Health and Mortality Delta: Assessing the Welfare Cost of Household Insurance Choice

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[1]The views expressed herein are not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

Two motivating questions

1. What is the optimal demand for health and longevity products?
   - Life insurance, annuities, Medigap insurance, and long-term care insurance.
     - Available in various maturities and payout structures.
     - Insurance markets are essentially complete.
     - Optimal demand as a portfolio choice problem.
   - Standard risk measures in the retail financial industry:
     - Equity products $\Rightarrow$ Beta
     - Fixed-income products $\Rightarrow$ Duration
     - Health and longevity products $\Rightarrow$ Health and mortality delta
   - Optimal life-cycle demand for insurance.
     - Switch from life insurance to longevity insurance (i.e., annuities) around retirement age.

2. How close is the observed demand to being optimal?
   - Estimate household preferences (risk aversion and bequest motive) from the observed demand.
     - Insurance choice: Desired path of savings in future health states.
     - Much more informative than the realized path of savings.
   - For U.S. households, the welfare cost of deviations from optimal demand is 17% of total wealth at age 51–58.
     - Life-cycle model predicts large variation in optimal demand along its state variables: Birth cohort, age, wealth, and health.
     - Observed demand mostly driven by heterogeneity and inertia due to passive annuitization through private pensions.

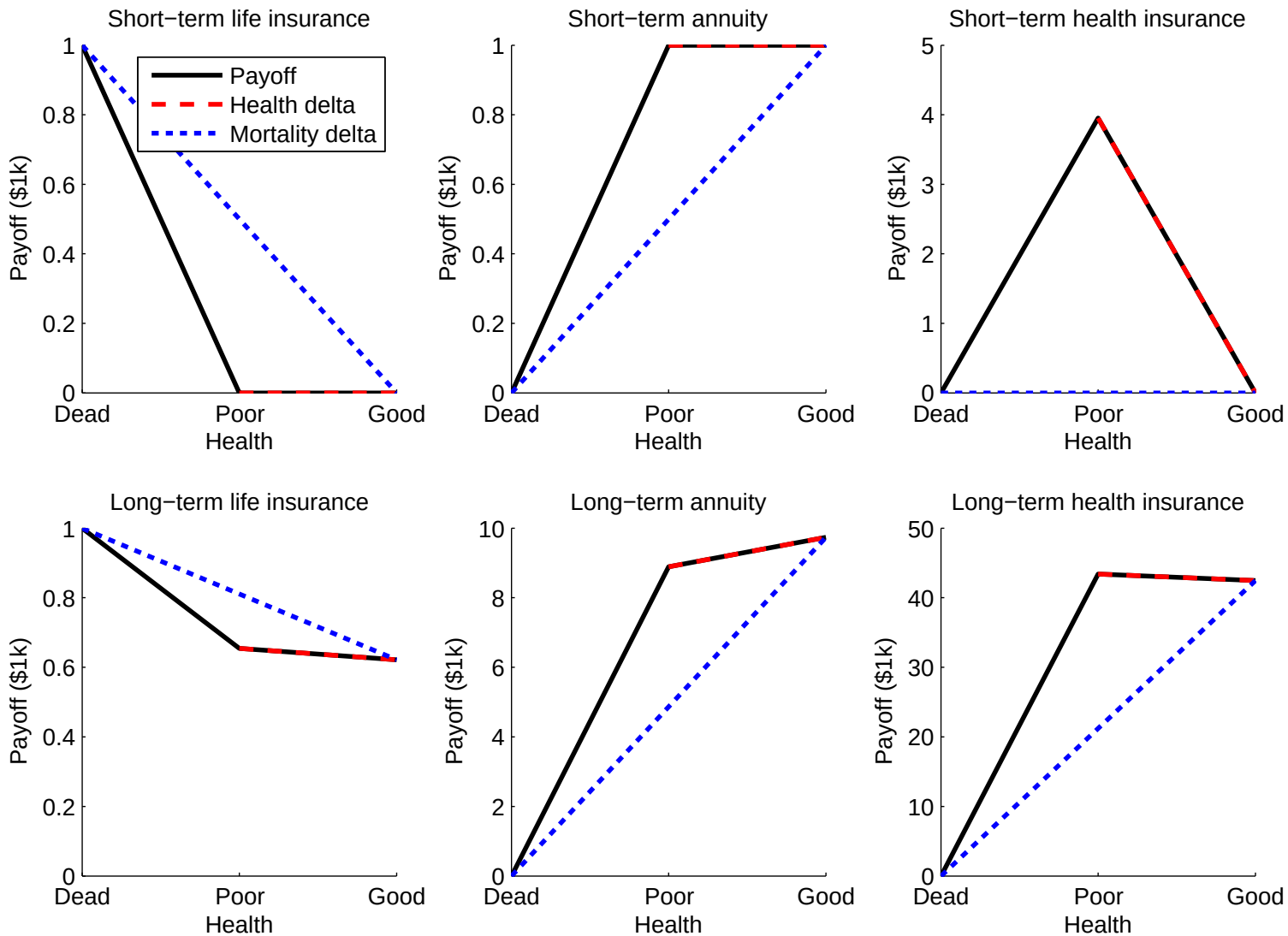
A life-cycle model with health and mortality risk

