneous or whether the data suggest that they should be specified as heterogeneous (i.e. a function of observable individual attributes). In Cameron and DeShazo (forthcoming) and in this paper, we depart from this model based on future individual *per-period* health state utilities. Instead, we allow individuals' decisions to be based directly on "present discounted time in future adverse health states" as the proximal determinants of choice. The choices we present to our subjects are forward-looking illness-scenarios, not experienced illnesses. Thus we consider nonlinear forms in $pdvi$, $pdvr$, and $pdvl$, and find that a flexible translog-type functional form seems to provide the best fit to the choice data among familiar and easily estimated forms.

The data also suggest that the function $f(\cdot)$ should be nonlinear. We have explored quadratic forms, and square-root forms, but we have settled on Box-Cox-type forms with a

transformation parameter of 0.45, determined via a line-search.[7] We treat this parameter as a known constant, rather than estimating it using a fixed effects conditional logit model with a nonlinear-in-parameters "index" ($x\beta$ term) since such a model is not readily available in packaged software.[8]

The systematic portion of equation (13), provided it can be written as a linear-in-*parameters* function of variables constructed from our data, can be interpreted as the $x\beta$ term in the standard conditional logit (and fixed effects conditional logit) models that we use to estimate the parameters of our models. In other work, we are developing models which permit nonlinearities in parameters in the logit index, in particular to accommodate estimated values of the discounting parameter. We treat the discount parameter as fixed in the present paper, and rely upon sensitivity analyses with respect to the assumed discount rate.[9]

Adaptation of Fitted Model to TTO calculations

Eliminate uncertainty; Use absolute utility rather than utility differences

[The material in this section is unique to this paper.] As a starting point, we base our model on the estimating specification used in Cameron and DeShazo (forthcoming). First, we take the actual estimating form of the model and make all possible substitutions by expanding the various simplifying abbreviations so that the utility-difference is expressed in its full extensive form,

[7] The quadratic form is the most general, but it involves one more parameter and it also permits marginal utility to go negative at extreme values of net income in some models with heterogeneous marginal utilities. The square root form is very close to the Box-Cox transformation with a parameter of 0.5, but reviewers of our early results have suggested that the 0.45 parameter may be preferable.

[8] Treating this value of the parameter as fixed is certainly no worse than using a linear or logarithmic specification and implicitly assuming a Box-Cox transformation parameter that is fixed at one or zero.

[9] These tables are yet to be added. In Cameron and DeShazo (forthcoming) we demonstrate the results from using of individual-specific discount rates, predicted based on a discounting model that has been estimated using a separate sample of approximately 4000 subjects drawn from the same population. These individual financial discount rates tend to be greater than 5%. However, when we take the utility parameters from this model and simulate, counterfactually, what would be respondents' predicted WTP amounts if their discount rates had been 5%, the results are very close to those from a model that simply assumes a 5% discount rate for all. Thus we calculate marginal rates of substitution in this paper based on the 5% assumption.

based only on income and the cost of the program, the probabilities, and discounted time in each health state. Note that the marginal utility of a discounted pre-illness/healthy year, α_0, is normalized at zero (utility is only ordinal, not cardinal, so we must benchmark it at some level).[10] With all substitutions, the utility difference $\Delta PDV\left(E[V_i^A]\right)$ that is that is assumed to drive a subject's choice between intervention program A and the status quo (N), can be expressed as follows:

(14)

$$
\begin{aligned}
&\Delta PDV\left(E\left[V_i^A\right]\right) \\
&= \beta_0 \left\{ \begin{array}{l}
\left[\frac{\left(Y_i - c_i^j\right)^{0.45} - 1}{0.45}\right]\left[\begin{array}{l}\left(1-\pi^{AS}\right)\left(pdve_i^j + pdvi_i^j + pdvr_i^j + pdvl_i^j\right) \\ +\left(\pi^{AS}\right)\left(pdve_i^j + \gamma_3 pdvi_i^j + pdvr_i^j + \gamma_4 pdvl_i^j\right)\end{array}\right] \\
+\left[\frac{\left(Y_i\right)^{0.45} - 1}{0.45}\right]\left[(-1)\left\{\begin{array}{l}\left(1-\pi^{NS}\right)\left(pdve_i^j + pdvi_i^j + pdvr_i^j + pdvl_i^j\right) \\ +\left(\pi^{NS}\right)\left(pdve_i^j + pdvr_i^j\right)\end{array}\right\}\right] \\
+\left[\frac{\left(\gamma_1 Y_i\right)^{0.45} - 1}{0.45}\right]\left[\left((1-\gamma_3)\pi^{AS} - \pi^{NS}\right) pdvi_i^j\right] \\
+\left[\frac{\left(\gamma_2 Y_i\right)^{0.45} - 1}{0.45}\right]\left[\left((1-\gamma_4)\pi^{AS} - \pi^{NS}\right) pdvl_i^j\right]
\end{array} \right\} \\
&+\alpha_{10}\left[\Delta\pi_i^{jS}\log\left(pdvi_i^j + 1\right)\right] + \alpha_{20}\left[\Delta\pi_i^{jS}\log\left(pdvr_i^j + 1\right)\right] + \alpha_{21}\left[age_{i0}\times\Delta\pi_i^{jS}\log\left(pdvr_i^j + 1\right)\right] \\
&+\alpha_{30}\left[\Delta\pi_i^{jS}\log\left(pdvl_i^j + 1\right)\right] + \alpha_{31}\left[age_{i0}\times\Delta\pi_i^{jS}\log\left(pdvl_i^j + 1\right)\right] + \alpha_{32}\left[age_{i0}^2\times\Delta\pi_i^{jS}\log\left(pdvl_i^j + 1\right)\right] \\
&+\alpha_{40}\left\{\Delta\pi_i^{jS}\left[\log\left(pdvl_i^j + 1\right)\right]^2\right\} + \alpha_{41}\left\{age_{i0}\times\Delta\pi_i^{jS}\left[\log\left(pdvl_i^j + 1\right)\right]^2\right\} \\
&+\alpha_{42}\left\{age_{i0}^2\times\Delta\pi_i^{jS}\left[\log\left(pdvl_i^j + 1\right)\right]^2\right\} \\
&+\alpha_{50}\left\{\Delta\pi_i^{jS}\left[\log\left(pdvi_i^j + 1\right)\right]\times\left[\log\left(pdvl_i^j + 1\right)\right]\right\} \\
&+\alpha_{51}\left\{age_{i0}\times\Delta\pi_i^{jS}\left[\log\left(pdvi_i^j + 1\right)\right]\times\left[\log\left(pdvl_i^j + 1\right)\right]\right\} + \varepsilon_i^j
\end{aligned}
$$

[10] In the QALY literature, typically, the "perfect health" state is normalized at 1.0 on a scale of 0 to 1, which is equally arbitrary.

In other papers, it has been our goal is to solve for a subject's maximum willingness to pay for an intervention program that produces a given-sized reduction in the risk of suffering the specified illness profile. In that case, we merely set this discounted expected utility-difference equal to zero and solve for the annual payment c_i^{j*} that would make this individual just indifferent between paying that annual amount and enjoying the risk reduction, or not paying and putting up with the risk. In this paper, however, our goal is to consider what our fitted utility parameters imply about the tradeoffs that people are willing to make, at the margin, between discounted latency-years ($pdve_i^j$), discounted sick-years ($pdvi_i^j$), discounted recovered/remission years ($pdvr_i^j$) and discounted lost life-years ($pdvl_i^j$).

To develop the intuition necessary to solve for estimates of these tradeoffs, we first review the concept of a total derivative:

$$dF = \frac{\partial F}{\partial x}dx + \frac{\partial F}{\partial y}dy + ... \tag{15}$$

If we wish to consider changes in the levels of x and y that will leave the value of the function F unchanged, we can set $dF = 0$ and set all other permutations besides dx and dy equal to zero. Then

$$\frac{dy}{dx} = -\frac{\partial F}{\partial x} \Big/ \frac{\partial F}{\partial y} \tag{16}$$

In this context, for example, we might be interested in knowing "healthy year equivalents" for time spent in different morbid states. If $y = pdve$ and $x = pdvi$, this expression answers the question "How many discounted healthy/pre-illness years are equivalent to one discounted sick-year." This is presumably a number less than one, and this is a way to establish the time trade-off between sick-time and healthy-time.

However, this method can also be used to estimate the tradeoffs that people are willing to make between other pairs of health states: between discounted sick-years and discounted recovered/remission years, between recovered/remission years and lost life-years, and directly between sick-years and lost life-years. The first step in determining these tradeoffs is to compute each of the four derivatives, one for each discounted health state.

