# Health Dynamics and Annuitization Decisions: The Case of Social Security

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# Outline

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  2. Can you afford to wait? $\rightarrow$ 87.5% can afford to wait until 65.
  3. How long you expect to live. $\rightarrow$ **82 years**.
- Standard life-cycle model would predict that most Americans should wait at least until 65.
- **Goal of this paper:** address this puzzle.

# This Paper

- Extends the standard life-cycle model with mortality risk:
  - Incomplete Markets.
  - Bequest motives.
  - Health dynamics (aging).
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  - Health dynamics (aging).
  - Health-dependent preferences (no mortality, joy of consumption).
- **Main Result:** Health-dependent preferences and bequest motives are key to account for early claiming.
  - The calibrated model produces the **66%** of early claimers and **36%** (out of 45%) of claimers at 62.
- **Policy implication:** Simple way to improve Social Security system: access life insurance through the pension system.

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  1. Impatience $\rightarrow$ **Reduces gains of waiting**.
  2. Bequests more appealing than future consumption $\rightarrow$ **Increases cost of waiting**.

**Early Claiming Behavior:**

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$\rightarrow$ **This paper:** Provides a framework easily extendable to portfolio choice problems.

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  2. Claiming age.
  3. Health measures $\rightarrow$ **Frailty Index**
  4. Medical and Non-medical consumption.
- Data is biennial. I use data from 1996-2018.

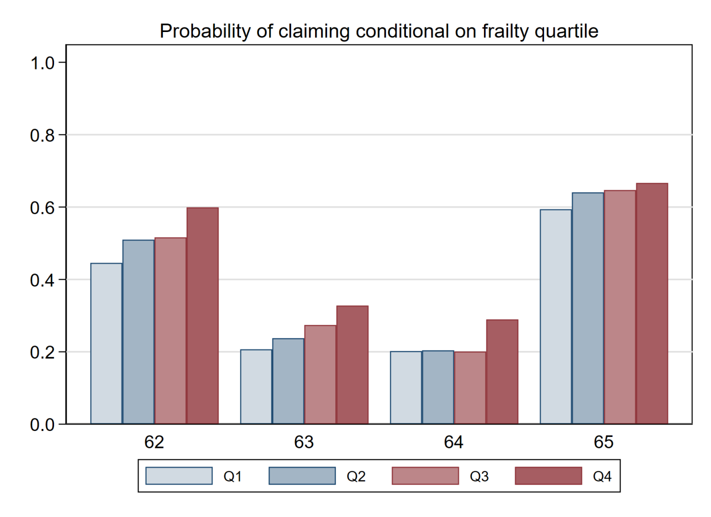
**Main Findings:**

- Rich and poor individuals have similar claiming behavior.
- Claiming behavior is sensitive to differences in health.

# Early Claiming Behavior

| Claiming Age | 62 | Before 65 | 65 |
|---|---|---|---|
| **Overall** | 45.06% | 66.58% | 19.37% |
| **Sex** | | | |
| Men | 44.53% | 65.37% | 20.15% |
| Women | 46.05% | 68.82% | 17.92% |
| **Wealth at 62** | | | |
| Bottom Quintile | 50.29% | 73.27% | 18.89% |
| Top Quintile | 53.12% | 71.83% | 18.71% |

# Probability of claiming is sensitive to health



# Outline

# Toy Model

- Assume an individual can live up to 2 periods. The probability of surviving to the next period is $P$.
- An individual has an initial wealth $w$.
- Suppose the individual wishes to consume $\bar{c}$ in periods 1 and 2.
- For simplicity, assume a discount factor $\beta = 1$ and a unique asset with gross return $R = 1$.
- Assume the individual also has bequests motives.

**Delaying decision.** The agent decides to delay the claim of social-security, $d \in \{0, 1\}$:

- Delaying decisions determine an income stream:

$$y_t(d) = \begin{cases} (1-d)y & \text{if } t = 1 \\ (1+R_{ss}d)y & \text{if } t = 2 \end{cases}$$

Assume $R_{ss} \geq \frac{1}{P}$.