- Household faces health and mortality risk.
  - Lives for at most T periods.
  - 3 health states:

$$h_t = \{\text{Dead}, \text{Poor}, \text{Good}\}$$

  - Health transition probability: $\pi_t(i, j)$
  - Out-of-pocket health expense: $M_t(h_t)$
- Receives income Y_t.
- Saves in riskless bond (loan) at interest rate R.
- Also saves in health and longevity products of maturities 1 through $T - t$:
  1. Life insurance: Payoff of \$1k at death.
  2. Annuities: Payoff of \$1k in each period while alive.
  3. Supplementary health insurance: Payoff of $M_{t+1}(\text{Poor}) - M_{t+1}(\text{Good})$ in poor health.

Health and mortality delta for health and longevity products



Objective function

$$U_t(h_t) = \Bigg\{ \underbrace{\omega(h_t)^{\gamma} C_t^{1-\gamma}}_{\text{present consumption}} + \beta \Bigg[\underbrace{\pi_t(h_t, \text{Dead})\, \omega(\text{Dead})^{\gamma} A_{t+1}(\text{Dead})^{1-\gamma}}_{\text{bequest motive}} + \sum_{j=\{\text{Poor},\text{Good}\}} \pi_t(h_t, j) \underbrace{U_{t+1}(j)^{1-\gamma}}_{\text{future consumption}} \Bigg] \Bigg\}^{1/(1-\gamma)}$$

- Relative risk aversion: γ
- Bequest motive: $\omega(\text{Dead})$
- Complementarity of consumption and health: $\omega(\text{Poor})$

Optimal health and mortality delta under complete markets

- Define total wealth:

$$\widehat{W}_t(h_t) = W_t + \sum_{s=1}^{T-t} \frac{\mathbf{E}_t[Y_{t+s} - M_{t+s}|h_t]}{R^s}$$

- Average propensity to consume: $c_t(h_t)$
- Optimal policy:
  1. Consumption: $C_t^* = c_t(h_t)\widehat{W}_t(h_t)$
  2. Health delta:

$$\Delta_t^* = A_{t+1}^*(\text{Poor}) - A_{t+1}^*(\text{Good})$$

  3. Mortality delta:

$$\delta_t^* = A_{t+1}^*(\text{Dead}) - A_{t+1}^*(\text{Good})$$

- Optimal wealth at death:

$$A^*_{t+1}(\text{Dead}) = \frac{(\beta R)^{1/\gamma}\omega(\text{Dead})C^*_t}{\omega(h_t)}$$

- Optimal wealth in state $j = \{\text{Poor}, \text{Good}\}$:

$$A^*_{t+1}(j) = \underbrace{\frac{(\beta R)^{1/\gamma}\omega(j)C^*_t}{\omega(h_t)c_{t+1}(j)}}_{\text{longevity risk}} - \underbrace{\sum_{s=1}^{T-t} \frac{\mathbf{E}_{t+1}[Y_{t+s} - M_{t+s}|j]}{R^{s-1}}}_{\text{health risk}}$$

Health and Retirement Study

- Representative panel of U.S. households whose primary respondent is aged 51 and older, interviewed every 2 years since 1992.
- Focus on the sub-sample of males.
- Use a probit model to estimate mortality rate as a function of observed health problems.
- Define 3 health states:
  1. Death
  2. Poor:
     - Predicted mortality rate is higher than median *and*
     - Ratio of health expenses to income is higher than median.
  3. Good:
     - Alive and not in poor health.

