Human Capital Risk, Contract Enforcement, and the Macroeconomy

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General Issue:

- **For many households (the young), human capital is the most important part of total wealth**

- **Human capital is an asset with three characteristics:**
  i) risky (health risk, labor market risk)
  ii) heterogeneous ex-ante returns (young vs old)
  iii) non-pledgeable

- **We argue that these three characteristics imply an interesting risk-insurance relationship: young households are the most exposed to human capital risk, but also the least insured**

This Paper – Contributions

- **We show analytically that young (high-return) households are the most exposed to human capital risk and also the least insured**

- **We establish this risk-insurance pattern in life-insurance data from SCF**

- **We show that a calibrated macro model can quantitatively match this fact**

- **We show that welfare cost of under-insurance of young households is substantial and discuss policy implication**

Intuition

- **Households with high expected human capital returns (young) choose to invest a lot in human capital**
- **These households therefore have high risk exposure and large demand for insurance**
- **With complete markets and perfect contract enforcement, these households will borrow and be perfectly insured**
- **With limited contract enforcement (US bankruptcy law), these households are borrowing constrained and under-insured**

This Paper – Additional Contribution

- **We develop a tractable macro model with human capital risk and limited contract enforcement**

- **We show that the endogenous (and infinite-dimensional) wealth distribution is not a relevant state variable**

- **We show that the constraint set of household decision problem is convex**

Production

$$\mathbf{Y_t = F(K_t, H_t)}$$

$\mathbf{Y_t}$: **aggregate output**

$\mathbf{K_t}$: **aggregate stock of physical capital**

$\mathbf{H_t}$: **aggregate stock of human capital**

Profit maximization:

$$\mathbf{r_{kt} = r_k(\tilde{K}_t)}$$

$$\mathbf{r_{ht} = r_h(\tilde{K}_t)}$$

$\mathbf{r_k}$: **rental rate of physical capital**

$\mathbf{r_h}$: **rental rate of human capital**

$\mathbf{\tilde{K}_t = K_t/H_t}$: **aggregate "capital-to-labor ratio"**

Preferences and Uncertainty

Expected lifetime utility of individual household:

$$\mathbf{U(\{c_t\})} = \sum_{\mathbf{t=0}}^{\infty} \beta^{\mathbf{t}} \sum_{\mathbf{s^t}} \mathbf{\ln c_t(s^t)}\pi\mathbf{(s^t|s_0)}$$

$\mathbf{s_t} = (\mathbf{s_{1t}}, \ldots, \mathbf{s_{nt}})$**: exogenous part of individual state**

$\mathbf{s^t} = (\mathbf{s_1}, ..., \mathbf{s_t})$**: history of individual states**

$\beta = \nu\tilde{\beta}$**: effective discount factor**

ν**: probability that household continues to exists**

Assumption:

$\{\mathbf{s_t}\}$ **is Markov – no aggregate risk**

Examples

1. **Simple example: $\mathbf{s_t = (s_{1t}, s_{2t})}$**

- $\mathbf{s_{1t} \in \{young, old\}}$: **persistent type**

- $\mathbf{s_{2t} \in \{good, bad\}}$: **i.i.d. human capital risk**

2. **Quantitative Analysis: $\mathbf{s_t = (s_{1t}, s_{2t}, s_{3t})}$**

- $\mathbf{s_{1t} \in \{23, \ldots, 60, transition, retirement\}}$ **– life-cycle**

- $\mathbf{s_{2t}}$: **death of an adult household member (widowhood)**

- $\mathbf{s_{3t}}$: **all other human capital risk (labor market risk, disability risk)**

Budget Constraint

$$\mathbf{c_t + i_{ht} + \sum_{s_{t+1}} q(s_{t+1}|s_t)a_{t+1}(s_{t+1}) \;=\; r_h\, h_t + a_t(s_t)}$$

$$\mathbf{h_{t+1} \;=\; (1 - \delta_h(s_t))h_t \;+\; i_{ht}}$$

$\delta_{\mathbf{h}}(\mathbf{s_t})$: **state-dependent "depreciation rate"**

- **can be positive or negative**
- **captures human capital risk (ex-post shocks) and ex-ante heterogeneity in human capital returns**
- **constant MP to human capital investment at household level**

Participation Constraint (Default)

$$\sum_{n=0}^{\infty} \beta^n \ln c_{t+n}(s^{t+n})\pi(s^{t+n}|s_t) \;\geq\; V_d(h_t, s_t)$$

