Variable annuities with financial risk and longevity risk in the decumulation phase of Dutch DC products

Netspar Pension Day

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Institutional (Dutch) setting

- At retirement age, mandatory conversion of pension wealth to a life-long annuity
- Since September 1, 2016 the participant, in a defined contribution (DC) pension scheme, can choose a variable annuity instead of a fixed annuity
- A consequence is that, the participant can retain **equity exposure** after retirement.
    - Advantage: A higher expected pension income
    - Drawback: Fluctuations/uncertainty in pension income
- Also with a variable annuity a participant can face **interest rate risk** after retirement.
    - In a fixed annuity there is interest rate risk until retirement age.
- The pension provider can leave the **micro and macro longevity risk** in the pool.
    - Macro longevity risk (changes in survival probabilities) is fundamentally different from micro longevity risk because it does not diversify.

Institutional (Dutch) setting

Continued

- Since 2019, pension providers are required to show the pension income distribution (in real terms) to a retiree using a uniform economic scenario set, based on Koijen, Nijman and Werker (2010) (KNW model)
- Not all risks are covered in current legislation. For example, macro longevity risk is not included in this set.
  - This implies that some pension providers leave this risk in the pool without quantifying the burden to the participants.
- Substantial heterogeneity accross pension products exists in terms of equity exposure, interest rate exposure, insuring the macro longevity risk and assumed interest rate.
  - Therefore, it is highly relevant for the participant to be able to compare the risks of different pension products

Key contribution

- In Bonekamp et al. (2017), the nominal pension income distribution is presented in a stylized model taking into account **stock market risk** only. Balter and Werker (2020) extend their analysis for pension products with different features (guaranteed benefit level, smoothing)
- In De Waegenaere and Vellekoop (2017), the implications of a **one year longevity shock** was investigated for the pension income distribution, in the absence of any financial market risk
    - We extend these papers by deriving the pension income distribution under interest rate risk and inflation risk.
    - We extend these papers by deriving the pension income distribution under financial market risk and longevity risk.
    - In particular, we show how micro and macro longevity risk could be included in the prescribed consumer information.

Model Assumptions

- The first payment of the pension product is given by the initial capital (W_T) and the assumed interest rate (AIR)

$$W_T = \text{First pension payment} \cdot \sum_{h=0}^{\text{max age}-1} \underbrace{\exp(-h \cdot AIR_h)}_{\text{discounting}} \cdot \underbrace{p_h(T)}_{\text{survival probability}}$$

- For each pension payment at horizon h, a 'money pot' can be allocated

$$V_h(T) = \text{First pension payment} \cdot \exp(-h \cdot AIR_h) \cdot p_h(T)$$

- The pension income stream can be determined by increasing the money pots with financial market and longevity returns, using any model for which we can generate scenarios for these risk factors.

Model Assumptions

- For stock market risk, a Black and Scholes financial market (r=0.43 %, $\sigma = 16.75\%$, $\lambda\sigma = 4.52\%$) is assumed[1]. Later on, we will take the KNW model, which is the underlying model of the scenario set prescribed by the Dutch regulator. This model adds uncertainty in bond and inflation returns.
- Typically, and throughout this presentation, the assumed interest rate is set (in line with the legal maximum) to obtain a constant expected pension income, $AIR = r + w\lambda\sigma$, where w is the asset allocation.
- For longevity risk, a Lee-Carter model (one risk factor) will be used. The expected life improvements and volatility of life improvements is calibrated on C=-1.90 and $\sigma_k = 2.32$ % respectively.
  - With some robustness checks.

[1] Parameters are set to get equivalence in long term parameters with the DNB calibration of the KNW model.

Model Assumptions

- Variable annuity with equity exposure of w=35 % with assumed interest rate (AIR=2.01 %), or fixed annuity with w=0 %.[2]
- Each risk will be shared within the own age group.
- Assume an agent at retirement age, with a deterministic amount of pension wealth of 233.000
  - The pension income distribution can be shown.
- Note that we will abstract from micro longevity risk. This case can be found in the paper.

[2] $AIR = r + w\lambda\sigma = 0.43\% + 35\% \cdot 4.52\% = 2.01\%$

Pension income distribution with stock market risk

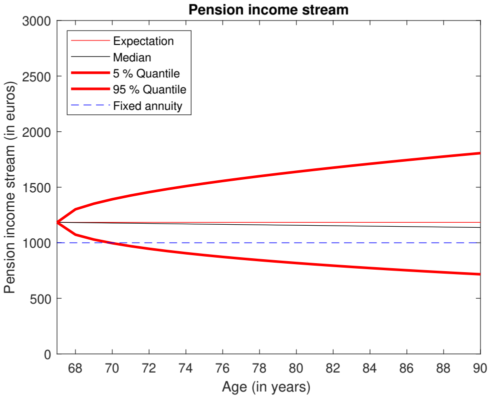
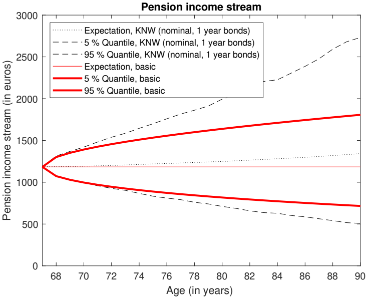


Figure: Pension income stream, w=35 %, AIR=2.01 %

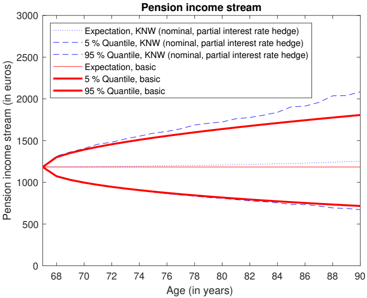
- By Dutch law, pension income stream must be non-decreasing in expectation.

