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Research Centre**  
Institute and Faculty  
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## Self-selection and risk sharing in a modern world of life-long annuities

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## The Research Project

This research is part of the grant

*Minimising longevity and investment risk while  
optimising future pension plans*

from the Actuarial Research Centre (ARC) of the  
Institute and Faculty of Actuaries (IFoA).



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## Merton (2014, Harvard Business Review)

- Do not make employees smarter about investments. We need smarter communication
- Provide a lower and an upper bound for future inflation adjusted return
- Do not throw the baby out with the bathwater when moving from defined benefit schemes to defined contributions
- Re-integrate define benefit type of properties in a defined contribution setting.

## Merton (2014, Harvard Business Review)

- Merton did not publish the technical details on how to implement his vision
- First piece in this grant: Technical details; see Donnelly, Guillen and Nielsen (2018, Astin Bulletin)
- We do believe that Merton could have published these technical details had he wanted to: all our published technical details were based on a simple application of the financial mathematics that Merton got the Nobel prize for inventing.

## Merton (2014, Harvard Business Review)

- We settled and published the technical details behind Merton's vision.
- However, while designing future digital pension schemes, the ambition of this grant is to go much further in the direction of:
  - Transparency
  - Easy communication
  - Backtrack of financial advice
  - Efficiency.



## Three innovations developed in this BAJ-sessional paper for the first time

- A product so easy to understand that the saver can self-select the financial risk and design the financial investment strategy within minutes
- Automatic mortality risk sharing between annuity customers
- Automatic investment guarantee risk sharing between customers, so that they do not have to pay for their investment guarantee and such that the pension company does not need to issue one.



## Let us stop up for a moment and think

- Are these innovations too good to be true?
- Any of these three "postulates" from the previous slide would potentially be a sensation would it turn out to be true...
- Three sensations at the same time.....
- For one BAJ-paper only....
- Any experienced actuary would raise a flag of scepticism: this is after all our actuarial nature.

## Let us stop up for a moment and think

- So here we are left with our healthy actuarial scepticism.
- However, we should not be so sceptical that we forget what it was all about.
- So, what were these three postulates again?

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## Emma designs her annuity

- Emma is 35 years old
- She wants to invest £300,000 (inheritance)
- She wants to retire at age 65.



## Emma designs her annuity

The actuary needs to handle

- Mortality risk
- Inflation risk
- Investment risk.

...But Emma shouldn't be bothered with those details.



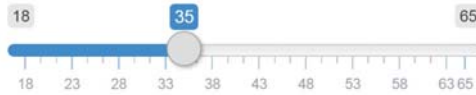
## Emma designs her annuity

We require an annuity product allowing Emma to select her optimal strategy in consistency with her financial risk preferences.

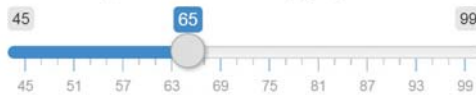


## Emma designs her annuity

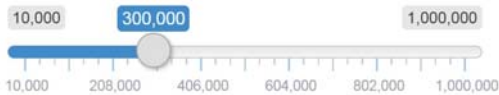
Your age (min 18; max 65)



At what age should monthly pay-outs start



Amount you want to pay in today (GBP)



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## Emma's Instructions

- Use the slider below in order to choose the number of years for which you want to have a monthly pension benefit guaranteed.
- The amount you see is your most likely life long pension when choosing that guarantee period .
- Your most likely life long pension is only guaranteed in the guarantee period.
- There is a fifty-fifty chance that your most likely life long pension will continue the rest of your life.
- There is a fifty-fifty chance that there will be reductions in your most likely life long pension when the guaranteed period is over.
- All amounts are in real terms, i.e., in today's values.