Denote by $u(.)$ and $\phi(.)$ the utility functions for consumption and bequests, respectively.

**Individual's problem:**

$$v(w, y; f) = \max_{d} \quad u(\bar{c}) + \beta P \left[ u(\bar{c}) + \beta \phi(b_2) \right] + \beta (1-P) \phi(b_1)$$

subject to:

$$b_1 = w + (1-d)y - \bar{c} \quad \text{and} \quad b_2 = Rb_1 + (1+R_{ss}d)y - \bar{c}$$

# Delay vs Wait

- Delaying allows us to have more resources in period 2:

$$G \equiv P \underbrace{\left(\phi(w + (1 + R_{ss})y - 2\bar{c}) - \phi(w + 2y - 2\bar{c})\right)}_{\text{(gains from terminal bequests)}}$$

- At the expense of having less in period 1:

$$L \equiv \underbrace{(1 - P)\left(\phi(w + y - \bar{c}) - \phi(w - \bar{c})\right)}_{\text{(losses from incidental bequests)}}$$

For simplicity, suppose $w = y = \bar{c}$, $R_{ss} = 2$ and $P = \frac{1}{2}$. Then:

$$G = \frac{1}{2}\left(\phi(2\bar{c}) - \phi(\bar{c})\right),$$

$$L = \frac{1}{2}(\phi(\bar{c}) - \phi(0))$$

- If $R_{ss} > 2$, with $\phi(.)$ linear $\rightarrow$ Delay is always optimal!
- With $\phi(.)$ concave $\rightarrow$ Claiming early can be optimal!

# Health-dependent preferences further reduce gains of waiting

- Suppose the individual is ill in the second period (aging) and consumes $0$ units in period 2:

$$G_{hd} \equiv \frac{1}{2}\left(\phi(3\bar{c}) - \phi(2\bar{c})\right) < \frac{1}{2}\left(\phi(2\bar{c}) - \phi(\bar{c})\right) = G,$$

- Smaller gains: Tradeoff between more resources and ability to smooth bequests.
- This result can be easily generalized and extended.

# Outline

# Environment and Endowments

- Life-cycle model for the elderly.
- Initial heterogeneity in wealth $a_1$, income $y_1$, health $f_1$, and full benefits (PIA).
- Idiosyncratic risks in mortality, medical expenses, and income.
- Individuals make consumption/saving and claiming decisions.
- The Government runs Social Security and guarantees a consumption floor.

# Preferences

- Utility from consumption and from leaving bequests
- Preferences in consumption are health-dependent:

$$U(c,f) = (1 + \delta f)\frac{c^{1-\sigma}}{1-\sigma}$$

- $f$ is health (frailty index), $\delta$ is a health dependence parameter, and $\sigma$ is a risk-aversion parameter.
- I follow De Nardi et al. (2004) to model bequest motives:

$$v(b) = \phi_1 \frac{(b + \phi_2)^{1-\sigma}}{1-\sigma},$$

- $\phi_1$ reflects the strength of bequest motives, while $\phi_2$ reflects the extent to which bequests are a luxury good.

## Exogenous Processes

- **Health:** Measured as a frailty index. The frailty of an individual $i$ of age $t$ is denoted by $f_{it} \in [0,1]$:

$$\ln f_{it} = \underbrace{\kappa_f(t)}_{deterministic} + \underbrace{\epsilon_{f,it}}_{stochastic},$$

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- **Out-of-pocket medical expenses** that depend on frailty, age, and a stochastic component:

$$\ln(m(t,f)) = \kappa_m(t,f) + \epsilon_{m,it}$$

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- **Income:** Individuals have income in each period:

$$\ln(y_{it}) = \kappa_y(t,f) + \epsilon_{y,it}$$

This is understood as any source of income that is not SS: labor income, pensions, etc.