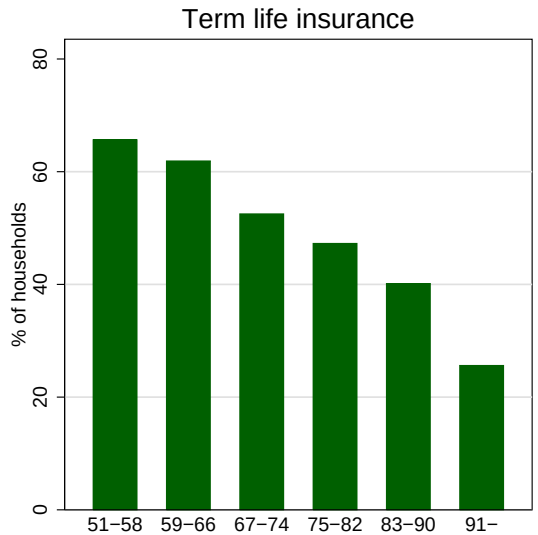
Key inputs for the life-cycle model

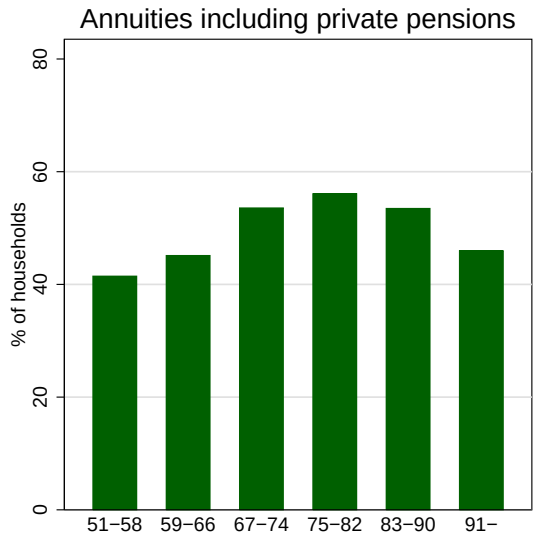
- Estimated for each cohort:
  1. Health transition probabilities.
  2. Out-of-pocket health expenses (after employer-provided insurance and Medicare).
  3. Income including Social Security (excludes annuities and private pensions).
  4. Actuarially fair prices for health and longevity products.
     - Results not sensitive to introducing markups.
- Observed for each household:
  1. Term and whole life insurance.
  2. Annuities including private pensions.
  3. Supplementary health (Medigap) insurance.
  4. Long-term care insurance.

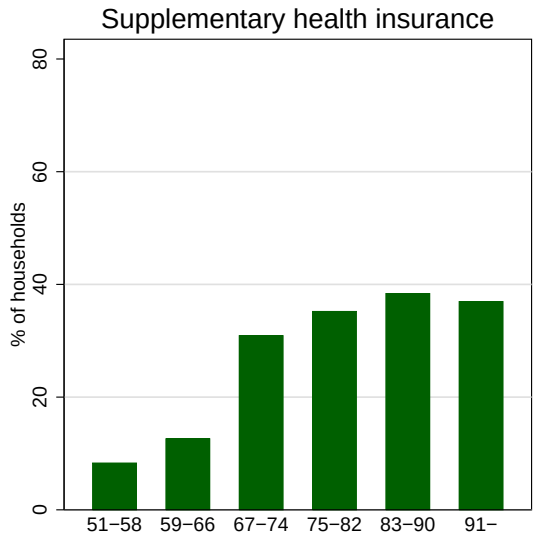
Out-of-pocket health expenses: Male born 1936–1940

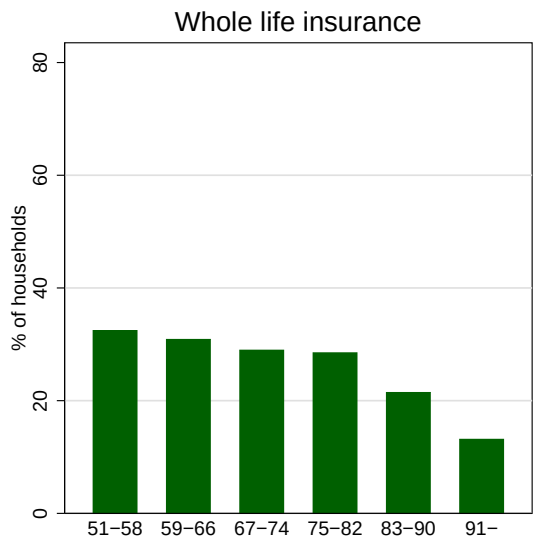
	Age						
Health	51	59	67	75	83	91	99
Out-of-pocket health expenses (thousands of 2005 dollars per year)							
Poor	2.0	4.5	7.6	12.5	21.4	37.9	69.5
Good	0.4	1.2	2.6	4.6	7.4	10.6	13.7
Mean	0.4	2.1	3.8	6.8	12.6	25.2	53.8
Income (thousands of 2005 dollars per year)							
Mean	51	38	26	21	18	16	14
Present value of future disposable income (thousands of 2005 dollars)							
Poor	428	232	107	18	-42	-78	-96
Good	467	270	135	31	-49	-106	-135
Mean	467	260	128	27	-46	-91	-107