$V_d(.)$: value function in case of default

Consequences of default (along the lines of Chapter 7):

i) all debt is cancelled: $a_t = 0$

ii) exclusion from financial markets in the future, $a_{t+n} = 0$, until stochastically determined future date

iii) no garnishment of labor income

Financial Intermediaries

- **no default in equilibrium**

- **perfect competition: insurance companies and credit companies (banks) make zero profit:**

$$\mathbf{q}(\mathbf{s_{t+1}}|\mathbf{s_t}) = \frac{\pi(\mathbf{s_{t+1}}|\mathbf{s_t})}{\mathbf{1} + \mathbf{r_f}}$$

Equilibrium

Definition

A (stationary) recursive equilibrium is a family of household plans, $\{\mathbf{c_t}, \mathbf{a_t}, \mathbf{h_t}\}$, a wage rate, $\mathbf{r_h}$, and an interest rate, r_f, so that

i) production firms maximize profit

ii) financial intermediaries maximize profit

iii) individual households maximize utility subject to the budget and participation constraint; the solution is recursive

iv) market clearing

Budget Constraint

The budget constraint can be transformed into

$$\mathbf{x_{t+1} = (1 + r(\theta_t, s_t))x_t - c_t}$$

where we have introduced the variables

$$\mathbf{x_t \doteq h_t + \sum_{s_t} q(s_t | s_{t-1}) a_t(s_t)} \qquad \textbf{(total wealth)}$$

$$\mathbf{\theta_t \doteq (\theta_{ht}, \theta_{at})} \qquad \textbf{(portfolio choice)}$$

$$\mathbf{\theta_{ht} = \frac{h_t}{x_t} \quad , \quad \theta_{at} \doteq \frac{a_t}{x_t}}$$

Bellman equation

$$\mathbf{V}(\mathbf{x},\theta,\mathbf{s}) \quad = \quad \max_{\mathbf{x}',\theta'} \left\{ \mathbf{ln}\left((\mathbf{1}+\mathbf{r}(\theta,\mathbf{s}))\mathbf{x}-\mathbf{x}'\right)+\beta\sum_{\mathbf{s}'}\mathbf{V}\left(\mathbf{x}',\theta',\mathbf{s}'\right)\pi(\mathbf{s}'|\mathbf{s}) \right\}$$

$$\textbf{s.t.} \quad \mathbf{1} \;=\; \theta'_{\mathbf{h}}+\sum_{\mathbf{s}'}\frac{\pi(\mathbf{s}'|\mathbf{s})\theta'_{\mathbf{a}}(\mathbf{s}')}{\mathbf{1}+\mathbf{r_f}}$$

$$\mathbf{0} \;\leq\; \mathbf{x}' \;\leq\; (\mathbf{1}+\mathbf{r}(\theta,\mathbf{s}))\mathbf{x}$$

$$\mathbf{V}(\mathbf{x}',\theta',\mathbf{s}') \;\geq\; \mathbf{V_d}(\mathbf{x}',\theta',\mathbf{s}')$$

Principle of Optimality and Computation

Let $\mathbf{V_0}$ be the (unique) solution to the Bellman equation without participation constraint. Let T be the operator associated with the Bellman equation with participation constraint. Then

i) $\lim_{\mathbf{n}\to\infty} \mathbf{T^n V_0} = \mathbf{V_\infty}$ exists and is the maximal solution to the Bellman equation with participation constraint

ii) $\mathbf{V_\infty}$ is the value function of the sequential household maximization problem.

Proposition: Tractability and Convexity

The value function, V, has the functional form

$$\mathbf{V}(\mathbf{x},\theta,\mathbf{s}) = \tilde{\mathbf{V}}(\mathbf{s}) + \frac{\mathbf{1}}{\mathbf{1}-\beta}\mathbf{ln}\left(\mathbf{1}+\mathbf{r}(\theta,\mathbf{s})\right) + \frac{\mathbf{1}}{\mathbf{1}-\beta}\mathbf{ln x}$$

and the corresponding optimal policy functions are linear in total wealth

$$\mathbf{c}(\mathbf{x},\theta,\mathbf{s}) = (\mathbf{1}-\beta)(\mathbf{1}+\mathbf{r}(\theta,\mathbf{s}))\mathbf{x}$$

$$\mathbf{x}'(\mathbf{x},\theta,\mathbf{s}) = \beta(\mathbf{1}+\mathbf{r}(\theta,\mathbf{s}))\mathbf{x}$$

$$\theta'(\mathbf{x},\theta,\mathbf{s}) = \theta'(\mathbf{s})$$

Proof (idea)