- **Incomplete Markets:** Individuals have access to a risk-free asset with gross return $(R_a)$.
- Individuals can not borrow.
- What age you start receiving your Social Security is a choice.
- Social Security benefits will depend on the individual's Primary Insurance Amount (PIA) and claiming age.

- The Government is in charge of running the Social Security program.
- Means-tested transfer program that guarantees a minimum level of consumption of $\underline{c}$.
- Transfers will be equal to zero if $\underline{c} + m - (R_a a + y + SS) \geq 0$.

# Timing of the model

1. Individuals enter the period with a stock of assets.
2. Draw realizations of the stochastic process for frailty, earnings, transfers, and medical expenses.
3. Decide whether to claim Social Security benefits or not (if eligible) and make consumption-saving decisions.

- The state variables for this problem are given by: $X \equiv (t, a, f, \epsilon_f, \epsilon_y, \epsilon_m, PIA)$.

$$V(X) = \underset{D \in \{0,1\}}{Max}\, W^e\,(X, D)$$

where

$$W^e(X, D=1) = \underset{c,a'}{Max} \quad U(c,f) + \beta \left\{ p_{t+1}(f_t)\mathbb{E}\left[V(X')\right] + (1 - p_{t+1}(f_t))\,\phi(a')\right\},$$

and

$$W^e(X, D=0) = \underset{c,a'}{Max} \quad U(c,f) + \beta \left\{ p_{t+1}(f_t)\mathbb{E}_t\left[V^c(X', t^c)\right] + (1 - p_{t+1}(f_t))\,\phi(a')\right\},$$

$$s.t.$$

$$c + a' + m(t,f) \leq R_a a + \mathbb{I}\,(D=0) * ss(PIA, t) + y(X) + Tr,$$

$$a' \geq 0,$$

$$Tr = Max\,\{0, \underline{c} + m - (R_a a + y + (D=0) * ss)\}$$

Claiming age $t^c$ is another state variable for this problem.

$$V^c(X,t^c) = \underset{c,a'}{Max} \quad U(c,f) + \beta p_{t+1}(f_t)\mathbb{E}_t\left[V^c(X',t^c)\right] + (1-p_{t+1}(f_t))\,\phi(a'),$$

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- Introduction
- Empirical Analysis
- Toy Model
- Quantitative Model
- Calibration
- Results

# Calibration: approach

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- Three sets of parameters:
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  3. Estimated using the model (Simulated Method of Moments):

- Calibrate bequest parameters to be consistent with the distribution of assets over the life-cycle.
- Calibrate health-dependence and consumption floor to be consistent with consumption fluctuations (**passthrough** of transitory shocks to consumption).

Parameters calibrated to match

1. P20, P40, P50, P60 and P75 of assets from 62 to 78 in 3-year age groups profile accumulation, and
2. Pass-through coefficients against transitory income shocks and frailty shocks.

**Intuition:** Negative earnings shock is equivalent to shock in medical expenses (Blundell et al. 2022, Russo (2022)).

# Calibration: second step

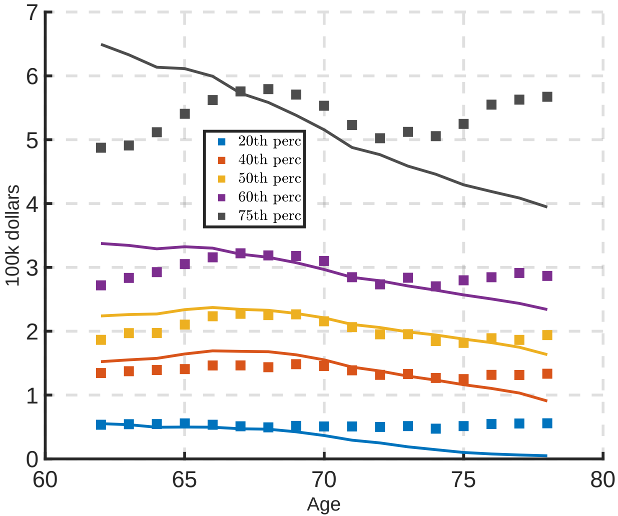
| Parameter | Description | Value |
|---|---|---|
| $\delta$ | Health dependence | -0.82 |
| $\phi_1$ | Bequest intensity | 50.70 |
| $\phi_2$ | Bequest curvature | 16.14 |
| $\underline{c}$ | Consumption floor | $5,320 USD |

