Two Types of Age Effects
in the Demand for Reductions
in Mortality Risks with Differing Latencies

1 Reviewer Appendix - Expanded Formulas

1.1 Elaboration of expected indirect utility terms

In the body of the paper, we do not labor through the general formulas for the present discounted values of expected utility, saving space by leaving them implicit in the terms such as $PDV(V_i^{AS})$. To aid verifcation of our final formulas, we provide additional details here. Expected utility if the individual *buys* program A is:

$$E_{S,H}\left[V_i^A\right] = \Pi_i^{AS} \times PDV(V_i^{AS}) + \left(1 - \Pi_i^{AS}\right) \times PDV(V_i^{AH}) \tag{1}$$

$$= \Pi_i^{AS} \begin{bmatrix} \sum \delta^t f(Y_{it}^* - c_{it}^{A*}) \\ +\alpha_{10} \sum \delta^t ill_{it}^A + \alpha_{11} \sum \delta^t age_{it} ill_{it}^A + \alpha_{12} \sum \delta^t age_{it}^2 ill_{it}^A \\ +\alpha_{20} \sum \delta^t rcv_{it}^A + \alpha_{21} \sum \delta^t age_{it} rcv_{it}^A + \alpha_{22} \sum \delta^t age_{it}^2 rcv_{it}^A \\ +\alpha_{30} \sum \delta^t lyl_{it}^A + \alpha_{31} \sum \delta^t age_{it} lyl_{it}^A + \alpha_{32} \sum \delta^t age_{it}^2 lyl_{it}^A + \varepsilon_i^{AS} \end{bmatrix}$$

$$+ \left(1 - \Pi_i^{AS}\right) \left[f(Y_i - c_i^A) \sum \delta^t + \varepsilon_i^{AH}\right]$$

Expected utility if the program is *not* purchased (i.e. "no program", N), with the expectation taken over uncertainty about whether the individual will suffer the illness, is:

$$E_{S,H}\left[V_i^N\right] = \Pi_i^{NS} \times PDV(V_i^{NS}) + \left(1-\Pi_i^{NS}\right) \times PDV(V_i^{NH}) \tag{2}$$

$$= \Pi_i^{NS}\left[\begin{array}{c} \sum \delta^t f(Y_{it}^*) \\ +\alpha_{10}\sum \delta^t ill_{it}^A + \alpha_{11}\sum \delta^t age_{it} ill_{it}^A + \alpha_{12}\sum \delta^t age_{it}^2 ill_{it}^A \\ +\alpha_{20}\sum \delta^t rcv_{it}^A + \alpha_{21}\sum \delta^t age_{it} rcv_{it}^A + \alpha_{22}\sum \delta^t age_{it}^2 rcv_{it}^A \\ +\alpha_{30}\sum \delta^t lyl_{it}^A + \alpha_{31}\sum \delta^t age_{it} lyl_{it}^A + \alpha_{32}\sum \delta^t age_{it}^2 lyl_{it}^A + \varepsilon_i^{NS} \end{array}\right]$$

$$+\left(1-\Pi_i^{NS}\right)\left[f\left(Y_i\right)\sum \delta^t + \varepsilon_i^{NH}\right]$$

When the annual income and annual program cost terms bear an asterisk (i.e. Y_{it}^* or c_{it}^{A*}) it signifies that annual income will differ according to the individual's future health state in each period. Income is either at its current level (in real terms) if the individual will be alive and healthy in future period t or it will be assumed to be some specified fraction of that income (i.e. γ_1, if the individual suffers one of these major illnesses, or γ_2 if the individual is dead). Annual program costs will also differ according to the individual's future health state in each period. They will either be at the level specified in the choice scenario, in real terms, if the individual is alive and healthy in period t, or they will be assumed to be some specified fraction of that amount (i.e. γ_3 if the individual suffers the major illness in question, or γ_4 if the individual is dead). In this paper, we will assume $(\gamma_1, \gamma_2, \gamma_3, \gamma_4) = (1, 0, 0, 0)$

1.2 Extensive formulas for expected utility differences

For a generic version of our indirect utility function, we assume only that utility is linear and additively separable in some unspecified function of net income, $f(Y_i)$, so that the contribution of net income to indirect utility is just $\beta f(Y_i)$. Net income may or may reflect the cost of the program, and may or may not be constant over time. We first show the main formulas for the expected discounted utility difference that explains choices using a version of the model without age-at-health-state heterogeneity (i.e. no age_{it} shifters on the underlying undiscounted marginal (dis)utilities of adverse health states).