When we *estimate* the parameters of the indirect utility-difference function, we must accommodate the complex probabilistic scenarios in the choice sets, especially respondents' possible interpretations of the time profile of income Y_i and program costs c_i^j as a function of the pattern of health states in the future if they do, or do not, develop the illness or experience the injury described in the choice scenario. For the simple question about tradeoffs between discounted time in different health states, however, the set of circumstances we wish to simulate is no longer one where the individual is *uncertain* about the probability of experiencing the health profile in question. We are no longer dealing with a choice between two program alternatives that differ in their implications for the individual's net income through their different effects on income and program costs over time. Instead, we are considering the individual's utility function if they experience a given adverse health profile.

Our estimated utility function can thus be tailored to the case where a given illness profile is experienced with certainty, and assuming that no intervention program is available. In this case, the *level* of indirect utility will be given by:

$$
\begin{aligned}
& PDV(V_i^{Nj}) \\
& = \beta_0 \left\{ \left[\frac{(Y_i)^{0.45} - 1}{0.45} \right] \left[pdve_i^j + pdvr_i^j \right] + \left[\frac{(\gamma_1 Y_i)^{0.45} - 1}{0.45} \right] \left[pdvi_i^j \right] + \left[\frac{(\gamma_2 Y_i)^{0.45} - 1}{0.45} \right] \left[pdvl_i^j \right] \right\} \\
& + \alpha_{10} \left[\log\left(pdvi_i^j + 1 \right) \right] + \alpha_{20} \left[\log\left(pdvr_i^j + 1 \right) \right] + \alpha_{21} \left[age_{i0} \times \log\left(pdvr_i^j + 1 \right) \right] \\
& + \alpha_{30} \left[\log\left(pdvl_i^j + 1 \right) \right] + \alpha_{31} \left[age_{i0} \times \log\left(pdvl_i^j + 1 \right) \right] + \alpha_{32} \left[age_{i0}^2 \times \log\left(pdvl_i^j + 1 \right) \right] \\
& + \alpha_{40} \left\{ \left[\log\left(pdvl_i^j + 1 \right) \right]^2 \right\} + \alpha_{41} \left\{ age_{i0} \times \left[\log\left(pdvl_i^j + 1 \right) \right]^2 \right\} + \alpha_{42} \left\{ age_{i0}^2 \times \left[\log\left(pdvl_i^j + 1 \right) \right]^2 \right\} \\
& + \alpha_{50} \left\{ \left[\log\left(pdvi_i^j + 1 \right) \right] \times \left[\log\left(pdvl_i^j + 1 \right) \right] \right\} \\
& + \alpha_{51} \left\{ age_{i0} \times \left[\log\left(pdvi_i^j + 1 \right) \right] \times \left[\log\left(pdvl_i^j + 1 \right) \right] \right\} + \varepsilon_i^j
\end{aligned}
\tag{17}
$$

Our estimated parameters for this indirect utility function are based upon respondents' choices among risk reduction programs when the health profiles are uncertain. These parameters can be used, as in the above equation, to characterize the level of utility implied by these choices for a health state where some or all of the discounted time periods corresponding to sick-years, recovered/remission years, and lost life-years are non-zero. For a health profile where all future time periods represent a continuation of the current health state and all remaining life years consist of the individual's current health state. In that case, utility would be given simply by:

$$
PDV(V_i^{Nj}) = \beta_0 \left\{ \left[\frac{(Y_i)^{0.45} - 1}{0.45} \right] \left[pdvc_i^j \right] \right\} + \varepsilon_i^j \tag{18}
$$

Where $pdvc_i = pdve_i^j + pdvi_i^j + pdvr_i^j + pdvl_i^j$, or the respondents remaining nominal life expectancy.

We now need to calculate the derivative of the expression for utility under the illness profile with respect to the duration of discounted time in each health state:

$$\frac{\partial PDV(V_i^{Nj})}{\partial pdve_i^j} = \beta_0 \left[\frac{\left(Y_i\right)^{0.45} - 1}{0.45} \right]$$

$$\frac{\partial PDV(V_i^{Nj})}{\partial pdvi_i^j} = \beta_0 \left[\frac{\left(\gamma_1 Y_i\right)^{0.45} - 1}{0.45} \right] + \frac{1}{\left(pdvi_i^j + 1 \right)} \left[\alpha_{10} + \left(\alpha_{50} + \alpha_{51} age_{i0} \right) \log\left(pdvl_i^j + 1 \right) \right]$$

(19)
$$\frac{\partial PDV(V_i^{Nj})}{\partial pdvr_i^j} = \beta_0 \left[\frac{\left(Y_i\right)^{0.45} - 1}{0.45} \right] + \frac{1}{\left(pdvr_i^j + 1 \right)} \left[\alpha_{20} + \alpha_{21} age_{i0} \right]$$

$$\frac{\partial PDV(V_i^{Nj})}{\partial pdvl_i^j} = \beta_0 \left[\frac{\left(\gamma_2 Y_i\right)^{0.45} - 1}{0.45} \right] + \frac{1}{\left(pdvl_i^j + 1 \right)} \left[\begin{array}{l} (\alpha_{30} + \alpha_{31} age_{i0} + \alpha_{32} age_{i0}^2) \\ +2(\alpha_{40} + \alpha_{41} age_{i0} + \alpha_{42} age_{i0}^2) \log\left(pdvl_i^j + 1 \right) \\ +\left(\alpha_{50} + \alpha_{51} age_{i0} \right) \log\left(pdvi_i^j + 1 \right) \end{array} \right]$$

It is important to note that we cannot compare individual utility levels, so we have normalized all of the utilities for each individual on their utility under their current health state (whatever that may be). The utility function in equation (17) is additively separable in the discounted prospective flow of all other goods (i.e. income) over time and the discounted pattern of different health states. The first derivative in equation (19), for example, shows that the extra utility for an extra year in the individual's current health state is simply the utility from an additional year of consumption of all other goods and services (as measured by income). Baseline utility from health is normalized to zero.

These derivatives imply that the number of discounted healthy years that would be viewed as equivalent to one discounted year in the sick state would be given by:

(20)
$$\frac{\dfrac{\partial PDV(V_i^{Nj})}{\partial pdvi_i^j}}{\dfrac{\partial PDV(V_i^{Nj})}{\partial pdve_i^j}} = \frac{\beta_0 \left[\dfrac{\left(\gamma_1 Y_i\right)^{0.45} - 1}{0.45} \right] + \dfrac{1}{\left(pdvi_i^j + 1 \right)} \left[\alpha_{10} + \left(\alpha_{50} + \alpha_{51} age_{i0} \right) \log\left(pdvl_i^j + 1 \right) \right]}{\beta_0 \left[\dfrac{\left(Y_i\right)^{0.45} - 1}{0.45} \right]}$$

Analogously, the number of discounted lost life years that an individual would be willing to trade for one more year in the healthy state would be:

$$(21)\quad \frac{\dfrac{\partial PDV(V_i^{Nj})}{\partial pdve_i^j}}{\dfrac{\partial PDV(V_i^{Nj})}{\partial pdvl_i^j}} = \frac{\beta_0\left[\dfrac{(Y_i)^{0.45}-1}{0.45}\right]}{\beta_0\left[\dfrac{(\gamma_2 Y_i)^{0.45}-1}{0.45}\right]+\dfrac{1}{\left(pdvl_i^j+1\right)}\left[\begin{array}{l}(\alpha_{30}+\alpha_{31}age_{i0}+\alpha_{32}age_{i0}^2)\\ +2(\alpha_{40}+\alpha_{41}age_{i0}+\alpha_{42}age_{i0}^2)\log\left(pdvl_i^j+1\right)\\ +\left(\alpha_{50}+\alpha_{51}age_{i0}\right)\log\left(pdvi_i^j+1\right)\end{array}\right]}$$

Finally, we might be interested to know how many years of a major illness such as the ones in our choice scenarios, on average, would be viewed by respondents as equivalent to a lost-life year.

$$(22)\quad \frac{\dfrac{\partial PDV(V_i^{Nj})}{\partial pdvl_i^j}}{\dfrac{\partial PDV(V_i^{Nj})}{\partial pdvi_i^j}} = \frac{\beta_0\left[\dfrac{(\gamma_2 Y_i)^{0.45}-1}{0.45}\right]+\dfrac{1}{\left(pdvl_i^j+1\right)}\left[\begin{array}{l}(\alpha_{30}+\alpha_{31}age_{i0}+\alpha_{32}age_{i0}^2)\\ +2(\alpha_{40}+\alpha_{41}age_{i0}+\alpha_{42}age_{i0}^2)\log\left(pdvl_i^j+1\right)\\ +\left(\alpha_{50}+\alpha_{51}age_{i0}\right)\log\left(pdvi_i^j+1\right)\end{array}\right]}{\beta_0\left[\dfrac{(\gamma_1 Y_i)^{0.45}-1}{0.45}\right]+\dfrac{1}{\left(pdvi_i^j+1\right)}\left[\alpha_{10}+\left(\alpha_{50}+\alpha_{51}age_{i0}\right)\log\left(pdvl_i^j+1\right)\right]}$$

The real power of this model, however, comes when we differentiate the utility parameters associated with the different phases of a health profile according to the type of illness or injury in question. In Cameron et al. (2011), we have allowed each of the preference parameters in our basic specification, above, to vary systematically with the name associated with the particular illness as it was described in the choice scenarios presented to our respondents.