By induction using the previous result and the fact that the value function after default has the functional form

$$\mathbf{V_d}(\mathbf{x}, \theta, \mathbf{s}) = \tilde{\mathbf{V}}_\mathbf{d}(\mathbf{s}) + \frac{\mathbf{1}}{\mathbf{1} - \beta}\mathbf{ln}\left(\mathbf{1} + \mathbf{r}(\theta, \mathbf{s})\right) + \frac{\mathbf{1}}{\mathbf{1} - \beta}\mathbf{ln x}$$

Proposition: Tractability

A stationary recursive equilibrium can be found by solving a finite-dimensional fixed-point problem that is independent of the wealth distribution (though the relative wealth distribution across types still matters)

Proof (idea): Apply previous result and transform market clearing conditions

Proposition: Risk-Insurance Correlation

Consider the simple economy described in more details in the paper. Define the following two insurance measures:

$$\mathbf{I_1(s_1) \doteq 1 - \frac{\sigma\left[c_{t+1}/c_t | s_1\right]}{\sigma\left[c_{aut,t+1}/c_{aut,t} | s_1\right]}} \qquad \mathbf{s_1 \in \{young, old\}}$$

$$\mathbf{I_2(s_1) \ \doteq \ \frac{\theta_a(s_1, bad) - E[\theta_a | s_1]}{\eta(bad)\, \theta_h(s_1)}} \qquad \mathbf{s_1 \in \{young, old\}}$$

We then have:

$$\mathbf{\theta_h(young) \geq \theta_h(old)}$$

$$\mathbf{I_1(young) \leq I_1(old)}$$

$$\mathbf{I_2(young) \leq I_2(old)}$$

Quantitative analysis

- $s_t = (s_{1t}, s_{2t}, s_{3t})$

- **Life-cycle model:** $s_1 \in \{23, \ldots, 60, \text{transition}, \text{retirement}\}$
  Expected depreciation rate (productivity) of human capital investment depends on age s_1

- s_{2t}: **human capital risk I – death of a household member (widowhood)**

- s_{3t}: **human capital risk II – everything else (labor market risk, disability risk)**

Calibration

- **Choose age-dependent depreciation rates to match the life-cycle profile of median earnings (growth)**

- **Choose human capital risk s_2 to be consistent with empirical evidence on human capital (labor income) loss in the cases of death of a family member – consequences of widowhood**

- **Choose human capital risk s_3 so that implied labor income process is consistent with estimates of the empirical literature on labor income risk**

Data: Survey of Consumer Finance

- **Repeated cross-section; every three years**

- **Household-level data**

- **We use data on labor income, net worth (financial wealth), and life insurance**