The difference in expected present discounted utility between the program and no-program cases will be:

$$
\begin{aligned}
& E_{S,H}\left[V_i^A\right] - E_{S,H}\left[V_i^N\right] \quad (3)\\
= \; & \Pi_i^{AS}\left[\beta\sum\delta^t f(Y_{it}^* - c_{it}^{A*}) + \alpha_1\sum\delta^t ill_{it}^A + \alpha_2\sum\delta^t rcv_{it}^A + \alpha_3\sum\delta^t lyl_{it}^A + \varepsilon_i^{AS}\right]\\
& + \left(1-\Pi_i^{AS}\right)\left[\beta f(Y_i - c_i^A)\sum\delta^t + \varepsilon_i^{AH}\right]\\
& -\Pi_i^{NS}\left[\beta\sum\delta^t f(Y_{it}^*) + \alpha_1\sum\delta^t ill_{it}^A + \alpha_2\sum\delta^t rcv_{it}^A + \alpha_3\sum\delta^t lyl_{it}^A + \varepsilon_i^{NS}\right]\\
& - \left(1-\Pi_i^{NS}\right)\left[\beta f(Y_i)\sum\delta^t + \varepsilon_i^{NH}\right]
\end{aligned}
$$

Distributing terms, this expected utility difference can be written as:

$$
\begin{aligned}
& E_{S,H}\left[V_i^A\right] - E_{S,H}\left[V_i^N\right] \quad (4)\\
= \; & \Pi_i^{AS}\left[\beta\sum\delta^t f(Y_{it}^* - c_{it}^{A*})\right]\\
& +\Pi_i^{AS}\left[\alpha_1\sum\delta^t ill_{it}^A + \alpha_2\sum\delta^t rcv_{it}^A + \alpha_3\sum\delta^t lyl_{it}^A\right] + \Pi_i^{AS}\left[\varepsilon_i^{AS}\right]\\
& + \left[\beta f(Y_i - c_i^A)\sum\delta^t\right]\\
& -\Pi_i^{AS}\left[\beta f(Y_i - c_i^A)\sum\delta^t\right] + \left(1-\Pi_i^{AS}\right)\left[\varepsilon_i^{AH}\right]\\
& \\
& -\Pi_i^{NS}\left[\beta\sum\delta^t f(Y_{it}^*)\right]\\
& -\Pi_i^{NS}\left[\alpha_1\sum\delta^t ill_{it}^A + \alpha_2\sum\delta^t rcv_{it}^A + \alpha_3\sum\delta^t lyl_{it}^A\right] - \Pi_i^{NS}\left[\varepsilon_i^{NS}\right]\\
& - \left[\beta f(Y_i)\sum\delta^t\right]\\
& +\Pi_i^{NS}\left[\beta f(Y_i)\sum\delta^t\right] - \left(1-\Pi_i^{NS}\right)\left[\varepsilon_i^{NH}\right]
\end{aligned}
$$

In the process of simplifying this expression, there are four components involving error terms. We will define the compound error term as ε. If the error terms ε_i^{Nk} are independent and identically distributed according to an extreme value distribution, and if the ε_i^{Nk} are similarly independent and identically distributed extreme value, then the resulting error term can be assumed to be logistic, so that a logit model is appropriate.

$$
\varepsilon_i = \Pi_i^{AS}\left[\varepsilon_i^{AS}\right] + \left(1-\Pi_i^{AS}\right)\left[\varepsilon_i^{AH}\right] - \Pi_i^{NS}\left[\varepsilon_i^{NS}\right] - \left(1-\Pi_i^{NS}\right)\left[\varepsilon_i^{NH}\right] \quad (5)
$$

In equation (4), pairs of terms can be combined in three cases. First, the two terms containing no probabilities can be combined:

$$\begin{aligned} & \left[\beta f(Y_i - c_i^A) \sum \delta^t\right] - \left[\beta f(Y_i) \sum \delta^t\right] \\ = \;& \beta\left[f(Y_i - c_i^A) - f(Y_i)\right] \sum \delta^t \end{aligned}$$

