Overview

• Introduction to the research programme
• Optimal decumulation strategies
• Our recent research
• Questions and comments
Introduction

Research programme: “Minimising Longevity and Investment Risk while Optimising Future Pension Plans”:

• Customers’ needs at the forefront.
• Provide customers with a real income in retirement that has the desired balance between stability and performance.
• Minimize costs for the customer.

Research topics

• Investment strategies throughout the customer’s lifetime
• Investment return smoothing and/or risk sharing
• Longevity risk sharing (modern tontines)
• Performance measurement: investment risk vs income stability
• Market timing
• Guarantees: only when needed
• Robustness to assumptions
Research coalition

- Joint project led by Heriot-Watt and Cass Business School.
- Funded by the Actuarial Research Centre (ARC).
- Research network extends to Australia, Austria, Germany and Spain with tenured academics.

Research outputs - selection

- Papers
  - Product options for enhanced retirement income, by C. Donnelly and J. Young.
  - Implementing individual savings' decisions for retirement with bounds on wealth, by C. Donnelly, M. Guillen, J.P. Nielsen, A.-M. Perez-Marín.
Research outputs relevant to this talk


- Webinar on modern tontines (Actuarial Research Centre website, under this Research Programme).

- How much to invest in a tontine, by T. Bernhardt and C. Donnelly [submitted paper].
Optimal investment strategies

  - Review of the literature on pension decumulation, mostly academic
- Covers investment and income withdrawal strategies, e.g.
  - how much to invest in equities vs bonds at each time.
  - how much to withdraw as an income every year.
- Investment in the financial markets is essential (Battocchio et al, 2017).

Optimal investment strategies

A good retirement product looks like…

![Diagram showing retirement product options]

Value

1st part: Investment only

2nd part: Pooling against longevity risk

High number

Lifetime protection

Stable income

Retirement date

Time

Death
Optimal investment strategies

Variety of **objective functions** studied...

(1) Max lifetime income \( \mathbb{E}[\int_0^T U(t, c) dt + V(T, X)] \).

(1) Min probability of wealth falling to zero.

(2) Max above level \( \mathbb{E}[\int_0^T U(t, c - h) dt + V(T, X - H)] \).

(2) Max mean-variance \( \mathbb{E}[X] - \gamma \text{Var}[X] \).

(2) Min distance from a target \( \mathbb{E}[\int_0^T a \times (c - f)^2 dt + b \times (X - F)^2] \).

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From maximizing/minimizing objective functions (1)

“Max lifetime income” or “Min probability of wealth falling to zero”:

- Mutual fund separation, ✓Presenting equity as one thing.
- Constant mix strategy, ✓How insurance companies invest.
- Equity ↓ then Longevity risk ↑, ✓~50% in equity for lowest lifetime ruin.
- Changing consumption, ✗Unstable income.
- Deplete savings, ✓Bequest is second order.
- Savings don’t last forever, ✓Annuity.

- “4% rule” for a stable income
  - How long? How much left?

<table>
<thead>
<tr>
<th>Initial annual withdrawal rate</th>
<th>3.0%</th>
<th>3.5%</th>
<th>4.0%</th>
<th>4.5%</th>
<th>5.0%</th>
<th>5.5%</th>
<th>6.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 100% 100% 100% 100% 100% 99% 97% 91%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20 100% 100% 98% 95% 85% 66% 65% 41%</td>
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<tr>
<td>25 100% 97% 92% 77% 51% 28% 12% 11%</td>
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<tr>
<td>30 97% 92% 75% 49% 27% 12% 5% 5%</td>
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</tr>
<tr>
<td>35 94% 81% 57% 33% 14% 6% 3% 3%</td>
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</tbody>
</table>
From maximizing/minimizing objective functions (2)

Optimizing remaining objective functions:

- Similar to “Max lifetime income”, i.e. robust optimal solutions.
- Variance increases over time,
  - Needs control.
- Varying equity proportion,
  - How investment firms invest.
- Stable profit,
  - Predictable outcome.

“4% rule”, i.e. income drawdown

- e.g. 50% in equity.
- Withdraw x% from initial savings, then increase with inflation.
- Probability savings last for at least...

<table>
<thead>
<tr>
<th>Years</th>
<th>3.0%</th>
<th>3.5%</th>
<th>4.0%</th>
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<td>97.30%</td>
<td>93.14%</td>
<td>87.00%</td>
<td>77.50%</td>
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<tr>
<td>20</td>
<td>98.53%</td>
<td>95.00%</td>
<td>87.70%</td>
<td>76.47%</td>
<td>63.24%</td>
<td>49.28%</td>
<td>36.48%</td>
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<tr>
<td>25</td>
<td>91.05%</td>
<td>79.27%</td>
<td>65.48%</td>
<td>48.87%</td>
<td>34.60%</td>
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<td>77.37%</td>
<td>60.04%</td>
<td>43.44%</td>
<td>29.39%</td>
<td>18.63%</td>
<td>11.13%</td>
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<tr>
<td>35</td>
<td>62.14%</td>
<td>44.17%</td>
<td>28.23%</td>
<td>18.16%</td>
<td>10.53%</td>
<td>5.65%</td>
<td>2.98%</td>
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</tbody>
</table>
Mean-variance objective function

• Annual optimization problem.
• Inflation adjusted percentage from initial savings.
• Probability savings last for at least...

