The effect of individual life cycle strategy on the investment strategy of pension fund

Chengyuan Lu
(SNR:2008373)

Supervisor: Bertrand Melenberg
(Tilburg University)
Damiaan Chen
(DNB)

Research Question

Are the collective investments similar to the aggregate of optimal individual investment?

→ What explains the difference? (e.g. DB or DC type, borrowing constraints, mortality, contribution rate, demography, etc.)

Background

In 2010, the Dutch government concluded that the long-run financial sustainability of the Dutch occupational funded pensions was under threat.

- Changing from DB to DC pension fund:
  The US, the UK, and Switzerland are examples of countries that have partly switched from DB arrangements to DC arrangements.

- Changing from uniform to personal pension fund system
  In 2017, the Dutch government claimed to reform the pension system into a more personal pension system with collective risk sharing (regeerakkoord: persoonlijke pensioen potten).

Summary

- Individual life cycle model,
  - DC life cycle model
  - Micro-longevity risk factor.
- Pension fund model.
  - The allocation rate of pension fund
  - Demography factor
- Empirical Results

The benchmark life cycle model

- Merton's life cycle Model:

  To optimize the utility over life cycle:

$$\max_{C_s, f_s} E\left(\int_0^D e^{-\rho s} u(C_s) ds\right)$$

- Model ingredients:
  - Consumption (C)
  - Allocation rate (f)
  - Financial wealth (F)
  - Human capital (H)

Optimal variables according to Merton

- Model ingredients:
- Consumption (C)
- Financial wealth (F)
- Human capital (H)

Optimal consumption:

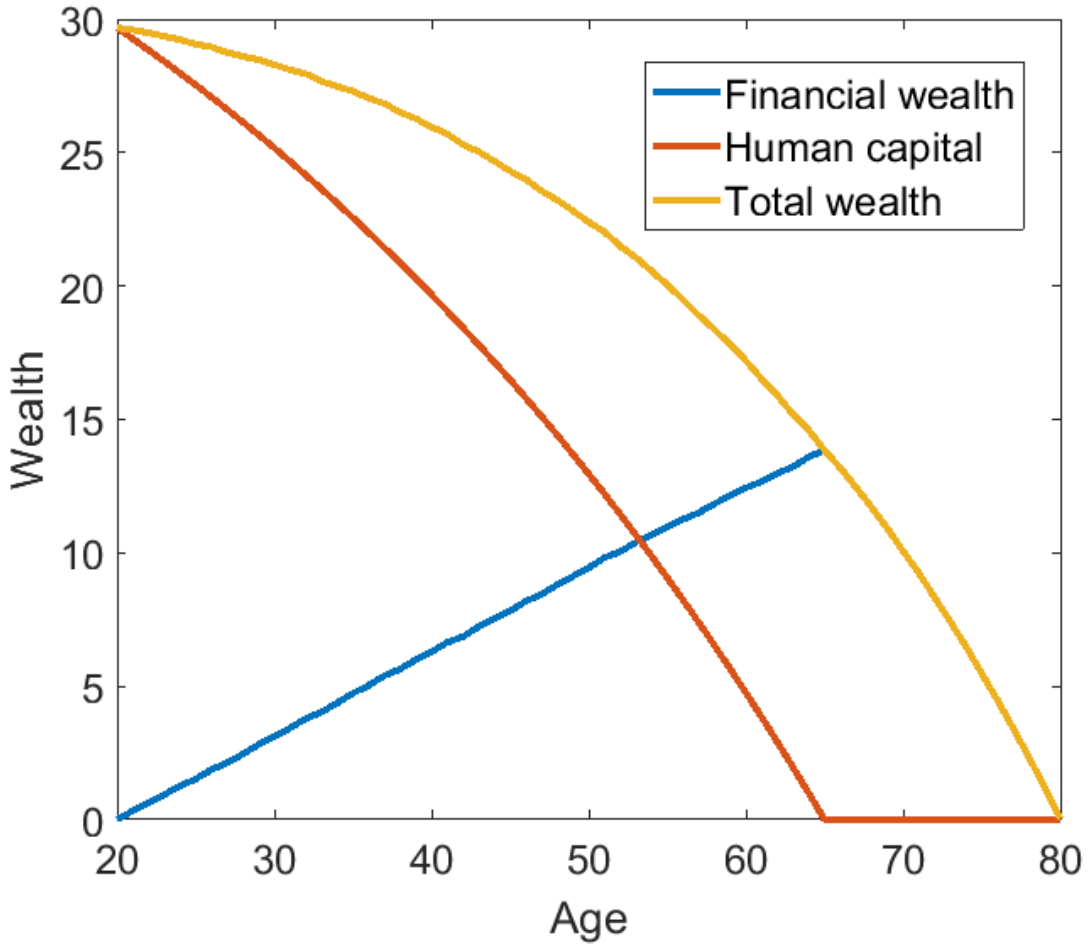
$$C_t = (F_t + H_t)g(D-t)^{-1}$$

$$g(D-t) = \frac{1}{A}(1 - e^{-A(D-t)})$$

Optimal investment strategy:

$$f_t^* = \frac{1}{\theta^i}\frac{\lambda}{\sigma}(1 + \frac{H_t}{F_t})$$

The benchmark life cycle model



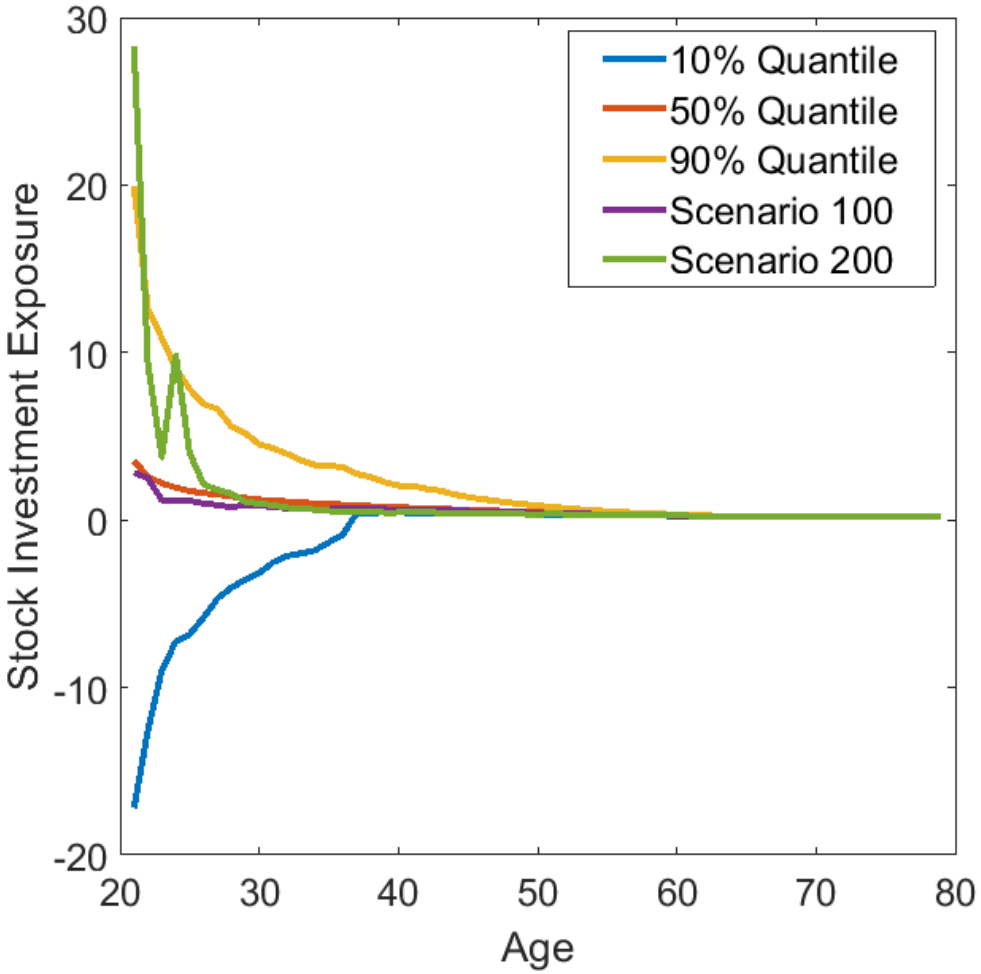
Financial wealth, human capital and total wealth over life cycle.

