# On the Asset Allocation of a Default Pension Fund

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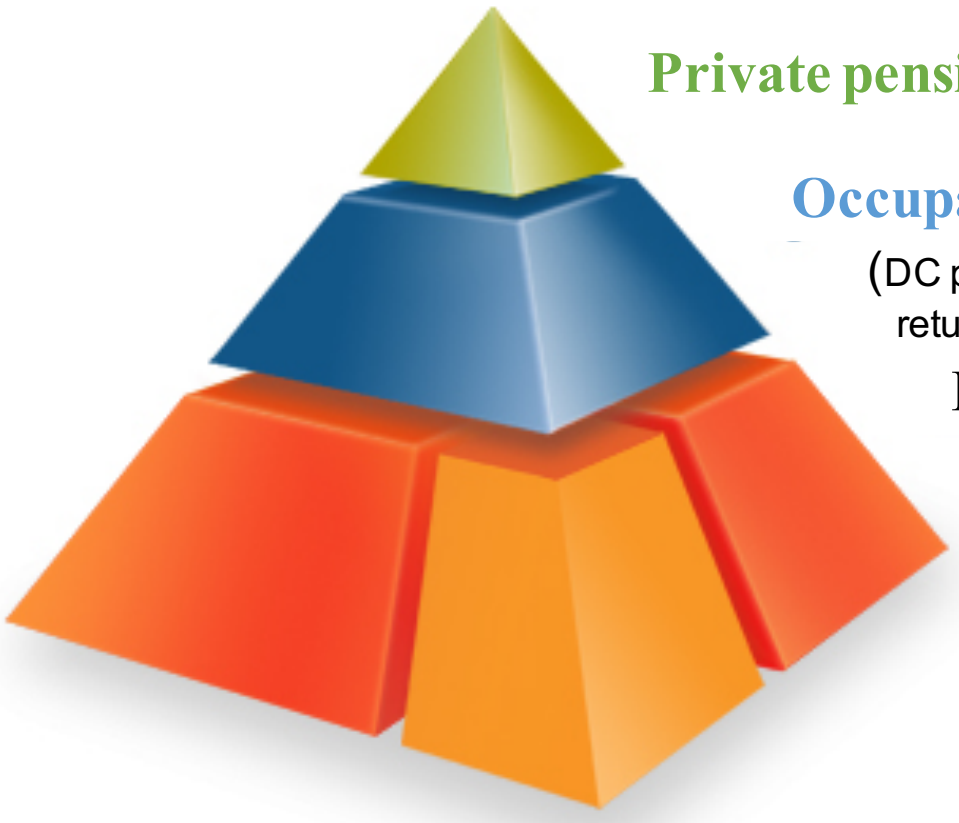
# Worldwide reform of pension systems: from DB to DC

## Example: Sweden, post-2000 reform



**Private pension scheme**

**Occupational pension:**

(DC plan; 4.5% contribution;
return depends on choice)

**Public pension system:**

– **Income pension**
(notional DC plan;
16% contribution;
return like wage growth)

– **Premium pension**
(DC plan; 2.5% contribution;
return depends on choice)

– **Guaranteed pension**

Adapted from the Swedish Pensions Agency

# This paper: the role of a default fund's asset allocation

- We consider Swedes' financial portfolios inside and outside the public pension system from 2000 to 2007
- We document heterogeneity between **passive** and **active** investors, and heterogeneity among passive investors
- We build a **quantitative life-cycle portfolio choice model** of the Swedish pension system, including an endogenous decision whether to be active (opt out from default fund)
  - We characterize default investors' **optimal customized** asset allocation
  - We report the welfare implications of introducing customization beyond age-based investing (e.g., beyond "100% minus age")

# Panel data set on individual investors

- We have detailed data from 2000 to 2007 on:
  - **Fund holdings in the government-mandated premium (DC) pension plan and number of fund changes**
  - Holdings outside the pension system (as in Calvet, Campbell, Sodini 2007, 2009)
  - Individuals' socio-demographics
- We define two investor types based on activity in the pension plan:
  1. Passive (60.5%): 31.3% default investors + 29.2% one-time initially active
  2. Active (39.5%)
     - Definition based on Dahlquist, Martinez, and Söderlind (2007)

# Averages of variables

| | All | Passive | Active |
|---|---|---|---|
| Investors | | | |
| Number of investors | 301,632 | 182,487 | 119,145 |
| Fraction of investors | 1.000 | 0.605 | 0.395 |
| State variables | | | |
| Age | 46.8 | 46.6 | 47.0 |
| Labor income | 248,420 | 224,526 | 285,017 |
| Financial wealth | 248,039 | 217,846 | 294,284 |
| Stock market exposure | | | |
| Participation dummy | 0.520 | 0.455 | 0.619 |
| Equity share (unconditional) | 0.234 | 0.196 | 0.290 |
| Equity share (conditional) | 0.449 | 0.432 | 0.469 |
| Educational dummies | | | |
| Elementary school | 0.157 | 0.184 | 0.116 |
| High school | 0.544 | 0.539 | 0.551 |
| College | 0.288 | 0.267 | 0.320 |
| PhD | 0.011 | 0.010 | 0.013 |

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**Regression analysis: non-participation outside and passivity inside pension system are positively correlated conditional on observables.**

# A MODEL OF PENSION INVESTORS

- Individuals live from age 25 up to at most age 100 (retirement at 65).
- Epstein-Zin preferences over a single consumption good.
- Uninsurable risky labor income during working age, **annuity payments** from pension accounts upon retirement.
- Save outside the pension system:
  - A risk-free bond and a stock market index:
    choose consumption/savings, stock market entry (costly), equity share
  - **A one-time participation cost:** $\kappa_i$, cross-sectionally distributed
- Save inside the pension system in 2 accounts:
  1. (Notional pension account: income-based, return of the risk-free bond)
  2. **DC account (premium pension plus occupational pension plan)**
     - Fixed contribution rates
     - Annuities are actuarially fair and insure against longevity risk
     - **A one-time activity (opt out) cost:** $\kappa_i^{\mathbf{DC}}$, cross-sectionally distributed

# Opt-out decision and asset allocation in the DC account

**Active investors**

- Opt out at a cost $\kappa^{DC}$
- Choose the equity share in the DC account, $\alpha_t^{DC}$, fully rationally

**Default investors**

- Stay in the default fund and do not pay cost $\kappa^{DC}$
- Default designs for $\alpha_t^{DC}$:
  1. "100-minus-age"
  2. The average optimal age-based equity share: a glide path that conditions only on age
  3. The rule of thumb: conditions on a sub-set of state variables
  4. The optimal equity share: conditions on all of the state variables (including $\kappa_i$, $\kappa_i^{DC}$)

# Calibration

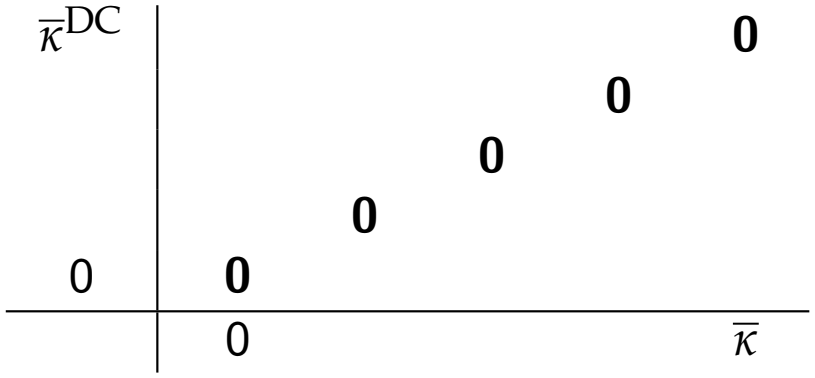
**"Exogenously" / Standard:**

- EIS, risk-free rate, equity premium, equity volatility
- Life-cycle profile for labor income, labor income shocks
- Contribution rates (16%+7%)
- Floor on annuity from notional account
- Age-based DC equity share: "100-minus-age"

**"Endogenously":**

1. Discount factor (match financial wealth / labor income 25-64).
2. Risk aversion coefficient (match weighted conditional equity share 25-69).
3. The joint distribution of $(\kappa, \kappa^{DC})$

# The joint distribution of $(\kappa, \kappa^{DC})$




- Square matrix $\Rightarrow$ the two marginal distributions have same shape and are symmetric
- Solve and simulate the model to determine:
  1. $\overline{\kappa}$: SEK 15,600 (USD 2,000)
  2. $\overline{\kappa}^{DC}$: SEK 3,600 (USD 460)
  3. Layers off diagonal: 3

# The joint distribution of $(\kappa, \kappa^{DC})$

| $\overline{\kappa}^{DC}$ | | | | | |
|---|---|---|---|---|---|
| | | | | **1** | **0** |
| | | | **1** | **0** | **1** |
| | | **1** | **0** | **1** | |
| | **1** | **0** | **1** | | |
| 0 | **0** | **1** | | | |
| | 0 | | | | $\overline{\kappa}$ |

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# The joint distribution of $(\kappa, \kappa^{DC})$

| $\overline{\kappa}^{DC}$ | | | | | |
|---|---|---|---|---|---|
| | | | **2** | **1** | **0** |
| | | **2** | **1** | **0** | **1** |
| | **2** | **1** | **0** | **1** | **2** |
| | **1** | **0** | **1** | **2** | |
| 0 | **0** | **1** | **2** | | |
| | 0 | | | | $\overline{\kappa}$ |

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  1. $\overline{\kappa}$: SEK 15,600 (USD 2,000)
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# The joint distribution of $(\kappa, \kappa^{DC})$

| $\overline{\kappa}^{DC}$ | | | | | |
|---|---|---|---|---|---|
| | | **3** | **2** | **1** | **0** |
| | **3** | **2** | **1** | **0** | **1** |
| | **2** | **1** | **0** | **1** | **2** |
| | **1** | **0** | **1** | **2** | **3** |
| 0 | **0** | **1** | **2** | **3** | |
| | 0 | | | | $\overline{\kappa}$ |

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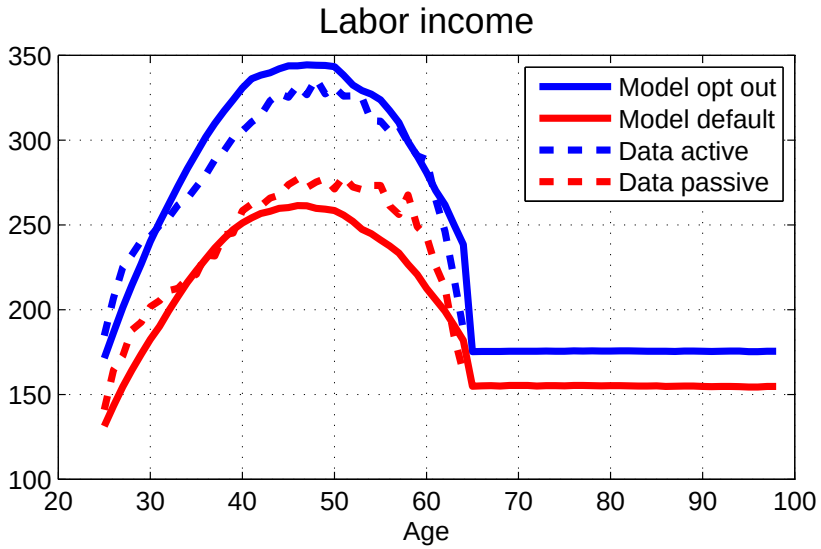
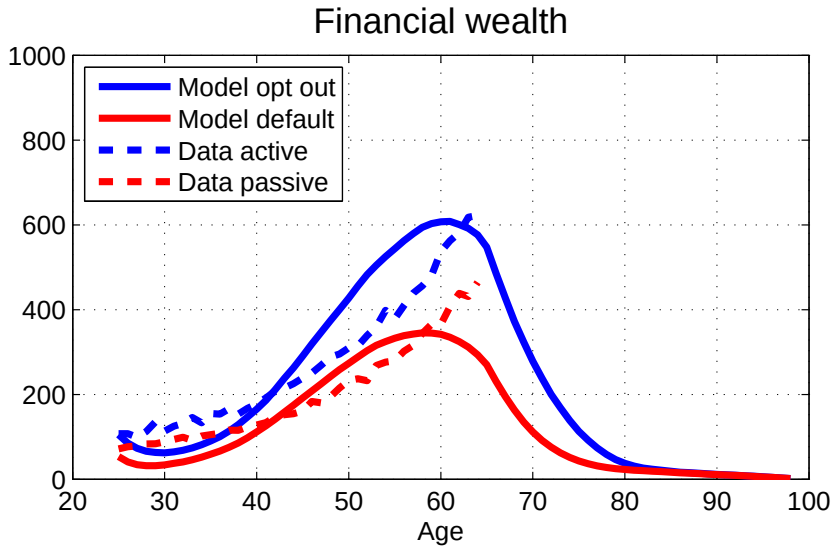
- Solve and simulate the model to determine:
  1. $\overline{\kappa}$: SEK 15,600 (USD 2,000)
  2. $\overline{\kappa}^{DC}$: SEK 3,600 (USD 460)
  3. Layers off diagonal: 3
- Equal weight on 23 types implies a correlation between $\kappa$ and $\kappa^{DC}$ of 0.2
- Low average costs: SEK 7,800 (USD 1,000) for participation and SEK 1,800 (USD 230) for opt-out

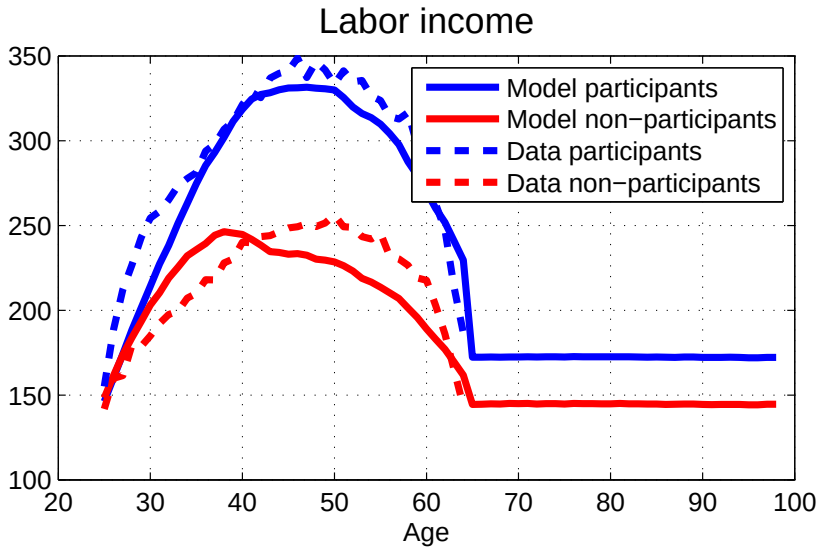
# Endogenously matched moments

| | Data | Model |
|---|---|---|
| Active (opting out) / non-participation | 0.151 | 0.158 |
| Active (opting out) / participation | 0.244 | 0.255 |
| Passive (default) / non-participation | 0.330 | 0.316 |
| Passive (default) / participation | 0.275 | 0.271 |

# Model fit


Labor income
Model opt out
Model default
Data active
Data passive
350
300
250
200
150
100
20
30
40
50
60
70
80
90
100
Age


Financial wealth
Model opt out
Model default
Data active
Data passive
1000
800
600
400
200
0
20
30
40
50
60
70
80
90
100
Age