- **We use surveys 1992-2007**

- **We always compute median value from the data (conditional on age)**

Figure 1: Life-cycle profile of log labor income

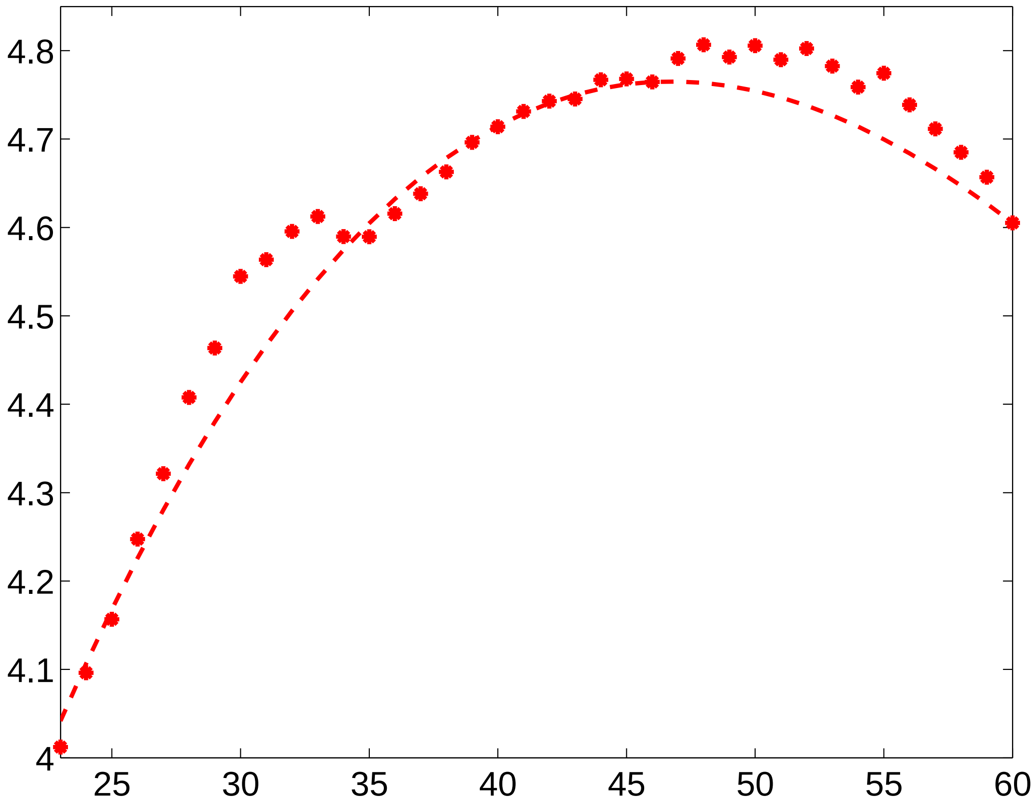
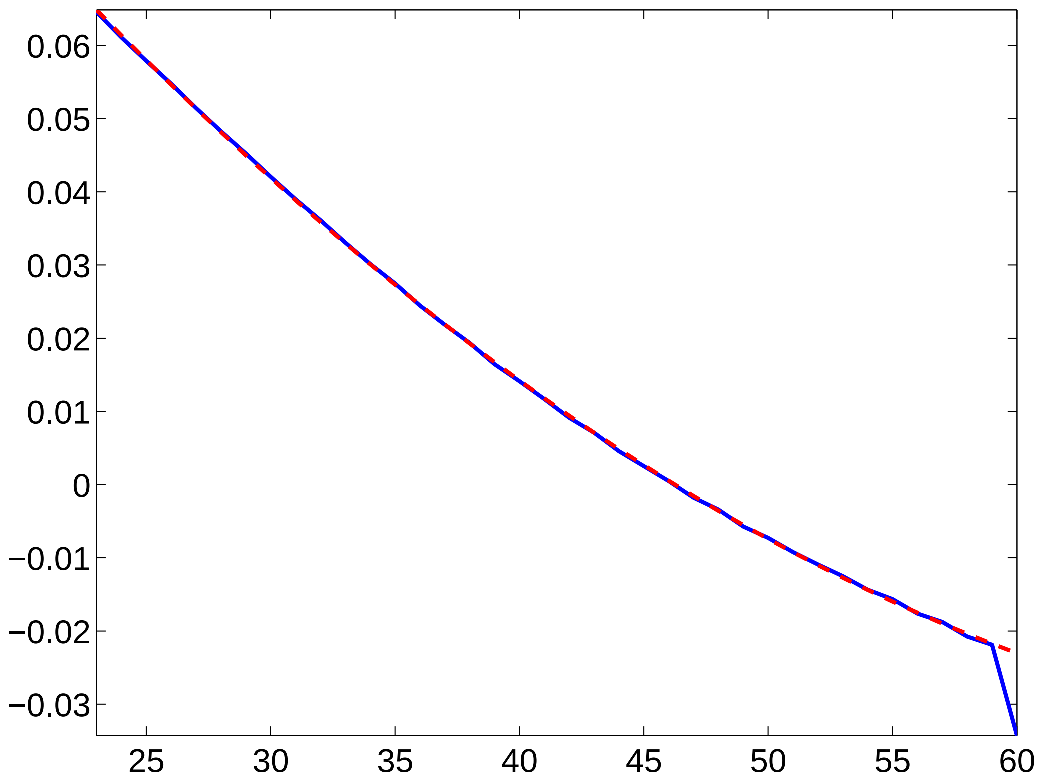