<table>
<thead>
<tr>
<th>Initial annual withdrawal rate</th>
<th>Years</th>
<th>3.0%</th>
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<th>5.5%</th>
<th>6.0%</th>
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</thead>
<tbody>
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<td>98.95%</td>
<td>96.63%</td>
<td>94.17%</td>
<td>-5.03</td>
<td>91.10%</td>
<td>89.80%</td>
<td>85.48%</td>
<td>77.82%</td>
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<td>20</td>
<td>96.03%</td>
<td>90.07%</td>
<td>85.34%</td>
<td>-2.36</td>
<td>80.35%</td>
<td>74.84%</td>
<td>63.14%</td>
<td>49.02%</td>
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<tr>
<td>25</td>
<td>91.99%</td>
<td>82.90%</td>
<td>75.49%</td>
<td>+10.01</td>
<td>66.26%</td>
<td>46.09%</td>
<td>23.35%</td>
<td>12.63%</td>
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<tr>
<td>30</td>
<td>87.19%</td>
<td>+9.82</td>
<td>75.03%</td>
<td>+14.99</td>
<td>61.94%</td>
<td>+18.50</td>
<td>37.28%</td>
<td>+7.89</td>
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<td></td>
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<td></td>
<td></td>
<td>7.67%</td>
<td>-10.96</td>
<td>1.48%</td>
<td>-5.85</td>
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<td></td>
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<td></td>
<td></td>
<td>0.48%</td>
<td>-5.85</td>
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<td></td>
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</tbody>
</table>
## Undesirable features of optimal strategies

<table>
<thead>
<tr>
<th>Undesirable feature</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult to communicate</td>
<td>…</td>
</tr>
<tr>
<td>Sensitive to parameters</td>
<td>…</td>
</tr>
<tr>
<td>Non-explicit indication for outcome</td>
<td>…</td>
</tr>
<tr>
<td>No constraints</td>
<td>…</td>
</tr>
<tr>
<td></td>
<td>Car mechanic analogy</td>
</tr>
<tr>
<td></td>
<td>Indication for wrong set-up</td>
</tr>
<tr>
<td></td>
<td>Explicit in idealistic situation</td>
</tr>
<tr>
<td></td>
<td>Numerical solutions</td>
</tr>
</tbody>
</table>

## Life annuities - features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guaranteed lifetime income</td>
<td>Premium reflects actuarially fair value + fees/solvency margin/other costs</td>
</tr>
<tr>
<td>Underlying low risk/low return investment strategy</td>
<td>Low annuity income</td>
</tr>
<tr>
<td>Longevity gains eventually out-pace investment gains</td>
<td>Happens around age 80</td>
</tr>
<tr>
<td>Not favourable to buy life annuity all the time</td>
<td>Optimal stopping problem</td>
</tr>
</tbody>
</table>
Life annuities - features

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<td></td>
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</table>

State of the art involving life annuities

- Annuity best option at high ages.
- Don’t fully annuitization at the retirement date,
  - phase transition (stagger purchase).
  - deferred annuities.
Our innovations in pension decumulation

Catherine Donnelly
Risk Insight Lab, Heriot-Watt University

www.risk-insight-lab.com

The ‘Minimising Longevity and Investment Risk while Optimising Future Pension Plans’ research programme is being funded by the Actuarial Research Centre.

What is a tontine?

- A tontine is a structure to pool longevity risk.

- A pure tontine has no guarantees – the pool of people bear the longevity risk.

- The purpose of modern tontines is to pay an income for life.
Imagine yourself

22 November 2018

Seeking advice…

Retirement options kiosk

22 November 2018
### Age 70 with £100K pot

<table>
<thead>
<tr>
<th></th>
<th>Pure modern tontine</th>
<th>Modern tontine with bequest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual income</strong></td>
<td>£7,100</td>
<td>£6,600</td>
</tr>
<tr>
<td><strong>Age at which out-live savings</strong></td>
<td>120 years</td>
<td>120 years</td>
</tr>
<tr>
<td><strong>Money left to heirs</strong></td>
<td>Nothing</td>
<td>20% of pot at death</td>
</tr>
<tr>
<td><strong>Basis</strong></td>
<td>(Mortality, Investment returns), [allocation to tontine], [income if use unadjusted table]</td>
<td>(S1PMA-2, 2% p.a.), [100% allocation], [£7,700 on S1PMA]</td>
</tr>
</tbody>
</table>