Individuals retire at 65 years old.

Before 65, working period, decreasing human capital and increasing financial wealth.

After 65, retirement period, no human capital, decreasing financial wealth.

The benchmark life cycle model



The optimal investment strategy is described by the allocation rate. The percentage of financial wealth invested in risky asset.

The allocation rate is decreasing over life cycle. It is constant during the retirement period.

The DC life cycle model

- DC Model:

Fixed contribution rate during the working period, hence fixed consumption. Use *m* to denote the contribution rate.

- Solution:

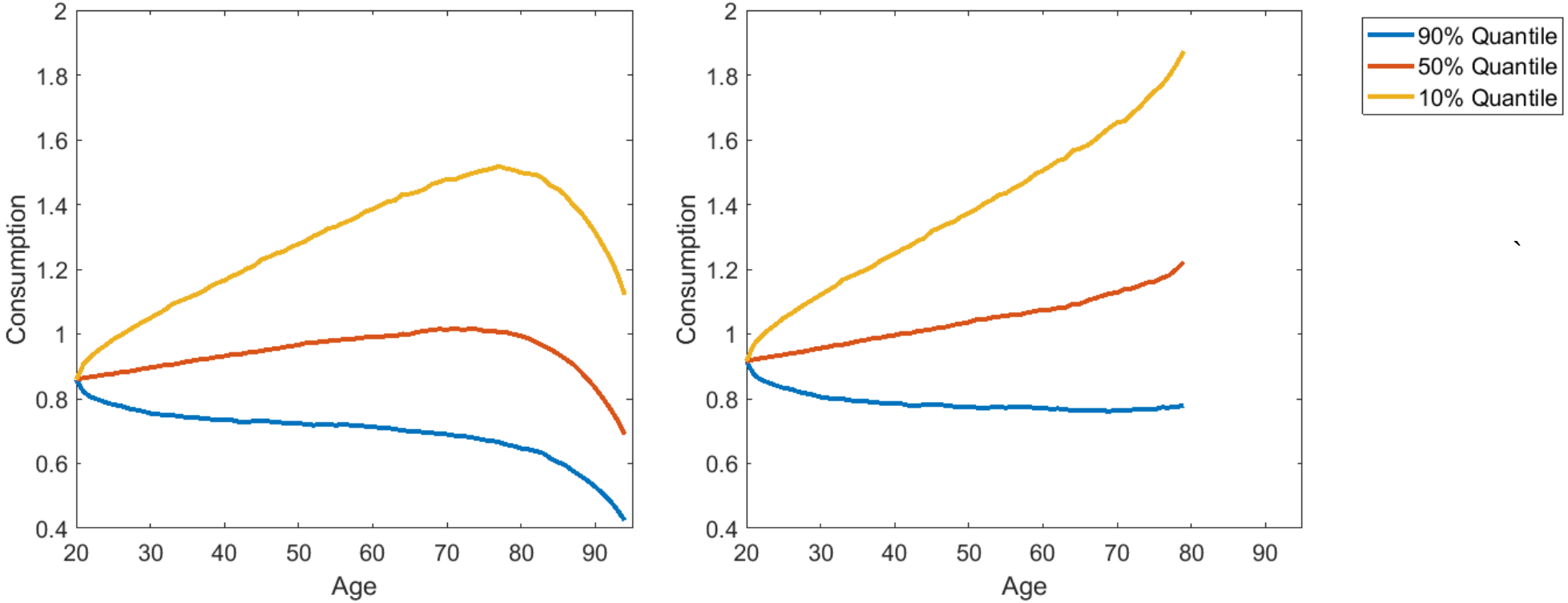
Optimal investment strategy: $$f_t^* = \frac{1}{\theta^i}\frac{\lambda}{\sigma}\left(\frac{F_t + H_t'}{F_t}\right)$$

$$H_t' = \frac{m}{r}\left(1 - e^{-r(T-t)}\right)$$

Micro-Longevity risk considered

The optimal consumption over life cycle

- On the right is the benchmark model without considering the longevity risk;
- On the left is the model with longevity risk considered.