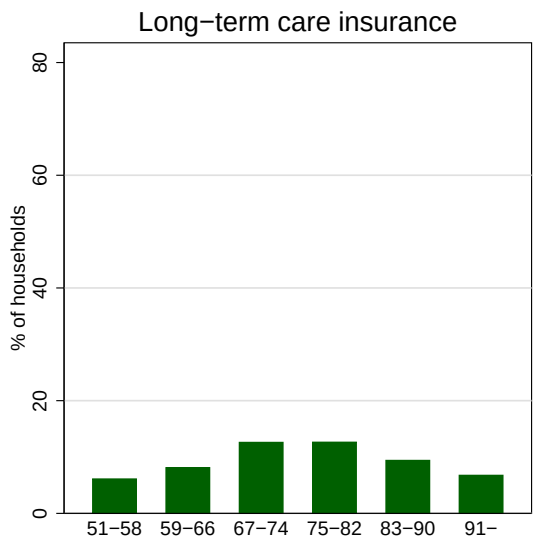
Ownership rates of health and longevity products



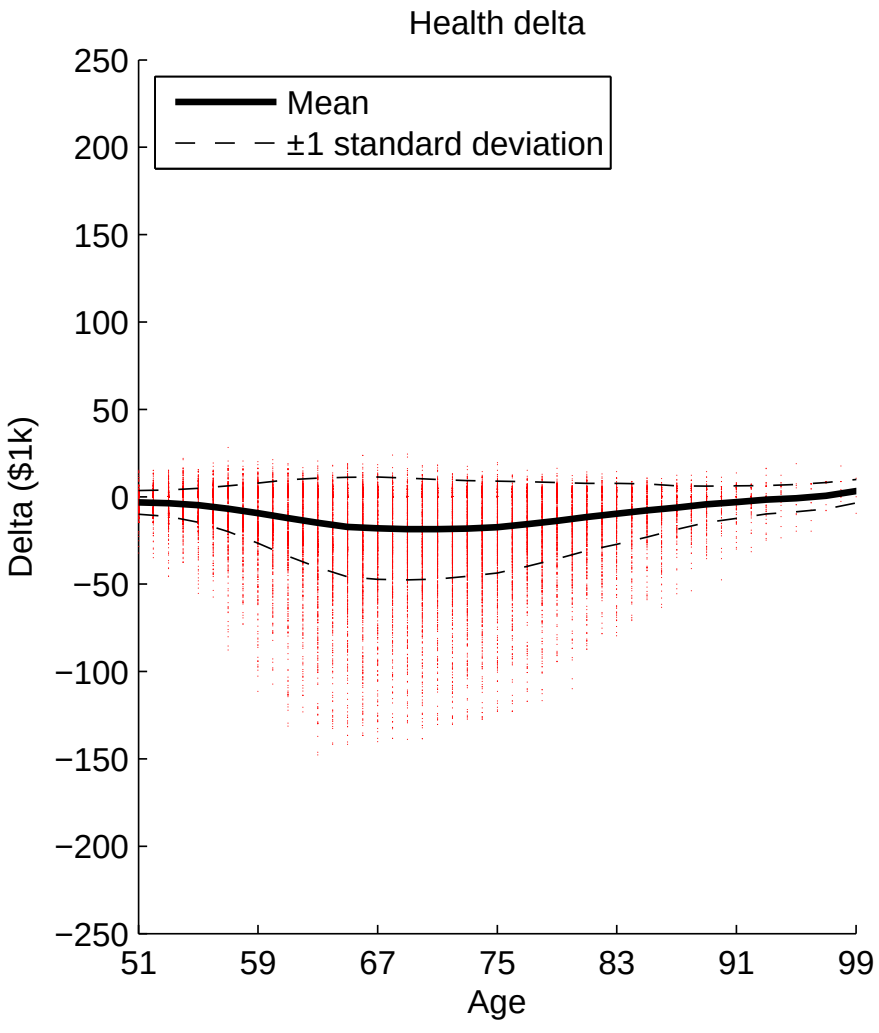


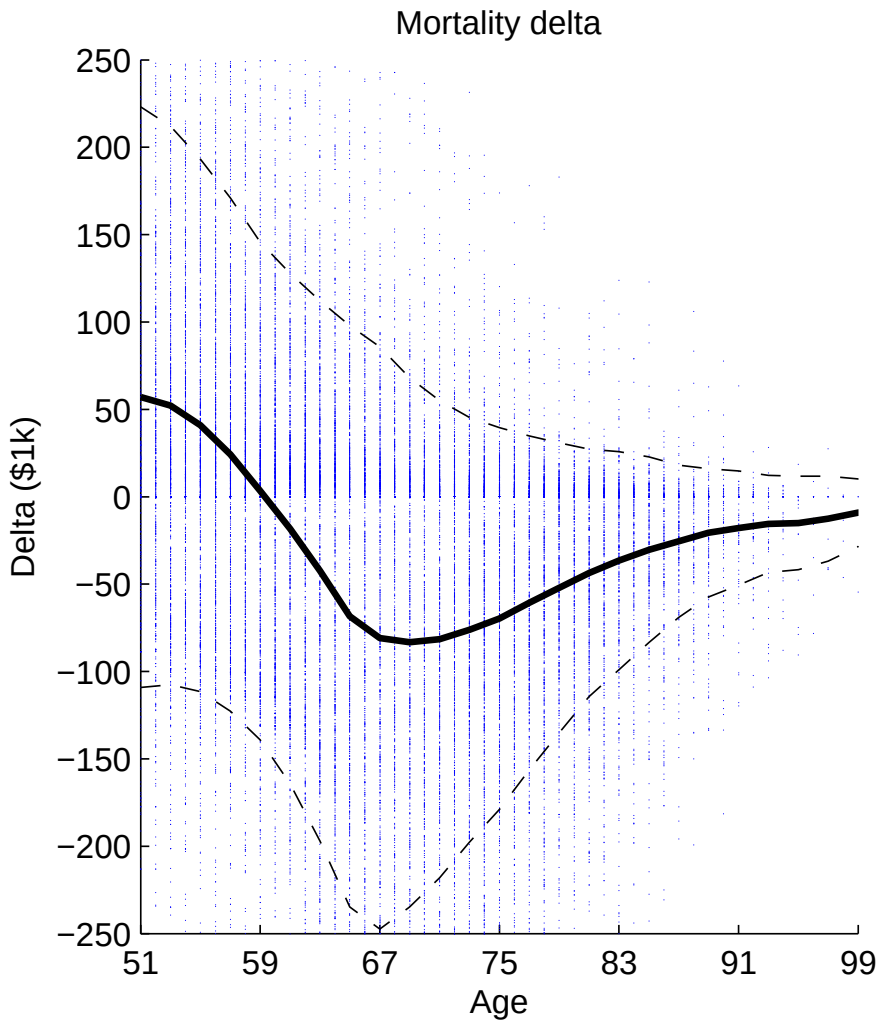






Observed health and mortality delta over the life cycle