Labor income
Model participants
Model non−participants
Data participants
Data non−participants
350
300
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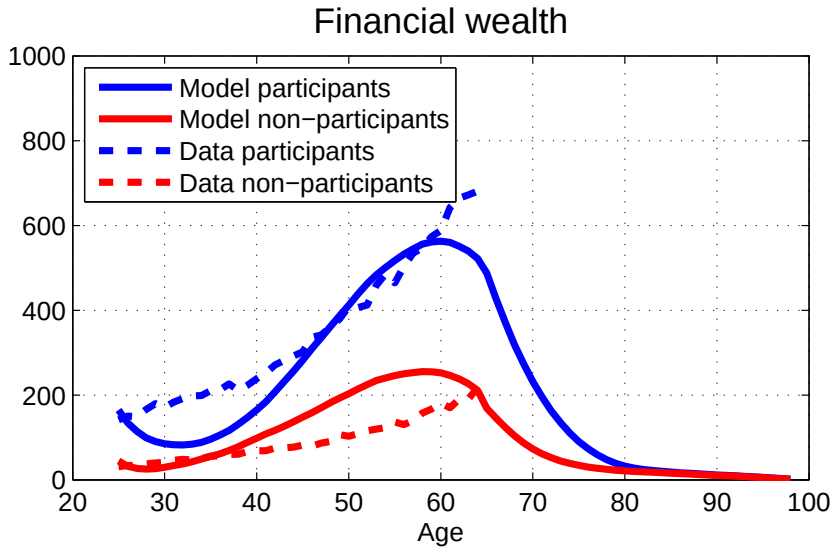
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1000
800
600
400
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80
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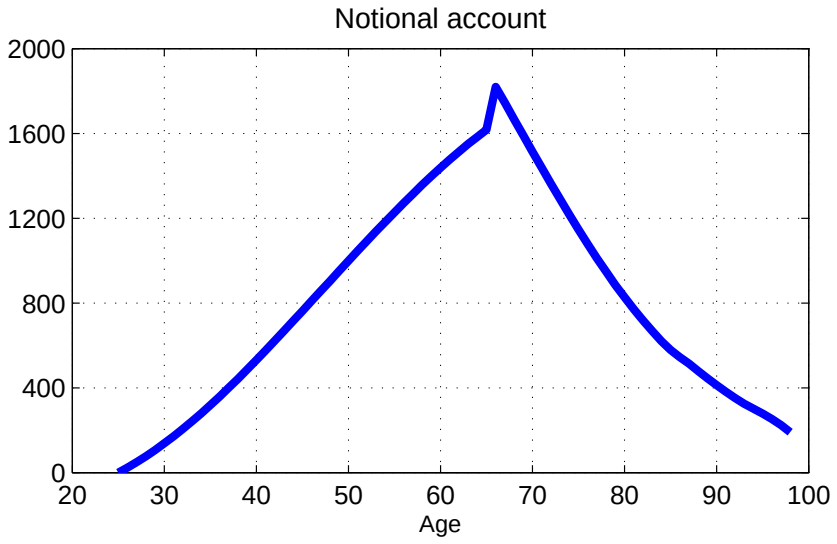
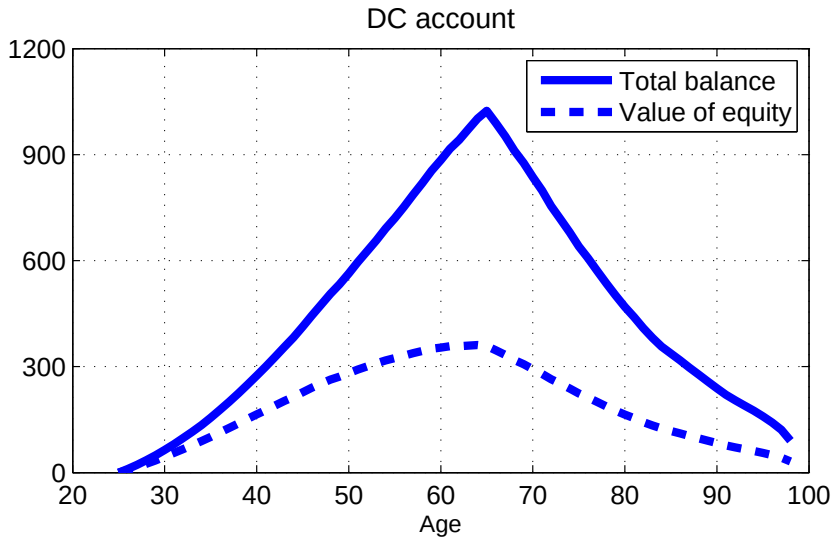
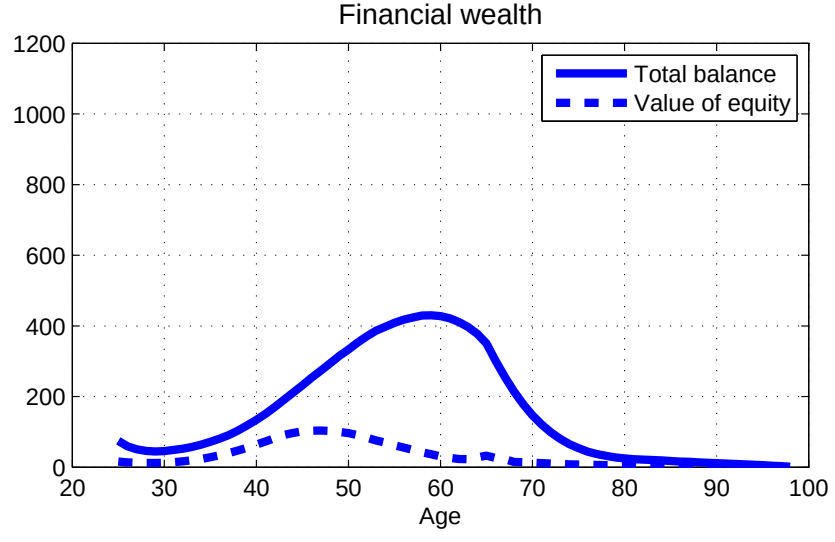
Age

# THE DC ACCOUNT IS IMPORTANT TO SUPPORT RETIREMENT



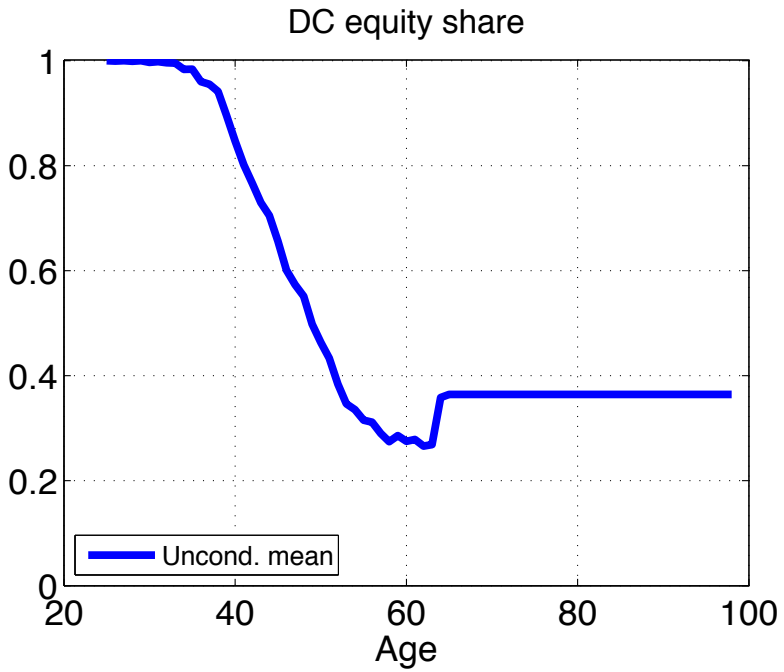



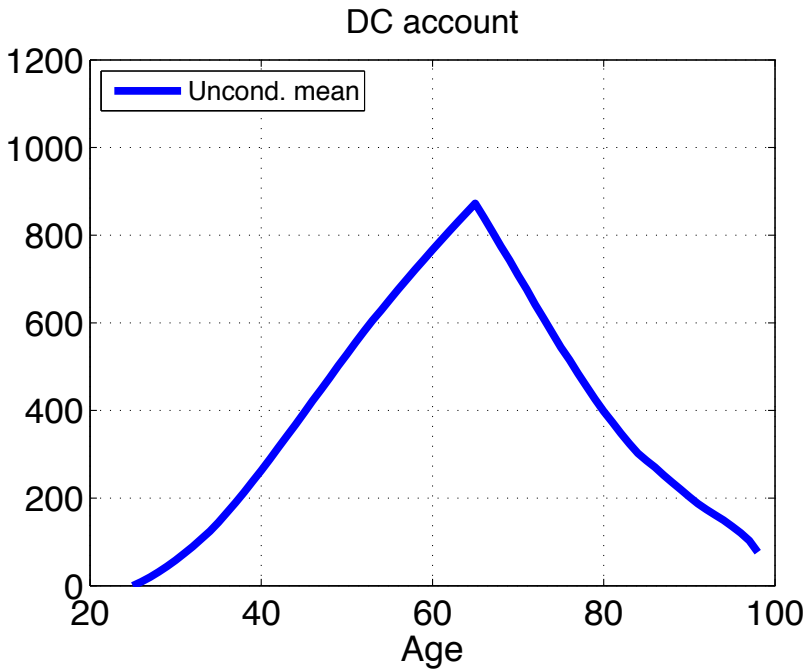



# Simulations to characterize the optimal DC equity share

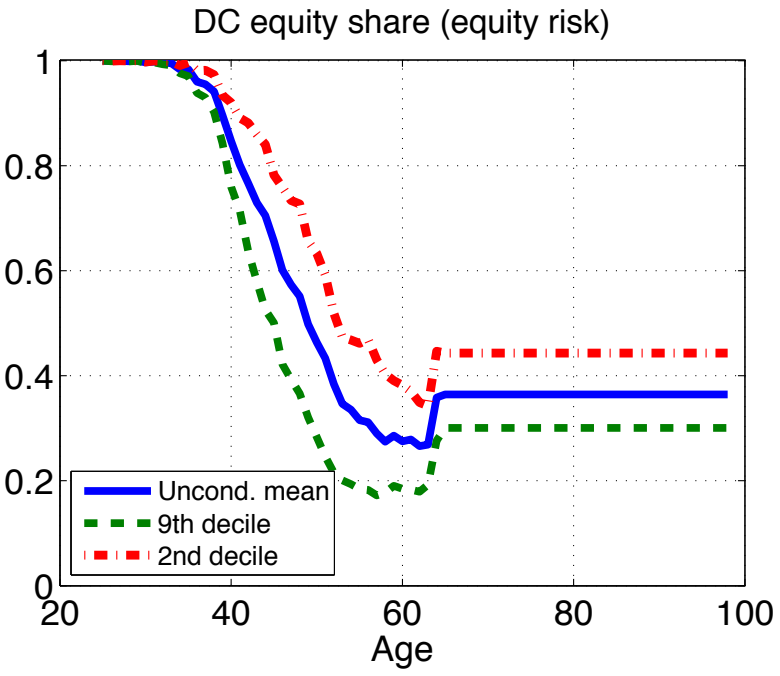
- Simulation method similar to Campbell and Cocco (JF, 2015)
- Two sources of risk:
  1. Aggregate – shocks to stock market (equity risk)
  2. Idiosyncratic – uninsurable labor income shocks (inequality)
- An economy: life-cycle path for one birth cohort exposed to common equity returns
- Simulate many economies with different returns & common income shocks
- 3 ways to characterize the optimal asset allocation and other outcomes:
  1. Unconditional mean (Average optimal)
  2. Equity risk
  3. Inequality

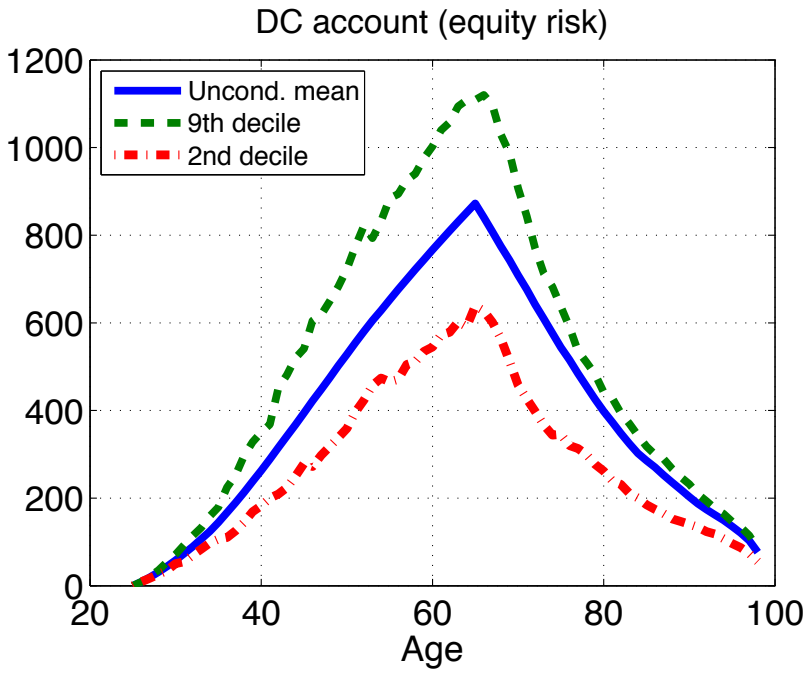
# DC EQUITY SHARE: UNCONDITIONAL MEAN



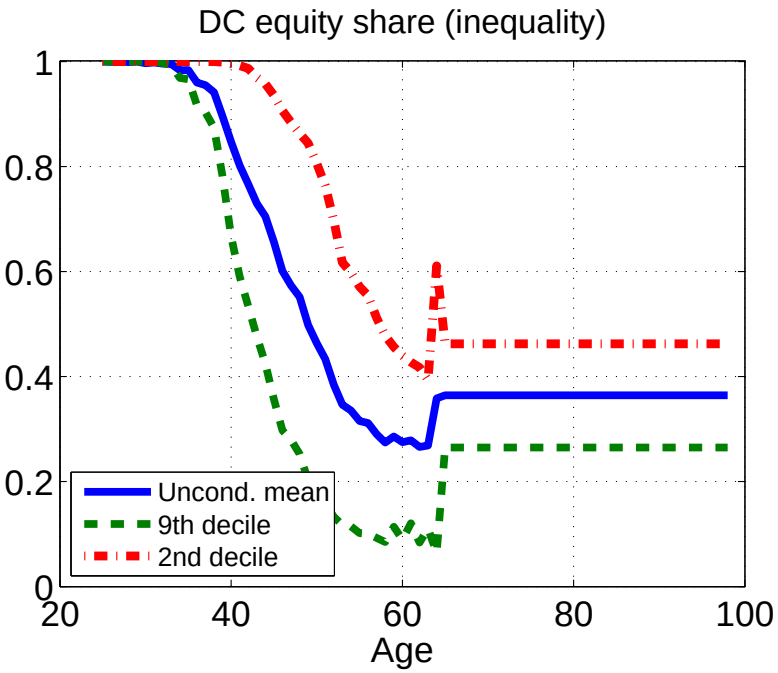
# DC equity share: Equity risk

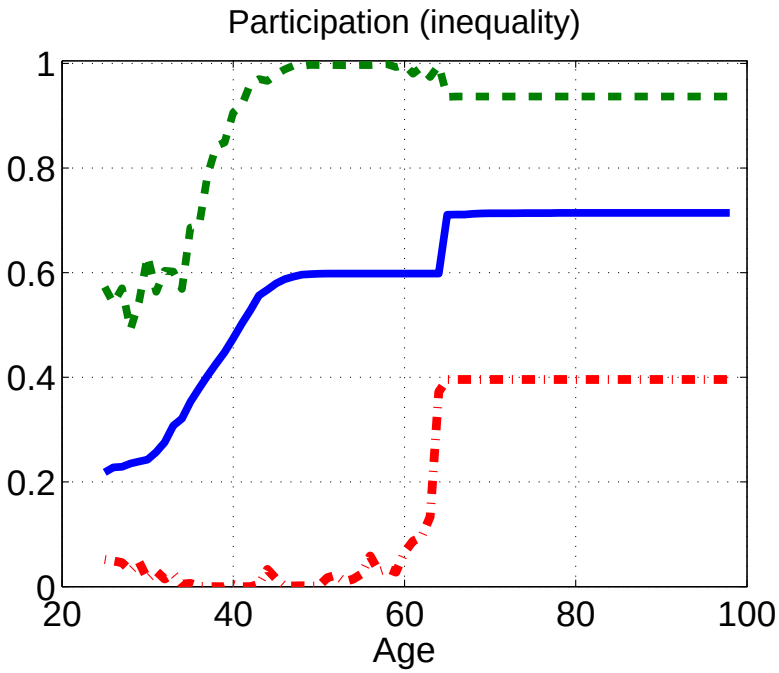



- High realized returns increase the DC account
- Optimal asset allocation reduces equity risk in pension income
- Cohort effects

# DC equity share: Inequality




- Participation rates correspond to the equity share deciles
- Optimal asset allocation compensates for non-participation outside

# Regressions on simulated data

| | I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|---|
| Constant | 1.746*** | 1.873*** | 1.585*** | 1.738*** | 1.313*** | 1.347*** | 1.266*** |
| | (0.016) | (0.015) | (0.018) | (0.016) | (0.013) | (0.011) | (0.012) |
| Age | –0.024*** | –0.023*** | –0.018*** | –0.022*** | –0.009*** | –0.008*** | –0.007*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Labor income | | –0.760*** | | | | | 0.262*** |
| | | (0.039) | | | | | (0.025) |
| Fin. wealth | | | –0.565*** | | | | –0.096*** |
| | | | (0.041) | | | | (0.032) |
| Participation | | | | –0.233*** | | –0.196*** | –0.198*** |
| | | | | (0.006) | | (0.003) | (0.004) |
| DC account | | | | | –0.666*** | –0.603*** | –0.618*** |
| | | | | | (0.026) | (0.022) | (0.017) |
| *R*-squared | 0.630 | 0.687 | 0.740 | 0.730 | 0.786 | 0.855 | 0.859 |

**Our proposal for rule of thumb in red!**

# Welfare analysis: Does customization matter?

- Compare welfare of gradual customization for default investors
- **Certainty equivalent consumption based on expected utility at 25**
- Welfare measure is ex ante – captures both risk and return
- In addition, we study changes in opt-out rates and pension income