- The estimated value of $\delta$ implies that a frailty shock (standard deviation) reduces the marginal utility of consumption by (6.17%).
- The bequest parameters imply an MPB of 0.92.
- Consumption floor in the range of former estimates (between $3.5K - $7K).

# Model Fit - Targeted

| Moment | Description | Data | Model |
|---|---|---|---|
| $\phi_u^f$ | Pass-through coefficient to transitory frailty shocks | -0.169 | -0.181 |
| $\phi_u^y$ | Pass-through coefficient to transitory income shocks | 0.064 | 0.049 |

# Model Fit - Targeted



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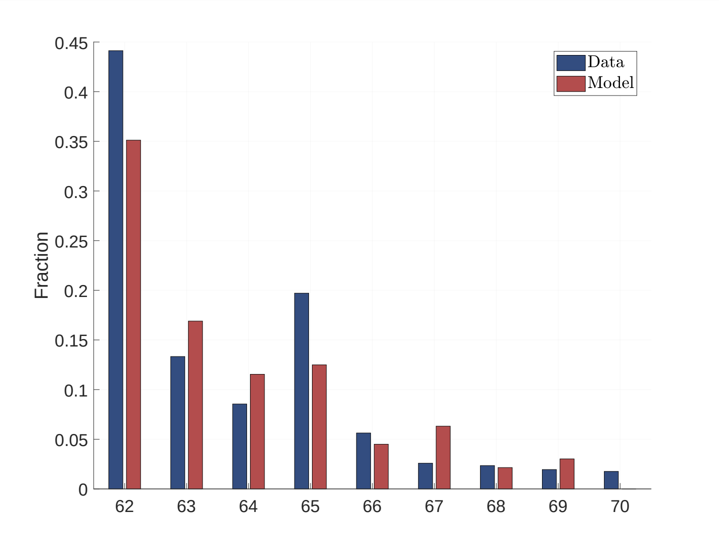
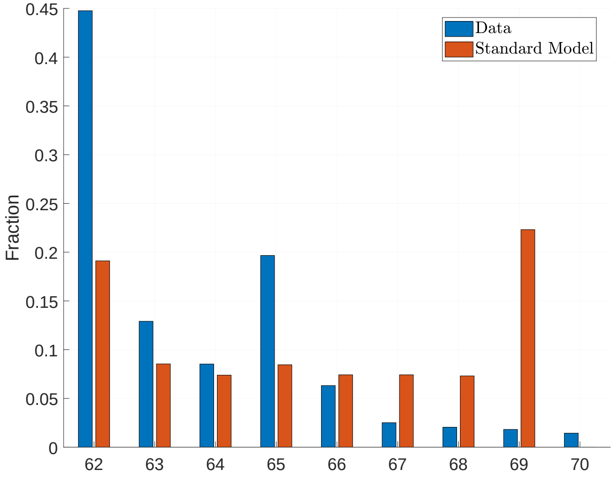
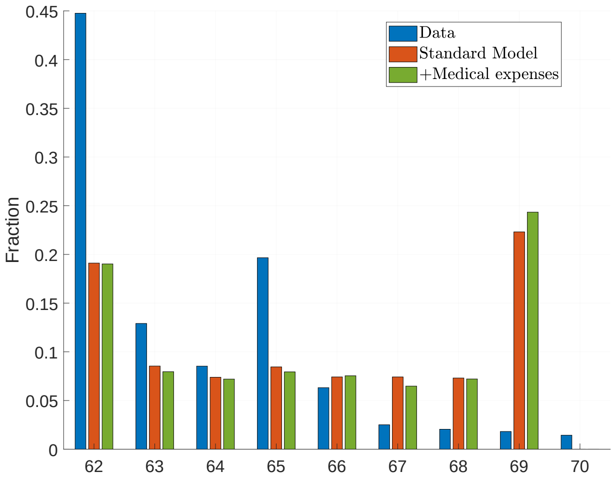
# Untargeted moments: Claiming behavior overall