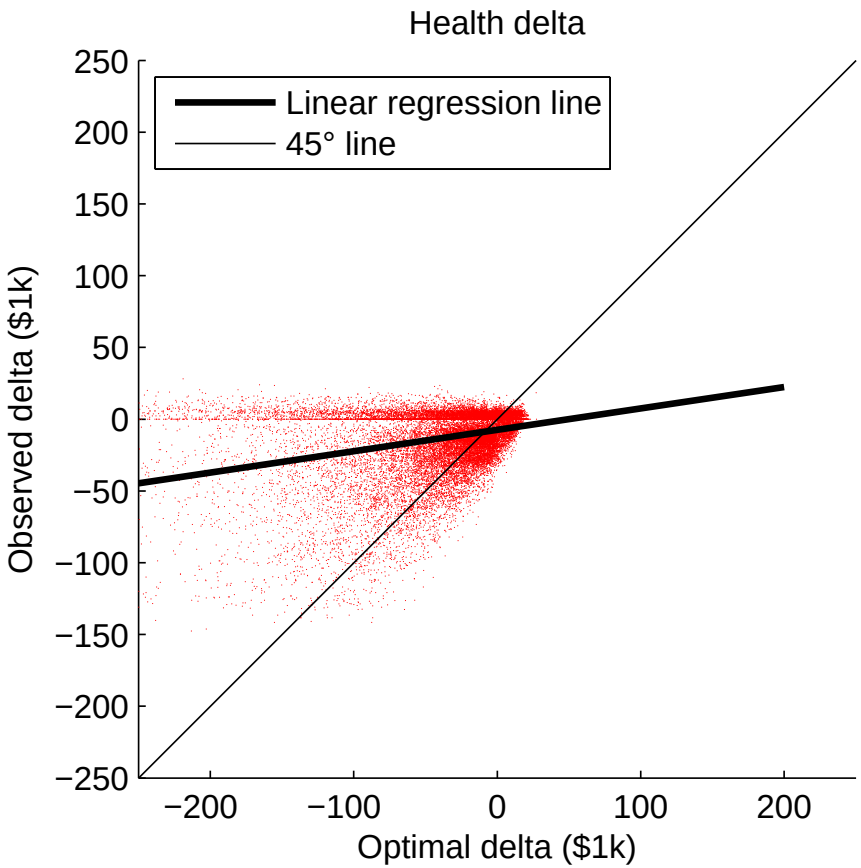


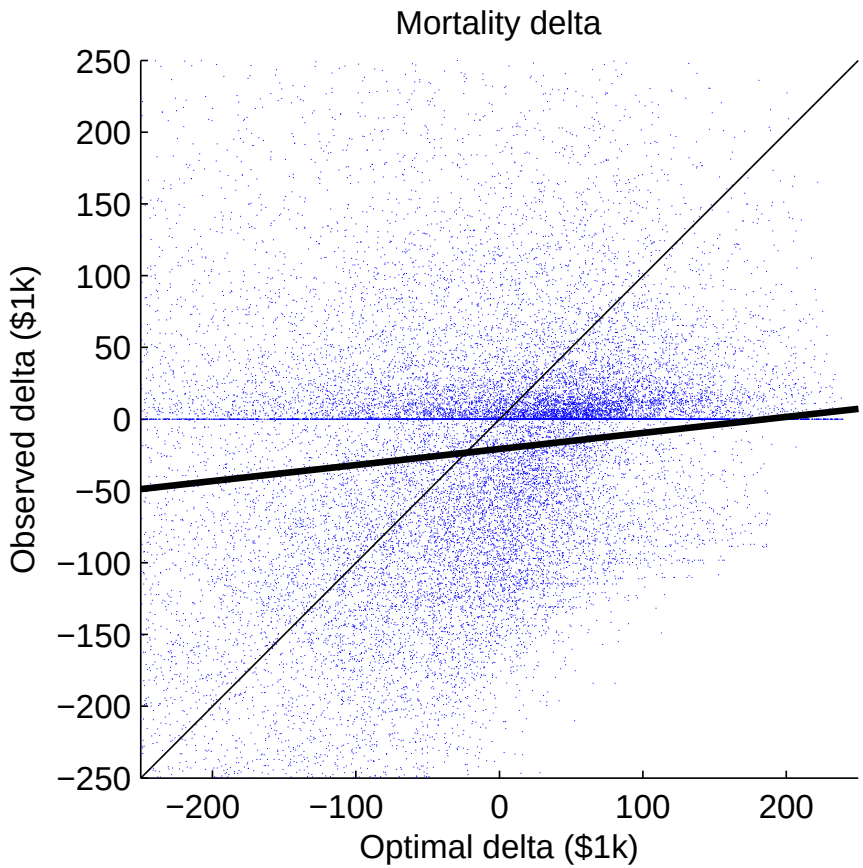
Estimating household preferences

- Given preferences, the life-cycle model implies optimal health and mortality delta.
- Estimate preferences to most closely match the observed health and mortality delta.

Parameter	Symbol	Value
Subjective discount factor	β	0.96
Relative risk aversion	γ	2.51
		(0.01)
Utility weight for death	$\omega(1)$	4.64
		(0.03)
Utility weight for poor health	$\omega(2)$	0.71
		(0.01)
Utility weight for good health	$\omega(3)$	1.00

