| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing | Estimation | Conclusion |
|------------|----------------------|-------------|--------------------|------------|------------|
|            |                      |             |                    |            |            |
|            |                      |             |                    |            |            |

Longevity risk sharing in collective pension schemes

Current practice and proposals for alternatives

# Michel Vellekoop (University of Amsterdam)

based on work with: Anja De Waegenaere (Tilburg University) Pascal Janssen (PGGM) Agnes Joseph (Achmea)



## IPAR Developments in Pensions Conference, OECD, Paris

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| Motivation | viacro iongevity Risk | 000 | OOOOOO | Estimation | Conclusions |
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| Motivatio  | n                     |     |        |            |             |

- Ongoing debate about pension reform in the Netherlands.
- Proposals to introduce individual accounts for accrued pension capital, possibly in combination with collective buffer.

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| Motivation | viacro iongevity Risk | 000 | OOOOOO | Estimation | Conclusions |
|------------|-----------------------|-----|--------|------------|-------------|
| Motivatio  | n                     |     |        |            |             |

- Ongoing debate about pension reform in the Netherlands.
- Proposals to introduce individual accounts for accrued pension capital, possibly in combination with collective buffer.
- Question:

What is exposure to systematic longevity risk for different ages?

| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|-------------|--------------------|------------|-------------|
| Motivat    | ion                  |             |                    |            |             |

- Ongoing debate about pension reform in the Netherlands.
- Proposals to introduce individual accounts for accrued pension capital, possibly in combination with collective buffer.
- Question:

What is exposure to systematic longevity risk for different ages?

• Question:

How can systematic longevity risk be shared between different age groups?

Image: A math a math

| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|-------------|--------------------|------------|-------------|
| Systema    | tic Risk             |             |                    |            |             |

#### Macro Longevity Risk

- Risk that future survival probabilities will be higher/lower than expected.
- Risk which does not diversify: sharing with others in same age group does not mitigate this risk.

| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|-------------|--------------------|------------|-------------|
| Systema    | tic Risk             |             |                    |            |             |

#### Macro Longevity Risk

- Risk that future survival probabilities will be higher/lower than expected.
- Risk which does not diversify: sharing with others in same age group does not mitigate this risk.
- Historical data suggests it is small for highest ages.

| Motivation | Macro longevity Risk | Assumptions<br>•00 | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|--------------------|--------------------|------------|-------------|
| Assumpti   | ons                  |                    |                    |            |             |

Participants have individual pension wealth which translates into aggregated pension benefit claim per cohort.

Without risk sharing:

- at beginning of the year, individual capital determines individual annuity benefit; benefits are paid out to pensioners and all remaining capital is invested in riskless assets;
- at end of the year, capital of deceased is redistributed within age group.

If number of survivors equals (exactly) what was expected, and prognosis of future survival probabilities does not change, size of pension income remains constant.

| Motivation | Macro longevity Risk | Assumptions<br>OOO | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|--------------------|--------------------|------------|-------------|
| Assumpt    | ions                 |                    |                    |            |             |

## Macro longevity shock leads to adjustment of claims per cohort that

| Motivation | Macro longevity Risk | Assumptions<br>O●O | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|--------------------|--------------------|------------|-------------|
| Assumpt    | ions                 |                    |                    |            |             |

Macro longevity shock leads to adjustment of claims per cohort that

- are incorporated immediately at the end of each year (no buffering over time), and
- may be different for different cohorts but should be zero-sum over whole fund.

< □ > < <sup>[]</sup> >

| Motivation | Macro longevity Risk | Assumptions<br>O●O | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|--------------------|--------------------|------------|-------------|
| Assumpt    | ions                 |                    |                    |            |             |

Macro longevity shock leads to adjustment of claims per cohort that

- are incorporated immediately at the end of each year (no buffering over time), and
- may be different for different cohorts but should be zero-sum over whole fund.

Stochastic survival scenarios generated by 1-factor model to ease interpretation (Lee Carter).

Image: A mathematic state of the state of

| Motivation | Macro longevity Risk | Assumptions<br>00 | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|-------------------|--------------------|------------|-------------|
| Green ar   | nd Grey fund         | ds                |                    |            |             |

Age composition determines percentage of total pension capital in each cohort. We use two benchmark funds (Green and Grey).



Represent 10% and 90% quantiles in modified duration. (Data DNB)

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| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing<br>●00000 | Estimation | Conclusions |
|------------|----------------------|-------------|------------------------------|------------|-------------|
| Sharing    | macro longev         | vity risk   |                              |            |             |

• Effect on accrued pension income per year is inversely proportional to annuity value.