22 November 2018
## Age 70 with £100K pot

<table>
<thead>
<tr>
<th></th>
<th>Pure modern tontine</th>
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<th>Life annuity</th>
<th>Income drawdown</th>
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<td>£6,600</td>
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<td>Age at which out-live savings</td>
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<td>120 years</td>
<td>Never</td>
<td>87 years</td>
</tr>
<tr>
<td>Money left to heirs</td>
<td>Nothing</td>
<td>20% of pot at death</td>
<td>Nothing</td>
<td>Whatever left in pot at death</td>
</tr>
<tr>
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<td>(S1PMA-2, 2% p.a.), [100% allocation], [£7,700 on S1PMA]</td>
<td>(S1PMA-2, 2% p.a.), [80% allocation], [£7,100 on S1PMA]</td>
<td>(S1PMA-4, UK yield curve), equivalently (S1PMA-2, -0.3% p.a.)</td>
</tr>
</tbody>
</table>

22 November 2018
**Life annuity feature**

- Despite the previous table...
- Life annuity gives higher income than income drawdown,
  - if follow same investment strategy, and
  - ignore fees, costs, taxes, etc.

(Different investment strategy in previous table)

- We can pool longevity risk without buying life annuities.

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**Tontine**

22 November 2018
Modern tontines

• Aim: retirement income, not a life-death gamble.

• Various tontines structures have been proposed.

• For a brief introduction to how to calculate longevity credits, see our October 2018 webinar (on IFoA ARC website)

Pure modern tontine – individual account structure

- Longevity credits
- Investment returns
- Participant’s account
- Withdrawals
Pure modern tontine

Account shared among tontine participants

Investment returns

Account value

Dead

Alive or dead?

Alive

Longevity credits

Investment returns

Account value

Withdrawals

Minimising Longevity and Investment Risk while Optimising Future Pension Plans

Recent project presentations

- Sessional Research Event in May 2018:
  

- Here, present work with Thomas Bernhardt, Risk Insight Lab, Heriot-Watt University
Modern tontine with bequest

Split pension savings into two accounts, 80% in tontine account

- **Tontine account**: 80% of pension savings
- **Bequest account**: 20% of pension savings
Modern tontine with bequest

Rebalance accounts (re-distribute longevity credits)

Re-balanced tontine account

Re-balanced bequest account

80% of pension savings

20% of pension savings

Modern tontine with bequest

Tontine account shared among tontine participants, Bequest account paid to estate

Investment returns

Previous tontine & bequest accounts value

Dead

Longevity credits

Investment returns

Previous tontine & bequest accounts value

Alive or dead?

Alive

Withdrawals
## Age 70 with £100K pot

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<td>20% of pot at death</td>
<td>Whatever left in pot at death</td>
</tr>
</tbody>
</table>

**Basis**

(Mortality, Investment returns), [allocation to tontine], [income if use unadjusted table]

- (S1PMA-2, 2% p.a.), [80% allocation], [£7,100 on S1PMA]
- (S1PMA, 2% p.a.)

## Bequest account vs Drawdown bequest

![Graph showing comparison between Bequest account value and Drawdown bequest over age at death.

22 November 2018

22 November 2018
Bequest account vs Drawdown bequest

Research question

What percentage of pension savings should you put in the tontine account?

- Allow for desire for income, bequest motive and risk aversion.
- Found that, for (normal) risk aversion, percentage is fairly stable and high.
- Harder to say for risk-seekers.
- Results are in theoretical model.
- Next step is to look at more realistic model.
Modern tontines - summary

- Reduce risk of running out of money in retirement.
- Should be structured to provide a stable, fairly constant income (not increasing exponentially with the longevity credit!).
- Provide a higher income than living off investment returns alone.
- Can seek higher investment returns than life annuity.
- Can incorporate bequests.

Modern tontines - applications

- Innovation in retirement products
  - e.g. allow for bequest: ‘modern tontine with bequest’.
  - e.g. provide downside protection that too few deaths occur (minimum income) – see Donnelly & Young (2017).
  - e.g. allow less liquid assets such as pensioner’s house.
- Foundation for collective DC plans
  - Provides income without buying life annuities.
  - Could be integrated into DC plans as post-retirement option.
The Actuarial Research Centre (ARC) is the Institute and Faculty of Actuaries’ (IFoA) network of actuarial researchers around the world.

The ARC seeks to deliver cutting-edge research programmes that address some of the significant, global challenges in actuarial science, through a partnership of the actuarial profession, the academic community and practitioners.

The ‘Minimising Longevity and Investment Risk while Optimising Future Pension Plans’ research programme is being funded by the ARC.

www.actuaries.org.uk/arc