Observed versus optimal health and mortality delta

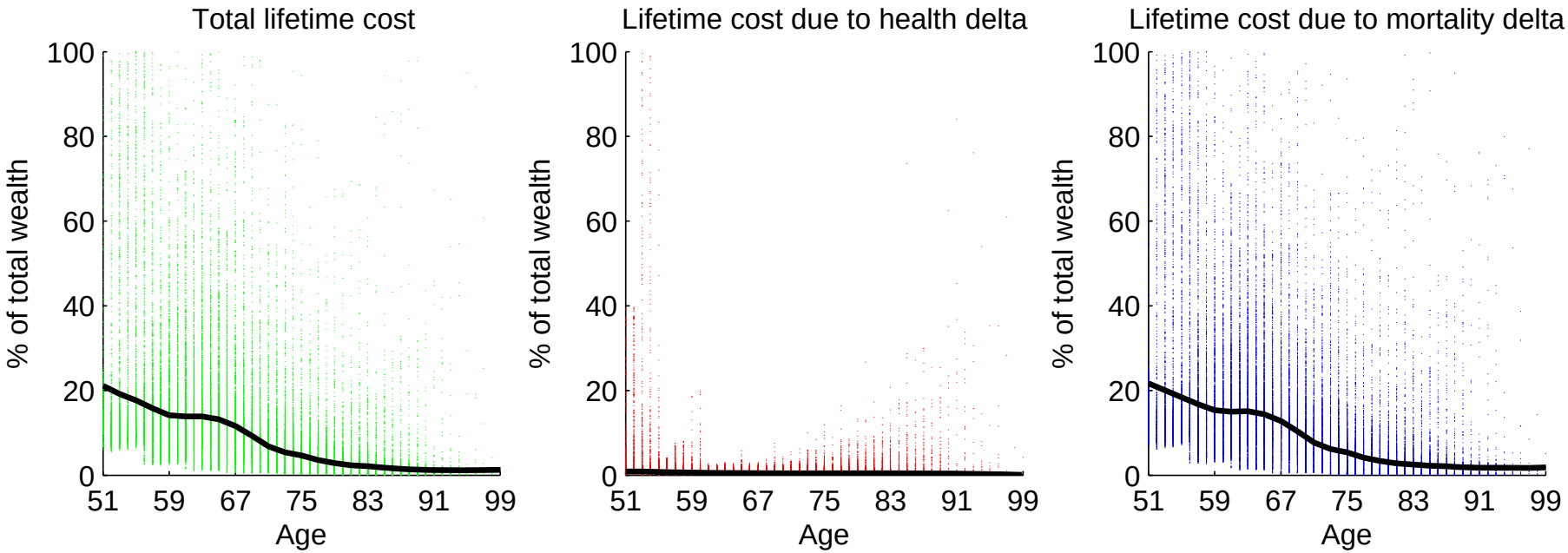




Testing for mis-specification

- Test whether deviations from optimal health and mortality delta are predicted by observed characteristics:
  1. Key life-cycle variables: Health, age, and cohort.
  2. Heterogeneity in bequest motive: Education, marital status, children, and self-reported probability of leaving a bequest.
  3. Heterogeneity in risk aversion: Responses to "income gamble" questions.
  4. Private information about health: Self-reported health status, difficulty with activities of daily living, self-reported probability of living to age 75, and self-reported probability of moving to a nursing home.
- Sign of the regression coefficients consistent with
  - Heterogeneity in bequest motive: Married households and those with living children have higher mortality delta.
  - Adverse selection: Household with worse self-reported health have higher mortality delta.
- However, R^2 less than 10%.

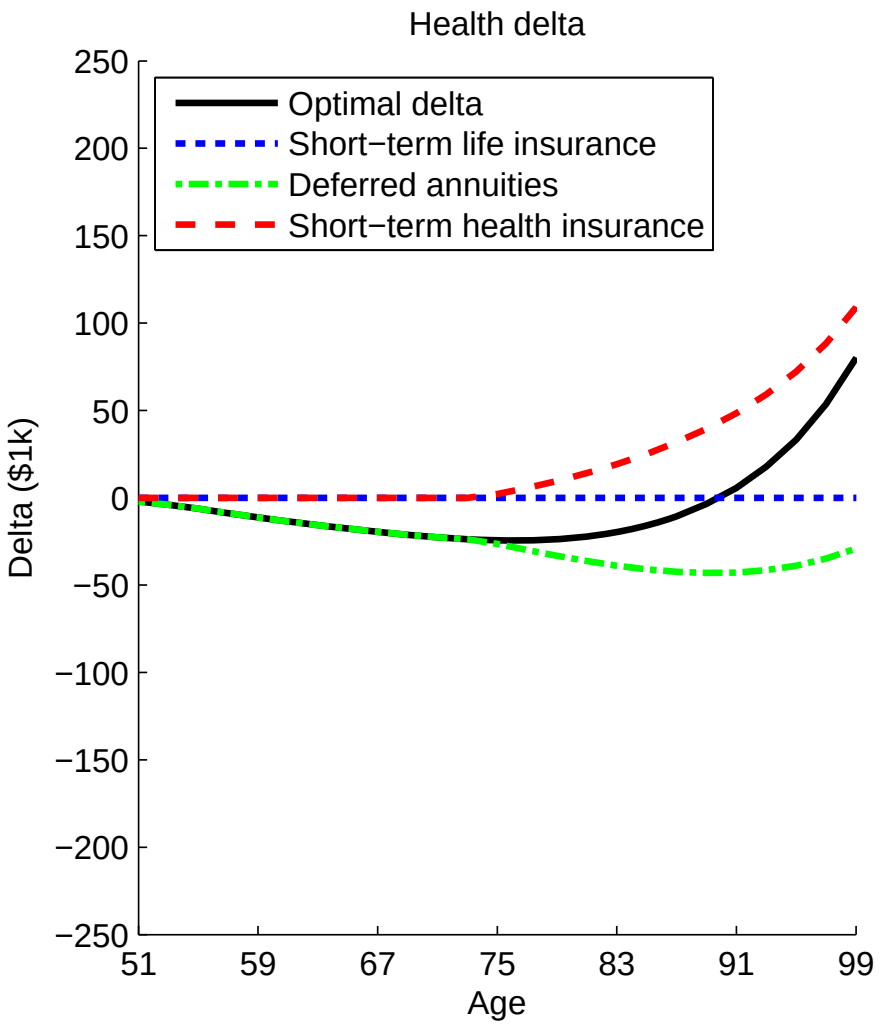
Welfare cost of household insurance choice