Figure 2: Life-cycle profile of labor income growth

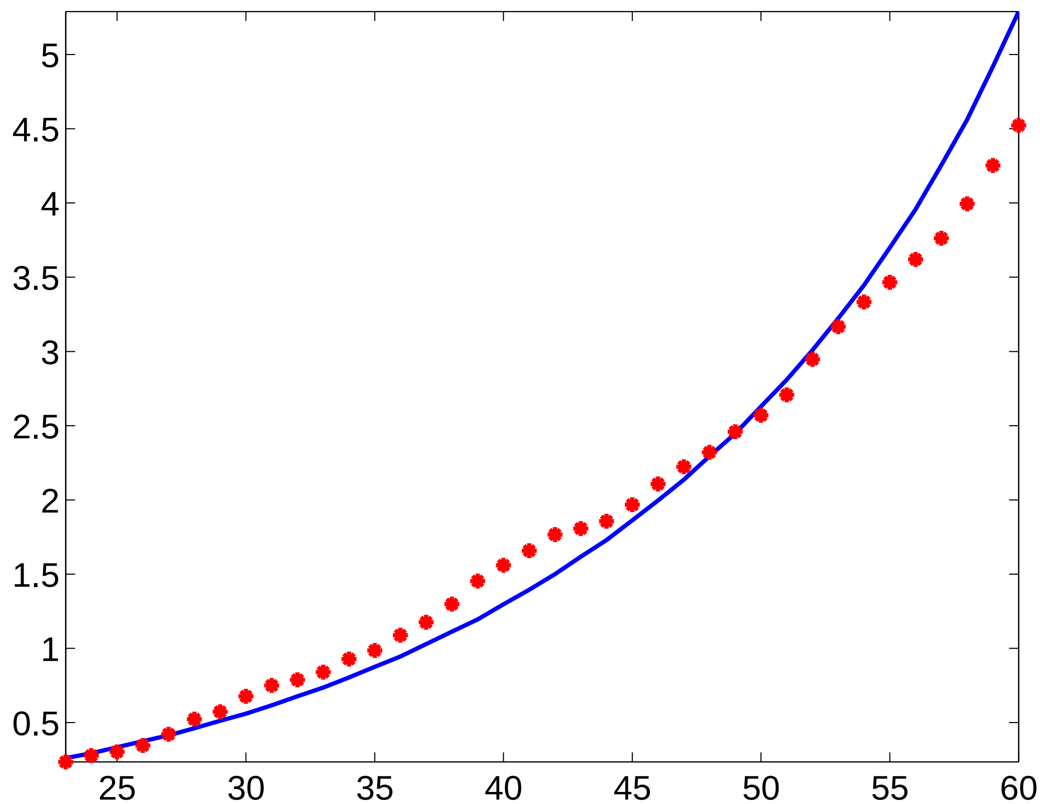


Result 1

The calibrated model provides a good quantitative account of the "observed" human capital choice over the life-cycle

$$\textbf{human capital choice} = \frac{\textbf{net worth}}{\textbf{labor income}}$$

Figure 3: Life-cycle profile of portfolio choice



Result 2

- **Calibrated model implies a substantial increase in insurance measures $\mathbf{I_1}$ and $\mathbf{I_2}$ over the life-cycle**

- **We construct an empirical insurance measure**

$$\tilde{\mathbf{I}}_{\mathbf{2}} = \frac{\textbf{insurance payout}}{\eta(\textbf{bad}) * (\textbf{current earnings}) * \textbf{PVF}}$$

  η(**bad**)**: fraction of human capital lost**

- **The empirical insurance measure $\tilde{\mathbf{I}}_{\mathbf{2}}$ increases with age**

- **Calibrated model matches the intensive margin of the life-insurance data well**