In our stylized illness profiles, the mix of attributes (e.g. the pattern of time in each future health state) was randomized independently from the names attached to the illness profiles,

except for a few combinations that would be implausible (such as recovery from Alzheimer's Disease, or sudden death from diabetes, with no prior morbidity). Thus there should be very little in the way of omitted variables bias if we estimate our model without controlling for the illness names. However, it is plausible that people will derive different amounts of (dis)utility, ex ante, from different prospective illnesses, so it is appropriate to allow the marginal (dis)utility parameters to differ systematically with a set of indicator variables that distinguish the illness names. We normalize on "heart disease."

It is also possible that the type of prospective illness will confer some autonomous difference in utility, independent of its pattern of future health states. The baseline autonomous utility is set to zero, but we introduce alternative-specific regressors into our choice model that permit overall utility to vary with the identity of the illness. In the context of our model, we accommodate heterogeneity by type of health risk via a vector of illness-name indicators, which we will denote as $D_i^j = 1$ if we are considering illness/disease j i from the perspective of individual i. Each α_k parameter in the equations above will be converted into a systematically varying parameter: $\alpha_k = \alpha_{k0} + \alpha_{k1} D_{1i}^j + \cdots + \alpha_{k11} D_{11i}^j$, where subscripts 1 through 11 signify the eleven illness names other than heart disease, the base case, for which α_{k0} will be the relevant version of the parameter in question. In vector notation, we will denote this inner product as $D_i^j \alpha_k$, where α_k is now a vector, rather than a simple scalar. We will denote the autonomous utility associated with a particular illness as $D_i^j \theta = \theta_1 D_{1i}^j + \cdots \theta_{11} D_{11i}^j$ where there is no "intercept" in this systematically varying parameter because the baseline is normalized to zero for heart disease.

(23)

$$
\begin{aligned}
&PDV(V_i^{Nj}) \\
&= \beta_0 \left\{ \left[\frac{(Y_i)^{0.45} - 1}{0.45} \right] \left[pdve_i^j + pdvr_i^j \right] + \left[\frac{(\gamma_1 Y_i)^{0.45} - 1}{0.45} \right] \left[pdvi_i^j \right] + \left[\frac{(\gamma_2 Y_i)^{0.45} - 1}{0.45} \right] \left[pdvl_i^j \right] \right\} \\
&+ D_i^j \theta + D_i^j \alpha_{10} \left[\log\left(pdvi_i^j + 1 \right) \right] + D_i^j \alpha_{20} \left[\log\left(pdvr_i^j + 1 \right) \right] + D_i^j \alpha_{21} \left[age_{i0} \times \log\left(pdvr_i^j + 1 \right) \right] \\
&+ D_i^j \alpha_{30} \left[\log\left(pdvl_i^j + 1 \right) \right] + D_i^j \alpha_{31} \left[age_{i0} \times \log\left(pdvl_i^j + 1 \right) \right] + D_i^j \alpha_{32} \left[age_{i0}^2 \times \log\left(pdvl_i^j + 1 \right) \right] \\
&+ D_i^j \alpha_{40} \left\{ \left[\log\left(pdvl_i^j + 1 \right) \right]^2 \right\} + D_i^j \alpha_{41} \left\{ age_{i0} \times \left[\log\left(pdvl_i^j + 1 \right) \right]^2 \right\} + D_i^j \alpha_{42} \left\{ age_{i0}^2 \times \left[\log\left(pdvl_i^j + 1 \right) \right]^2 \right\} \\
&+ D_i^j \alpha_{50} \left\{ \left[\log\left(pdvi_i^j + 1 \right) \right] \times \left[\log\left(pdvl_i^j + 1 \right) \right] \right\} \\
&+ D_i^j \alpha_{51} \left\{ age_{i0} \times \left[\log\left(pdvi_i^j + 1 \right) \right] \times \left[\log\left(pdvl_i^j + 1 \right) \right] \right\} + \varepsilon_i^j
\end{aligned}
$$

The autonomous components of utility, $D_i^j \theta$, enter in an additively separable fashion, so they will not affect any of the derivatives relevant to the calculation of time tradeoffs. The introduction of systematically varying parameters for the (dis)utility of adverse health states therefore amounts to no more than a generalization of each of the key parameters in the model. The data are permitted to dictate which coefficient differentials, relative to "heart disease" are statistically significantly different from zero, and we use a robust and parsimonious specification. In general, however, the array of tradeoff calculations we outline above can be generalized very easily.

In particular, we note that the more-general model permits us to ask about time tradeoffs between discounted years in current health, versus discounted sick-years in a variety of different illnesses, or between sick-years from one illness and sick-years from another illness. For example, illnesses *k* and *j* will toggle different indicator variables in the vector of indicators that

activates different utility-parameter differentials in the more general version of the utility function. The following formula tells us how many years with illness *j* are viewed as equivalent to one year with illness *k*.

$$(24)\quad \frac{\frac{\partial PDV(V_i^{Nk})}{\partial pdvi_i^k}}{\frac{\partial PDV(V_i^{Nj})}{\partial pdvi_i^j}} = \frac{\beta_0\left[\frac{(\gamma_1 Y_i)^{0.45}-1}{0.45}\right]+\frac{1}{(pdvi_i^k+1)}\left[D_i^k\alpha_{10}+\left(D_i^k\alpha_{50}+D_i^k\alpha_{51}age_{i0}\right)\log\left(pdvl_i^k+1\right)\right]}{\beta_0\left[\frac{(\gamma_1 Y_i)^{0.45}-1}{0.45}\right]+\frac{1}{(pdvi_i^j+1)}\left[D_i^j\alpha_{10}+\left(D_i^j\alpha_{50}+D_i^j\alpha_{51}age_{i0}\right)\log\left(pdvl_i^j+1\right)\right]}$$

It is readily apparent that these tradeoffs depend on a wide variety of factors, including age, income, and the baseline future health state profile, since discounting lost life-years affect the derivative of utility with respect to discounted sick-years.

Results

Table 5 and all of its sub-tables (5A through 5G) describe the parameters estimates for a parsimonious model that allows each of the main coefficients in the model to vary systematically with the name of the illness or injury. This single model takes the basic specification in Cameron and DeShazo (2011) and generalizes the coefficients on the key variables in Table 5 to permit heterogeneity by illness, to the extent that the data dictate. As in Cameron et al. (2011), we allow utility to be higher or lower than it is for prospective heart disease, according to a set of automonous utility-shifters. These indicator variables, with estimated coefficients as displayed in Table 5A, will affect willingness to pay for risk reductions for each illness profile. Any statistically significant positive coefficient indicates that the corresponding variable will increase estimated WTP to avoid that illness (often to an extent that decreases with age, and in three cases to an extent that is considerably higher if the individual is a smoker). However, these indicator variables for each disease will have no effect on the marginal rates of substitution between health

states, since they drop out of all of the derivatives of the utility terms with respect to time in each health state under a given illness profile.

For this paper, our main concern is the marginal rate of substitution between discounted sick-years and discounted time in current health. We health-based utility to zero for the current health state, so that utility in current health is given by the present discounted utility from the consumption of all other goods and services (income). This discounted utility is not constant across all future illness profiles because we assume that the individual does not expect to keep earning income (or consuming other goods) beyond the time when they die as a result of the illness in question. Thus the present discounted value of net income cannot also be normalized to zero. The key to our estimates of the marginal rate of substitution, therefore, is the set of coefficients in Table 5B (for the numerator), and the coefficient on the net income term in Table 5a.[11] As can be seen in this table, once we have controlled for so many other variables, the heterogeneity in these coefficients is somewhat limited.