# Welfare analysis

| | 100-minus-age | Average optimal | Rule of thumb | Optimal |
|---|---|---|---|---|
| Cumulative welfare gain | — | | | 1.5% |
| Share of default investors | 0.587 | | | 1.000 |
| Regressions | | | | |
| Constant | | | | |
| Age | | | | |
| Participation dummy | | | | |
| DC account balance | | | | |
| $R$-squared | | | | |
| Pension income | | | | |
| Mean | | | | |
| Equity risk | | | | |
| Inequality | | | | |

# Welfare analysis

| | 100-minus-age | Average optimal | Rule of thumb | Optimal |
|---|---|---|---|---|
| Cumulative welfare gain | — | 0.3% | 0.9% | 1.5% |
| Share of default investors | 0.587 | 0.679 | 0.753 | 1.000 |
| Regressions | | | | |
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**Welfare gain of a shift from 50-50 flat profile to 100-minus-age is 0.1%**

# Welfare analysis

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| Share of default investors | 0.587 | 0.679 | 0.753 | 1.000 |
| Regressions | | | | |
| Constant | 1.347 | 1.363 | 1.384 | 1.411 |
| Age | –0.008 | –0.009 | –0.009 | –0.010 |
| Participation dummy | –0.196 | –0.199 | –0.198 | –0.195 |
| DC account balance | –0.603 | –0.564 | –0.533 | –0.505 |
| *R*-squared | 0.855 | 0.855 | 0.853 | 0.850 |
| Pension income | | | | |
| Mean | | | | |
| Equity risk | | | | |
| Inequality | | | | |

# Welfare analysis

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| DC account balance | –0.603 | –0.564 | –0.533 | –0.505 |
| *R*-squared | 0.855 | 0.855 | 0.853 | 0.850 |
| Pension income | | | | |
| Mean | 154,880 | 155,461 | 158,952 | 152,281 |
| Equity risk | 0.121 | 0.122 | 0.127 | 0.087 |
| Inequality | 0.234 | 0.233 | 0.194 | 0.196 |

# Results are robust to:

1. Left-skewed equity returns and a low equity premium
2. Implementing a rule of thumb from a misspecified model
3. Simple forms of investment mistakes ("Down or Out") outside the DC account
4. A higher correlation between labor income and equity returns (combined with left-skewness)
5. Accounting for wealth tied in real estate

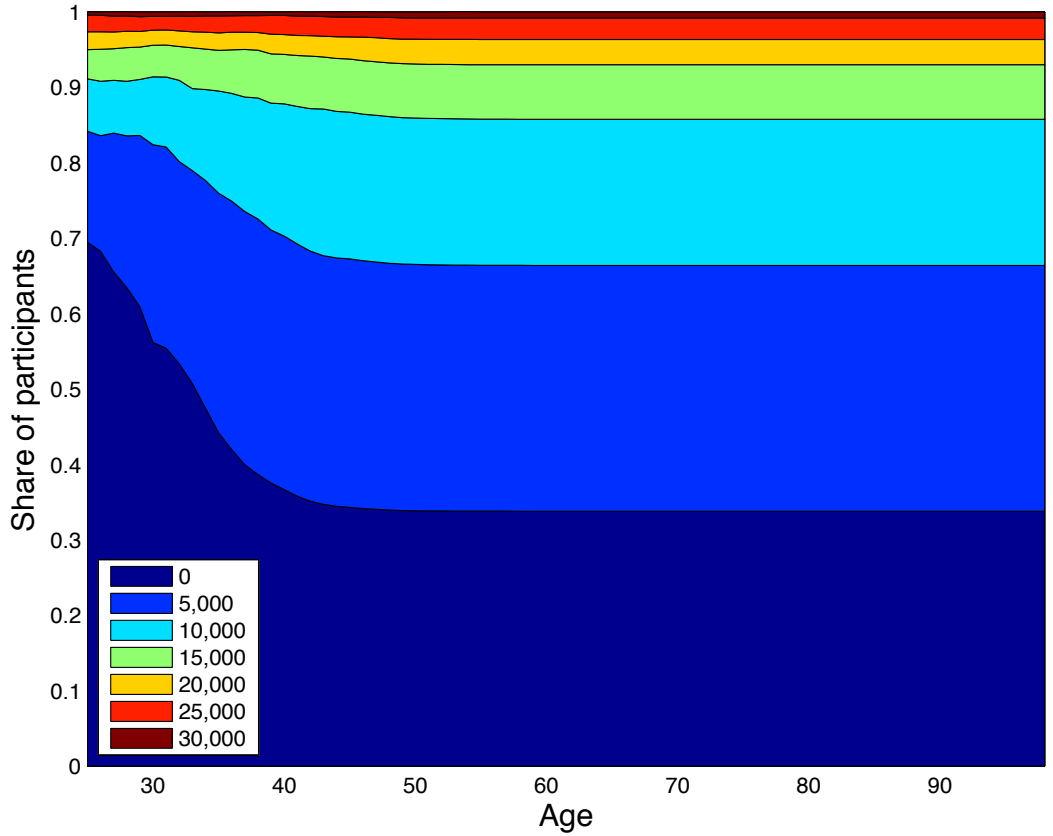
# Conclusions

- Using Swedish defined contribution pension plan data we find:
  - Heterogeneity across passive and active pension investors
  - Vast amount of heterogeneity among passive investors
- We set up a life-cycle model that allows for investor heterogeneity and endogenous opt-out/default
- Individual customization of the default fund's asset allocation yields sizable welfare gains
  - A simple rule of thumb attains a large share of the total gain

# Extra slides

# Details on Sweden's statistics, pension and opt out

# Fraction of each type among participants



# Passive vs active investors + real estate

| | Active | Passive | All |
|---|---|---|---|
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| Number of investors | 119,145 | 182,487 | 301,632 |
| Fraction of investors | 0.395 | 0.605 | 1.000 |
| State variables | | | |
| Age | 47.0 | 46.6 | 46.8 |
| Financial wealth | 294,284 | 217,846 | 248,039 |
| Labor income | 285,017 | 224,526 | 248,420 |
| Educational dummies | | | |
| Elementary school | 0.116 | 0.184 | 0.157 |
| High school | 0.551 | 0.539 | 0.544 |
| College | 0.320 | 0.267 | 0.288 |
| PhD | 0.013 | 0.010 | 0.011 |
| Real estate ownership and net worth | | | |
| Real estate dummy | 0.793 | 0.652 | 0.708 |
| Real estate wealth | 1,009,899 | 817,972 | 893,784 |
| Net worth | 847,993 | 665,790 | 737,760 |

Nominal values are in SEK (SEK 8=$US 1)

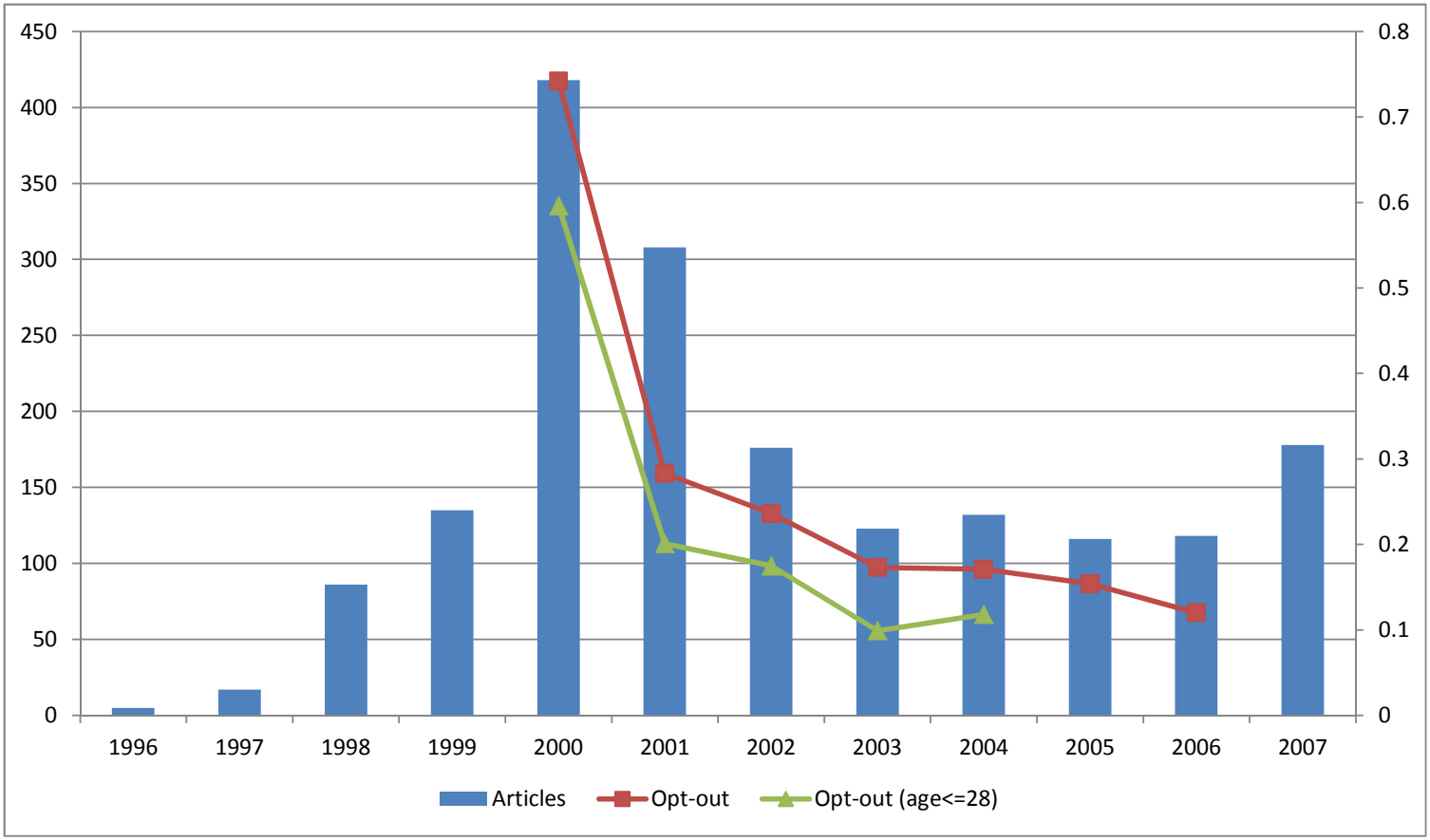
▸ Back to active vs passive statistics

# Heterogeneity within passive investors

| | 10% | 25% | 50% | 75% | 90% | Mean |
|---|---|---|---|---|---|---|
| **A. All passive investors** | | | | | | |
| Age | 30 | 38 | 46 | 56 | 64 | 46.6 |
| Labor income | 0 | 99,911 | 225,373 | 303,797 | 401,252 | 224,526 |
| Financial wealth | 7,135 | 17,116 | 68,580 | 218,505 | 560,981 | 217,846 |
| Equity share | 0.000 | 0.000 | 0.000 | 0.401 | 0.634 | 0.196 |
| **B. Participants** | | | | | | |
| Age | 32 | 39 | 48 | 58 | 65 | 48.3 |
| Labor income | 0 | 137,245 | 250,315 | 336,004 | 460,812 | 258,714 |
| Financial wealth | 26,272 | 68,468 | 176,367 | 432,910 | 934,804 | 374,888 |
| Equity share | 0.088 | 0.234 | 0.438 | 0.609 | 0.764 | 0.432 |
| **C. Non-participants** | | | | | | |
| Age | 30 | 36 | 44 | 54 | 62 | 45.2 |
| Labor income | 0 | 72,964 | 205,647 | 277,920 | 350,952 | 195,969 |
| Financial wealth | 7,135 | 7,135 | 26,996 | 83,589 | 207,063 | 86,676 |
| Equity share | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

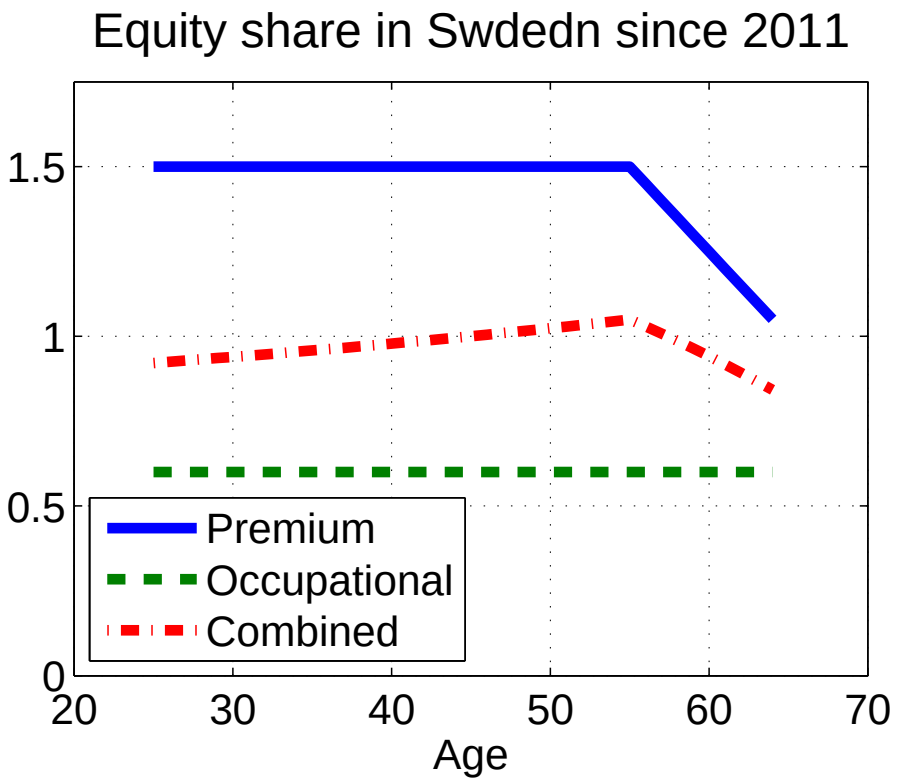
▸ Back to heterogeneity within passive investors

# Opt out profile



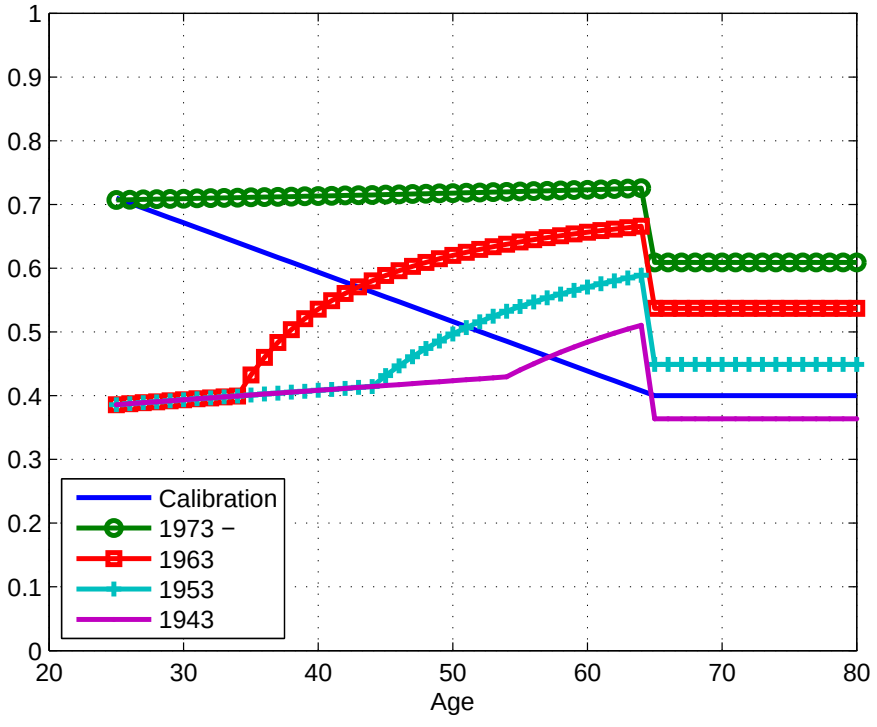

Back to active vs passive statistics

# Equity share since 2011




Back

# Calibration: Composition of cohorts




Back

# Stock market participation

| | I | II | III | IV |
|---|---|---|---|---|
| Default investor dummy | | –0.133*** | –0.087*** | –0.087*** |
| | | (0.002) | (0.002) | (0.003) |
| Initially active dummy | | –0.055*** | –0.037*** | –0.038*** |
| | | (0.002) | (0.002) | (0.002) |
| Age | 0.080*** | 0.022*** | — | — |
| | (0.007) | (0.007) | | |
| Labor income | 0.153*** | 0.119*** | — | — |
| | (0.004) | (0.004) | | |
| Financial wealth | 0.293*** | 0.289*** | — | — |
| | (0.002) | (0.002) | | |
| Real estate dummy | 0.149*** | 0.127*** | 0.063*** | 0.054*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Educational dummies | Yes | Yes | Yes | Yes |
| Geographical dummies | Yes | Yes | Yes | Yes |
| Industry & occupational dummies | No | No | No | Yes |
| Age/income/wealth splines | No | No | Yes | Yes |
| $R$-squared | 0.141 | 0.153 | 0.295 | 0.283 |
| Number of observations | 318,345 | 318,345 | 318,345 | 186,651 |