Data
Standard Model
Fraction
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
62
63
64
65
66
67
68
69
70

# Counterfactual Experiments



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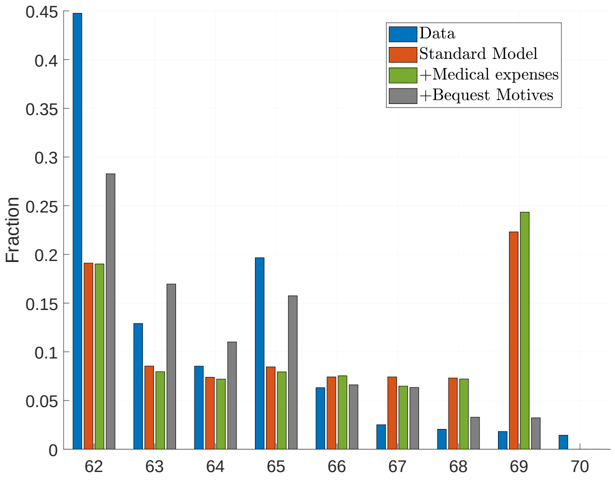

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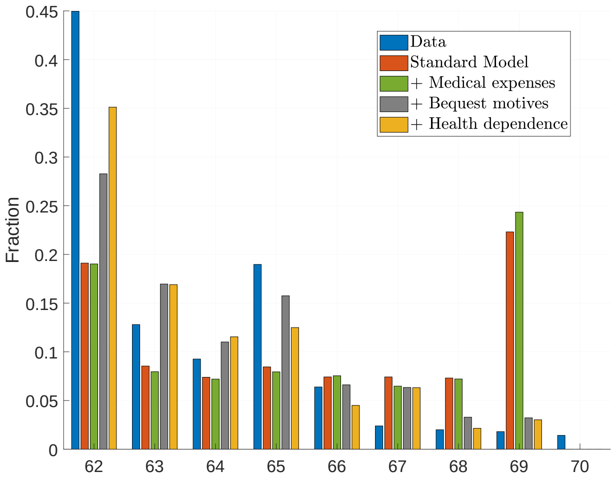

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- Future work: retirement decision, endogenous health.

**Policy Implications:**

- Complementarity between the incentives to insure against longevity and health risks.
- Potential welfare gains from allowing to choose between pension and life insurance.

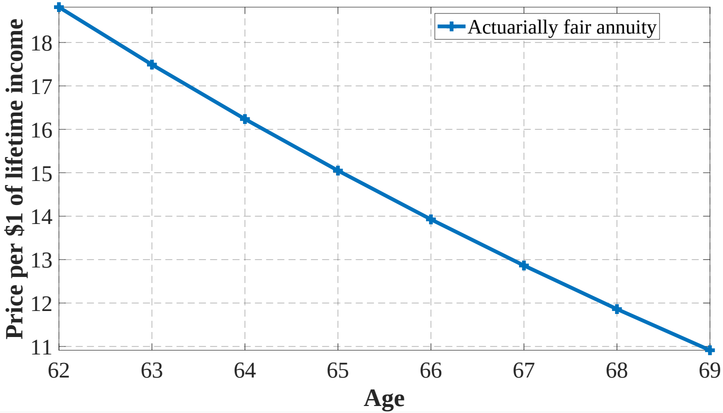
# Appendix

# Institutional Background

| Age | 62 | 63 | 64 | **65=FRA** | 66 | 67 | 68 | 69 | 70 |
|---|---|---|---|---|---|---|---|---|---|
| % of full benefits | 80% | 86.7% | 93.3% | 100% | 106.5% | 113% | 119.5% | 126% | 132.5% |