In contrast to the models in Cameron et al. (2011), the specification in Table 5 retreats from the use of attitudinal variables that control for differences across individuals in subjective risks and subjective controllability of the different types of illnesses. We also drop the set of variables that controls for differences in the subjective probability of suffering at least one of these illnesses in the individual's future and in their assessment of the timeliness and efficicacy of their medical care. These subjective assessments change with age. We had been norming these variables on marginal modal ratings for each variable. This means we "simulated out" the effects of any age-based differences in these attitudes. We are now concerned that doing so may suppress important age heterogeneity that really should not be suppressed as we consider age

[11] We do not currently attempt to differentiate the coefficient on the net income term by future illness, but we plan to explore that generalization in the future, as it would permit the denominator in equation (20), for example, to vary systematically with illness names as well.

profiles in marginal rates of substitution between health states. Clearly, whether to control for attitudes is an open question that still needs to be resolved.

Based upon the parameter estimates in Table 5 and its subsidiary tables, we have begun to explore the implied marginal rates of substitution between sick-years and years in the respondent's current health state. Note that utlility is linear in the shifted logarithms of discounted time in each adverse health state. This means that the implied marginal utilities vary with the number of sick-years, recovered/remission years, or lost life-years in a particular illness profile. Table 6 begins with a selection of non-fatal illnesses. We demonstrate the heterogeneity in the standard tradeoff between sick-years and years in current health, analogous to those summarized in Table 2 at the end of this paper. We simulate the distribution for each estimate based on 1000 draws from the joint normal distribution of the maximum likelihood parameter estimates and report the median as well as the 5^{th} and 95^{th} percentiles of these distributions (which reflect the amount of noise in the parameter estimates used to construct each measure).[12]

Given that marginal utilities are nonconstant, our model produces a unique estimate of the marginal rate of substitution for each different illness profile. Table 6 considers individuals who are 30, 40, 50 and 60 years old now. For each of them, we consider the relevant MRS between sick-years and current health for illnesses that involve either 5 or 10 years of latency, three years of illness and either 3 or 5 lost life-years.[13] For these non-fatal illnesses, based on ex ante impressions of our sample from the general population of the U.S. about breast cancer, colon cancer, lung cancer, respiratory disease, traffic accidents and diabetes, our estimates of the MRS do not differ statistically from those for heart disease. Our estimates for the arbitrarily

[12] We do not report the means because the mean of a ratio of normal is undefined. As a result, the mean of the sampling distribution can be erratic when a random draw for the terms that go into the denominator occasionally yields a number very close to zero.

[13] Recovery is implausible for diabetes or Alzheimer's disease, but we conduct these simulations regardless, for completeness. No scenarios with recovery from diabetes or Alzheimer's were employed in our survey.

selected illness profiles in Table 6 (ignoring the negative signs which merely indicates that sick years are considered to be a bad and the current health state to be a good) range from about 0.26 for the longer-latency case for 30-year-olds, to 0.62 for the five-year latency case with five lost life-years, for fifty-year-olds. (For 60-year-olds, there is enough noise in the estimates of this MRS that we cannot exclude an estimate of zero.)

The estimates from time trade-off studies in the literature, summarized in Table 2, range rather widely (with each estimate implied to be constant, presumably). Many of these estimates are elicited from different age groups or from people with different levels of initial health. Other time trade-offs are based on the expert judgment of physicians.

If the heterogeneity by age and illness profile that we identify in our models is pervasive in the general population, it is entirely possible that the variety of estimates in the time trade-off literature to date stem partly from heterogeneity across individuals and across their expectations about the time-profile of the illness in question. Our estimates control for both age and illness profile, and we find greater heterogeneity across these dimensions that we do across most illness names. We can differentiate between these various dimensions because of the independent variation in our stated preference survey. Except for a few exclusions on account of implausibility, the illness profiles were orthogonal to the disease names assigned to each illness.

We expected to find lower estimates of the MRS for our sample of ex ante choice questions, compared to tradeoffs elicited from patients who are already ill from a given disease. There appears to be considerable evidence that preferences are reference-dependent. Anticipated disutility from compromised health may be less than experienced disutility, should a person find themselves in that health state.

Conclusions and Directions for Future Research

The estimates provided in Tables 6 and 7 are, as yet, preliminary. Our specification involves 12 basic parameters, eleven illness indicators (other than heart disease, our base case) that can be permitted to shift any or all of those 12 basic parameters. On top of the numerous interaction terms required to identify illness-name heterogeneity in the basic parameters, we introduce autonomous utility terms that permit utility to differ in its absolute level by illness name, independent of the pattern of sick-time, recovered/remission time, or lost life-years that make up the illness profile in question. Finally, our survey permitted respondents to reveal, ex post, whether they had violated any of the assumptions they had been instructed to make in considering our choice scenarios. We normalized to zero the desired conditions or assumptions and allowed the implied preferences to differ systematically with departures from these choice-scenario assumptions and allow these variables to further shift the basic utility parameters in main part of Table 5. With all of the basic variables, plus the illness name indicators, plus the "scenario adjustement" variables, the potential parameter space for this model is huge. We expect that it make take a little more time to winnow the number of interaction terms down to a smaller number of persistently significant shifters.

There are some remaining puzzles associated with this work. It would be extremely convenient if the derived expressions for the marginal utilities per discounted health state year were actually the logarithms of the desired marginal utility. If that were the case, the expressions could be exponentiated and the baseline utility due to income (the consumption of other goods) would drop out of the numerator and the denominator of the marginal rate of substitution calculations and exp(0) =1 would be the normalized denominator for the discounted time in current health. While this would be very convenient, we have not yet determined whether any

simple assumption would permit us to interpret the fitted utility function in such a way. To be sure, we could treat the current utility function in equation (17) as the logarithm of utility, so that the actual utility function would correspond to the exponentiated value of the right-hand-side. But this would leave the marginal utilities the same as before, but with each of the terms simply multiplied by the same exponentiated utility level (which would cancel, leaving us with exactly the same marginal rates of substitution, as would be expected given that one can use any monotonic transformation of utility and get the same marginal rates of substitution).

We must also explore the consequences of differentiating the marginal utility of future income (other consumption) streams by the name of the illness being considered. This could provide some additional heterogeneity.

Further work will be necessary to establish confidence in the estimates of the other marginal rates of substitution between discounted time in alternative health states. Our models produce a wide range of results. However, we report here only the MRS between sick time and time in the current health state. We are still trying to understand why our empirical estimates of the marginal (dis)utility of discounted lost life-years are large and negative for 30-year-olds, but less negative as the simulated subject gets older and large and positive for 60-year-olds. We are still trying to firm up our intuition about how to conceptualize a marginal rate of substitution between sick-time and lost life-years, for example. Our model produces these estimates as readily as it provides estimates of the MRS between sick-time and healthy years, but there are fewer models in the literature against which we can compare our empirical findings.

It is also somewhat perplexing that the marginal utility of a discounted prospective recovered/remission year seems to be greater than the marginal utility of discounted years in

current health for a young person. As the individual ages, however, this marginal utility becomes negative and gets increasingly negative for an older person.

Figure 1: One of the 11,385 randomized choice sets

Choose the program that reduces the illness that you most want to avoid. But think carefully about whether the costs are too high for you. If both programs are too expensive, then choose Neither Program.

If you choose “neither program”, remember that you could die early from a number of causes, including the ones described below.

	Program A for Heart Disease	**Program B for Colon Cancer**
Symptoms/ Treatment	Get sick when 71 years old 2 weeks of hospitalization No surgery Moderate pain for remaining life	Get sick when 68 years old 1 month of hospitalization Major surgery Severe pain for 18 months Moderate Pain for 2 years
Recovery/ Life expectancy	Chronic heart condition Die at 79	Recover at 71 Die of something else at 73
Risk Reduction	5% From 40 in 1,000 to 38 in 1,000	50% From 4 in 1,000 to 2 in 1,000
Costs to you	$15 per month [= $180 per year]	$4 per month [= $48 per year]
Your choice	☐ **Reduce my chance of heart disease**	☐ **Reduce my chance of colon cancer**
	☐ **Neither Program**	

Table 1 – Examples of TTO elicitation questions

Panel A: Open-ended TTO

Lundberg et al. (1999):

"Imagine that you are told that you have 20 years left to live. In connection with this you are also told that you can choose to live these 20 years in your current health state or that you can choose to give up some life years to instead live for a shorter period in full health. Indicate with a cross on the line below the number of years in full health that you think is of equal value to 20 years in your current health state."

Dominitz et al. (1995):

Patients were also asked how much time (of a 20 year remaining life expectancy) they would give up to avoid 1) living in their current health state, 2) living with colon cancer, and 3) living with a colostomy.

Panel B: Choice TTO

Samsa et al. (1998):

"Would you prefer living 10 more years after a major stroke or 8 more years in excellent health? In other words, would you give up 2 years of life after a major stroke in order to live 8 years in excellent health?" (Time in excellent health was varied until a point of indifference was reached.)