Next, the two terms involving Π_i^{AS} and the income expression can be combined:

$$\begin{aligned} & \Pi_i^{AS}\left[\beta \sum \delta^t f(Y_{it}^* - c_{it}^{A*})\right] - \Pi_i^{AS}\left[\beta f(Y_i - c_i^A) \sum \delta^t\right] \\ = \;& \beta \Pi_i^{AS}\left\{\left[\sum \delta^t f(Y_{it}^* - c_{it}^{A*})\right] - \left[f(Y_i - c_i^A) \sum \delta^t\right]\right\} \end{aligned}$$

Finally, the two terms involving Π_i^{NS} and the income expression can be collected:

$$\begin{aligned} & \Pi_i^{NS}\left\{\left[\beta f(Y_i) \sum \delta^t\right] - \left[\beta \sum \delta^t f(Y_{it}^*)\right]\right\} \\ = \;& \beta \Pi_i^{NS}\left\{\left[f(Y_i) \sum \delta^t\right] - \left[\sum \delta^t f(Y_{it}^*)\right]\right\} \end{aligned}$$

Taking advantage of these simplifications, and collecting terms, the expected indirect utility difference can be re-written as:

$$\begin{aligned} & E_{S,H}\left[V_i^A\right] - E_{S,H}\left[V_i^N\right] \qquad (6) \\ = \;& \beta\left[f(Y_i - c_i^A) - f(Y_i)\right] \sum \delta^t \\ & +\beta \Pi_i^{AS}\left\{\left[\sum \delta^t f(Y_{it}^* - c_{it}^{A*})\right] - \left[f(Y_i - c_i^A) \sum \delta^t\right]\right\} \\ & -\beta \Pi_i^{NS}\left\{\left[\sum \delta^t f(Y_{it}^*)\right] - \left[f(Y_i) \sum \delta^t\right]\right\} \\ & + \left(\Pi_i^{AS} - \Pi_i^{NS}\right)\left[\alpha_1 \sum \delta^t ill_{it}^A + \alpha_2 \sum \delta^t rcv_{it}^A + \alpha_3 \sum \delta^t lyl_{it}^A\right] + \varepsilon_i \end{aligned}$$

In this expression, the second and third lines to the right of the equals sign are present because of the different patterns of income and program costs implied by a choice of the program. It is probably appropriate to assume that there is zero income (meaning no consumption of other goods and services) after death and that program costs will not be paid if the individual is ill or dead. In what follows, we will also maintain the hypotheses that $(\gamma_1, \gamma_2, \gamma_3, \gamma_4) = (1, 0, 0, 0)$. In words, usual income is sustained through illness by insurance, but not after death (there are no bequests), and program costs are only paid while alive and healthy. These parameters are embedded in the Y_{it}^* and c_{it}^{A*} terms in our models.

1.3 Generalizing to the model with age-at-health-state effects

We now restoring the key age-at-health-state effects that are central to this paper. We also generalize the manner in which net income enters the indirect utility function. We desire to specify a model that readily accommodates indirect utility that is quadratic in net income, as well as a variant that is linear in the logarithm of net income. Thus we use a net-income-related term in the indirect utility function of the form $(\beta_0+\beta_1 Y_i)f(Y_i)$. if $f(Y_i)=Y_i$ and β_1 is non-zero, then indirect utility is quadratic in net income. If $f(Y_i)=\log(Y_i)$ and $\beta_1=0$, then indirect utility is linear in the logarithm of net income. (Here, however, we will mostly emphasize the quadratic variant.) In the general case, the expected discounted indirect utility difference is:

$$
\begin{aligned}
& E_{S,H}\left[V_i^A\right]-E_{S,H}\left[V_i^N\right] \qquad (7)\\
= \; & \beta_0\left[f(Y_i-c_i^A)-f(Y_i)\right]\sum\delta^t \\
& +\beta_1\left[(Y_i-c_i^A)f(Y_i-c_i^A)-(Y_i)f(Y_i)\right]\sum\delta^t \\
& +\beta_0\Pi_i^{AS}\left\{\left[\sum\delta^t f(Y_{it}^*-c_{it}^{A*})\right]-\left[f(Y_i-c_i^A)\sum\delta^t\right]\right\} \\
& +\beta_1\Pi_i^{AS}\left\{\left[\sum\delta^t(Y_{it}^*-c_{it}^{A*})f(Y_{it}^*-c_{it}^{A*})\right]-\left[(Y_i-c_i^A)f(Y_i-c_i^A)\sum\delta^t\right]\right\} \\
& -\beta_0\Pi_i^{NS}\left\{\left[\sum\delta^t f(Y_{it}^*)\right]-\left[f(Y_i)\sum\delta^t\right]\right\} \\
& -\beta_1\Pi_i^{NS}\left\{\left[\sum\delta^t(Y_{it}^*)f(Y_{it}^*)\right]-\left[(Y_i)f(Y_i)\sum\delta^t\right]\right\} \\
& +\left(\Pi_i^{AS}-\Pi_i^{NS}\right)\left[\begin{array}{c}
\alpha_{10}\sum\delta^t ill_{it}^A+\alpha_{11}\sum\delta^t age_{it}ill_{it}^A+\alpha_{12}\sum\delta^t age_{it}^2 ill_{it}^A \\
+\alpha_{20}\sum\delta^t rcv_{it}^A+\alpha_{21}\sum\delta^t age_{it}rcv_{it}^A+\alpha_{22}\sum\delta^t age_{it}^2 rcv_{it}^A \\
+\alpha_{30}\sum\delta^t lyl_{it}^A+\alpha_{31}\sum\delta^t age_{it}lyl_{it}^A+\alpha_{32}\sum\delta^t age_{it}^2 lyl_{it}^A
\end{array}\right]+\varepsilon_i
\end{aligned}
$$

The expected indirect utility difference can be simplified if we assume $f(Y_i)=\beta_0 Y_i$.

Under this assumption, equation (7) can be simplified to:

$$
\begin{aligned}
& E_{S,H}\left[V_i^A\right] - E_{S,H}\left[V_i^N\right] \qquad (8)\\
= \; & \beta_0\left[-c_i^A\right]\sum\delta^t + \beta_1\left[(Y_i - c_i^A)(Y_i - c_i^A) - (Y_i)(Y_i)\right]\sum\delta^t \\
& +\beta_0\Pi_i^{AS}\left\{\left[\sum\delta^t\left(Y_{it}^* - c_{it}^{A*}\right)\right] - \left[\left(Y_i - c_i^A\right)\sum\delta^t\right]\right\} \\
& +\beta_1\Pi_i^{AS}\left\{\left[\sum\delta^t\left(Y_{it}^* - c_{it}^{A*}\right)\left(Y_{it}^* - c_{it}^{A*}\right)\right] - \left[\left(Y_i - c_i^A\right)\left(Y_i - c_i^A\right)\sum\delta^t\right]\right\} \\
& -\beta_0\Pi_i^{NS}\left\{\left[\sum\delta^t Y_{it}^*\right] - \left[(Y_i)\sum\delta^t\right]\right\} \\
& -\beta_1\Pi_i^{NS}\left\{\left[\sum\delta^t Y_{it}^* Y_{it}^*\right] - \left[(Y_i)(Y_i)\sum\delta^t\right]\right\} \\
& + \left(\Pi_i^{AS} - \Pi_i^{NS}\right)\left[\begin{array}{c}
\alpha_{10}\sum\delta^t ill_{it}^A + \alpha_{11}\sum\delta^t age_{it} ill_{it}^A + \alpha_{12}\sum\delta^t age_{it}^2 ill_{it}^A \\
+\alpha_{20}\sum\delta^t rcv_{it}^A + \alpha_{21}\sum\delta^t age_{it} rcv_{it}^A + \alpha_{22}\sum\delta^t age_{it}^2 rcv_{it}^A \\
+\alpha_{30}\sum\delta^t lyl_{it}^A + \alpha_{31}\sum\delta^t age_{it} lyl_{it}^A + \alpha_{32}\sum\delta^t age_{it}^2 lyl_{it}^A
\end{array}\right] + \varepsilon_i
\end{aligned}
$$