♦

# Delaying is equivalent to demanding a cheap annuity



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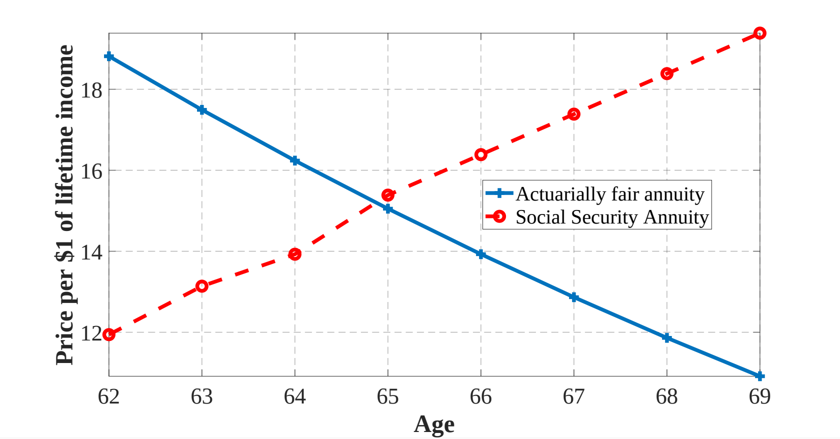
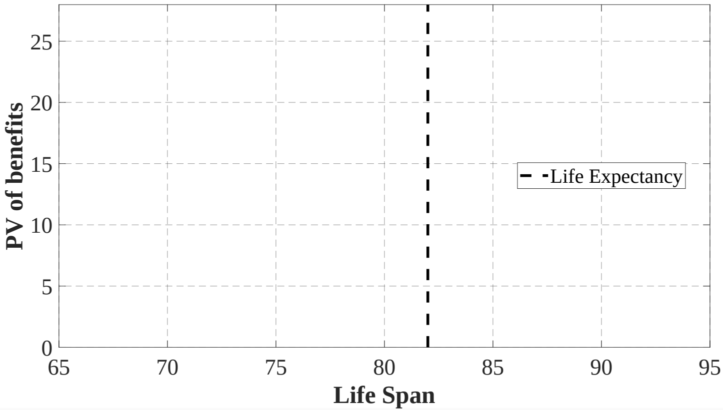


# PDV of benefits as a function of lifespan and claiming age ($(PIA = \$1$ & $r = 2\%$)



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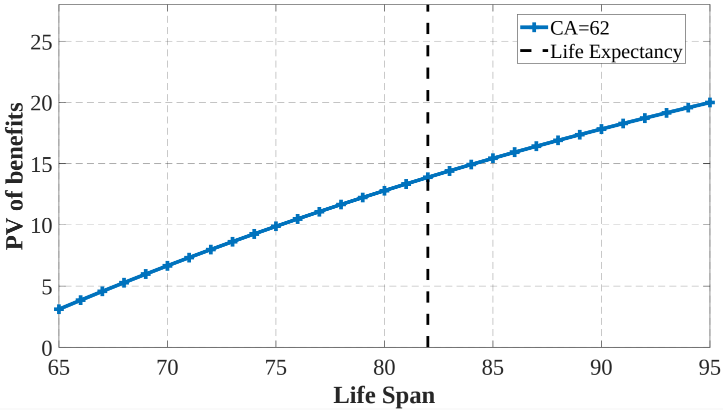