Williams (1995):

…subjects are asked to make a decision between two alternatives: either to remain in health state (Hi) for a period of time (t=20 years) followed by death, or to be healthy for a shorter period of time (x) followed by death. The duration x is varied until the subject is indifferent between the two alternatives…

Panel C: DCE

Burr et al. (2007):

Each choice question describes two health situations: Situation A and B. Imagine that you have these difficulties and pick the scenario you think is WORSE. You may not like either situation but choose the one that is less preferable to you by putting a tick in the appropriate box. Please tick just ONE box for every question.

SITUATION A	**SITUATION B**
No difficulty with: • Central and near vision • Lighting and glare • Mobility **Some difficulty** with: • Activities of daily living • Eye discomfort • Other effects of glaucoma and its treatment	**No difficulty** with: • Central and near vision **Some difficulty** with: • Lighting and glare **Quite a lot difficulty** with: • Activities of daily living • Eye discomfort **Severe difficulty** with: • Mobility • Eye discomfort
(Tick one box only) ☐ **Situation**	☐ **Situation**

Bansback et al. (2012):

Now you would either live in Life A for the described number of years and then die or live in Life B for the described number of years and then die. Would you prefer Life A or Life B?

	LIFE A	**LIFE B**
Anxiety/depression	Extremely anxious or depressed	Not anxious or depressed
Pain/discomfort	Moderate pain or discomfort	Extreme pain or discomfort
Mobility	Confined to bed	No problems in walking about
Usual Activities	Some problems performing usual activities	Some problems performing usual activities
Self-care	Unable to wash or dress self	No problems with self-care
Duration of life	Live for 4 years	Live for 10 years
Choose one	☐	☐

Table 2 – Quality of life weight estimates using TTO

Condition	Study	Respondents (Sample Size)	TTO
Breast Cancer			
Receiving chemotherapy	Milne et al. (2006)	General Population (50)	0.46
Moderate to severe hypercalcaemia	"	General Population (50)	0.13
Hormonal therapy	"	General Population (50)	0.54
Severe bone pain requiring radiotherapy	"	General Population (50)	0.35
Prostate Cancer			
Early progressive disease	Bennett et al. (1996)	Physicians (43)	0.83
Late progressive disease	"	Physicians (43)	0.42
Stroke			
Mild stroke	Huang et al. (2007)	Patients (701)	0.7
Major stroke	"	Patients (701)	0.31
Major stroke	Samsa et al. (1998)	At risk (1183)	0.3*
Minor stroke	Duncan et al. (2000)	Survivors (459)	0.71
Major stroke	"	Survivors (459)	0.44
Severe residual deficit	Gore et al. (1995)	Patients (7)	0.71
Moderate residual deficit	"	Patients (32)	0.81
Minor residual deficit	"	Patients (60)	0.89
No residual deficit	"	Patients (15)	0.92
Heart Disease			
Angina	Huang et al. (2007)	Patients (701)	0.64
Angina - Severe	Read et al. (1984)	Physicians (60)	0.53
Angina - Moderate	"	Physicians (60)	0.83
Angina - Severe chest pain	Pliskin et al. (1980)	General Population (10)	0.69
Angina - Mild chest pain	"	General Population (10)	0.74
Angina - Pain-free	"	General Population (10)	0.88
Diabetes			
Diabetic neuropathy	Huang et al. (2007)	Patients (701)	0.66
Diabetic retinopathy	"	Patients (701)	0.53
Diabetic nephropathy	"	Patients (701)	0.64
Type 1, no complications (Male)	Coffey et al. (2002)	Patients (784)	0.67
Type 1, no complications (Female)	"	Patients (784)	0.64
Type 2, no complications (Male)	"	Patients (1257)	0.69
Type 2, no complications (Female)	"	Patients (1257)	0.65
Colon Cancer			
Colon Cancer	Dominitz et al. (1995)	Patients (12)	0.76
Colostomy	"	Patients (12)	0.84

*This is the mean score with worse-than-dead collapsed to 0. Approximately 45% of the respondents considered major stroke worse-than-dead.

Table 3 – Net income for different health states and program choices

Indirect utility, Probability	Pre-illness/ latency ("e")	Illness/ injury time ("i")	Recovered/ remission ("r")	Lost life-years("l")
$V_t^{AH}, \left(1-\Pi^{AS}\right)$	*Y-c*	*Y-c*	*Y-c*	*Y-c*
V_t^{AS}, Π^{AS}	*Y-c*	$\gamma_1 Y - \gamma_3 c$	*Y-c*	$\gamma_2 Y - \gamma_4 c$
$V_t^{NH}, \left(1-\Pi^{NS}\right)$	*Y*	*Y*	*Y*	*Y*
V_t^{NS}, Π^{NS}	*Y*	$\gamma_1 Y$	*Y*	$\gamma_2 Y$
Discounted time in health state:	*pdve*	*pdvi*	*pdvr*	*pdvl*

The γ parameters reflect the investigator's best assessment of the fractions of income or program costs respondents typically assumed they would receive/pay during any sick-years and after their death. For indirect utility functions which are nonlinear in net income, such as the Box-Cox transformed specification used in the main paper, it is necessary for tractability that the parameters γ_3 and γ_4 take on no values other than 0 or 1. The parameters γ_1 and γ_2, however, may take on any value between 0 to 1 inclusive.

Table 4 – Utility from one period in each health state, by program choice

Indirect utility, Probability	Pre-illness/ latency ("e")	Illness/ injury time ("i")	Recovered/ remission ("r")	Lost life-years("l")
$V_t^{AH}, \left(1-\Pi^{AS}\right)$	α_0	α_0	α_0	α_0
V_t^{AS}, Π^{AS}	α_0	α_1	α_2	α_3
$V_t^{NH}, \left(1-\Pi^{NS}\right)$	α_0	α_0	α_0	α_0
V_t^{NS}, Π^{NS}	α_0	α_1	α_2	α_3
Discounted time in health state:	*pdve*	*pdvi*	*pdvr*	*pdvl*

TABLE 5—ESTIMATED PARAMETERS FOR PARSIMONIOUS MODEL
WHEN ATTITUDINAL VARIABLES ARE SET TO THEIR NEUTRAL (MODAL) VALUES[A]

Basic Model Terms

$(\beta_0)\left[\frac{\left(Y_i - c_i^j\right)^{0.45} - 1}{0.45}\right] cterm_i^j - \left[\frac{\left(Y_i\right)^{0.45} - 1}{0.45}\right] yterm_i^j$	.01307 (9.05)***
(δ_j)[illness-specific indicators]	(expanded in TABLE 5A)
$(\alpha_{10})\Delta\pi_i^{jS}\left[\log\left(pdvi_i^j + 1\right)\right]$	(expanded in TABLE 5B)
$(\alpha_{20})\Delta\pi_i^{jS}\log\left(pdvr_i^j + 1\right)$	61.5 (1.91)*
$(\alpha_{21})age_{i0}\Delta\pi_i^{jS}\log\left(pdvr_i^j + 1\right)$	-1.41 (2.28)**
$(\alpha_{30})\Delta\pi_i^{jS}\log\left(pdvl_i^j + 1\right)$	(expanded in TABLE 5C)
$(\alpha_{31})age_{i0}\cdot\Delta\pi_i^{jS}\log\left(pdvl_i^j + 1\right)$	24.98 (2.77)***
$(\alpha_{32})age_{i0}^2\cdot\Delta\pi_i^{jS}\log\left(pdvl_i^j + 1\right)$	-.2073 (2.33)**
$(\alpha_{40})\Delta\pi_i^{jS}\left[\log\left(pdvl_i^j + 1\right)\right]^2$	(expanded in TABLE 5D)
$(\alpha_{41})age_{i0}\cdot\Delta\pi_i^{jS}\left[\log\left(pdvl_i^j + 1\right)\right]^2$	-10.93 (2.39)**
$(\alpha_{42})age_{i0}^2\cdot\Delta\pi_i^{jS}\left[\log\left(pdvl_i^j + 1\right)\right]^2$	.09029 (1.97)**
$(\alpha_{50})\Delta\pi_i^{jS}\left[\log\left(pdvi_i^j + 1\right)\right]\cdot\left[\log\left(pdvl_i^j + 1\right)\right]$	(expanded in TABLE 5E)
$(\alpha_{51})age_{i0}\cdot\Delta\pi_i^{jS}\left[\log\left(pdvi_i^j + 1\right)\right]\cdot\left[\log\left(pdvl_i^j + 1\right)\right]$	1.41 (3.07)***
Total number of: choice sets (alternatives)	11,385 (34155)
LogL	-14454.227

[a] All of the coefficients in Tables 5 and 5A through 5G pertain to the same model.