Micro-Longevity risk considered

- If we do not consider longevity risk, the consumption go up over life cycle
- When we consider about longevity risk, the consumption drops when the individual is very old.

The allocation rate is generally not affected

Pension contract

Pension fund is defined by the pension contract

Y(t) be salary, C(t) be the theoretical consuption, f(t) be the theoretical allocation rate.

General contract (Benchmark life cycle model)

- Contribution during the working period: contribute Y(t)-C(t) annually
- Receive pension during the retirement period: receive C(t) anually.
- The investment is defined by the allocation rate f(t)

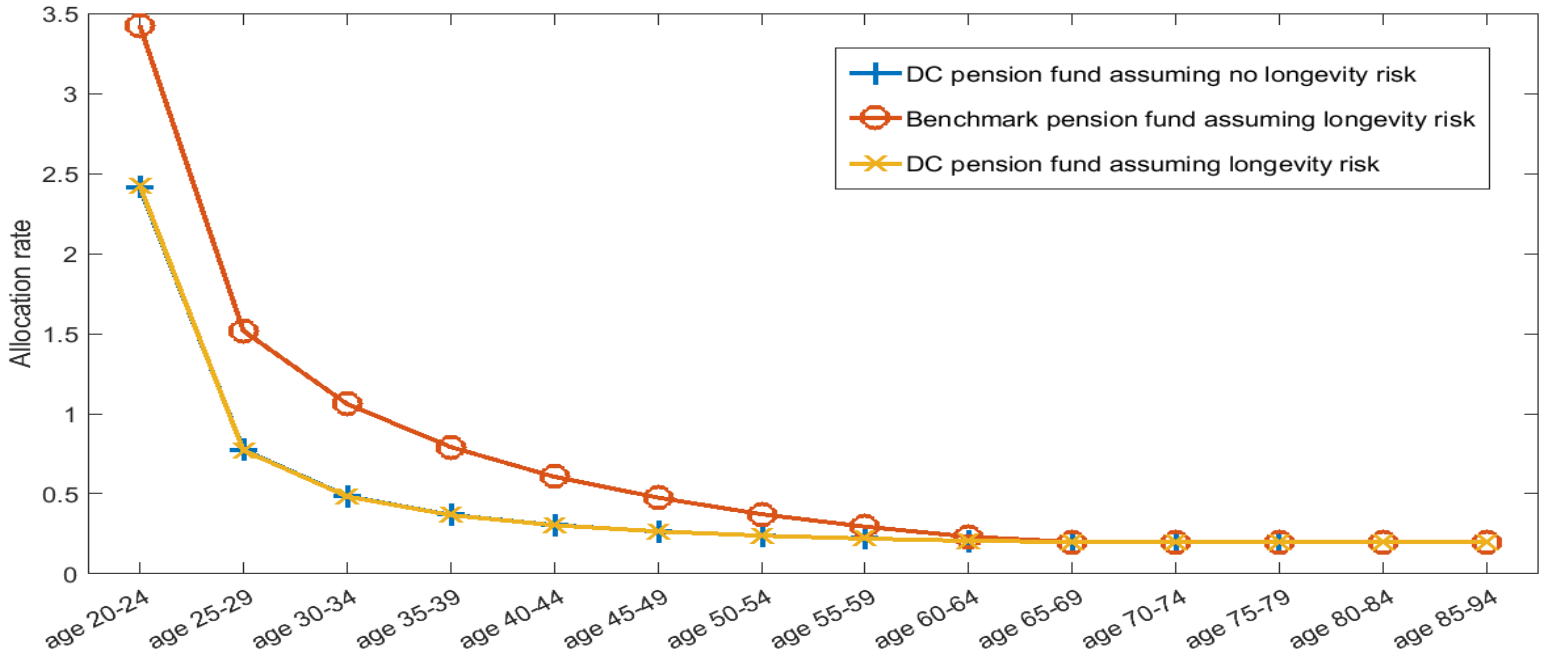
Allocation rates of generations

- Allocation rates of generations

The graph describes the allocation rate of each generation

The red line assumes benchmark life cycle model

The yellow line assumes DC life cycle model



Allocation rate of Pension fund

- Allocation rate of pension fund:

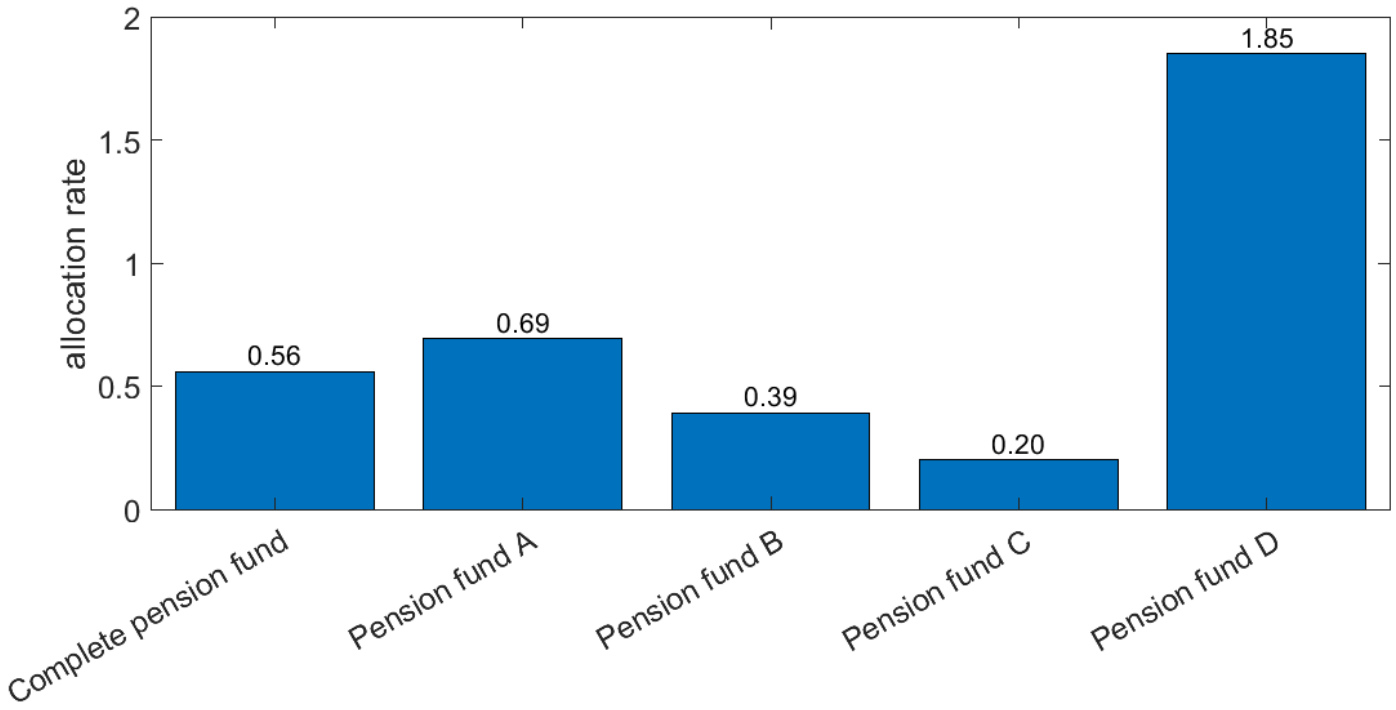
$$Pf_t^* = \sum_j \frac{F_{t,j}}{PF_t} f_{t,j}^*$$

- The allocation rate of pension fund is the weighted sum of the allocation rates of the generations. The weight of a generation is the ratio of the financial wealth of that generation to the total financial wealth of the pension fund.

- The generation which owns a larger part of the financial wealth will have a larger influence on the allocation rate of the pension fund.

Demography effects

- **A** Pension funds lacking old participants
- **B** Pension funds lacking young participants
- **C** Pension funds consisting of only old participants
- **D** Pension funds consisting of only young participants



Demography effects

- Different demographies give different allocation rates of the pension fund.

- the more young participants, the higher allocation rate of the pension fund, and vice versa.