Pension income distribution with interest rate and inflation risk

- In the KNW model, the current calibration has an increase in the expected returns on stocks over time due to an increasing instantaneous interest rate, it is not so straightforward to find a full interest rate hedge and act in line with the requirement in the Dutch law on a constant pension income stream in expectation.



(a) Pension income stream, w=35 %, no interest rate hedge in nominal terms



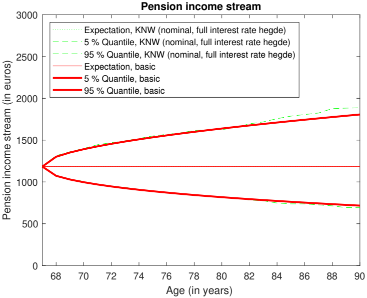
(b) Pension income stream, w=35 %, partial interest rate hedge in nominal terms

Pension income distribution with interest rate and inflation risk

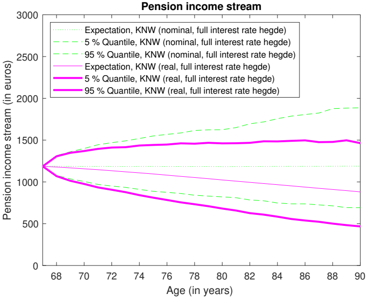
- In the KNW model, the expected return on stocks consists of a constant risk premium plus the expected nominal instantaneous interest rate.
- We find the full interest rate hedge (in nominal terms) as follows
  - We invest each money pot needed h years from retirement age onwards completely in a nominal bond with duration h.
  - We take a long position in the stock market, with amount the asset allocation (w) times the accumulated pension wealth (W_T).
  - We take a short position in a one year bond, with amount the asset allocation (w) times the accumulated pension wealth (W_T).
  - We have to repeat this procedure each year.
- We will not present the interest rate hedge (in real terms) since inflation linked bonds are not available in the Netherlands.

Pension income distribution with interest rate and inflation risk

- We present the outcome of the full interest rate hedge that we derived on the previous slide. Additionally, we quantify the pension income distribution in real terms.

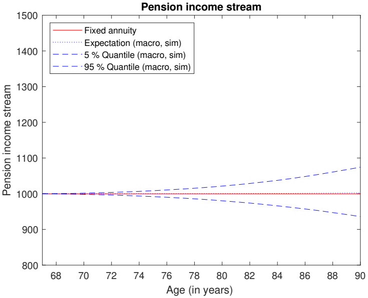


(a) Pension income stream, w=35 %, full interest rate hedge in nominal terms

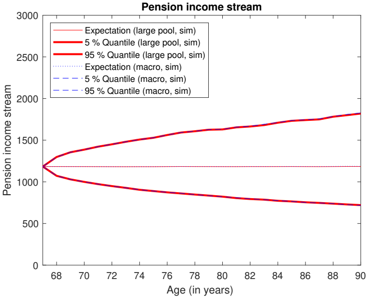


(b) Pension income stream, w=35 %, full interest rate hedge in real terms

Pension income distribution with macro longevity risk



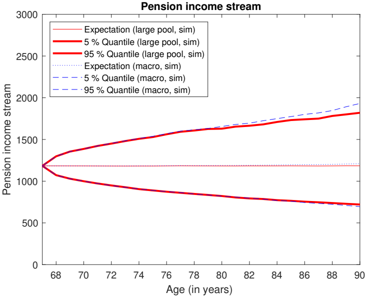
(a) Pension income stream, w=0 %, AIR=0.43 %



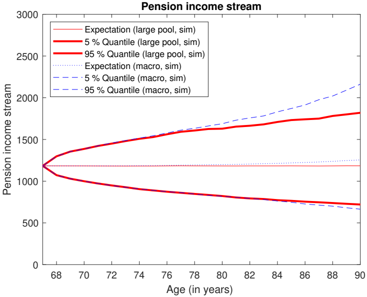
(b) Pension income stream, w=35 %, AIR=2.01 %

- Financial market risk dominates the longevity risk, though the stand alone longevity risk can be substantial.

Pension income distribution with macro longevity risk



(a) Pension income stream, w=35 %, AIR=2.01 %, $\tilde{\sigma_k} = 3 \cdot \sigma_k$



(b) Pension income stream, w=35 %, AIR=2.01 %, $\tilde{\sigma_k} = 5 \cdot \sigma_k$

- By assuming a higher volatility on life improvements, than historically calibrated, longevity risk becomes a more important risk factor. Still the downside risk seems marginal.

General conclusion

- The results are important for countries worldwide, that have variable annuities or drawdown products. Therefore, we have created a general framework such that the risks of variable annuities can be presented under any model that is able to generate scenarios for stock, bond, inflation and longevity returns.
  - Assuming the KNW model, we were able to show that interest rate risk can lead to significant additional uncertainty in the pension product. We were able to derive the interest rate hedge.
  - By taking into account longevity risk in variable annuities, the dominating risk is the financial market risk. Given some robustness check, longevity risk becomes more important.
- In this presentation, the focus was a basic variable annuity, though the results can be generalized for a wide variety of (Dutch) pension products (i.e. smoothing, guaranteed benefit level, high low) which is described in the paper.

End of presentation

- Thank you for your attention!