TABLE 5A—AUTONOMOUS EFFECT OF ILLNESSES ON UTILITY IN PARSIMONIOUS MODEL [a]

Autonomous utility term (indicators)	Basic Terms	Shifters × Age	Shifters × Smoker
(base case = heart disease)	0	.003004	.07845
		(1.95)*	(2.68)***
heart attack	.3115	-	-
	(3.08)***		
breast cancer	.9564	-.01453	-
	(3.50)***	(2.88)***	
prostate cancer	.6546	-	-
	(4.63)***		
lung cancer	-	-	.2606
			(9.24)***
colon cancer	-	-	-
skin cancer	-	-.0102	-
		(5.76)***	
respiratory disease	-	-.006086	.1746
		(4.24)***	(5.56)***
stroke	.451	-	-
	(5.13)***		
traffic accident	.6629	-.01747	-
	(1.96)*	(2.60)***	
diabetes	.5923	-.01213	-
	(2.94)***	(3.10)***	
Alzheimer's disease	-	-	-

[a] Utility is normalized on the level for heart disease, so the coefficient for heart disease is set to zero.

TABLE 5B—EFFECTS OF ILLNESS ON SICK-YEARS TERMS IN PARSIMONIOUS MODEL

		Shifters[a]	
Sick Year Terms	Basic Terms	* Age	* Smoker
$(\alpha_{10})\Delta\pi_i^{jS}\log(pdvi_i^j+1)$ (base case = heart disease)	-43.07 (4.68)***		
*heart attack	40.29 (1.85)*		
*breast cancer			
*prostate cancer	86.62 (1.92)*		
*lung cancer			
*colon cancer			
*skin cancer			
*stroke		.6948 (1.75)*	
*respiratory disease			
*traffic accident			
*diabetes			
*Alzheimer's disease		1.039 (2.06)**	

[a] See footnote to TABLE 5A.

TABLE 5C—EFFECTS OF ILLNESS ON LOST LIFE-YEARS TERM IN PARSIMONIOUS MODEL

		Shifters[a]	
Lost Life-years Years Term	Basic Terms	* Age	* Age^2
$(\alpha_{30})\Delta\pi_i^{jS}\log(pdvl_i^j+1)$	-697.7		
(base case = heart disease)	(3.15)***		
*heart attack			
*breast cancer	-39.8		
	(1.62)		
*prostate cancer		1.589	
		(1.68)*	
*lung cancer			
*colon cancer			
*skin cancer			
*stroke			
*respiratory disease			
*traffic accident		7.741	-.1392
		(1.78)*	(1.87)*
*diabetes			
*Alzheimer's disease	-1011	35.06	-.2849
	(2.12)**	(1.94)*	(1.72)*

[a] See footnote to TABLE 5A.

TABLE 5D—EFFECTS OF ILLNESS ON SQUARED LOST LIFE-YEARS TERM IN PARSIMONIOUS MODEL

		Shifters[a]	
Squared Lost life-year Terms	Basic Terms	* Age	* Age^2
$(\alpha_{30})\Delta\pi_i^{jS}\left[\log\left(pdvl_i^j+1\right)\right]^2$	291		
(base case = heart disease)	(2.60)***		
*heart attack			
*breast cancer			
*prostate cancer			
*lung cancer			
*colon cancer	238.6	-9.699	.09016
	(2.42)**	(2.41)**	(2.29)**
*skin cancer			
*stroke			
*respiratory disease			
*traffic accident	-	-3.204	.05865
		(1.74)*	(1.82)*
*diabetes			
*Alzheimer's disease			

[a] See footnote to TABLE 5A.

TABLE 5E—EFFECTS OF ILLNESS ON LOST LIFE-YEARS TERMS IN PARSIMONIOUS MODEL

		Shifters[a]	
Squared Lost life-year Terms	Basic Terms	* Age	* Age^2
$(\alpha_{50})\Delta\pi_i^{jS}\left[\log\left(pdvi_i^j+1\right)\right]\left[\log\left(pdvl_i^j+1\right)\right]$	-50.62		
(base case = heart disease)	(2.04)**		
*heart attack			
*breast cancer			
*prostate cancer		-1.695	
		(1.91)*	
*lung cancer			
*colon cancer			
*skin cancer		-.8269	
		(2.87)***	
*stroke			
*respiratory disease			
*traffic accident			
*diabetes			
*Alzheimer's disease	1271	-41.41	
	(2.15)**	(2.03)**	

[a] See footnote to TABLE 5A.

TABLE 5F – COEFFICIENTS ON SCENARIO ADJUSTMENT/REJECTION INTERACTION TERMS

Base coef.	Main Constructed Variable ↓ / Shifter →	1 Would never benefit?	2 Log(pos. life expect. diff+1)	3 Log(neg. life expect. diff+1)	4 Shortens life most? incorrect	5 Failed risk comp. test	6 Status quo b/c reject scenario	7 Ingored affordab.	8 Dev. from median select. prob
β_0	$\left[\frac{\left(Y_i - c_i^j\right)^{0.45} - 1}{0.45}\right] cterm_i^j - \left[\frac{\left(Y_i\right)^{0.45} - 1}{0.45}\right] yterm_i^j$	-.02076 (5.32)***	-	-	-	-	.5008 (18.83)***	-.007477 (4.56)***	-
α_{10}	$\Delta\pi_i^{jS} \log\left(pdvi_i^j + 1\right)$	-	-	-	-	-	-	-	-
α_{20}	$\Delta\pi_i^{jS} \log\left(pdvr_i^j + 1\right)$	-	-	-	-	-	-	-	-
α_{21}	$\ldots\ age_{i0} \times \Delta\pi_i^{jS} \log\left(pdvr_i^j + 1\right)$	-	-	-	-	-	-	-	-
α_{30}	$\Delta\pi_i^{jS} \log\left(pdvl_i^j + 1\right)$	-	-	-51.32 (2.50)**	215.4 (2.49)**	421.8 (3.21)***	-	-	-
α_{31}	$\ldots\ age_{i0} \times \Delta\pi_i^{jS} \log\left(pdvl_i^j + 1\right)$	-	-	2.182 (2.51)**	-4.912 (2.93)***	-15.41 (2.95)***	-	-	-
α_{32}	$\ldots\ age_{i0}^2 \times \Delta\pi_i^{jS} \log\left(pdvl_i^j + 1\right)$	-	-	-.02174 (2.47)**	-	.1462 (2.96)***	-	-	-
α_{40}	$\Delta\pi_i^{jS} \left[\log\left(pdvl_i^j + 1\right)\right]^2$	411 (9.96)***	-	25.11 (2.42)**	-115.8 (2.48)**	-	-	-	-
α_{41}	$\ldots\ age_{i0} \times \Delta\pi_i^{jS} \left[\log\left(pdvl_i^j + 1\right)\right]^2$	-18.52 (7.19)***	-	-1.104 (2.48)**	2.88 (3.12)***	-	-	-	-
α_{42}	$\ldots\ age_{i0}^2 \times \Delta\pi_i^{jS} \left[\log\left(pdvl_i^j + 1\right)\right]^2$	-	-	.0113 (2.46)**	-	-.01305 (2.12)**	-	-	-
α_{50}	$\Delta\pi_i^{jS} \left[\log\left(pdvi_i^j + 1\right)\right] \times \left[\log\left(pdvl_i^j + 1\right)\right]$	-385 (3.88)***	10.1 (2.37)**	-	-	-	-	-	-
α_{51}	$\ldots\ age_{i0} \times \Delta\pi_i^{jS} \left[\log\left(pdvi_i^j + 1\right)\right] \times \left[\log\left(pdvl_i^j + 1\right)\right]$	8.427 (4.19)***	-.2079 (2.25)**	-	-	-	-	-	-
α_{61}	1(no program) = "status quo" indicator	-	-	-	.11 (2.79)***	-	-	-	-