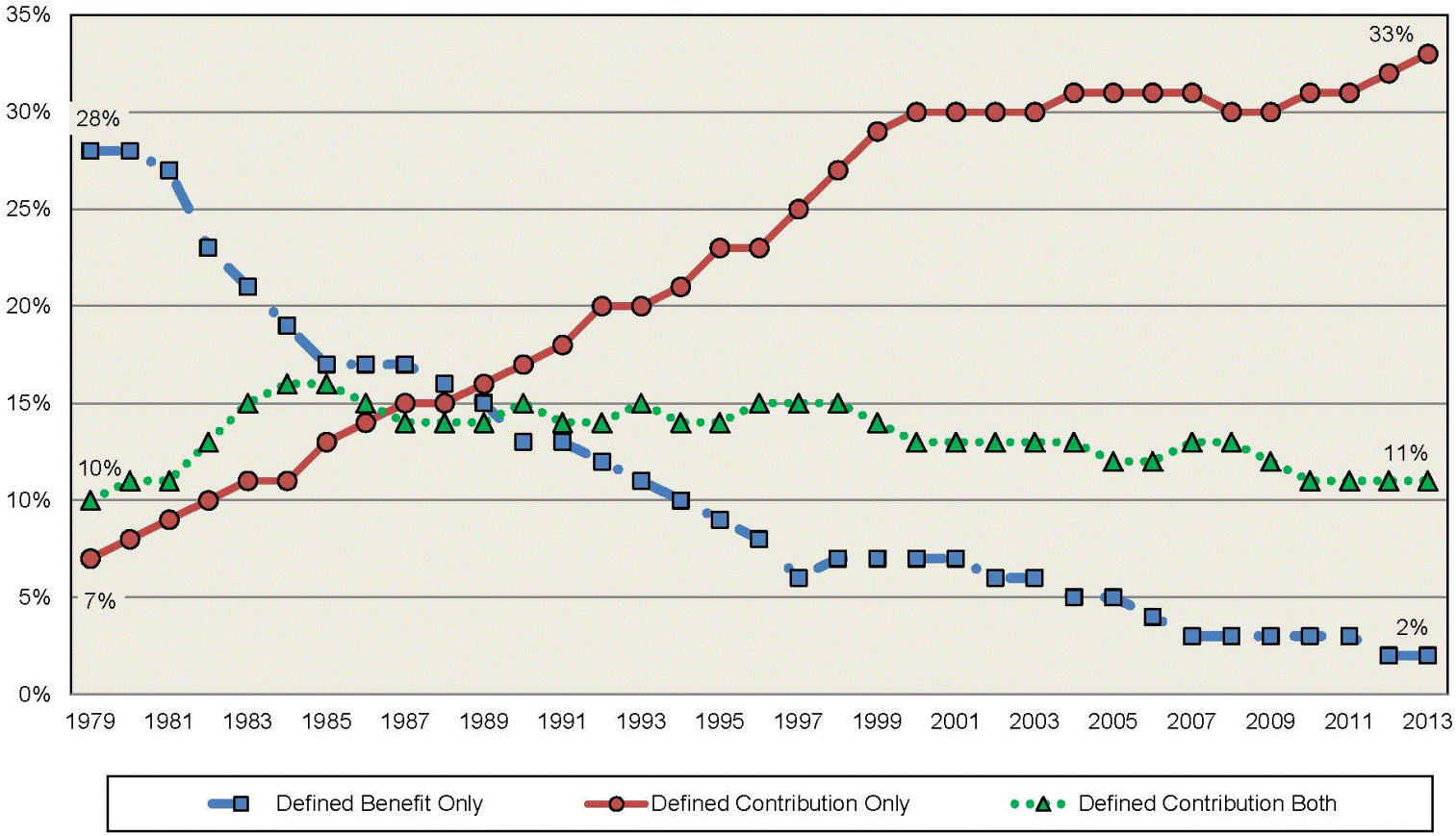
Back

# DC vs DB US

Figure 1

**Private-Sector Workers Participating in Employment-Based Retirement Plans, by Plan Type, 1979–2013**

(*Among All Workers*)




Source: U.S. Department of Labor Form 5500 Summaries 1979–1998, Pension Benefit Guaranty Corporation,

Back to motivation

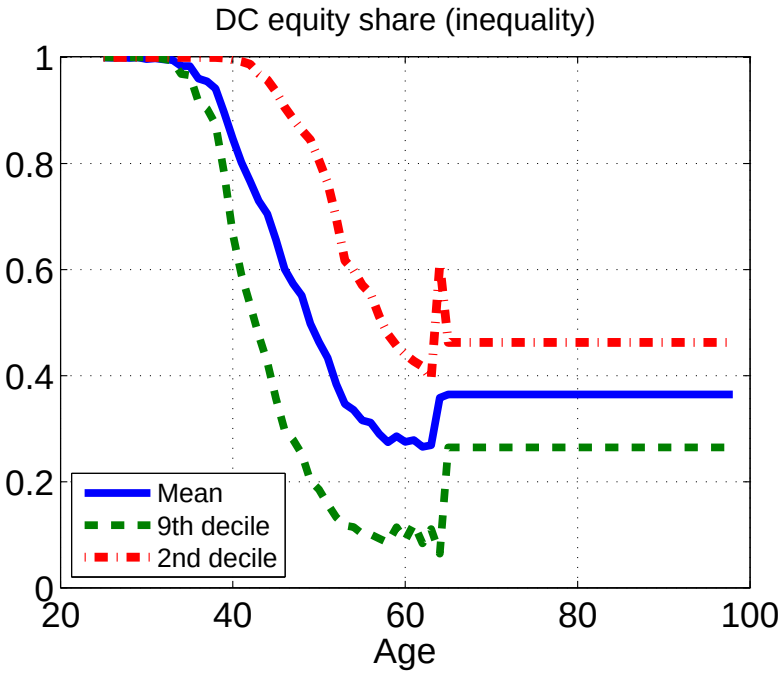
# Activity and stock market participation

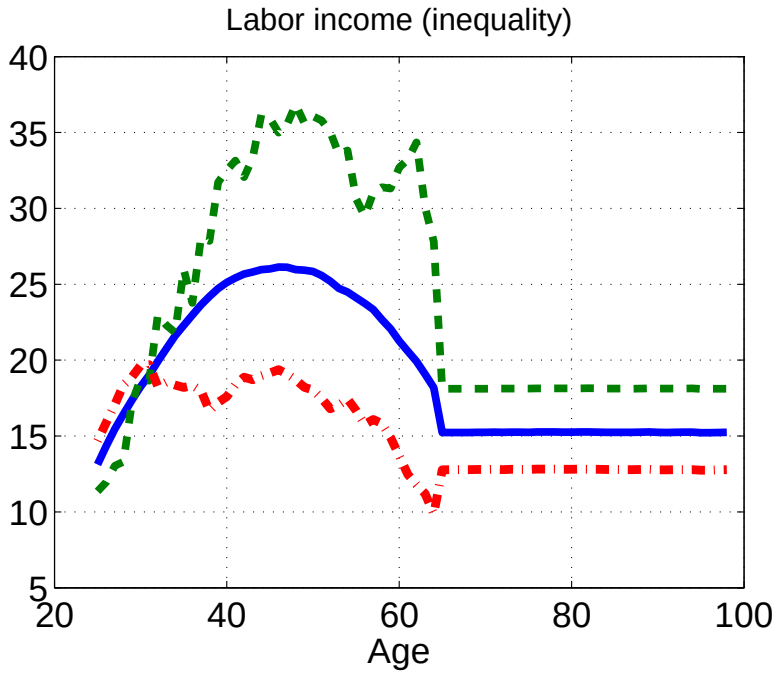
| | Activity dummy | | Participation dummy | |
|---|---|---|---|---|
| | I | II | III | IV |
| **A. Main regressions** | | | | |
| Age | 0.038*** (0.008) | — | 0.220*** (0.008) | — |
| Labor income | 0.216*** (0.004) | — | 0.173*** (0.004) | — |
| Financial wealth | 0.049*** (0.002) | — | 0.281*** (0.002) | — |
| Real estate dummy | 0.122*** (0.002) | 0.068*** (0.002) | 0.167*** (0.002) | 0.074*** (0.002) |
| Educational dummies | Yes | Yes | Yes | Yes |
| Geographical dummies | Yes | Yes | Yes | Yes |
| Age/income/wealth splines | No | Yes | No | Yes |
| *R*-squared | 0.044 | 0.067 | 0.150 | 0.291 |
| Number of observations | 301,632 | 301,632 | 301,632 | 301,632 |
| **B. Residual regressions** | | | | |
| Activity | | | 0.101*** (0.002) | 0.060*** (0.002) |
| *R*-squared | | | 0.011 | 0.005 |
| Number of observations | | | 301,632 | 301,632 |

▸ Back to active vs passive statistics

# Model - additional figures

# Driving forces - labor income

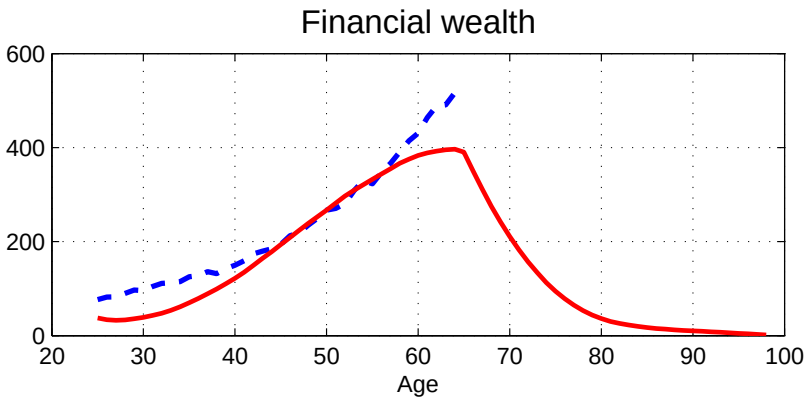


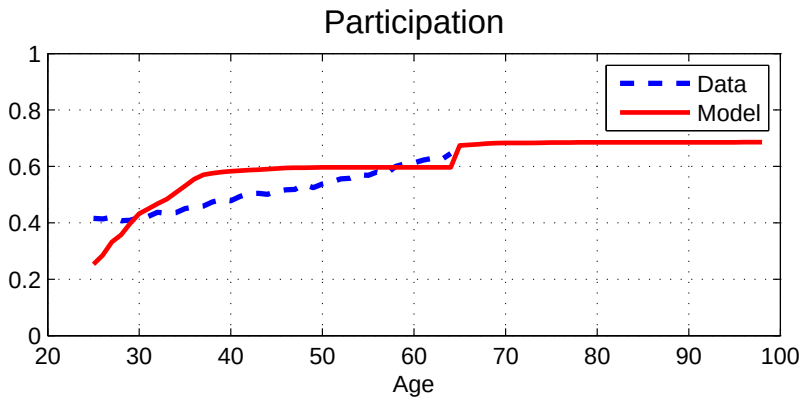



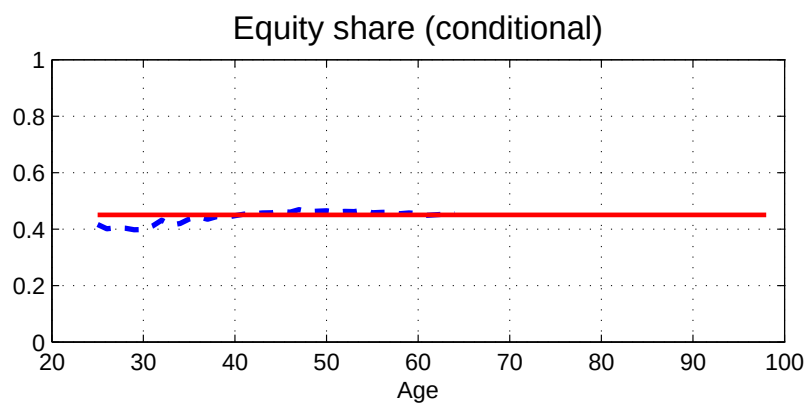

- Labor income levels that correspond to the equity share deciles
- Labor income decreases with equity share but less relative to DC balance
- Investors with low income are relatively wealth-poor
- Investors rebalance by increasing the equity share