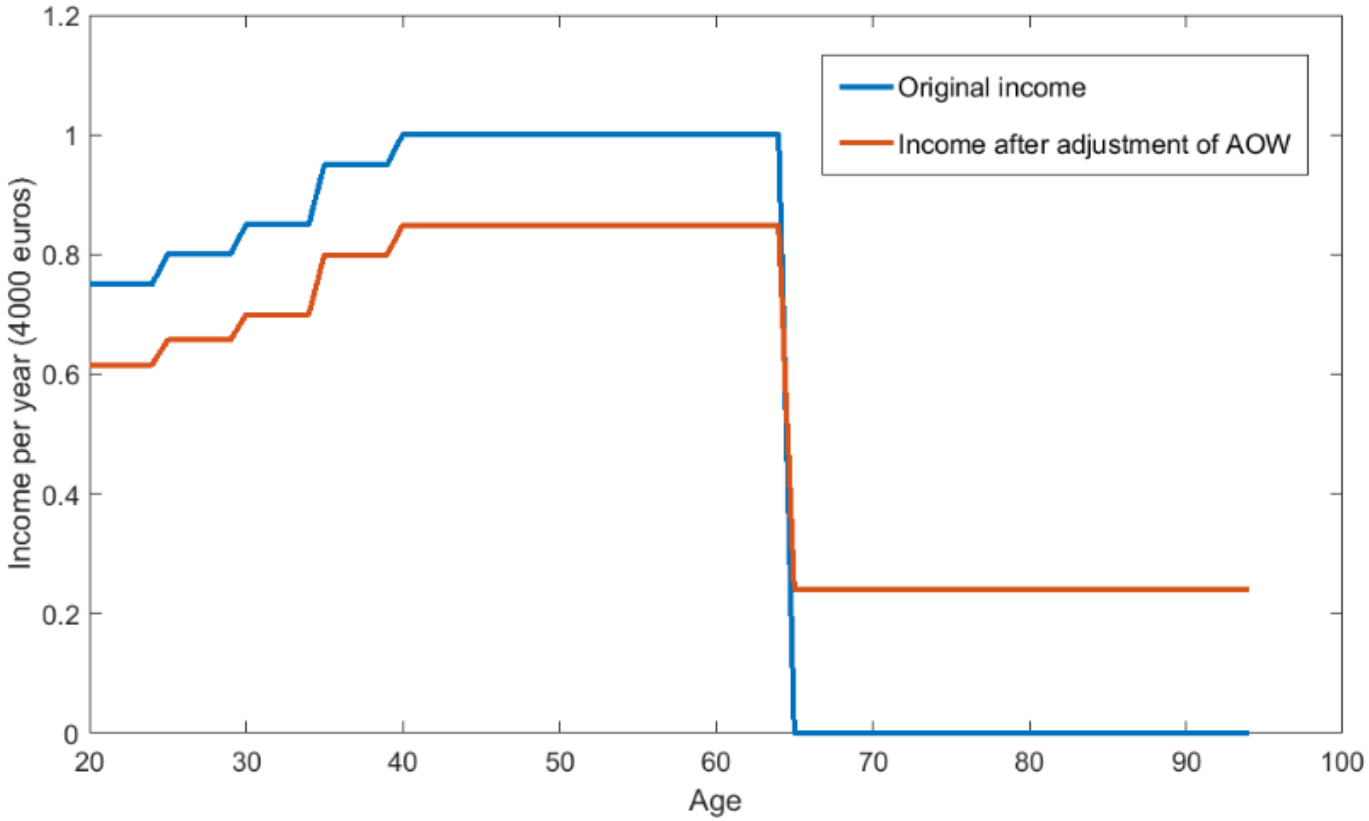
First pillar: AOW

- Contribution:

During the working period, the participant contributes an amount of 17.9% × min(Yt, 33715) euros.

- Benefit:

During the retirement period, the participant receives an amount of 960 euros.