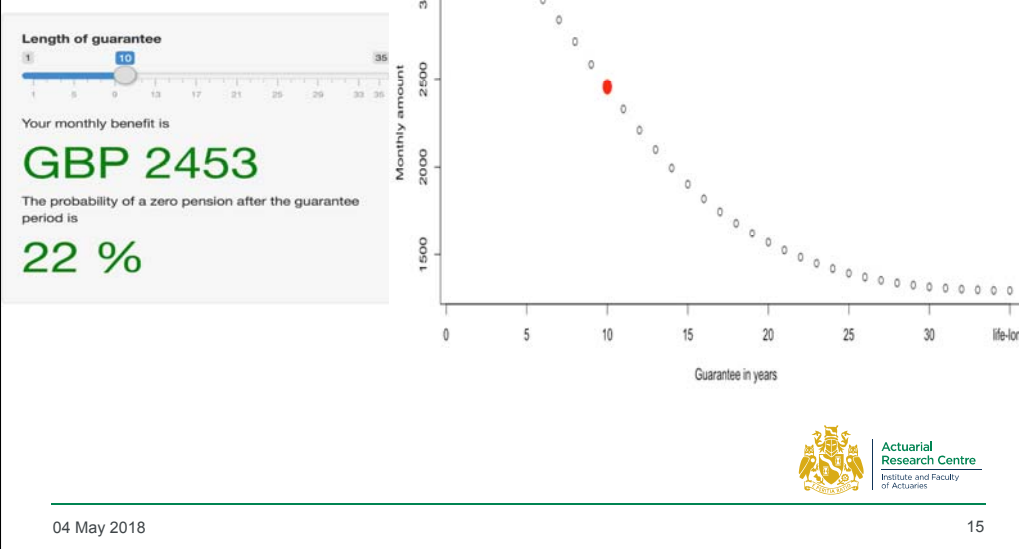


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## The Risk-Return Trade-Off

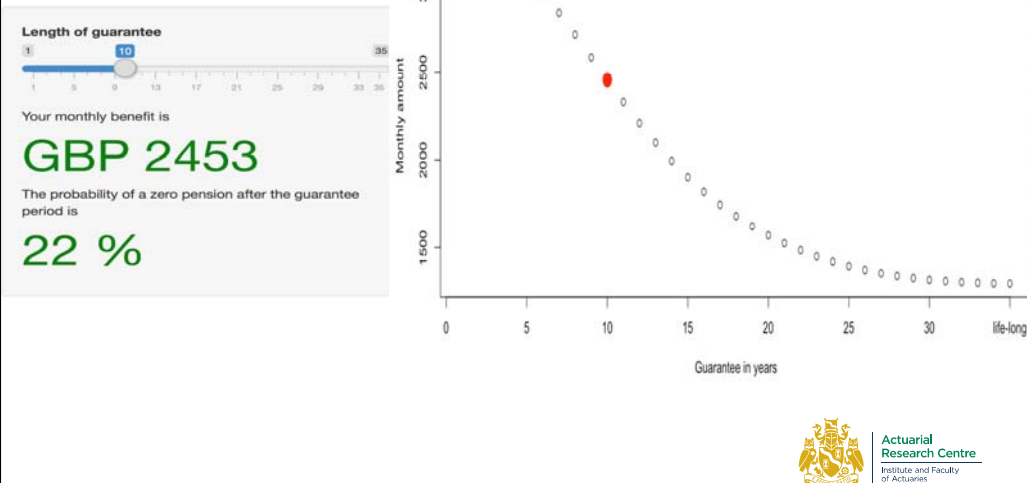


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## The Risk-Return Trade-Off



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## The Risk-Return Trade-Off

- Emma could directly pick a risk-return trade-off according to her risk preferences (10 years).
- She can do that because she understands the trade-off which is directly linked to her future pension.
- Traditional defined benefits corresponds to the extreme infinite length – say 40 years – of the guarantee.

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## The Risk-Return Trade-Off

- Last year's webinar showed – in a similar but different case - that there could be a loss of up to 20% for being forced to buy an extreme guarantee when it is not needed.
- Academics – my own pension - current USS defined benefit scheme is forcing me to buy such an extreme guarantee.

## Flexibility

- Emma can readjust or add additional investment at any time.
- She could increase or decrease the guarantee period at any given time given the current status of the savings.
- Emma could also buy another annuity when 60. But this time with payouts starting from the age of 85.
- There is an endless amount of possibilities of creating building blocks towards a pension product using the framework of this paper. The best possible way of turning the principles of this paper into an optimal saving design is beyond the scope of this presentation and requires more work.