Back to DC wealth

# Calibration: Model fit

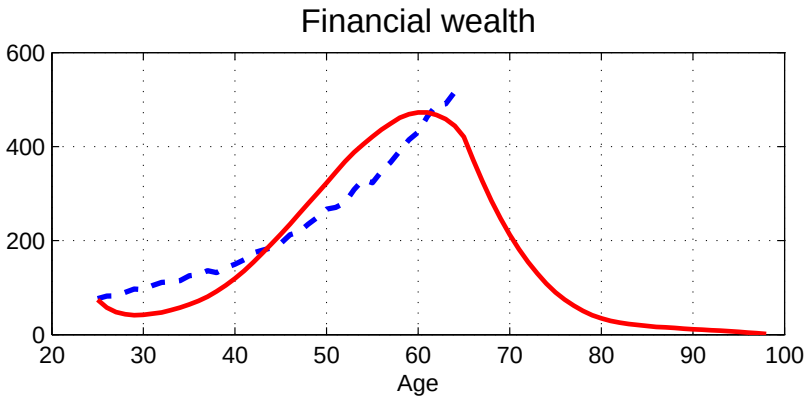


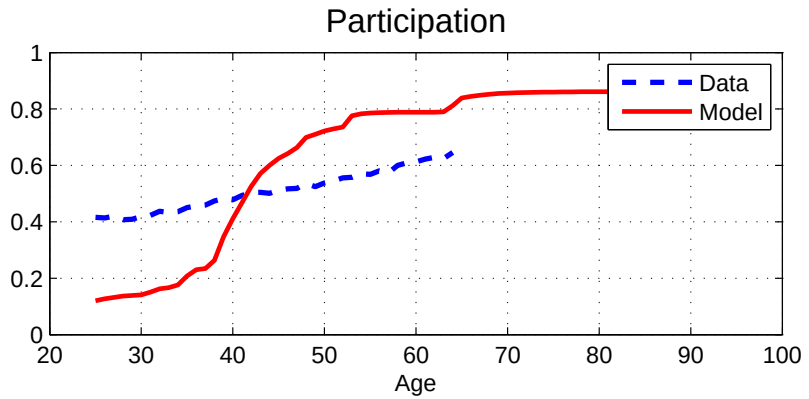



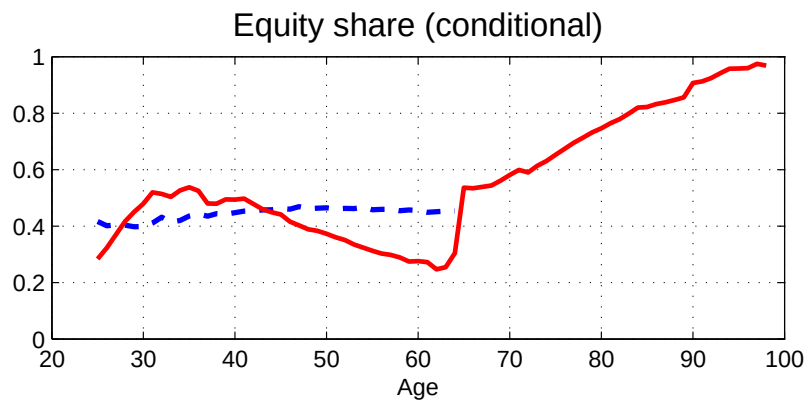




Back to model fit

# Model fit - high correlation and a disaster shock

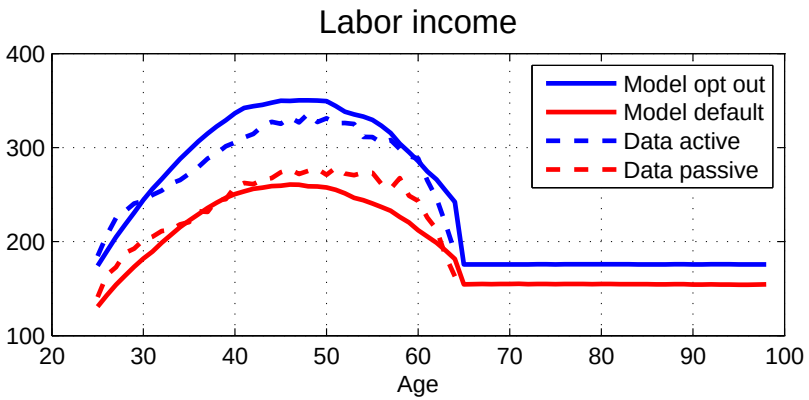


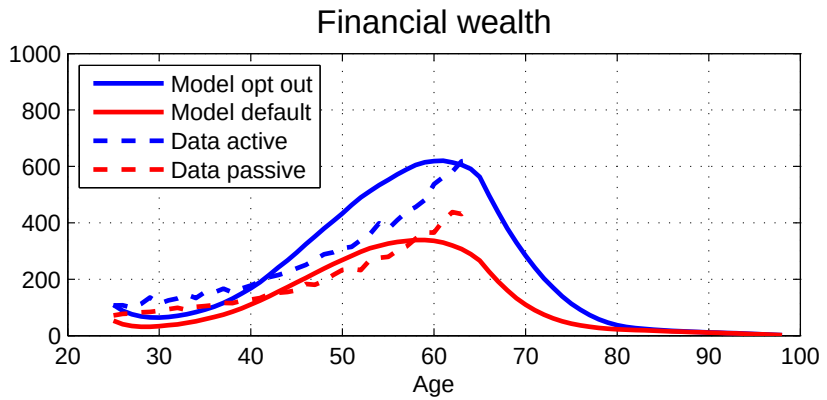



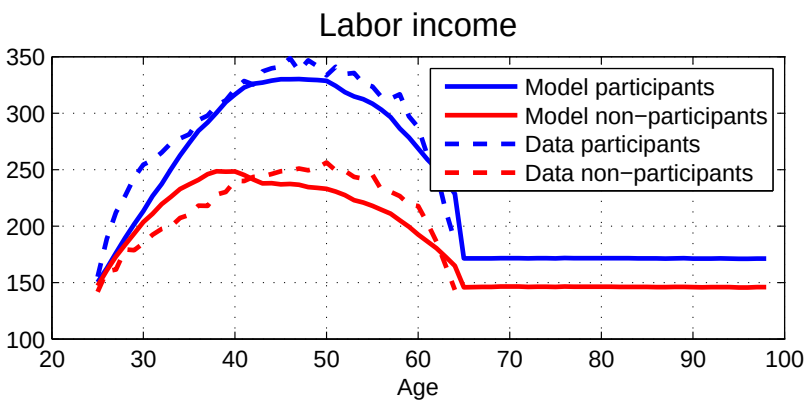



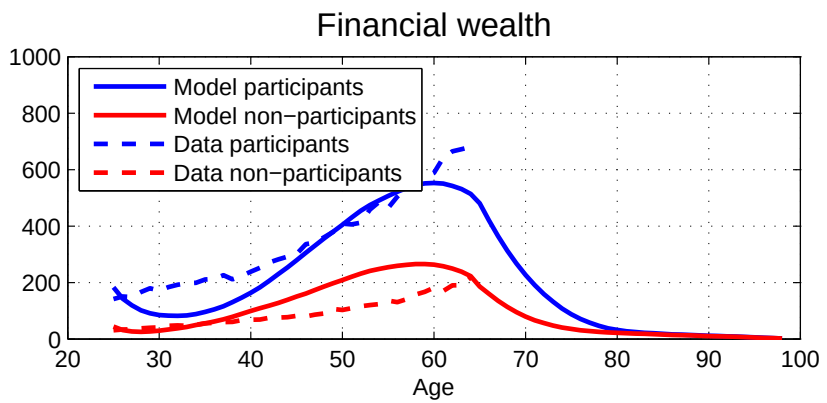

Back to model fit I

# Calibration: Model fit II



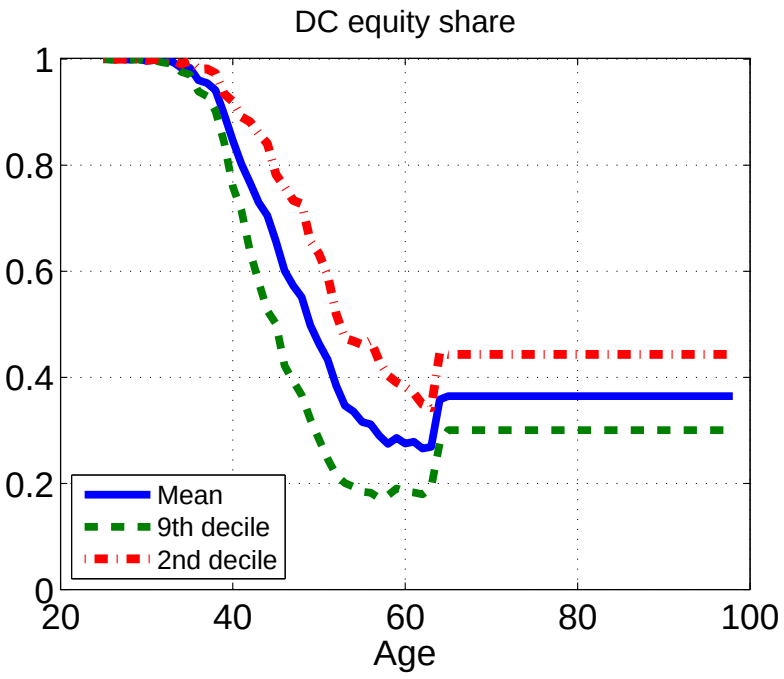



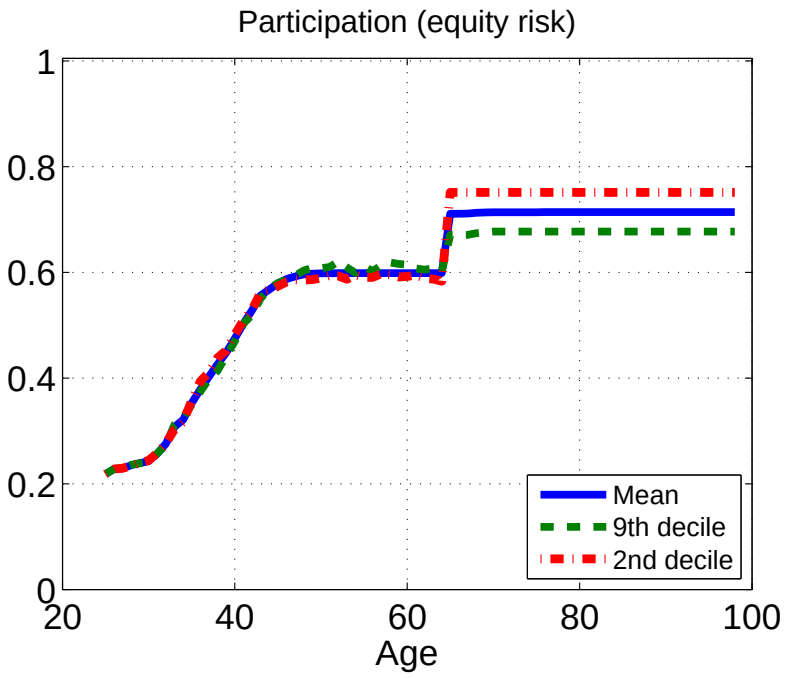




▸ Back to model fit II

# DC EQUITY SHARE VERSUS PARTICIPATION




- A much weaker link between participation and DC equity share (relative to inequality)

Back to DC equity share versus balance equity risk

# Thought experiment

- Default choice may be rational, rational inattention or irrational
- Once the default choice had been made - treat investor as rational
- Three options for life-cycle asset allocation of default:
  - A representative agent
  - Aggregation of heterogenous agents
  - Full characterization and partial customization for investors – This paper!
- Asset allocation is based on age and additional observable variables

Back (Methodology)

# THREE SAVING ACCOUNTS

1. Financial wealth (liquid)
   - Access to stocks via the one-time participation shock

$$A_{it+1} = A_{it}\left(R_f + \alpha_{it}(R_{t+1} - R_f)\right) + Y_{it+1} - C_{it}$$

$$X_{it+1} \equiv A_{it}\left(R_f + \alpha_{it}(R_{t+1} - R_f)\right) + Y_{it+1}$$

2. A fully-funded (FF) DC account in the pension system
   - Income based, investors choose bonds and stocks allocation
   - Corresponds to the default fund we wish to design

$$A^{DC}_{it+1} = A^{DC}_{it}(R_f + \alpha^{DC}_{it}(R_{t+1} - R_f)) + \lambda^{DC} Y_{it}$$

3. A notional account belonging to the pension system
   - Income based, evolves at the rate of the risk-free bond

$$A^{N}_{it+1} = A^{N}_{it} R_f + \lambda^{N} \min\{Y_{it}, \overline{Y}\}$$

   - Together with FF becomes an annuity at retirement with longevity insurance

Back to investor problems

# Who opts out?

Probability (in percent) of opting out for each type:

| $\kappa^{DC}$ | | | | | | |
|---|---|---|---|---|---|---|
| | 3,600 | — | 2.6 | 2.6 | 2.8 | 3.0 |
| | 2,700 | 9.4 | 9.8 | 1.0 | 11.4 | 15.8 |
| | 1,800 | 28.0 | 28.2 | 30.2 | 31.8 | 34.2 |
| | 900 | 43.2 | 46.2 | 78.4 | 80.6 | 82.6 |
| | 0 | 100.0 | 100.0 | 100.0 | 100.0 | — |
| | | 0 | 3,900 | 7,800 | 11,700 | 15,600 |
| | | | | $\kappa$ | | |

Back to who opts out

# Primer on asset allocation over the life cycle

- Conventional wisdom: equity share should decrease with age
- Another conventional wisdom: this is due to the time horizon
  - This is wrong (Samuelson, 1963, *Risk and Uncertainty: the Fallacy of the Law of Large Numbers*)
- Recent papers have incorporated labor income
  - Labor income substitutes a riskless asset (Cocco et al RFS 2005)
  - Age $\uparrow \Rightarrow$ labor income stock $\downarrow \Rightarrow$ total bond in portfolio $\downarrow$

    $\Rightarrow$ Rebalance by $\uparrow$ bond in portfolio $\Rightarrow$ Equity share decreases with age
  - More generally, equity share is a function of labor income and assets

▸ Back to results ▸ Illustration

# Welfare analysis - robustness

| | Main | Fixed allocation outside | Random allocation outside | Left-skewed equity returns | Low equity premium | Low share of default investors |
|---|---|---|---|---|---|---|
| Main results | | | | | | |
| Welfare gain of Optimal | 1.6% | 2.2% | 2.4% | 1.6% | 1.7% | 1.8% |
| Optimal age | 0.4% | 0.4% | 0.4% | 0.4% | 0.6% | 0.5% |
| Rule of thumb (incremental) | 0.6% | 0.7% | 0.7% | 0.6% | 0.5% | 0.7% |
| Share of default investors under Rule of thumb | 0.75 | 0.73 | 0.74 | 0.77 | 0.76 | 0.62 |
| Preferences & stock market participation cost | | | | | | |
| Discount factor* $\beta$ | 0.933 | 0.940 | 0.943 | 0.933 | 0.951 | 0.939 |
| Relative risk aversion* $\gamma$ | 14 | 14 | 14 | 14 | 8 | 14 |
| Ceiling for opt-out cost* $\overline{\kappa}^{DC}$ | 3,600 | 5,800 | 5,700 | 3,700 | 3,300 | 13,700 |
| Ceiling for stock market entry cost* $\overline{\kappa}$ | 15,600 | 5,400 | 4,200 | 14,700 | 5,200 | 1,800 |
| Number of layers in the cost distribution* | 3 | 4 | 4 | 3 | 4 | 3 |
| Moments | | | | | | |
| Financial wealth to labor income ratio | 0.921 | 0.890 | 0.913 | 0.911 | 0.932 | 0.904 |
| Equity share (conditional) | 0.519 | 0.432 | 0.530 | 0.485 | 0.461 | 0.568 |
| Active (opting out) / non-participation | 0.158 | 0.150 | 0.124 | 0.140 | 0.147 | 0.289 |
| Active (opting out) / participation | 0.255 | 0.254 | 0.271 | 0.251 | 0.262 | 0.382 |
| Passive (default) / non-participation | 0.316 | 0.309 | 0.321 | 0.343 | 0.333 | 0.193 |
| Passive (default) / participation | 0.271 | 0.287 | 0.284 | 0.266 | 0.259 | 0.135 |

Back

# Endogenous parameters details I

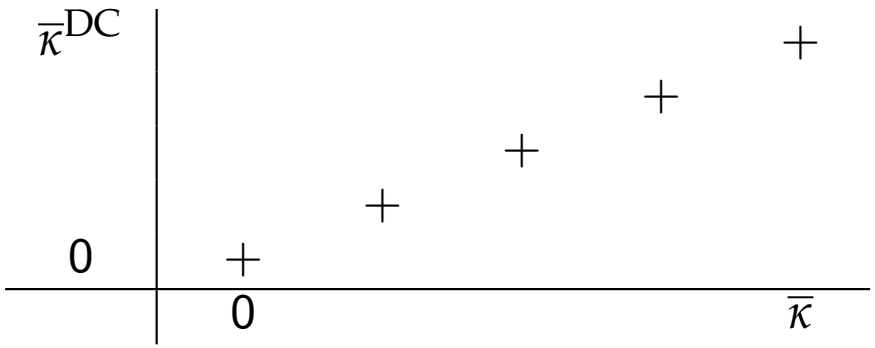
- Matching the opt-out and participation choices
  - Cap on opt-out cost ($\kappa^{DC}$) affects the opt-out decision
  - Cap on participation ($\kappa$) affects the participation decision
- To capture the joint distribution use the following cost structure:

| $\overline{\kappa}^{\mathrm{DC}}$ | | | | | |
|---|---|---|---|---|---|
| | 4 | 3 | 2 | 1 | 0 |
| | 3 | 2 | 1 | 0 | 1 |
| | 2 | 1 | 0 | 1 | 2 |
| | 1 | 0 | 1 | 2 | 3 |
| 0 | 0 | 1 | 2 | 3 | 4 |
| | 0 | | | | $\overline{\kappa}$ |

- Key degree of freedom: distance from the diagonal

# Endogenous parameters details II

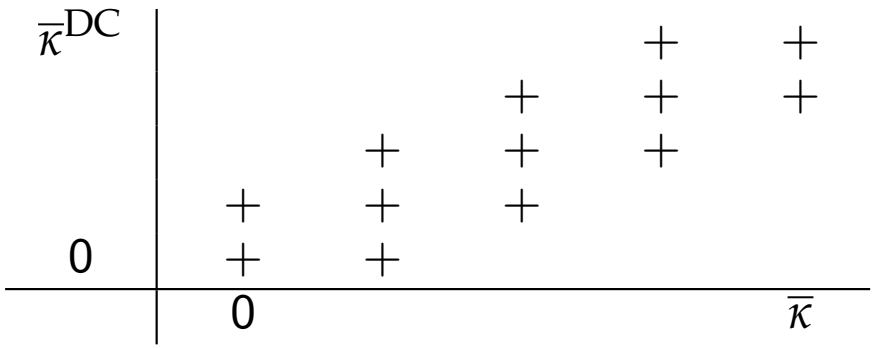
- Matching the opt-out and participation choices
  - Cap on opt-out cost ($\kappa^{DC}$) affects the opt-out decision
  - Cap on participation ($\kappa$) affects the participation decision
- To capture the joint distribution use the following cost structure:




- Diagonal **only** $\Rightarrow$ **strong** correlation in choices

# Endogenous parameters details III

- Matching the opt-out and participation choices
  - Cap on opt-out cost ($\kappa^{DC}$) affects the opt-out decision
  - Cap on participation ($\kappa$) affects the participation decision
- To capture the joint distribution use the following cost structure:




- Diagonal **plus one level** $\Rightarrow$ **milder** correlation in choices

# Endogenous parameters details IV

- Parameters used:
  - Diagonal distance $= 3$
  - Cap on opt-out cost ($\kappa^{DC} = 3,600$)
  - Cap on participation ($\kappa = 15,600$)

| Moment | Data | Model |
|---|---|---|
| Active (opt out) / non-participation | 0.15 | 0.16 |
| Active (opt out) / participation | 0.24 | 0.25 |
| Passive (default) / non-participation | 0.33 | 0.32 |
| Passive (default) / participation | 0.28 | 0.27 |