Figure 4: Life-cycle profile of consumption insurance

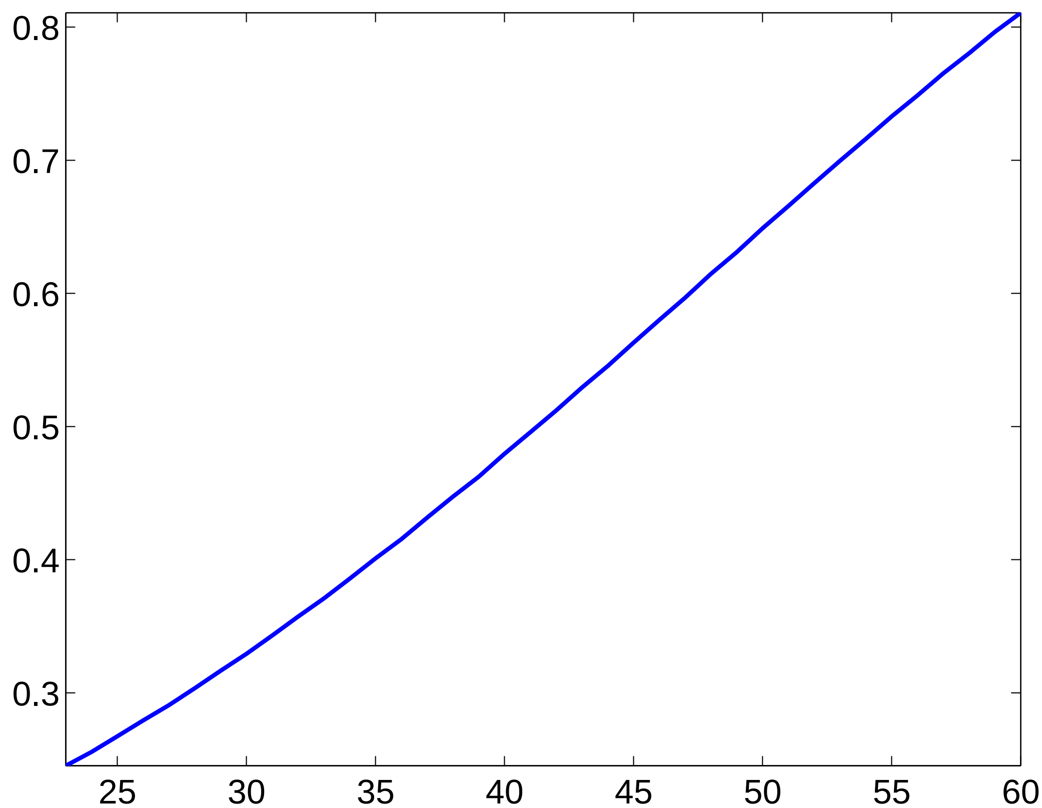
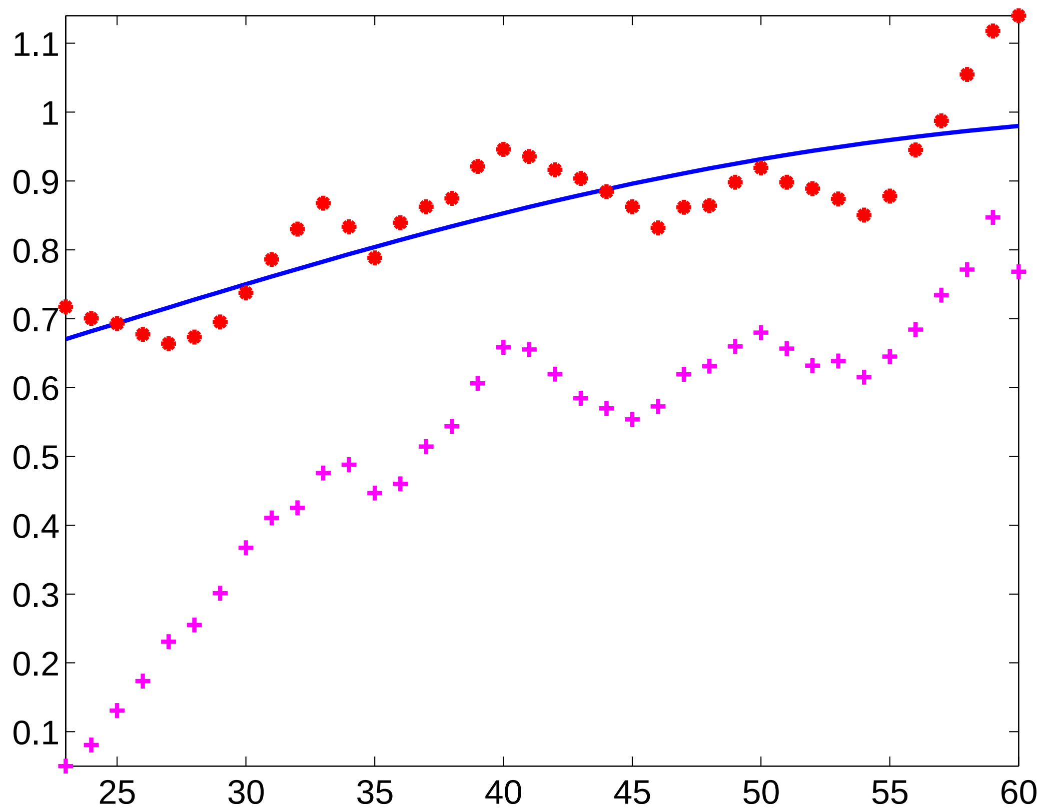