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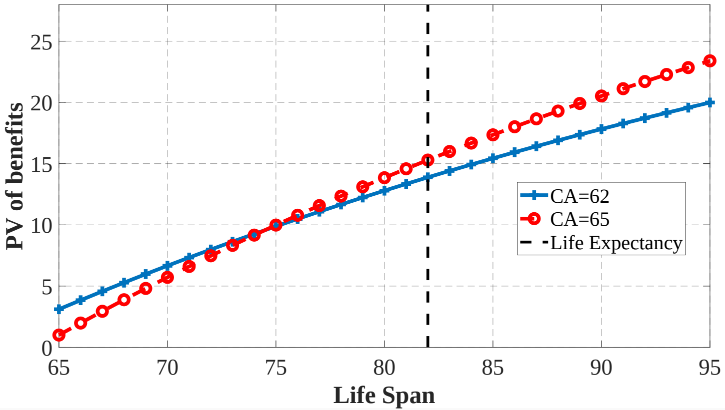

# Mortality Probability estimation

| | Death indicator |
|---|---|
| age | 0.166 |
| | (0.413) |
| $age^2$ | 3.403*** |
| | (0.436) |
| frailty | 2.677*** |
| | (0.110) |
| $frailty^2$ | -0.404*** |
| | (0.124) |
| Education | -0.0399*** |
| | (0.0145) |
| Constant | -3.077*** |
| | (0.101) |
| Observations | 206,964 |
| Number of individuals | 38,611 |
| Cohort effects | Yes |

Note: age is scaled such that: $age = \frac{(age-25)}{100}$

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Go back to the Approach slide. Take the square root of estimates to make it annual.

# Details of Frailty Estimation

- I model frailty following Hosseini et al. (2022). $f \equiv \psi(t, s, \epsilon_f)$ gives an individual's frailty.
- frailty index for an individual i of age t can be written as:

$$\ln f_{it} = X'_{it}\beta + \epsilon_{f,it}$$

- $X_{it}$ is a set of covariates, including a polynomial on age and education dummies.
- The residual $\epsilon_{f,it}$ is given by:

$$\epsilon_{f,it} = \alpha_i + z_{it} + u_{it}$$

- $\alpha_i \sim N(0, \sigma^2_\alpha)$ represents the individual fixed effect.
- $z_{it}$ is an $AR(1)$ process. White noises are assumed to be independent.
- At each age t, the probability of being alive at $t+1$ is a function of frailty, and age $p_{t+1}(f)$.

# Details of Frailty Estimation

- I estimate frailty using SMM to control for mortality selection (using mortality estimates).
- I target the age profile of log frailty in 2-year groups between 50 and 95 years old (deterministic component).
- Estimate variance of frailty shocks by matching the variance and autocovariance moments by age group of the frailty net of its deterministic component.

Go back to the Approach slide.

# Frailty Process Estimates (SMM)

| | Log of frailty |
|---|---|
| age | 1.4276 |
| $age^2$ | -0.0751 |
| $age^3$ | -1.7403 |
| $age^4$ | 6.2246 |
| Education | -0.0023 |
| Constant | -1.395 |

Note: age is scaled such that: $age = \frac{(age-25)}{100}$

| Parameter | Value |
|---|---|
| $\rho_{z,f}$ | 0.9171 |
| $\sigma_{z,f}$ | 0.0156 |
| $\sigma_{u,f}$ | 0.0601 |
| $\sigma_{\alpha,f}$ | 0.643 |

# Details of Earnings Process Estimation

- Measure of income (household level) includes wages, salaries, bonuses, capital income, self-employment, rents, dividends, etc.
- The deterministic function is estimated by regressing the $\ln(y_{it})$ on a second-order polynomial of age, frailty, education, and cohort effects.
- To estimate the stochastic components, compute the residuals of the previous regression and use equally weighted minimum distance to obtain $\rho_{z,y}$, $\sigma^2_{z,y}$, $\sigma^2_{u,y}$, $\sigma^2_{\alpha,y}$.

Go back to the Approach slide.