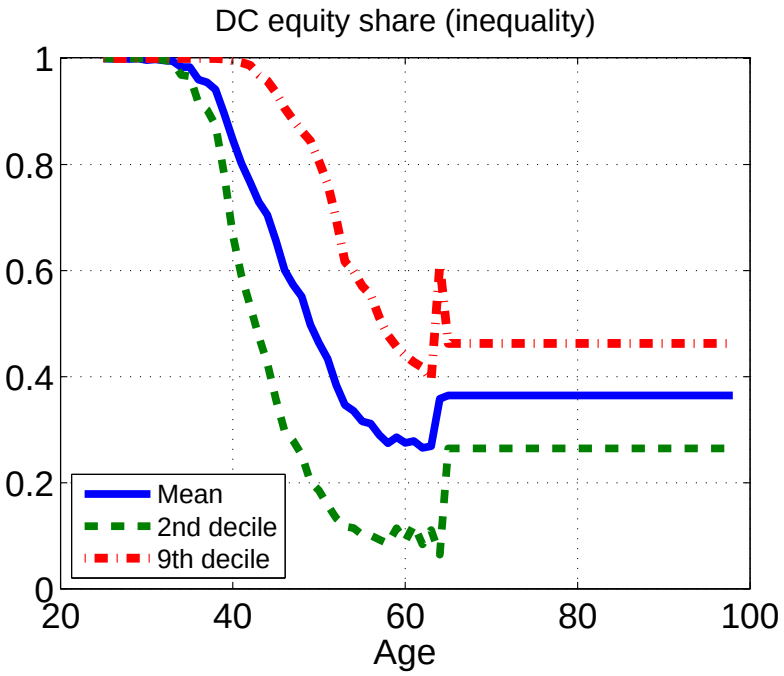
Back to endogenous parameters

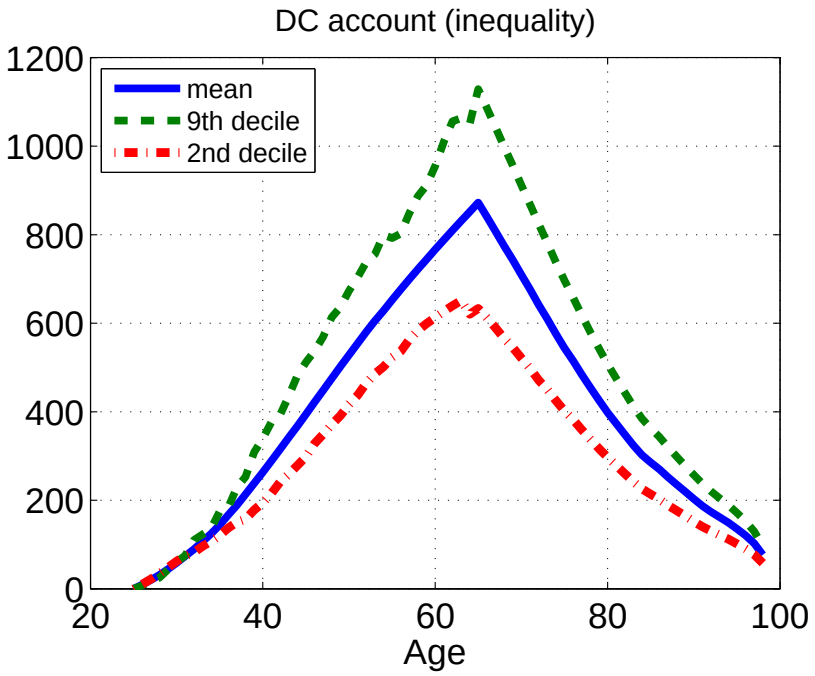
# Heterogeneity within passive investors

| Percentiles: | 10% | 25% | 50% | 75% | 90% | Mean |
|---|---|---|---|---|---|---|
| **All passive investors** | | | | | | |
| Age | 30 | 38 | 46 | 56 | 64 | 46.6 |
| Labor income | 0 | 99,911 | 225,373 | 303,797 | 401,252 | 224,526 |
| Financial wealth | 7,135 | 17,116 | 68,580 | 218,505 | 560,981 | 217,846 |
| Equity share | 0.000 | 0.000 | 0.000 | 0.401 | 0.634 | 0.196 |
| Age profile: | | | | | | |
| Age profile | 30 | 38 | 46 | 56 | 64 | Mean |
| Labor income | 201,696 | 244,114 | 276,989 | 261,305 | 163,009 | 224,526 |
| Financial wealth | 88,165 | 115,597 | 183,358 | 301,847 | 464,663 | 217,846 |
| Equity share | 0.086 | 0.144 | 0.176 | 0.202 | 0.249 | 0.196 |

▸ Back to heterogeneity within passive investors

# DC equity share versus DC account




- DC account levels that correspond to the equity share deciles
- DC account responds to labor income shock
- No reverse causality story here
- Compression of pension income

▸ Labor income

# Results: Who opts out?

Opt out is a response to a mix of factors; It

- decreases with the opt-out cost ($\kappa^{DC}$)
- increases with the participation cost ($\kappa$)
  - indicating substitution between the two accounts
- increases with the potential gain (in absence of the opt-out cost)
  - As in Carroll et al., (2009) for 401(k)

▸ Share of default investors ▸ DC equity share average

# Simulation method

- Two sources of risk:
  1. Idiosyncratic – uninsurable labor income shocks (inequality)
  2. Aggregate – shocks to stock market (equity risk)
- An economy: life-cycle path for one cohort with common equity returns
- Simulate many economies with different returns, each with many investors
- We study the life-cycle profile of the optimal DC equity share:
  1. Inequality: taking the average DC equity share of each individual over economies and sort *individuals*
  2. Equity risk: taking the average DC equity share of each economy over individuals and sort *economies*

Back to results

# Default portfolio

TABLE: Comparison of the Default Fund and the Mean Actively Chosen Portfolio

| Portfolio characteristic | Default | Mean actively chosen portfolio |
|---|---|---|
| Asset allocation | | |
| Equities | 82 | 96.2 |
| Sweden | 17 | 48.2 |
| Americas | 35 | 23.1 |
| Europe | 20 | 18.2 |
| Asia | 10 | 6.7 |
| Fixed-income securities | 10 | 3.8 |
| Hedge funds | 4 | 0 |
| Private equity | 4 | 0 |
| Indexed | 60 | 4.1 |
| Fee | 0.17 | 0.77 |
| Beta | 0.98 | 1.01 |
| *Ex post* performance | 29.9 | 39.6 |

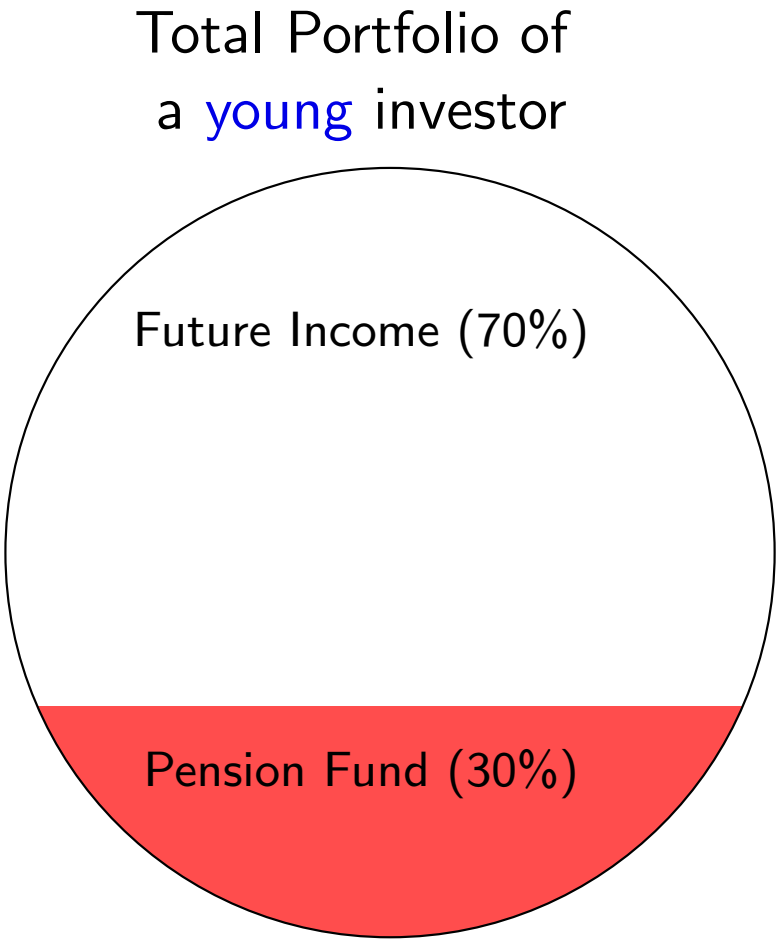
Source: Cronqvist and Thaler (2004)