## Comparison with a traditional DC scheme

Call a stereo-typical traditional defined contribution scheme for TDC and call our new defined contribution proposal for ODC.

In the next few slides, we will try to highlight some of the most important differences between the traditional TDC and our new ODC.



## Comparison, TDC versus ODC

### TDC scheme

- Unclear investment risk
- Unclear inflation risk
- Unclear mortality risk
- Unclear future pension

### Our proposed ODC scheme

- A clearly stated most likely future income
- A clearly stated guarantee period of this most likely future income
- Everything is expressed in real terms linking it smoothly to financial planning.



## Comparison TDC versus our DC-scheme



TDC: Final pension is hard to predict

Our proposed ODC-scheme: Financial planning is possible



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## TDC versus ODC: communication and financial planning

### In a TDC scheme

- Unclear communication
- Unclear financial advice
- Unclear legal rights, when financial advice is not well understood
- Uncertainty about the future
- Risk of bad decisions.

### Our proposed ODC scheme

- Clear communication
- The saver is able to pick the exact risk profile he or she is looking for
- The saver takes informed decisions
- The saver can plan for the long run.



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## The machine room

- Customer reveals risk appetite
- Annuity principle
- Financial hedging strategy
- Risk pooling.

## Machine room: Customer Reveals Risk Appetite

By specifying the required guarantee length, Emma directly specifies her financial risk appetite. Results from last year's webinar: there is a loss between 20% and 80% when a financial advisor misjudge a pension savers financial risk. That is why our easy-to-do self-selection of risk is so important.

This webinar is being written into a formal scientific paper and will be available at ARC's website next month.

## Machine room: Annuity principle

We use the annuity overlay fund introduced in Bräutigam et al. (2017, Geneva Papers):

- Longevity risk is not transferred to an insurer, it is shared among the members of the pension fund
- The annuity principle is transparent: whenever someone in the pool dies, money is distributed to the survivors
- Distribution is actuarially fair, see Donnelly et al., (2013, 2014, IME)



## Machine room: The financial hedging strategy based on exponential utility

Invest the following amount into the risky asset:

$$\underbrace{300,000 e^{rt + \int_0^t \lambda_i(s) ds}}_{\text{value of } \pounds 300,000 \text{ at } t}$$

$$\times \mathbb{P} \left( 0 \leq \underbrace{X_i^*(T_i) + \mathcal{P}_i(0) - 300,000 (\mu - r) T_i}_{\text{terminal wealth of unconstr. strategy corrected by drift}} \leq G_{U_i}(T_i) | X_i^*(t) \right)$$

- $\mu$  is the average mean return on the risky asset
- $r$  the average inflation per year,
- $t$  the time passed since commencement,
- $T_i$  time from commencement until end of guarantee period,
- $\lambda_i$  the force of mortality of individual  $i$ ,
- $X_i^*$  wealth of  $i$  following optimal unconstrained strategy
- $\mathcal{P}_i(0)$  the initial price of the hedge,
- $G_{U_i}(T_i)$  the actuarially fair price at  $T_i$  for a life-long annuity



## Machine room: Risk Pooling/Investment guarantee

The overall principle of investment risk pooling is that the inflation fund is risky, one can therefore not find complete safety in the inflation fund. The risk pooling investment principle becomes:

- The individual transfer risk from the inflation fund by calibrating the joint stock and inflation risk until the sought after investment risk (according to the hedging principle) is obtained
- If the sought after risk is less than the risk in the inflation fund, then the risk is transferred to those with risk appetite in the pool
- If there is too little risk appetite in the pool, then we need an intermediary to provide risk appetite.



## Technical details: be careful doing this at home

The technical details of this talk are provided in the accompanying paper that is available online and that will appear in BAJ.

- The good news is: the big break has been done and our three big innovations see the light of day for the first time.
- The bad news is: it takes more than reading one paper and going to a couple of seminars to be proficient in our new methodologies.
- So, yes it is possible to do these great things!
- But it will take time and training and insight to to carry these ideas out in practice.
- Please contact Jens Perch Nielsen at [jens.nielsen.1@city.ac.uk](mailto:jens.nielsen.1@city.ac.uk) if you are interested in how Cass Business School via Cass Consultancy can help facilitate these ideas in your company or your organization.



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Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.



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