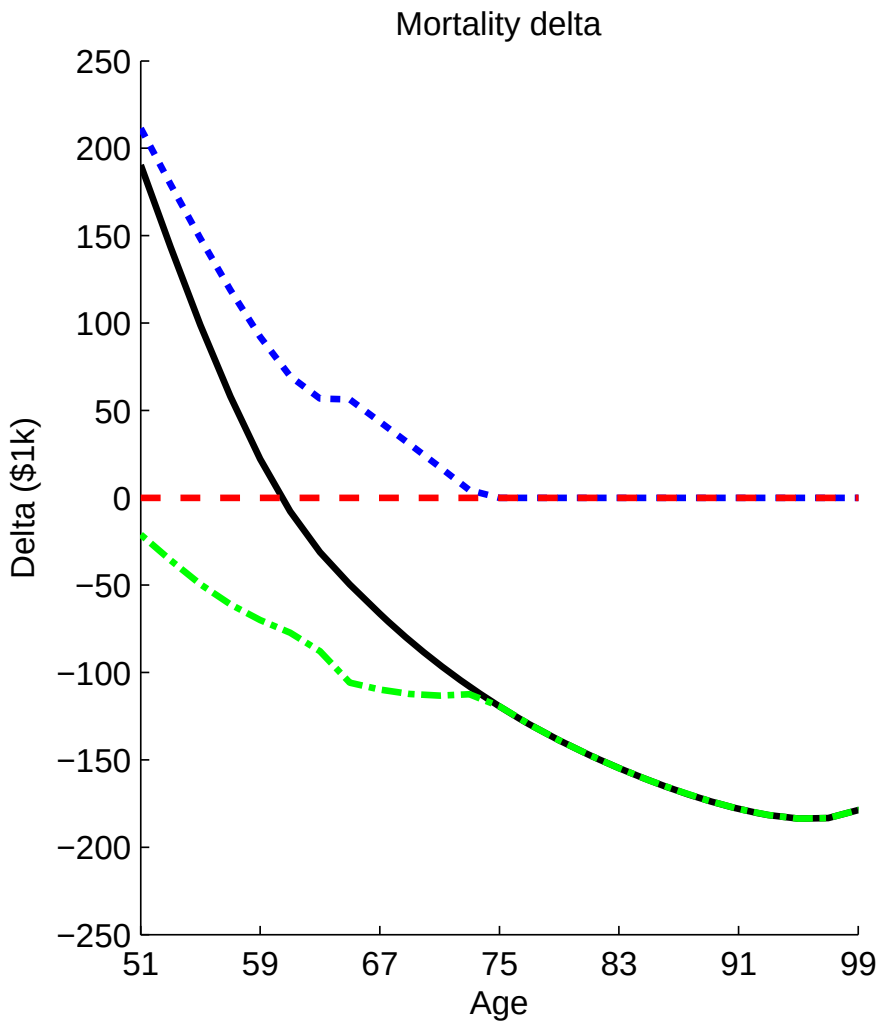


Constructing an optimal portfolio with existing health and longevity products

- Male born 1936–1940.
  - Good health at age 51.
  - Initial wealth of $65k.
- Portfolio choice between
  1. Short-term (2-year) life insurance.
  2. Deferred (until age 65) annuity.
  3. Short-term (2-year) health insurance.
  4. Bond at interest rate of 2%.

Optimal health and mortality delta over the life cycle





Conclusion

- Retail financial advisors and insurance companies should report the health and mortality delta of their health and longevity products.
- We hope that these risk measures will
  - Facilitate standardization of products.
  - Identify overlap between existing products.
  - Identify risks that are not insured by existing products.
  - Lead to new product development.
- Life-cycle product that is analogous to life-cycle (equity/fixed-income) funds:
  - Package life insurance and deferred annuities.
  - Automatically switches from positive to negative mortality delta around retirement age.