TABLE 5G – COEFFICIENTS ON SCENARIO ADJUSTMENT/REJECTION INTERACTION TERMS

Indicator variables ↓ / Shifter →	1 Would never benefit?	2 Log(pos. life expect. diff+1)	3 Log(neg. life expect. diff+1)	4 Shortens life most? incorrect	5 Failed risk comp. test	6 Status quo b/c reject scenario	7 Ingored affordab.	8 Dev. from median select. prob
Heart disease	-3.062 (8.73)***	-	-	-	-	-	.2549 (2.62)***	-
Heart attack	-3.847 (8.72)***	-	.114 (2.58)***	-	-	-	-	-
Breast cancer	-2.773 (6.58)***	-	-	-	-	-	-	-
Prostate cancer	-2.911 (6.13)***	-	-	-	-	-	-	-
Colon cancer	-3.353 (8.88)***	-	-	-	-	-	.277 (3.39)***	-
Lung cancer	-2.825 (10.45)***	-.2072 (3.33)***	-	-	-	-		-
Skin cancer	-2.489 (7.97)***	-	-	-	-.2969 (1.78)*	-	-	-
Stroke	-3.806 (8.60)***	-	-	-.257 (2.41)**	-	-	-	-
Respiratory disease	-3.077 (8.57)***	-	-		-	-	-	-
Traffic accident	-3.116 (8.46)***	-	-		-	-	-	-
Diabetes	-2.591 (8.48)***	-	-		-.255 (1.71)*	-	-	-
Alzheimer's disease	-3.125 (8.31)***	-	-		-.3873 (2.46)**	-	-	-

TABLE 6A—NON-FATAL ILLNESSES, AT THREE YEARS OF ILLNESS: MARGINAL RATES OF SUBSTITUTION;
DISCOUNTED TIME IN CURRENT HEALTH DEEMED EQUIVALENT TO ONE UNIT OF DISCOUNTED TIME IN SICK STATE;
EXPECTED SIGN NEGATIVE (CURRENT HEALTH= "GOOD", SICK STATE="BAD")
(DISCOUNT RATE = 5%, MIDPOINT OF MALE/FEMALE LIFE EXPECTANCIES)

	Age 30 now			**Age 40 now**		
Health Threat	Latency=5 yrs Sick=3 yrs Lost=3 yrs	Latency=5 yrs Sick=3 yrs Lost=5 yrs	Latency=10 yrs Sick=3 yrs Lost=3 yrs	Latency=5 yrs Sick=3 yrs Lost=3 yrs	Latency=5 yrs Sick=3 yrs Lost=5 yrs	Latency=10 yrs Sick=3 yrs Lost=3 yrs
Heart Disease	-0.32* (-0.58; -0.22)	-0.31* (-0.57; -0.22)	-0.26* (-0.45; -0.18)	-0.37* (-0.69; -0.25)	-0.38* (-0.74; -0.25)	-0.30* (-0.53; -0.20)
Heart Attack	0.34 (-3.88; 3.40)	0.34 (-3.99; 3.96)	0.27 (-3.32; 3.07)	0.38 (-2.86; 4.03)	0.38 (-3.93; 3.42)	0.32 (-2.77; 3.79)
Breast Cancer	-0.32* (-0.58; -0.22)	-0.31* (-0.57; -0.22)	-0.26* (-0.45; -0.18)	-0.37* (-0.69; -0.25)	-0.38* (-0.74; -0.25)	-0.30* (-0.53; -0.20)
Prostate Cancer	0.19 (-1.02; 1.30)	0.20 (-1.15; 1.46)	0.16 (-0.97; 1.12)	0.22 (-1.12; 1.76)	0.23 (-1.83; 1.90)	0.19 (-0.93; 1.67)
Colon Cancer	-0.32* (-0.58; -0.22)	-0.31* (-0.57; -0.22)	-0.26* (-0.45; -0.18)	-0.37* (-0.69; -0.25)	-0.38* (-0.74; -0.25)	-0.30* (-0.53; -0.20)
Lung Cancer	-0.32* (-0.58; -0.22)	-0.31* (-0.57; -0.22)	-0.26* (-0.45; -0.18)	-0.37* (-0.69; -0.25)	-0.38* (-0.74; -0.25)	-0.30* (-0.53; -0.20)
Skin Cancer	-0.27* (-0.43; -0.19)	-0.25* (-0.38; -0.17)	-0.22* (-0.34; -0.16)	-0.26* (-0.40; -0.18)	-0.24* (-0.36; -0.16)	-0.21* (-0.32; -0.15)
Stroke	-0.59 (-5.04; 3.55)	-0.57 (-3.75; 3.60)	-0.49 (-3.84; 2.07)	-0.33 (-4.94; 5.04)	0.24 (-4.51; 5.55)	-0.33 (-4.34; 4.91)
Respiratory Disease	-0.32* (-0.58; -0.22)	-0.31* (-0.57; -0.22)	-0.26* (-0.45; -0.18)	-0.37* (-0.69; -0.25)	-0.38* (-0.74; -0.25)	-0.30* (-0.53; -0.20)
Traffic Accident	-0.32* (-0.58; -0.22)	-0.31* (-0.57; -0.22)	-0.26* (-0.45; -0.18)	-0.37* (-0.69; -0.25)	-0.38* (-0.74; -0.25)	-0.30* (-0.53; -0.20)
Diabetes[b]	-0.32* (-0.58; -0.22)	-0.31* (-0.57; -0.22)	-0.26* (-0.45; -0.18)	-0.37* (-0.69; -0.25)	-0.38* (-0.74; -0.25)	-0.30* (-0.53; -0.20)
Alzheimer's Disease[b]	0.13* (0.07; 0.54)	0.09* (0.05; 0.39)	0.11* (0.06; 0.47)	0.19* (0.06; 0.95)	0.14* (0.04; 0.70)	0.17 (-0.27; 0.92)

Note: Based on 1000 random draws from the asymptotically joint normal distribution of the estimated parameters. CAUTION: Model includes statistically insignificant quadratic term in age as a shifter on the coefficient of log(pdvr+1). Removed in subsequent runs.

[a] Preferences over time in future health states exhibit diminishing marginal utility in discounted time in each future health state, so marginal rates of substitution are not constant, but vary with expected duration in each state.

[b] Recovery from Diabetes and Alzheimers was never portrayed in choice scenarios, but analogous fitted MRS are provided for illness profiles with recovery for symmetry.

TABLE 6B (CONTINUED)—NON-FATAL ILLNESSES, AT THREE YEARS OF ILLNESS: MARGINAL RATES OF SUBSTITUTION; DISCOUNTED TIME IN CURRENT HEALTH DEEMED EQUIVALENT TO ONE UNIT IF DISCOUNTED TIME IN SICK STATE; EXPECTED SIGN NEGATIVE (CURRENT HEALTH= "GOOD", SICK STATE="BAD") (DISCOUNT RATE = 5%, MIDPOINT OF MALE/FEMALE LIFE EXPECTANCIES)

	Age 50 now			**Age 60 now**		
Health Threat	Latency=5 yrs Sick=3 yrs Lost=3 yrs	Latency=5 yrs Sick=3 yrs Lost=5 yrs	Latency=10 yrs Sick=3 yrs Lost=3 yrs	Latency=5 yrs Sick=3 yrs Lost=3 yrs	Latency=5 yrs Sick=3 yrs Lost=5 yrs	Latency=10 yrs Sick=3 yrs Lost=3 yrs
Heart Disease	-0.51* (-1.29; -0.31)	-0.62* (-2.25; -0.32)	-0.40* (-0.92; -0.25)	-0.96 (-7.76; 4.79)	0.58 (-9.99; 9.75)	-0.77 (-4.41; 4.53)
Heart Attack	0.36 (-2.42; 3.38)	0.35 (-2.39; 3.09)	0.31 (-2.78; 2.22)	0.30 (-0.72; 1.69)	0.26* (0.13; 0.98)	0.27 (-0.70; 1.74)
Breast Cancer	-0.51* (-1.29; -0.31)	-0.62* (-2.25; -0.32)	-0.40* (-0.92; -0.25)	-0.96 (-7.76; 4.79)	0.58 (-9.99; 9.75)	-0.77 (-4.41; 4.53)
Prostate Cancer	0.23 (-2.50; 2.20)	0.18 (-2.57; 2.71)	0.20 (-1.88; 2.03)	0.17 (-3.19; 2.52)	-0.17 (-2.04; 2.08)	0.14 (-2.35; 2.02)
Colon Cancer	-0.51* (-1.29; -0.31)	-0.62* (-2.25; -0.32)	-0.40* (-0.92; -0.25)	-0.96 (-7.76; 4.79)	0.58 (-9.99; 9.75)	-0.77 (-4.41; 4.53)
Lung Cancer	-0.51* (-1.29; -0.31)	-0.62* (-2.25; -0.32)	-0.40* (-0.92; -0.25)	-0.96 (-7.76; 4.79)	0.58 (-9.99; 9.75)	-0.77 (-4.41; 4.53)
Skin Cancer	-0.25* (-0.42; -0.17)	-0.23* (-0.39; -0.15)	-0.21* (-0.33; -0.14)	-0.26* (-0.52; -0.16)	-0.23* (-0.56; -0.14)	-0.21* (-0.41; -0.13)
Stroke	0.40 (-3.79; 3.75)	0.40 (-2.81; 3.63)	0.35 (-2.79; 4.00)	0.28 (-0.71; 1.42)	0.24* (0.12; 1.00)	0.24 (-0.71; 1.39)
Respiratory Disease	-0.51* (-1.29; -0.31)	-0.62* (-2.25; -0.32)	-0.40* (-0.92; -0.25)	-0.96 (-7.76; 4.79)	0.58 (-9.99; 9.75)	-0.77 (-4.41; 4.53)
Traffic Accident	-0.51* (-1.29; -0.31)	-0.62* (-2.25; -0.32)	-0.40* (-0.92; -0.25)	-0.96 (-7.76; 4.79)	0.58 (-9.99; 9.75)	-0.77 (-4.41; 4.53)
Diabetes	-0.51* (-1.29; -0.31)	-0.62* (-2.25; -0.32)	-0.40* (-0.92; -0.25)	-0.96 (-7.76; 4.79)	0.58 (-9.99; 9.75)	-0.77 (-4.41; 4.53)
Alzheimer's Disease	0.25 (-2.28; 3.14)	0.17 (-1.78; 3.03)	0.21 (-2.60; 2.49)	-0.24 (-2.26; 1.58)	-0.17 (-1.40; 1.24)	-0.20 (-1.74; 1.44)