# Earnings Process Estimates (MD)

| | Log of income |
|---|---|
| age | -11.42*** |
| | (0.337) |
| $age^2$ | 6.675*** |
| | (0.376) |
| education | 0.369*** |
| | (0.00254) |
| frailty | -2.611*** |
| | (0.0682) |
| $frailty^2$ | 1.455*** |
| | (0.0996) |
| Constant | 3.567*** |
| | (0.316) |
| Observations | 199,521 |
| Cohort effects | Yes |

Note: age is scaled such that: $age = \frac{(age-25)}{100}$
*** p<0.01, ** p<0.05, * p<0.1

| Parameter | Value |
|---|---|
| $\rho_{z,y}$ | 0.932 |
| $\sigma_{z,y}$ | 0.483 |
| $\sigma_{u,y}$ | 0.002 |
| $\sigma_{\alpha,y}$ | 0.153 |

# Medical Expenses

- I assume that medical expenses are a deterministic function of frailty plus a transitory shock:

$$\ln(m(t,f)) = \kappa_m(t,f) + \epsilon_{m,it}$$

$\epsilon_{m,it} \sim N(0, \sigma_m^2)$ and represents a transitory shock on medical expenses.

# Details of Medical Expenses Estimation

- Medical expenses include out-of-pocket doctor visits, hospital and nursing home stays, prescription drugs, and insurance premiums.
- $\kappa_m$ is estimated by regressing the log of medical expenses on a second-order polynomial in household age, frailty, education level, and cohort effects.
- To estimate $\sigma^2_{um}$, I regress the squared residuals from the previous regression on the same covariates. The variance of the predicted values of this last regression is my estimate.

Go back to the Approach slide.

# Estimation of out-of-pocket medical expenses

| | Log of medical expenses |
|---|---|
| age | 2.859 |
| | (2.869) |
| age$^2$ | -1.180 |
| | (2.815) |
| frailty | 2.634*** |
| | (0.858) |
| frailty$^2$ | -6.277** |
| | (2.732) |
| frailty$^3$ | 5.155** |
| | (2.472) |
| education | 0.182*** |
| | (0.0120) |
| Constant | -4.138*** |
| | (1.467) |
| Observations | 7,434 |
| Cohort effects | Yes |

Note: age is scaled such that: $age = \frac{(age-25)}{100}$
*** p<0.01, ** p<0.05, * p<0.1

| Parameter | Value |
|---|---|
| $\sigma_{u,m}$ | .389 |

# Passthrough estimation

- Define passthrough coefficient of an idiosyncratic shock $x_t$ to consumption as:

$$\phi^x = \frac{Cov(\Delta \log c_t, x_t)}{var(x_t)}$$

- It measures what fraction of shock $x$ translates in a change in consumption.
- As in Kaplan and Violante (2010), define the quasi-difference of log earnings as

$$\tilde{\Delta} \log y_t = \log y_t - \rho_y \log y_{t-1}$$

  and the quasi-difference of log frailty as:

$$\tilde{\Delta} \log f_t = \log f_t - \rho_z \log f_{t-1}$$

# Passthrough estimation

- Given the permanent-transitory assumption of our detrended variables, it can be shown that:

$$\phi_u^y = \frac{Cov(\Delta \log c_t, \tilde{\Delta} \log y_{t+1})}{Cov(\tilde{\Delta} \log y_t, \tilde{\Delta} \log y_{t+1})},$$

$$\phi_u^f = \frac{Cov(\Delta \log c_t, \tilde{\Delta} \log f_{t+1})}{Cov(\tilde{\Delta} \log f_t, \tilde{\Delta} \log f_{t+1})},$$

- All variables are detrended from the deterministic component.
- Use GMM for the estimation.

# Pass-through coefficient estimates

| Parameter | Value |
|---|---|
| $\phi_u^f$ | -0.169*** |
| | (.062) |
| $\phi_u^y$ | 0.064** |
| | (.032) |
| *** $p<0.01$, ** $p<0.05$, * $p<0.1$ | |

Go back to the Approach slide.