Now define $\Delta\Pi_i^{AS} = \left(\Pi_i^{AS} - \Pi_i^{NS}\right)$ and distribute this probability difference in anticipation of the need to construct the estimating variables from the raw data:

$$
\begin{aligned}
& E\left[V_i^A\right] - E\left[V_i^N\right] \qquad (9)\\
= \; & \beta_0\left[-c_i^A\right]\sum\delta^t \\
& +\beta_0\Pi_i^{AS}\left\{\left[\sum\delta^t\left(Y_{it}^* - c_{it}^{A*}\right)\right] - \left[\left(Y_i - c_i^A\right)\sum\delta^t\right]\right\} \\
& -\beta_0\Pi_i^{NS}\left\{\left[\sum\delta^t Y_{it}^*\right] - \left[(Y_i)\sum\delta^t\right]\right\} \\
& +\beta_1\left[(Y_i - c_i^A)(Y_i - c_i^A) - (Y_i)(Y_i)\right]\sum\delta^t \\
& +\beta_1\Pi_i^{AS}\left\{\left[\sum\delta^t\left(Y_{it}^* - c_{it}^{A*}\right)\left(Y_{it}^* - c_{it}^{A*}\right)\right] - \left[\left(Y_i - c_i^A\right)\left(Y_i - c_i^A\right)\sum\delta^t\right]\right\} \\
& -\beta_1\Pi_i^{NS}\left\{\left[\sum\delta^t Y_{it}^* Y_{it}^*\right] - \left[(Y_i)(Y_i)\sum\delta^t\right]\right\} \\
& +\alpha_{10}\Delta\Pi_i^{AS}\sum\delta^t ill_{it}^A + \alpha_{11}\Delta\Pi_i^{AS}\sum\delta^t age_{it} ill_{it}^A + \alpha_{12}\Delta\Pi_i^{AS}\sum\delta^t age_{it}^2 ill_{it}^A \\
& +\alpha_{20}\Delta\Pi_i^{AS}\sum\delta^t rcv_{it}^A + \alpha_{21}\Delta\Pi_i^{AS}\sum\delta^t age_{it} rcv_{it}^A + \alpha_{22}\Delta\Pi_i^{AS}\sum\delta^t age_{it}^2 rcv_{it}^A \\
& +\alpha_{30}\Delta\Pi_i^{AS}\sum\delta^t lyl_{it}^A + \alpha_{31}\Delta\Pi_i^{AS}\sum\delta^t age_{it} lyl_{it}^A + \alpha_{32}\Delta\Pi_i^{AS}\sum\delta^t age_{it}^2 lyl_{it}^A + \varepsilon_i
\end{aligned}
$$

As described in the body of the paper, using this model to estimate willingness to pay to avoid specified adverse health profiles involves estimating the unknown parameters of the indirect utility function and then solving this model to isolate an expression for the common certain payment c_{it}^A that makes this utility difference exactly zero. The previous equation therefore needs to be re-written to isolate this variable. Maintaining generality, let the present discounted health-state years in each health profile be abbreviated as follws. In each column below, the five terms correspond to (1) overall remaining lifespan, (2) pre-illness years, (3) sick-years, (4) post-illness (recovered) years, and (5) lost life-years. The second and third columns pertain to terms where each health state dummy is interacted with the individual's future age in that period (also called "age-at-future-health-state").

$$\begin{aligned}
pdvc_i^A &= \sum \delta^t & agepdvc_i^A &= \sum \delta^t age_{it} & age2pdvc_i^A &= \sum \delta^t age_{it}^2 \\
pdve_i^A &= \sum \delta^t pre_{it}^A & agepdve_i^A &= \sum \delta^t age_{it} pre_{it}^A & age2pdve_i^A &= \sum \delta^t age_{it}^2 pre_{it}^A \\
pdvi_i^A &= \sum \delta^t ill_{it}^A & agepdvi_i^A &= \sum \delta^t age_{it} ill_{it}^A & age2pdvi_i^A &= \sum \delta^t age_{it}^2 ill_{it}^A \\
pdvr_i^A &= \sum \delta^t rcv_{it}^A & agepdvr_i^A &= \sum \delta^t age_{it} rcv_{it}^A & age2pdvr_i^A &= \sum \delta^t age_{it}^2 rcv_{it}^A \\
pdvl_i^A &= \sum \delta^t lyl_{it}^A & agepdvl_i^A &= \sum \delta^t age_{it} lyl_{it}^A & age2pdvl_i^A &= \sum \delta^t age_{it}^2 lyl_{it}^A
\end{aligned}$$

Since the indicator variables for each health status are mutually exclusive and exhaustive, the following simplifications are possible:

$$\begin{aligned}
pdvc_i^A &= pdve_i^A + pdvi_i^A + pdvr_i^A + pdvl_i^A \\
agepdvc_i^A &= agepdve_i^A + agepdvi_i^A + agepdvr_i^A + agepdvl_i^A \\
age2pdvc_i^A &= age2pdve_i^A + age2pdvi_i^A + age2pdvr_i^A + age2pdvl_i^A
\end{aligned}$$