Back to Sweden pension plan

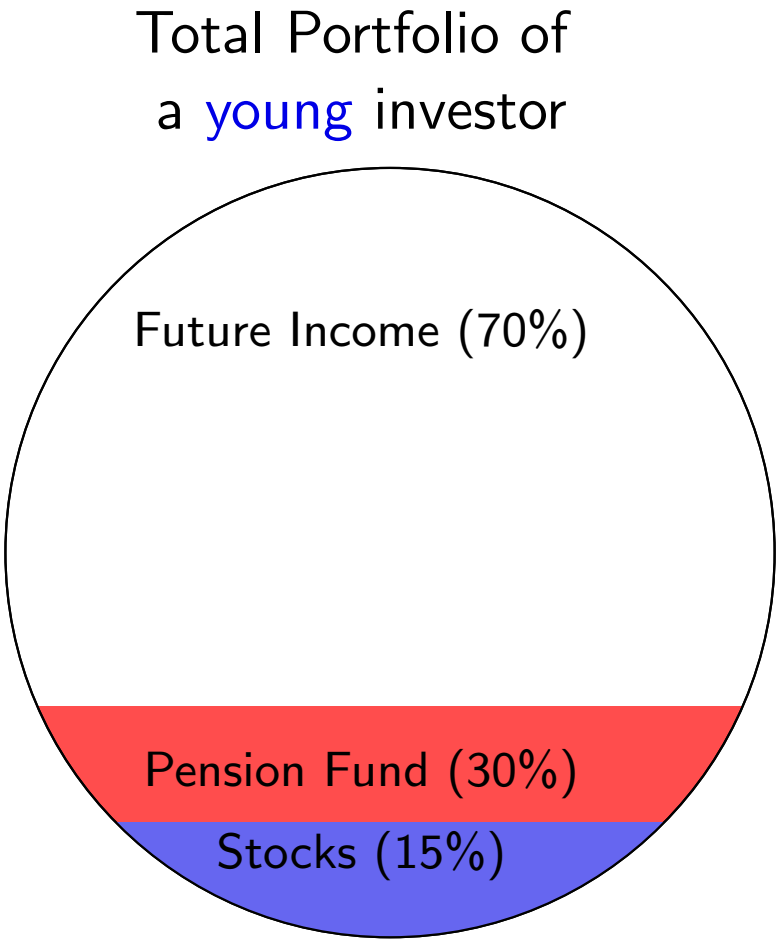
# Portfolio decisions - the role of age

Total Portfolio of
a young investor

# Portfolio decisions - the role of age

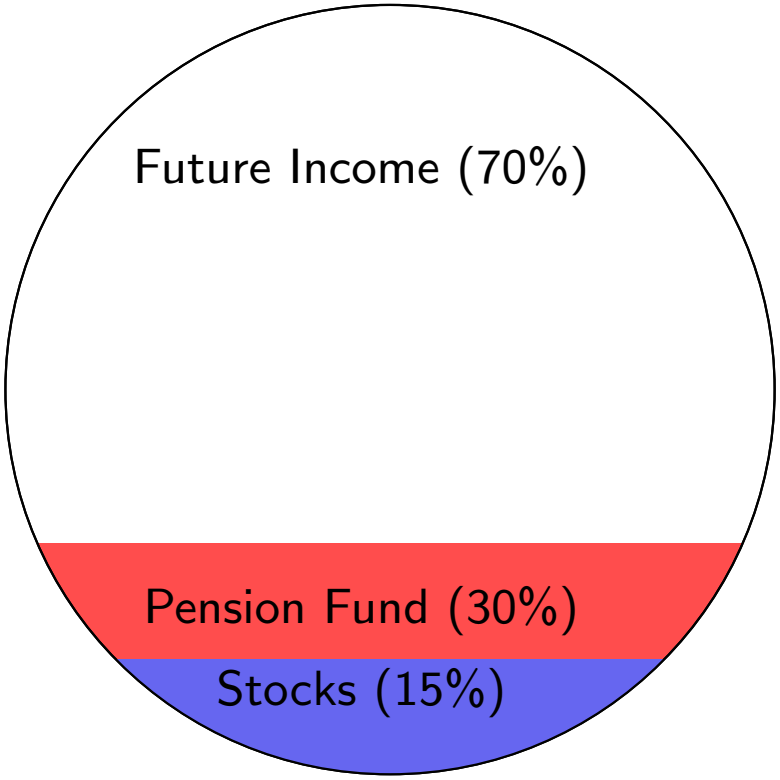


# Portfolio decisions - the role of age



# Portfolio decisions - the role of age

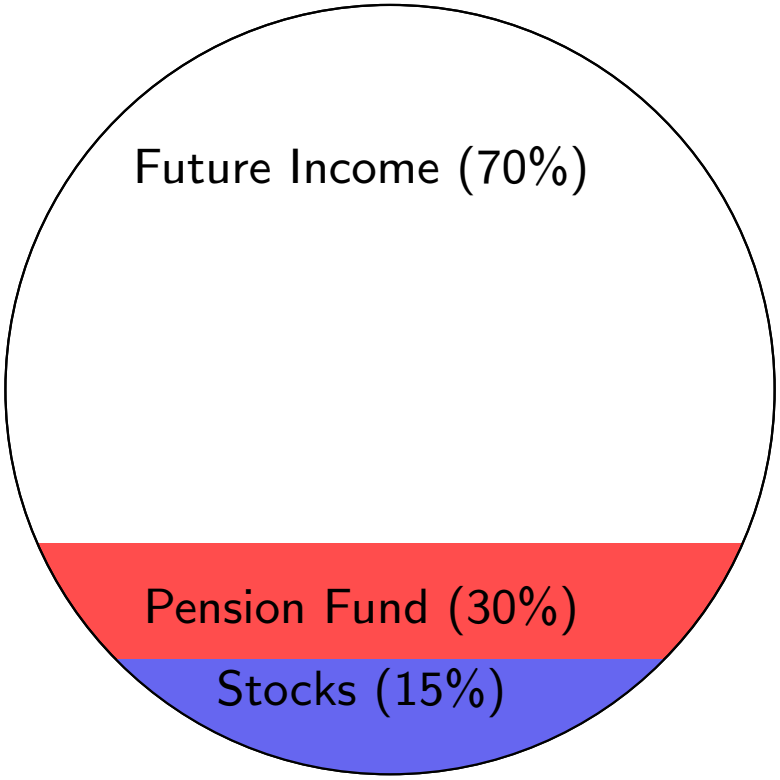
Total Portfolio of
a young investor




Equity share $= \frac{15\%}{30\%} = 0.5$

# Portfolio decisions - the role of age

Total Portfolio of
a young investor

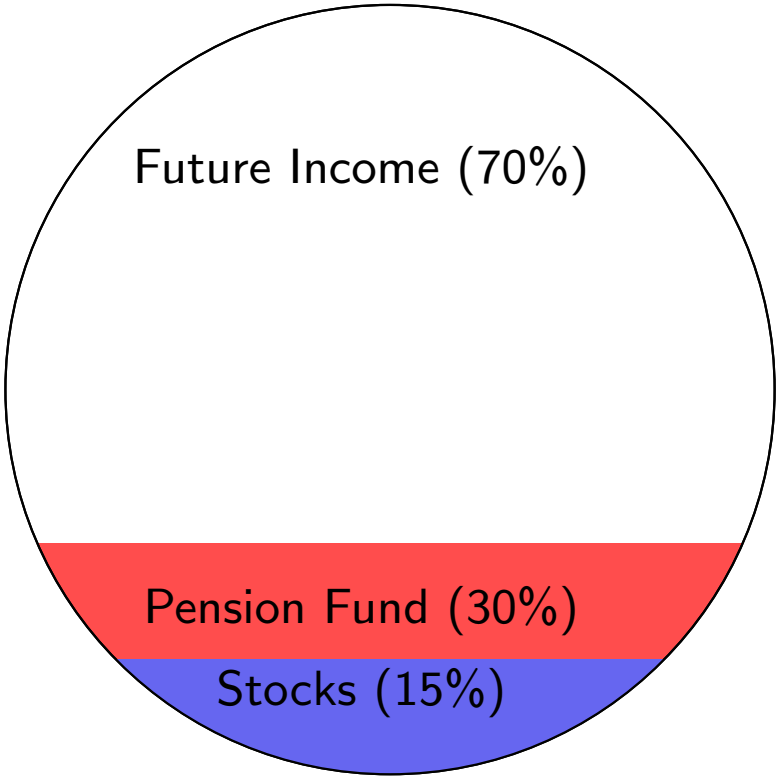



Equity share $= \frac{15\%}{30\%} = 0.5$

Total Portfolio of
an older investor

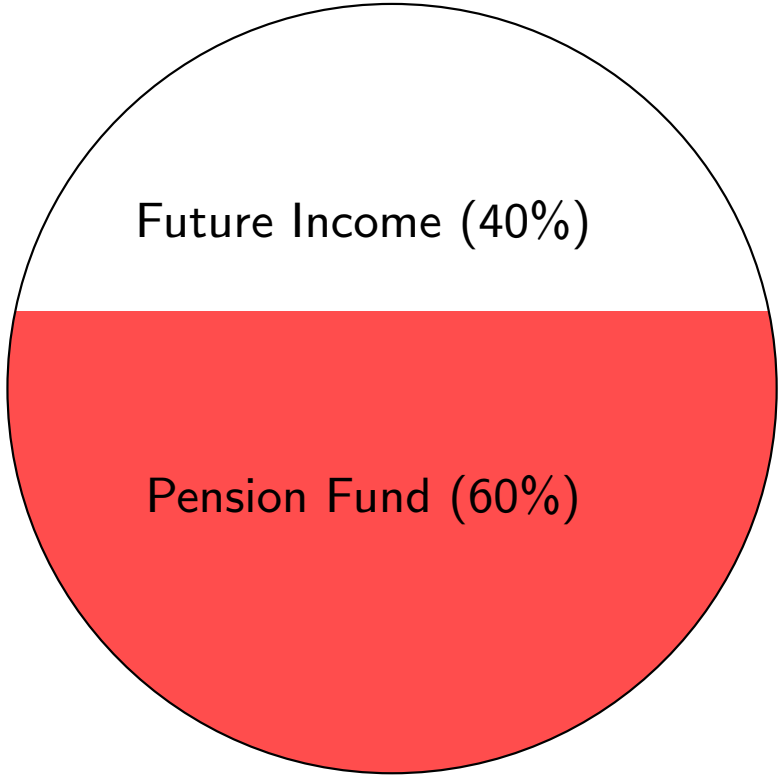
# Portfolio decisions - the role of age

Total Portfolio of
a young investor



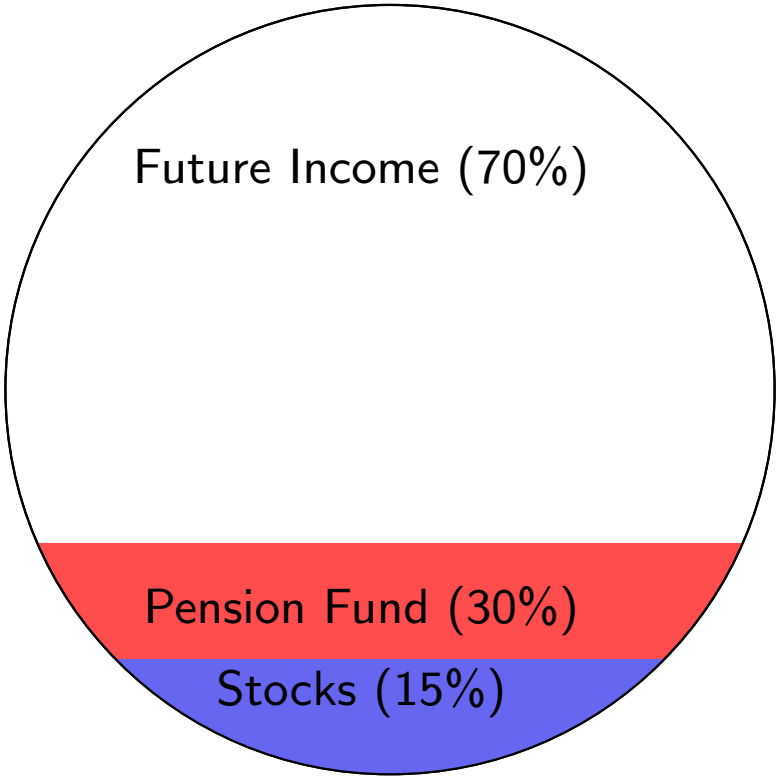

Equity share $= \frac{15\%}{30\%} = 0.5$

Total Portfolio of
an older investor



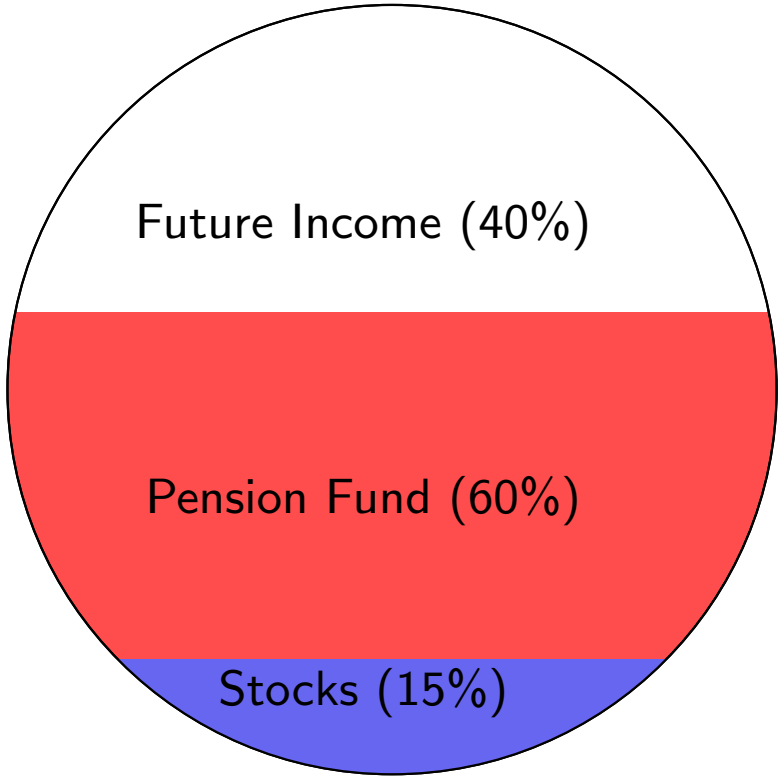
# Portfolio decisions - the role of age

Total Portfolio of
a young investor



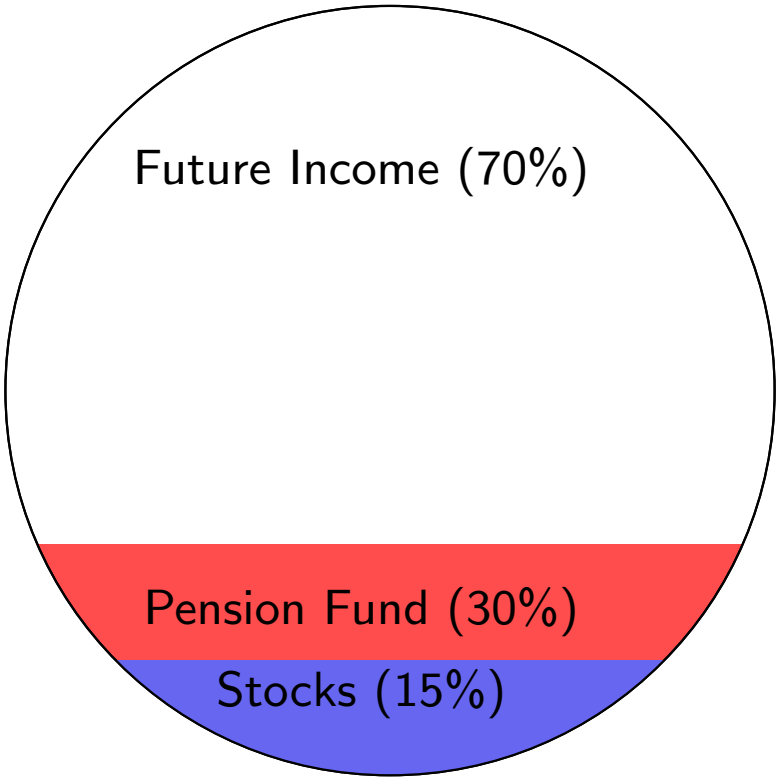

Equity share $= \frac{15\%}{30\%} = 0.5$

Total Portfolio of
an older investor



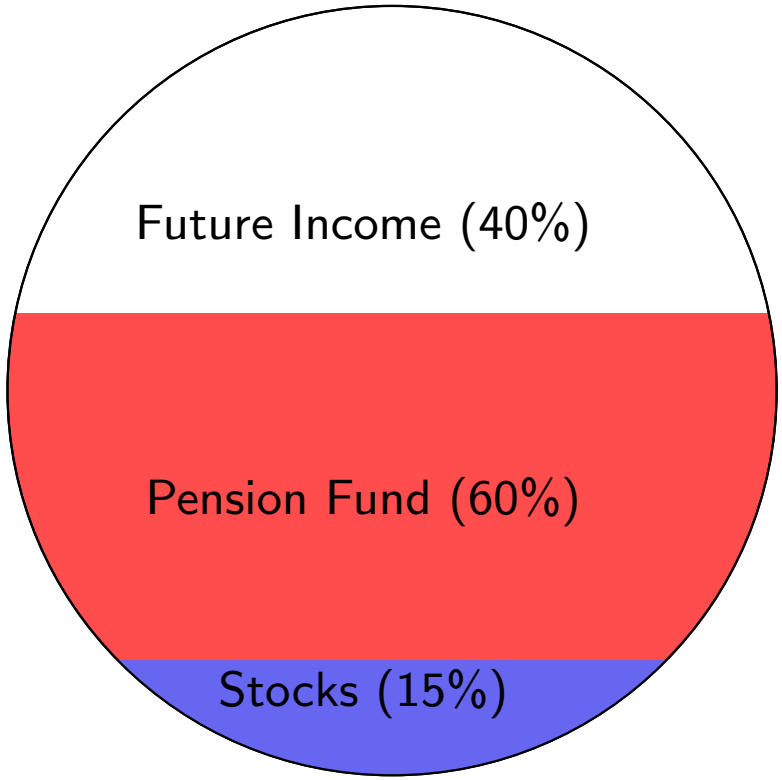
# Portfolio decisions - the role of age

Total Portfolio of a young investor




Equity share $= \frac{15\%}{30\%} = 0.5$

Total Portfolio of an older investor




Equity share $= \frac{15\%}{60\%} = 0.25$

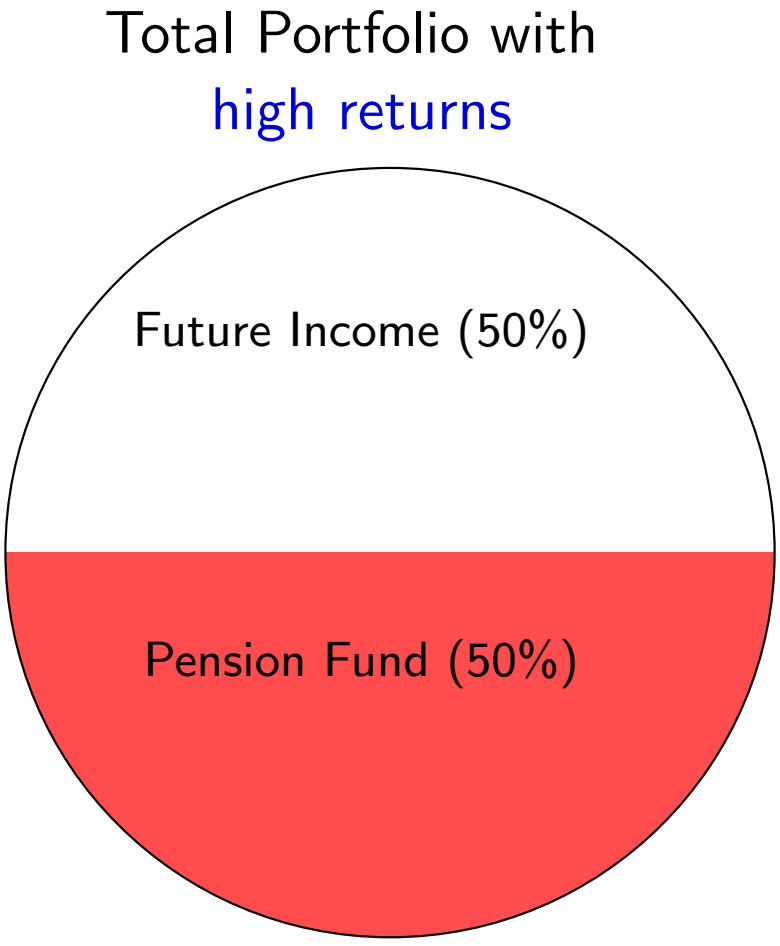
▸ Back to literature ▸ Back to DC equity share average