Note: Based on 1000 random draws from the asymptotically joint normal distribution of the estimated parameters. CAUTION: Model includes statistically insignificant quadratic term in age as a shifter on the coefficient of log(pdvr+1). Removed in subsequent runs.

[a] Preferences over time in future health states exhibit diminishing marginal utility in discounted time in each future health state, so marginal rates of substitution are not constant, but vary with expected duration in each state.

[b] Recovery from Diabetes and Alzheimers was never portrayed in choice scenarios, but analogous fitted MRS are provided for illness profiles with recovery for symmetry.

TABLE 7A—FATAL ILLNESSES, AT THREE YEARS OF ILLNESS, STARTING NOW: MARGINAL RATES OF SUBSTITUTION; DISCOUNTED TIME IN CURRENT HEALTH DEEMED EQUIVALENT TO ONE UNIT IF DISCOUNTED TIME IN SICK STATE; EXPECTED SIGN NEGATIVE (CURRENT HEALTH= "GOOD", SICK STATE="BAD")
(DISCOUNT RATE = 5%, MIDPOINT OF MALE/FEMALE LIFE EXPECTANCIES)

MU(healthy)=3.48	**Age 30 now**		**Age 40 now**	
Health Threat	Latency=5 yrs Sick=3 yrs Lost=47 yrs	Latency=10 yrs Sick=3 yrs Lost=42 yrs	Latency=5 yrs Sick=3 yrs Lost=38 yrs	Latency=10 yrs Sick=3 yrs Lost=33 yrs
Heart Disease	-0.19* (-0.92; -0.08)	-0.17* (-0.73; -0.08)	-0.34 (-3.41; 2.78)	-0.32 (-2.71; 1.90)
Heart Attack	-0.21 (-2.57; 2.52)	-0.19 (-2.16; 2.92)	0.29 (-1.98; 2.26)	0.26 (-2.13; 1.94)
Breast Cancer	-0.19* (-0.92; -0.08)	-0.17* (-0.73; -0.08)	-0.34 (-3.41; 2.78)	-0.32 (-2.71; 1.90)
Prostate Cancer	-0.10* (-0.44; -0.04)	-0.10 (-0.46; 0.08)	-0.09 (-0.56; 0.30)	-0.09 (-0.59; 0.28)
Colon Cancer	-0.19* (-0.92; -0.08)	-0.17* (-0.73; -0.08)	-0.34 (-3.41; 2.78)	-0.32 (-2.71; 1.90)
Lung Cancer	-0.19* (-0.92; -0.08)	-0.17* (-0.73; -0.08)	-0.34 (-3.41; 2.78)	-0.32 (-2.71; 1.90)
Skin Cancer	-0.09* (-0.18; -0.06)	-0.08* (-0.16; -0.05)	-0.11* (-0.23; -0.06)	-0.09* (-0.20; -0.06)
Stroke	-0.24 (-1.77; 1.62)	-0.22 (-1.56; 1.11)	0.31 (-3.28; 3.25)	0.26 (-2.89; 2.98)
Respiratory Disease	-0.19* (-0.92; -0.08)	-0.17* (-0.73; -0.08)	-0.34 (-3.41; 2.78)	-0.32 (-2.71; 1.90)
Traffic Accident	-0.19* (-0.92; -0.08)	-0.17* (-0.73; -0.08)	-0.34 (-3.41; 2.78)	-0.32 (-2.71; 1.90)
Diabetes	-0.19* (-0.92; -0.08)	-0.17* (-0.73; -0.08)	-0.34 (-3.41; 2.78)	-0.32 (-2.71; 1.90)
Alzheimer's Disease	0.01* (0.01; 0.05)	0.01* (0.01; 0.05)	0.03 (-0.07; 0.20)	0.03 (-0.07; 0.19)

Note: Based on 1000 random draws from the asymptotically joint normal distribution of the estimated parameters.
[a] Preferences over time in future health states exhibit diminishing marginal utility in discounted time in each future health state, so marginal rates of substitution are not constant, but vary with expected duration in each state.

TABLE 7B (CONTINUED)—FATAL ILLNESSES, AT THREE YEARS OF ILLNESS, STARTING NOW: MARGINAL RATES OF SUBSTITUTION; DISCOUNTED TIME IN CURRENT HEALTH DEEMED EQUIVALENT TO ONE UNIT IF DISCOUNTED TIME IN SICK STATE; EXPECTED SIGN NEGATIVE (CURRENT HEALTH= "GOOD", SICK STATE="BAD")
(DISCOUNT RATE = 5%, MIDPOINT OF MALE/FEMALE LIFE EXPECTANCIES)

	Age 50 now		**Age 60 now**	
Health Threat	Latency=5 yrs Sick=3 yrs Lost=29 yrs	Latency=10 yrs Sick=3 yrs Lost=24 yrs	Latency=5 yrs Sick=3 yrs Lost=21 yrs	Latency=10 yrs Sick=3 yrs Lost=16 yrs
Heart Disease	0.40 (-2.80; 2.58)	0.41 (-2.76; 3.49)	0.23* (0.12; 0.73)	0.26* (0.12; 1.19)
Heart Attack	0.19* (0.10; 0.63)	0.18* (0.10; 0.75)	0.13* (0.08; 0.26)	0.13* (0.08; 0.28)
Breast Cancer	0.40 (-2.80; 2.58)	0.41 (-2.76; 3.49)	0.23* (0.12; 0.73)	0.26* (0.12; 1.19)
Prostate Cancer	-0.08 (-0.63; 0.41)	-0.08 (-0.59; 0.43)	-0.08 (-0.64; 0.53)	-0.08 (-0.55; 0.66)
Colon Cancer	0.40 (-2.80; 2.58)	0.41 (-2.76; 3.49)	0.23* (0.12; 0.73)	0.26* (0.12; 1.19)
Lung Cancer	0.40 (-2.80; 2.58)	0.41 (-2.76; 3.49)	0.23* (0.12; 0.73)	0.26* (0.12; 1.19)
Skin Cancer	-0.13* (-0.35; -0.07)	-0.11* (-0.29; -0.06)	-0.15* (-0.68; -0.06)	-0.14* (-0.53; -0.07)
Stroke	0.21* (0.11; 0.80)	0.20* (0.10; 0.86)	0.12* (0.08; 0.25)	0.12* (0.08; 0.28)
Respiratory Disease	0.40 (-2.80; 2.58)	0.41 (-2.76; 3.49)	0.23* (0.12; 0.73)	0.26* (0.12; 1.19)
Traffic Accident	0.40 (-2.80; 2.58)	0.41 (-2.76; 3.49)	0.23* (0.12; 0.73)	0.26* (0.12; 1.19)
Diabetes	0.40 (-2.80; 2.58)	0.41 (-2.76; 3.49)	0.23* (0.12; 0.73)	0.26* (0.12; 1.19)
Alzheimer's Disease	-0.04 (-0.65; 0.75)	-0.04 (-0.71; 0.69)	-0.06 (-0.34; 0.30)	-0.06 (-0.38; 0.31)

Note: Based on 1000 random draws from the asymptotically joint normal distribution of the estimated parameters.
[a] Preferences over time in future health states exhibit diminishing marginal utility in discounted time in each future health state, so marginal rates of substitution are not constant, but vary with expected duration in each state.

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