To accommodate the different time profiles of income and program costs over the individual's remaining lifespan, we must also define two additional terms (where here we preserve the general form of the γ vector):

$$\begin{aligned}
pdvy_i^A &= \sum \delta^t \left(pre_{it}^A + \gamma_1 ill_{it}^A + rcv_{it}^A + \gamma_2 lyl_{it}^A \right) = pdve_i^A + \gamma_1 pdvi_i^A + pdvr_i^A + \gamma_2 pdvl_i^A \\
pdvp_i^A &= \sum \delta^t \left(pre_{it}^A + \gamma_3 ill_{it}^A + rcv_{it}^A + \gamma_4 lyl_{it}^A \right) = pdve_i^A + \gamma_3 pdvi_i^A + pdvr_i^A + \gamma_4 pdvl_i^A
\end{aligned}$$

If $(\gamma_1, \gamma_2, \gamma_3, \gamma_4) = (1, 0, 0, 0)$, then $pdvy_i^A = pdve_i^A + pdvi_i^A + pdvr_i^A = 1 - pdvl_i^A$ and $pdvp_i^A = pdve_i^A + pdvr_i^A$. We will refer to *pdvy*, generically, as the present discounted profile for income, and to *pdvp* as the present discounted profile for program costs.

To isolate c_{it}^A, so it is easier to solve for the value of c_{it}^A that would make the expected discounted indirect utility difference exactly zero, we now focus separately on each of the terms involving income and the different β coefficients in equation (8). We re-write each of the terms, then collect them to highlight the resulting quadratic form in c_{it}^{A}. The terms in β_0 in equation (8) can be re-written in a couple of steps as follows:

$$\begin{aligned}
& \beta_0 \left[-c_i^A\right] \sum \delta^t \\
& +\beta_0 \Pi_i^{AS} \left\{ \left[\sum \delta^t \left(Y_{it}^* - c_{it}^{A*}\right) \right] - \left[\left(Y_i - c_i^A\right) \sum \delta^t \right] \right\} \\
& -\beta_0 \Pi_i^{NS} \left\{ \left[\sum \delta^t Y_{it}^* \right] - \left[(Y_i) \sum \delta^t \right] \right\} \\
= & \left[-c_i^A\right] \beta_0 pdvc_i^A - \left[-c_i^A\right] \beta_0 \Pi_i^{AS} pdvc_i^A + \left[-c_i^A\right] \beta_0 \Pi_i^{AS} pdvp_i^A \\
& +Y_i \beta_0 \Pi_i^{AS} \left\{ pdvy_i^A - pdvc_i^A \right\} - Y_i \beta_0 \Pi_i^{NS} \left\{ pdvy_i^A - pdvc_i^A \right\} \\
= & \left[-c_i^A\right] \beta_0 \left[\left(1 - \Pi_i^{AS}\right) pdvc_i^A + \Pi_i^{AS} pdvp_i^A \right] \\
& +\beta_0 Y_i \Delta \Pi_i^{AS} \left\{ pdvy_i^A - pdvc_i^A \right\}
\end{aligned}$$

The terms involving β_1 in equation (8) can be written to isolate terms in c_i^A and $(c_i^A)^2$ if we define the following additional abbrevations for new terms to be introduced. Again, the fact that our indicator variables for each distinct health status are mutually exclusive and exhaustive allows some important simplifications (where again, we preserve the generality of the γ parameters):

$$\begin{aligned}
pdvyy_i^A &= \sum \delta^t \left(pre_{it}^A + \gamma_1 ill_{it}^A + rcv_{it}^A + \gamma_2 lyl_{it}^A\right)^2 = pdve_i^A + \gamma_1^2 pdvi_i^A + pdvr_i^A + \gamma_2^2 pdvl_i^A \\
pdvpp_i^A &= \sum \delta^t \left(pre_{it}^A + \gamma_3 ill_{it}^A + rcv_{it}^A + \gamma_4 lyl_{it}^A\right)^2 = pdve_i^A + \gamma_3^2 pdvi_i^A + pdvr_i^A + \gamma_4^2 pdvl_i^A \\
pdvyp_i^A &= \sum \delta^t \left(pre_{it}^A + \gamma_1 ill_{it}^A + rcv_{it}^A + \gamma_2 lyl_{it}^A\right) \left(pre_{it}^A + \gamma_3 ill_{it}^A + rcv_{it}^A + \gamma_4 lyl_{it}^A\right) \\
&= pdve_i^A + \gamma_1 \gamma_3 pdvi_i^A + pdvr_i^A + \gamma_2 \gamma_4 pdvl_i^A
\end{aligned}$$