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| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing<br>●00000 | Estimation | Conclusions |
|------------|----------------------|-------------|------------------------------|------------|-------------|
| Sharing    | macro longe          | vity risk   |                              |            |             |

- Effect on accrued pension income per year is inversely proportional to annuity value.
- Shock to survival probabilities which leads to change in accrued pension income (macro longevity risk) can be
  - shared among all age groups (GSA) accrued pension income of every individual changes by same proportional factor
  - shared among pensioners only pension income of the retired changes by same proportional factor
  - taken over from pensioners by active participants pension income of the retired does not change, accrued pension income of all active participants changes by the same proportional factor

A D > A B > A B >

| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing<br>0●0000 | Estimation | Conclusions |
|------------|----------------------|-------------|------------------------------|------------|-------------|
| Macro      | longevity risk       | sharing     |                              |            |             |

Uniform risk sharing over all participants.



Percentage change in (accrued) pension income. Green fund (left) and grey fund (right).

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| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|-------------|--------------------|------------|-------------|
| Macro      | longevity risk       | sharing     |                    |            |             |

Uniform risk sharing among the retired only.



Percentage change in (accrued) pension income. Green fund (left) and grey fund (right).

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| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing<br>000●00 | Estimation | Conclusions |
|------------|----------------------|-------------|------------------------------|------------|-------------|
| Macro      | longevity risk       | sharing     |                              |            |             |

Active participants take over risk from the retired.



Percentage change in (accrued) pension income. Green fund (left) and grey fund (right).

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| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing<br>0000●0 | Estimation | Conclusions |
|------------|----------------------|-------------|------------------------------|------------|-------------|
| Macro      | longevity risk       | sharing     |                              |            |             |

- (1) group that is protected, by
- (2) group taking over the risk, and a
- (3) group which only carries their own risk.



| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing<br>00000● | Estimation | Conclusions |
|------------|----------------------|-------------|------------------------------|------------|-------------|
| Macro      | longevity risk       | sharing     |                              |            |             |

Example: Active members protect people older than 80.



Percentage change in (accrued) pension income. Green fund (left) and grey fund (right).

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Dutch actuarial committee responsible for prediction of survival rates uses extensive dataset based on European peer group.



Stochastic model AG2018 separates European trend, Dutch deviation from trend and noise due to micro longevity risk.

Image: A matrix and a matrix



• If macro longevity risk is shared by all members (or by all pensioners among themselves), exposure may increase too much for the highest ages.

Image: A math a math



- If macro longevity risk is shared by all members (or by all pensioners among themselves), exposure may increase too much for the highest ages.
- For macro risk we recommend defining three groups:
  - a group which is fully protected against this risk, by
  - a group which takes over this risk, plus
  - a group which only carries their own risk.

These groups should be chosen by pension fund board.



- If macro longevity risk is shared by all members (or by all pensioners among themselves), exposure may increase too much for the highest ages.
- For macro risk we recommend defining three groups:
  - · a group which is fully protected against this risk, by
  - a group which takes over this risk, plus
  - a group which only carries their own risk.

These groups should be chosen by pension fund board.

• Risk taken over by second group should be bounded.

| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|-------------|--------------------|------------|-------------|
| Further    | Work                 |             |                    |            |             |
|            |                      |             |                    |            |             |

Not taken into consideration in these results:

- Survivor pension for partners & children.
- Effect on future accrual of pension income (on top of what has been accrued so far).
  - Relative effect of shock to expected pension income at retirement is very similar to relative effect on currently accrued pension income,
  - but risk sharing only affects accrued entitlements!

Image: A mathematic state of the state of

| Motivation | Macro longevity Risk | Assumptions | Macro Risk Sharing | Estimation | Conclusions |
|------------|----------------------|-------------|--------------------|------------|-------------|
| Further    | Work                 |             |                    |            |             |
|            |                      |             |                    |            |             |

Not taken into consideration in these results:

- Survivor pension for partners & children.
- Effect on future accrual of pension income (on top of what has been accrued so far).
  - Relative effect of shock to expected pension income at retirement is very similar to relative effect on currently accrued pension income,
  - but risk sharing only affects accrued entitlements!
- Postponing retirement can also be used to mitigate effect of the macro longevity shock corresponding to 2.5% quantile:
  - 2 months (around age 65), up to
  - 3 months (around age 20).

| Motivation | Macro longevity Risk   | Assumptions                                       | Macro Risk Sharing                     | Estimation       | Conclusions |
|------------|--|---|--|------------------|-------------|
| Reference  | ces  |   |  |                  |             |
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Royal Dutch Actuarial Society.

Projection Table AG2018.

Report of the AG Committee for Mortality Research, 2018.

A B > A
 B > A
 B