Second pillar DC contract

Second pillar DC contract:

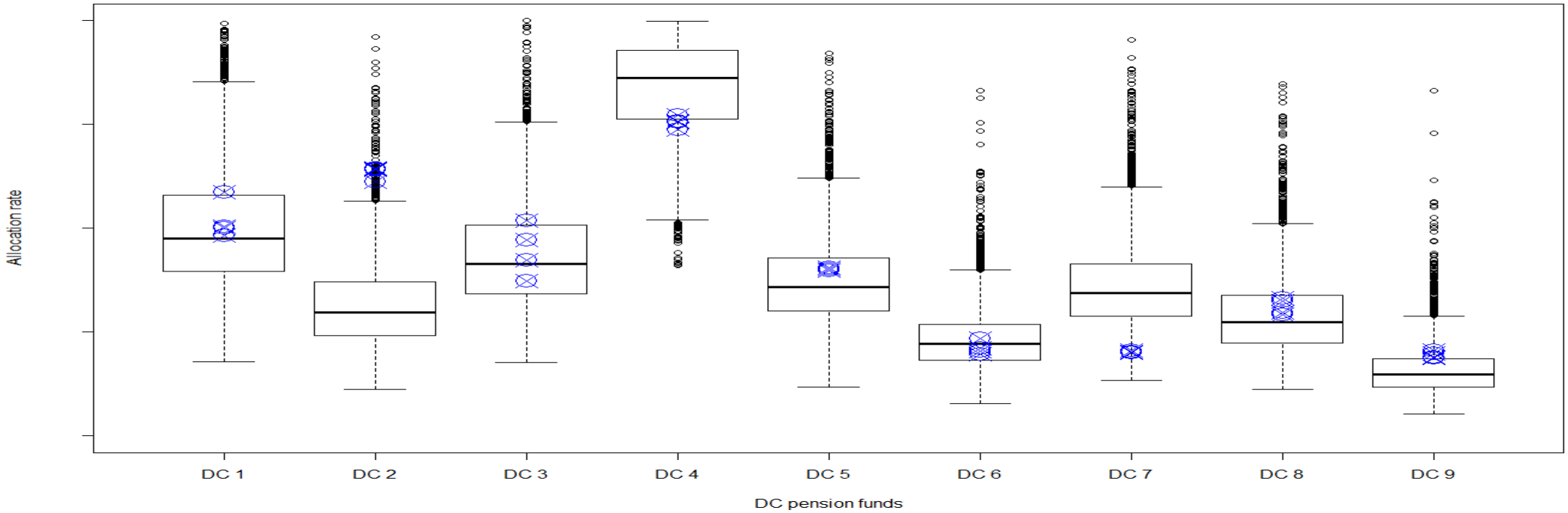
Contribute m*(Salary adjusted by AOW – Franchaise) during working period.

Receive C(t) during the retirement period.

Investement strategy following f(t).

Allocation rate of the pension fund (model versus empirics)

- The box plots show the median, the 25% and 75% quantile by the box. The blue crosses in circle are the real allocation rate quarterly reported from the 4th quarter of 2016 to the 3rd quarter of 2017.



Conclusions

- There is one outlier (fund 2): real-life data does not fit the model

- Fro the other pension funds: results roughly match the real allocation rates.

→ Except for fund 2, the mean of the bias = −0.002 and the standard error of the bias = 0.064

- Fund 4 and 7 are exceptional DC pension funds: their real allocation rates which are much lower than the median one can be explained by their specific type of participants / industry.

→ Due to confidentiality, no further details in this presentation

Future Research

- What about DB Pension funds?

  DB pension funds have a much higher allocation rates compared to that predicted by the DC model.
  → results will be presented in next version

- Which factors can explain the difference?

  DB versus DC
  Premium of fund ratio
  Pension right per participant

- **Policy question**: how much do the portfolios need to change in case of a transition from collective DB to individual DC?

Thank you!

Questions?

Micro-Longevity risk considered

- Precommitment case:

  To solve the optimization problem:

$$J' = \max E_t\left(\int_t^{D^{\max}} e^{-\rho^i (s-t)} \frac{C_s'^{1-\theta^i}}{1-\theta^i} \mathbb{1}_{s \le D} ds\right)$$

- Solution:

  Optimal consumption:

$$C_t'^{*} = p^{\frac{1}{\theta^i}} \frac{(F_t + H_t)}{g(t)} \qquad g(t) = \int_t^{D^{\max}} e^{-A(s-t)} p(s)^{\frac{1}{\theta^i}} ds$$

  Optimal investment strategy:

$$f_t^* = \frac{1}{\theta^i} \frac{\lambda}{\sigma} \frac{(F_t + H_t)}{F_t}$$