If we assume that $(\gamma_1, \gamma_2, \gamma_3, \gamma_4) = (1, 0, 0, 0)$, then note that $pdvyy_i^A = pdvy_i^A$ and $pdvpp_i^A = pdvyp_i^A = pdvp_i^A$. Either way, these terms allow us to streamline our notation via the following steps:

$$
\begin{aligned}
& \beta_1 \left[(Y_i - c_i^A)(Y_i - c_i^A) - (Y_i)(Y_i)\right] \sum \delta^t \\
& + \beta_1 \Pi_i^{AS} \left\{ \left[\sum \delta^t \left(Y_{it}^* - c_{it}^{A*}\right) \left(Y_{it}^* - c_{it}^{A*}\right) \right] - \left[\left(Y_i - c_i^A\right) \left(Y_i - c_i^A\right) \sum \delta^t \right] \right\} \\
& - \beta_1 \Pi_i^{NS} \left\{ \left[\sum \delta^t Y_{it}^* Y_{it}^* \right] - \left[(Y_i)\,(Y_i) \sum \delta^t \right] \right\} \\
= \; & [-c_i^A] 2\beta_1 (Y_i) pdvc_i^A + [-c_i^A]^2 \beta_1 pdvc_i^A + \beta_1 (Y_i)^2 pdvc_i^A - \beta_1 (Y_i)^2 pdvc_i^A \\
& + \beta_1 \Pi_i^{AS} (Y_i)^2 \, pdvyy_i^A + [-c_i] 2\beta_1 \Pi_i^{AS} (Y_i) \, pdvyp_i^A + [-c_i]^2 \beta_1 \Pi_i^{AS} pdvpp_i^A \\
& - \beta_1 \Pi_i^{AS} (Y_i)^2 \, pdvc_i^A - [-c_i] 2\beta_1 \Pi_i^{AS} (Y_i) \, pdvc_i^A - [-c_i]^2 \beta_1 \Pi_i^{AS} pdvc_i^A \\
& - \beta_1 \Pi_i^{NS} (Y_i)^2 \, pdvyy_i^A + \beta_1 \Pi_i^{NS} (Y_i)^2 \, pdvc_i^A \\
= \; & [-c_i^A] 2\beta_1 (Y_i) pdvc_i^A + [-c_i] 2\beta_1 \Pi_i^{AS} (Y_i) \, pdvyp_i^A - [-c_i] 2\beta_1 \Pi_i^{AS} (Y_i) \, pdvc_i^A \\
& + [-c_i^A]^2 \beta_1 pdvc_i^A + [-c_i]^2 \beta_1 \Pi_i^{AS} pdvpp_i^A - [-c_i]^2 \beta_1 \Pi_i^{AS} pdvc_i^A \\
& + \beta_1 \Pi_i^{AS} (Y_i)^2 \, pdvyy_i^A - \beta_1 \Pi_i^{NS} (Y_i)^2 \, pdvyy_i^A \\
& - \beta_1 \Pi_i^{AS} (Y_i)^2 \, pdvc_i^A + \beta_1 \Pi_i^{NS} (Y_i)^2 \, pdvc_i^A \\
= \; & [-c_i^A] \beta_1 2Y_i \left[\left(1 - \Pi_i^{AS}\right) pdvc_i^A + \Pi_i^{AS} pdvyp_i^A \right] \\
& + [-c_i^A]^2 \beta_1 \left[\left(1 - \Pi_i^{AS}\right) pdvc_i^A + \Pi_i^{AS} pdvpp_i^A \right] \\
& + \beta_1 Y_i^2 \Delta \Pi_i^{AS} \left(pdvyy_i^A - pdvc_i^A \right)
\end{aligned}
$$

With a little more incidental factoring of the shared β_0 and β_1 coefficients, these final simplifications match the constructed variables outlined in the body of the paper, to be used in estimation of the underlying marginal utility parameters originating in the undiscounted per-period indirect utility function for arbitrary health states.