# Portfolio decisions - the role of equity risk

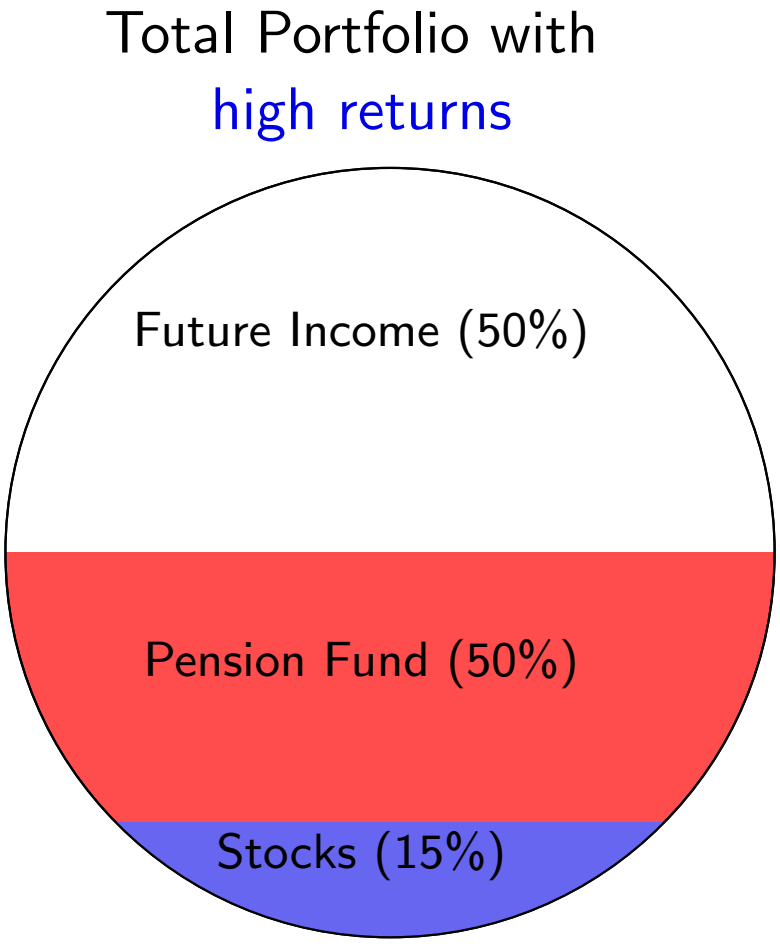
Total Portfolio with

high returns

# Portfolio decisions - the role of equity risk

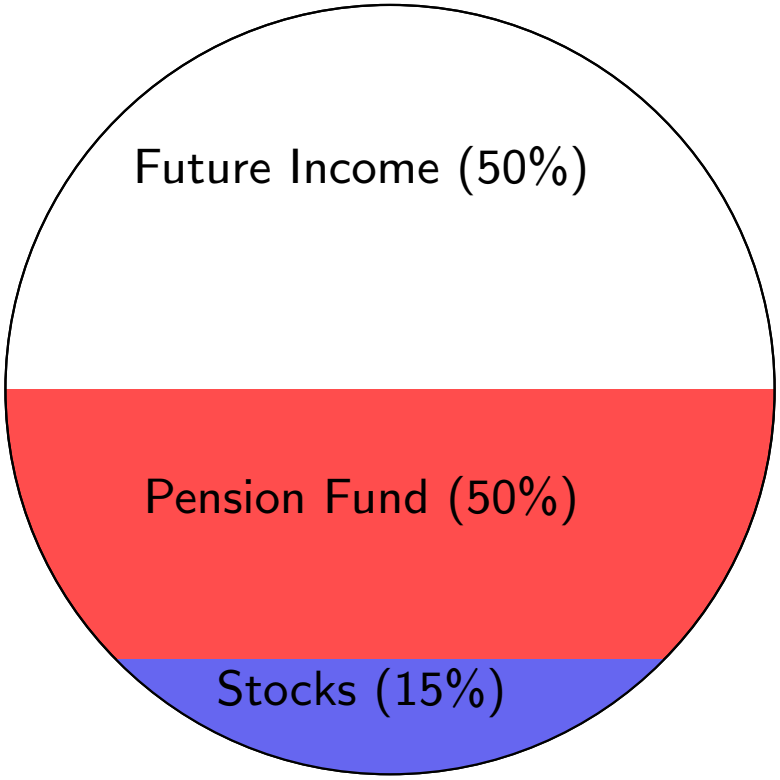


# Portfolio decisions - the role of equity risk



# Portfolio decisions - the role of equity risk

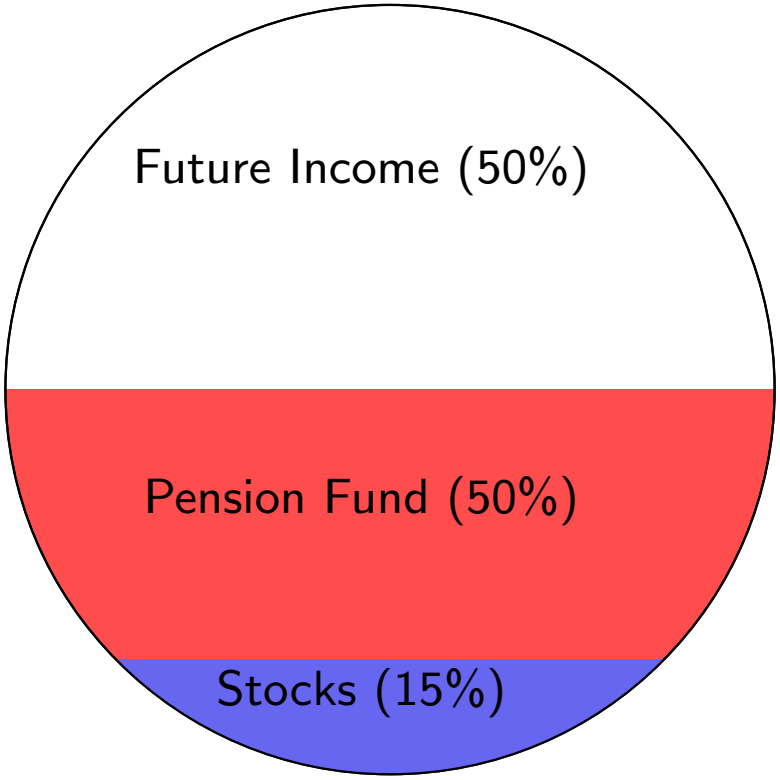
Total Portfolio with
high returns




Equity share $= \frac{15\%}{50\%} = 0.3$

# Portfolio decisions - the role of equity risk

Total Portfolio with
high returns

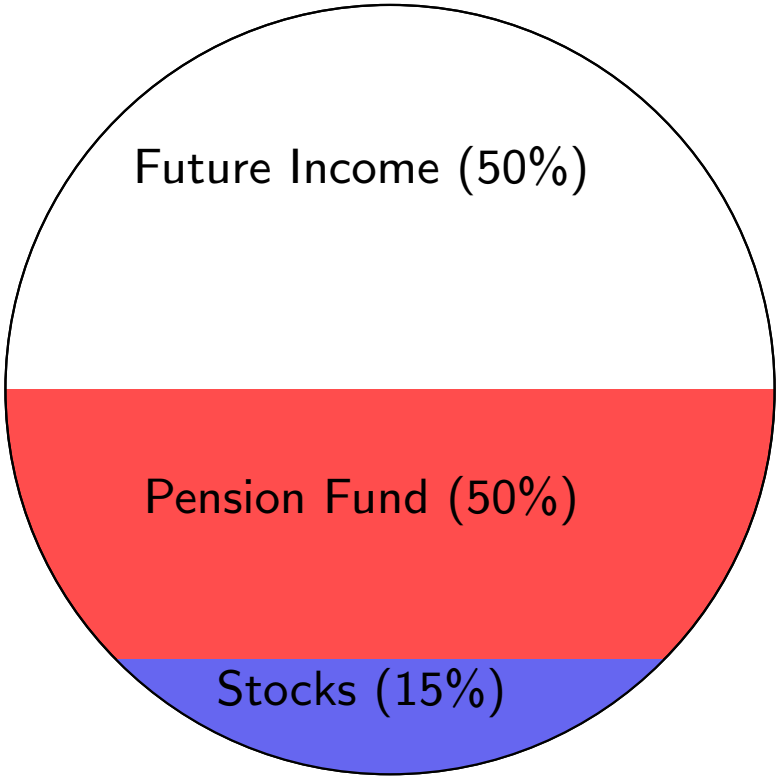



Equity share $= \frac{15\%}{50\%} = 0.3$

Total Portfolio with
low returns

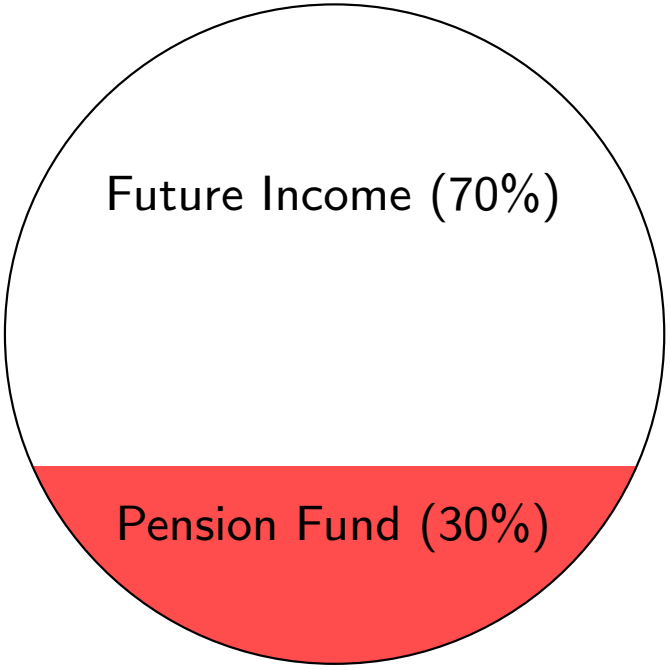
# Portfolio decisions - the role of equity risk

Total Portfolio with
high returns



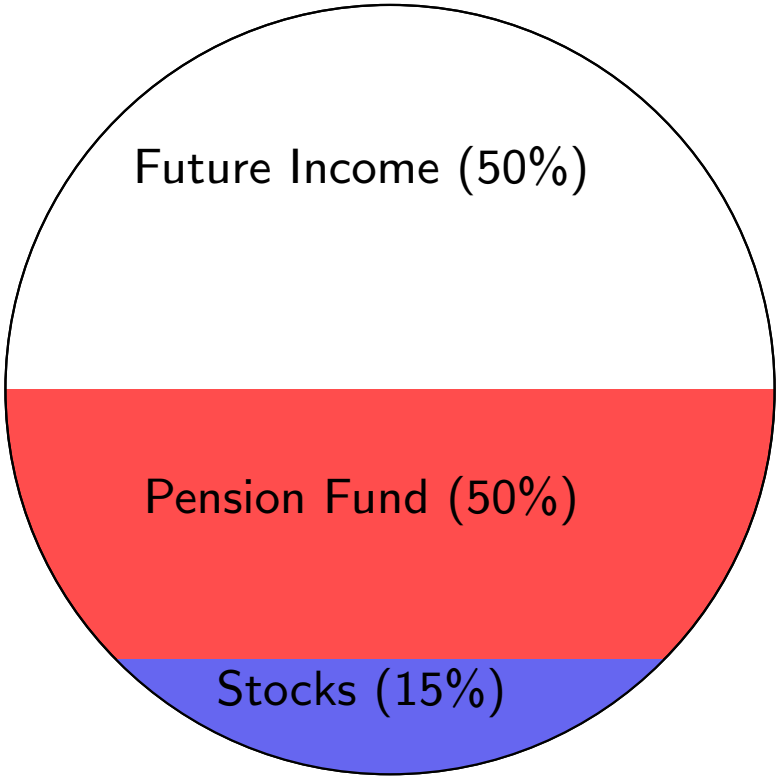

Equity share $= \frac{15\%}{50\%} = 0.3$

Total Portfolio with
low returns



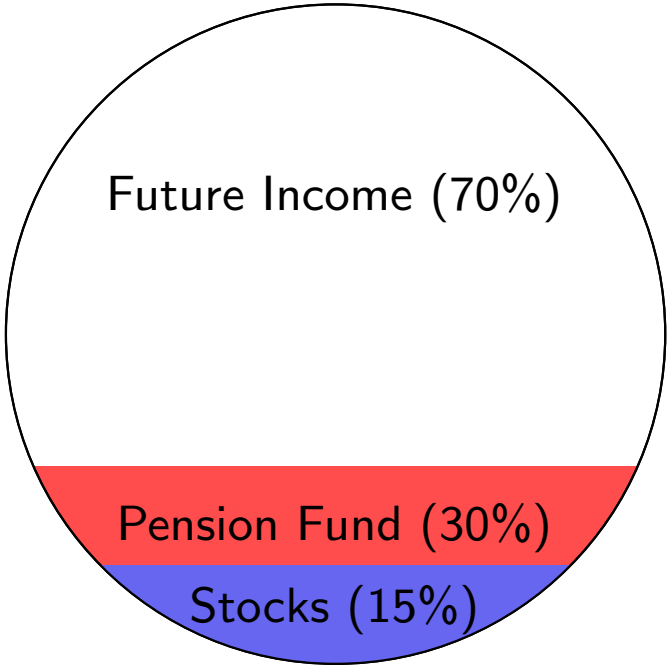
# Portfolio decisions - the role of equity risk

Total Portfolio with
high returns



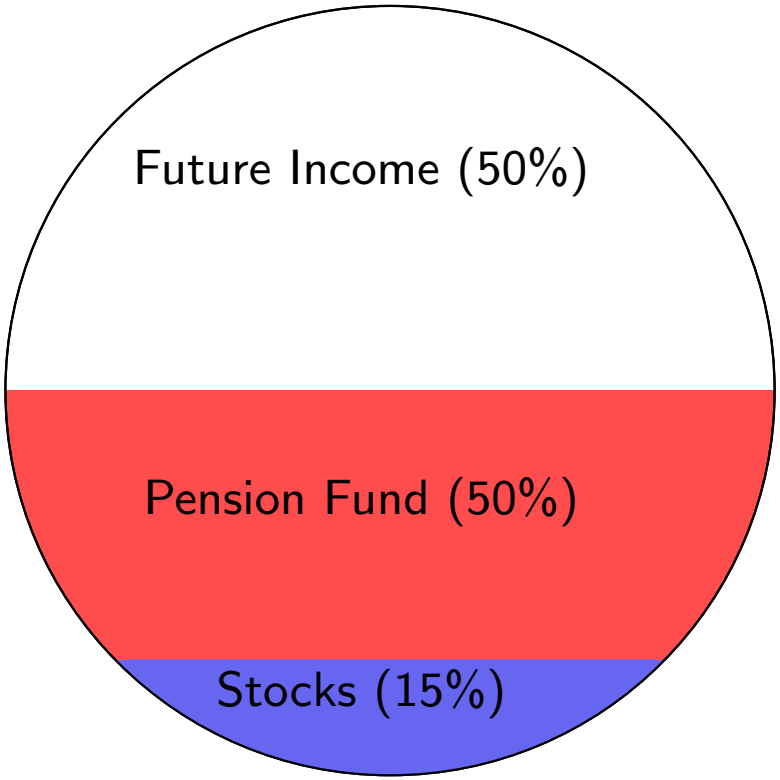

Equity share $= \frac{15\%}{50\%} = 0.3$

Total Portfolio with
low returns



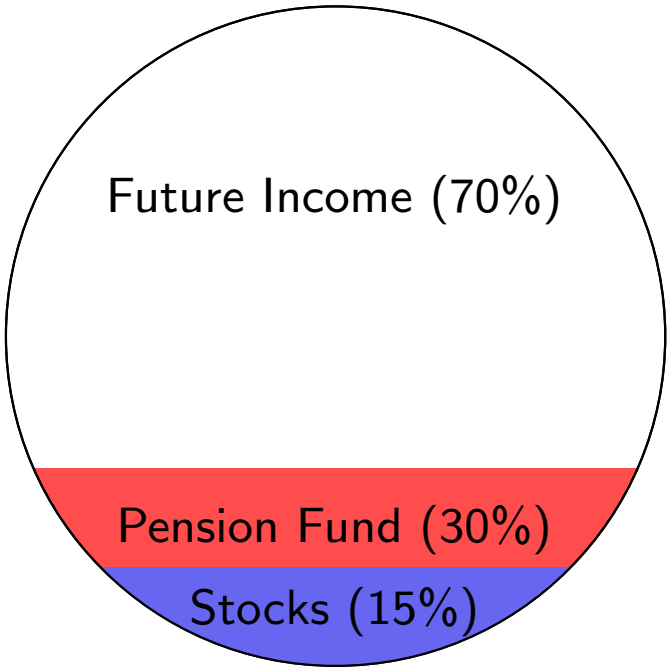
# Portfolio decisions - the role of equity risk

Total Portfolio with
high returns




Equity share $= \frac{15\%}{50\%} = 0.3$

Total Portfolio with
low returns




Equity share $= \frac{15\%}{30\%} = 0.5$

▸ back to DC equity share versus balance equity risk

# Model overview

- A life-cycle model with incomplete markets
  - Epstein-Zin preferences

# Model overview

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  - Working life (25-64) with survival rates
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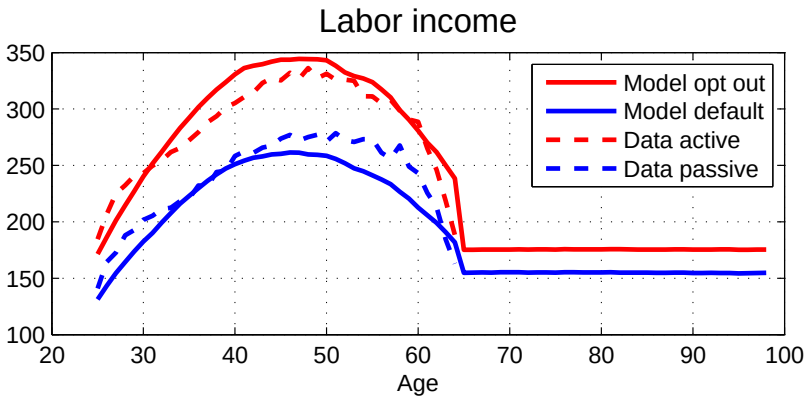
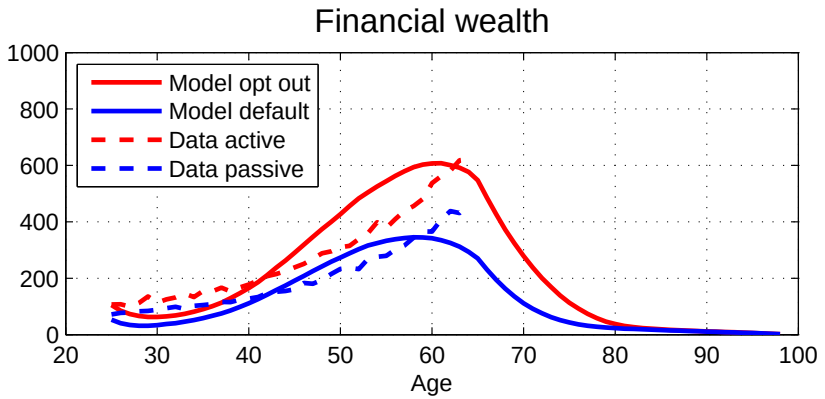
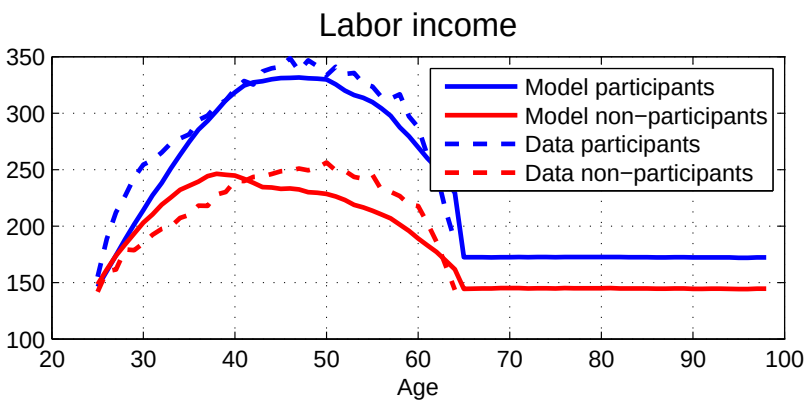
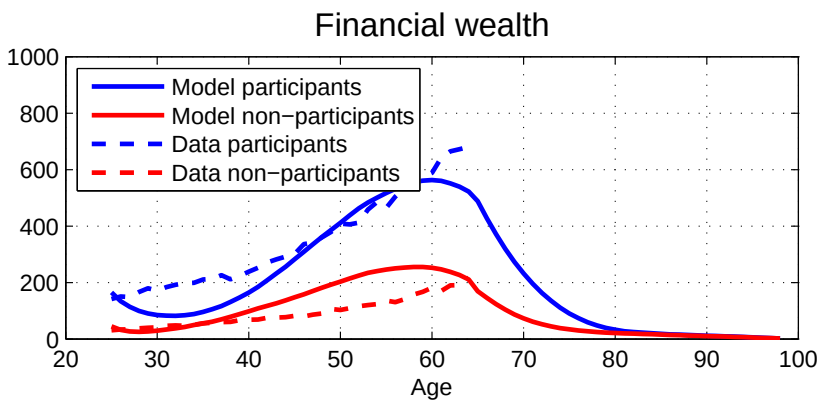
    - Receive annuities from two mandatory savings accounts
- Assets can be allocated into either:
  - Risk-free bond with gross return $R_f$
  - Stock market equity with $\log(R_{t+1}) = \log(R_f) + \underbrace{\mu}_{\text{Equity premium}} + \underbrace{\varepsilon_{t+1}}_{\text{Equity risk}}$

# Model fit - by types




▸ Alternative model specification ▸ Back to model fit I