Figure 7: Life-cycle profile of life insurance



Result 3

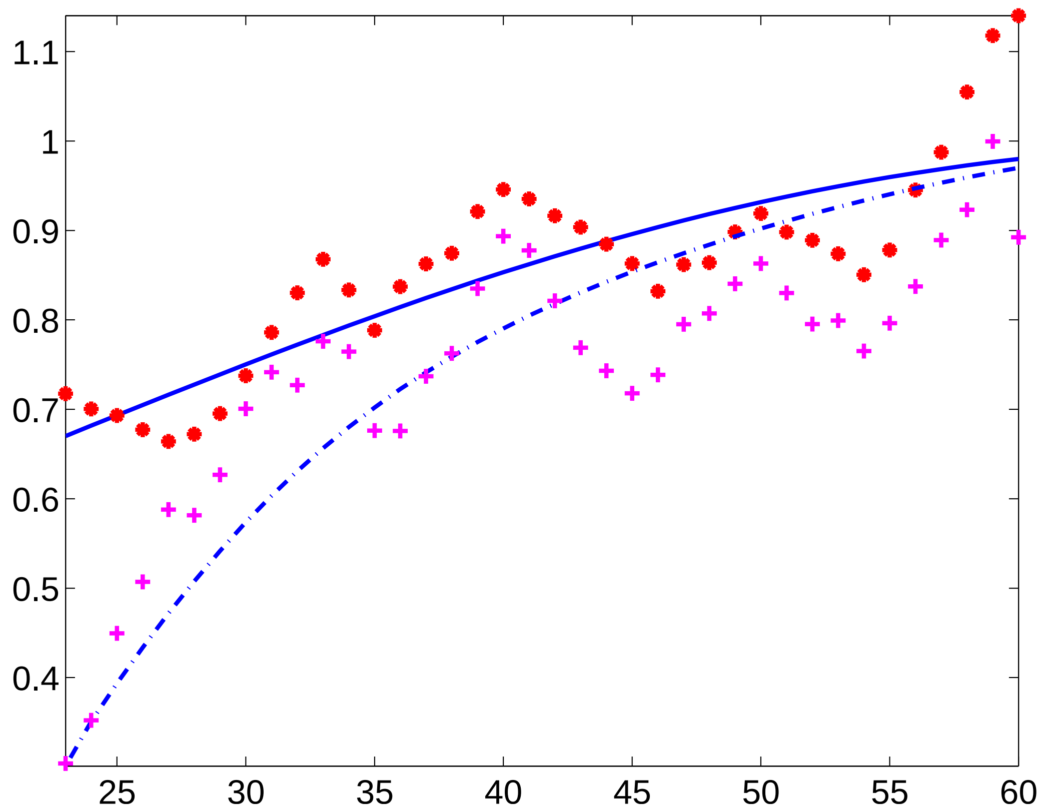
- **Extended model with heterogeneity in family structure (for example, number of kids) and therefore heterogeneity in η(bad)**

- **Some families have no need for life-insurance, $\eta(\text{bad}) = 0$, and some families need life insurance, $\eta(\text{bad}) > 0$ drawn from a fixed distribution)**

- **The fraction of families with $\eta(\text{bad}) = 0$ decreases with age**

- **Extended model matches both intensive and extensive margin of life-insurance data**

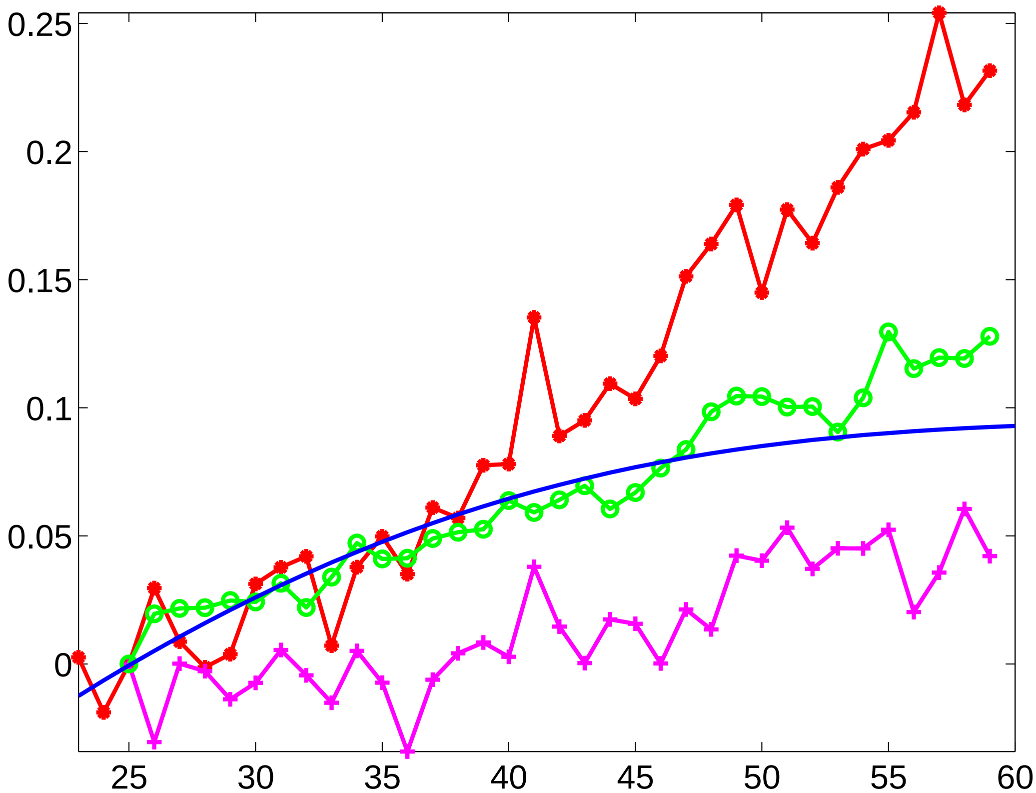
Figure 10: Life-cycle profile of life insurance (extended model)



Result 4

Calibrated model is consistent with the empirical life-cycle profile of consumption inequality

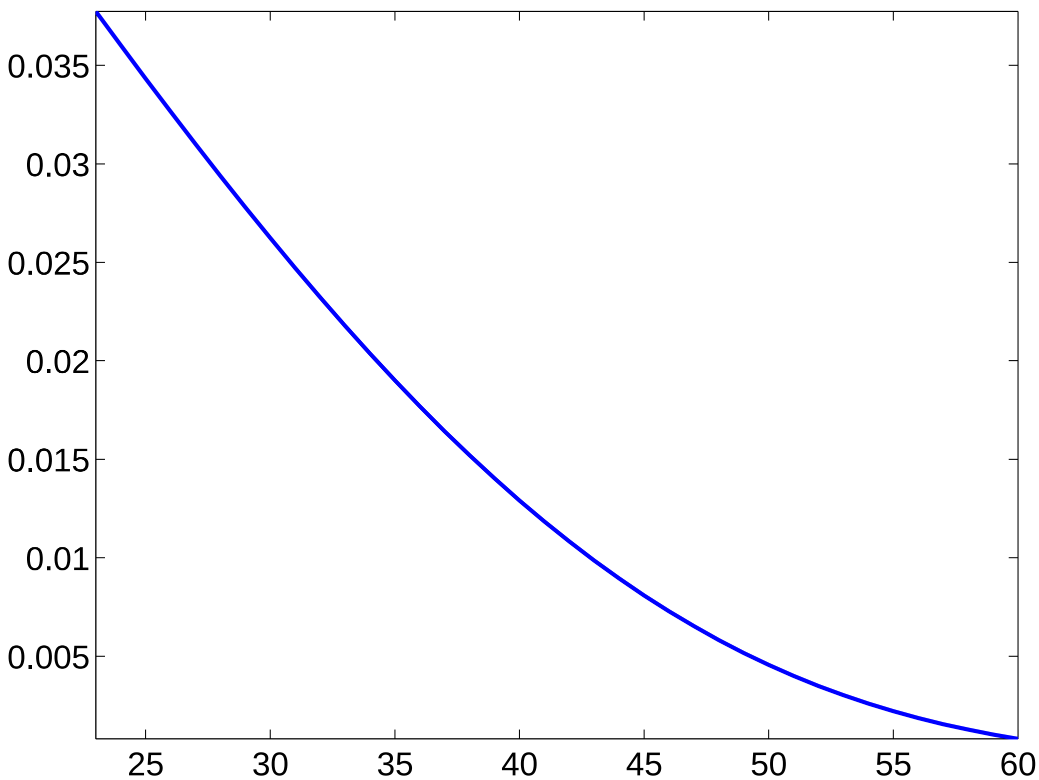
Figure 6: Life-cycle profile of consumption inequality



Result 5

Calibrated model implies substantial welfare costs of under-insurance for the young – equivalent to almost 4 percent of lifetime consumption for 23-old household

Figure 5: Life-cycle profile of welfare cost of under-insurance



Policy Implications

What type of policy reform would lead to a welfare-improving increase in insurance and human capital investment?

- **subsidize credit – but ensure that households in default do not have access to the subsidy (not in paper)**

- **more stringent bankruptcy code – garnish labor income (in paper)**