Longevity risk sharing for income-based mortality heterogeneity: An assessment framework for equitability

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Not-so-hidden inequalities in longevity:

Impact on retirement outcomes

Wealthy retire with

7x

higher

in their superannuation balances than poor

Women retire with

30%

less

in their superannuation balances than men

Wealthy live

6.4

years longer

than poor

Women live

4.1

years longer

than men

Why does it matter in longevity pooling?

- Global interest: Financial well-being for retirees
- Innovative solutions: Longevity pooling
  * Mechanism: Pool and share
  * Key characteristic: Mortality-linked benefits
- Concerns: Equitable retirement product design (Ayuso et al., 2017; Holzmann et al., 2020; Van Raalte et al., 2023)

Differences in lifespan behavior by socioeconomic status $\rightarrow$

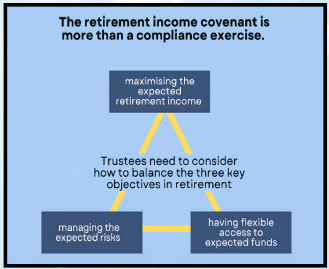
'Unfair' wealth transfers that disproportionately benefit some groups $\rightarrow$

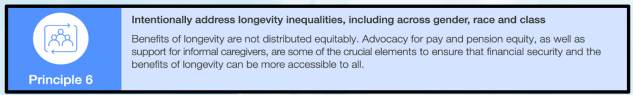
Inequitable distribution of benefits $\rightarrow$ Redistributive unfairness

- Intentionally addressing longevity inequalities is important

Addressing longevity inequalities:

Link to pension policy reforms





Ensure member outcomes for differing needs and circumstances

Our work

Research question: How to assess the equitability of a given pooling arrangement?

Our findings:

1. Not accounting for longevity inequalities lead to higher wealth transfers
2. Transfers are directly proportional to the proportion of the low-income group in the pooling arrangement
3. Pooling requires a trade-off between ensuring equitability and volatility reduction

Modelling contribution: A framework to assess equitable longevity pooling arrangements

1. Can quantify the wealth transfers due to pooling participants with unequal wealth and lifespans
2. Can tell who is subsidizing whom
3. Can help detect whether a benefit structure leads to an equitable longevity pooling arrangement

Heterogeneity in longevity pooling arrangements

		Measurement			Effectiveness	
		Mean	Variance	Distribution	Pool composition	Pool size
Heterogeneity dimension	Age-linked longevity (multi-cohort)	Milevsky and Salisbury (2016) Chen et al. (2023)				
	Wealth	Sabin (2010) Donnelly (2014) Bernhardt and Qu (2023)			Bernhardt and Donnelly (2020)	
	Wealth-linked longevity	Milevsky (2020)	Milevsky (2020)			
	Disability	Hieber and Lucas (2022) Kabuche et al. (2024)				
	Gender longevity	Sabin (2010)				
	Wealth and Longevity	Dhaene and Milevsky (2024)				

Gap: Coherently assessing the impact of longevity heterogeneity and wealth heterogeneity at the distribution level to assess the redistributive fairness in benefits

Comparing means is not enough...

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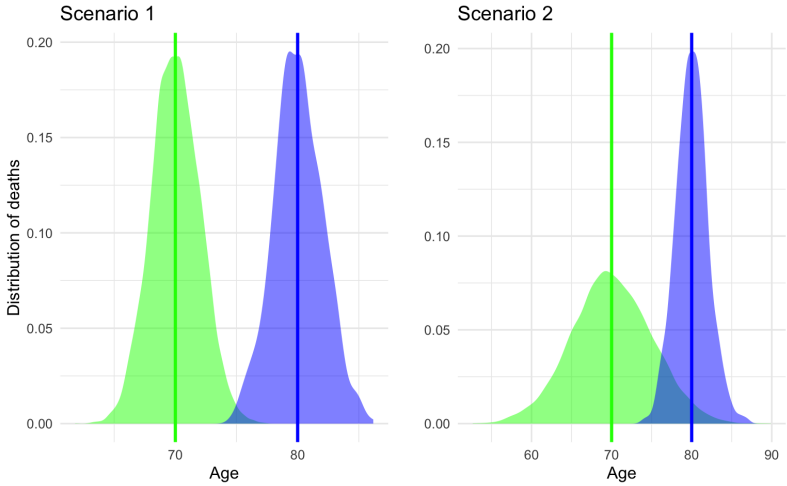
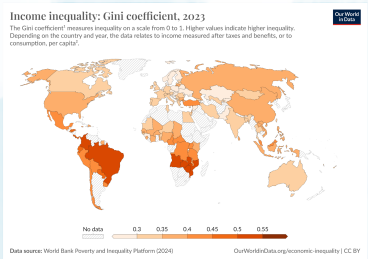
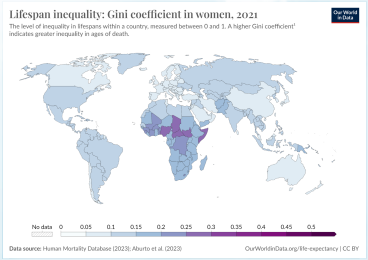


Measuring inequality: Gini coefficient



Australia: 0.34
USA: 0.4
Sri Lanka: 0.38
Zimbabwe: 0.50
Colombia: 0.55
Germany: 0.32

Australia: 0.07
USA: 0.11
Sri Lanka: 0.09
Zimbabwe: 0.20
Colombia: 0.11
Germany: 0.08



Source: https://ourworldindata.org

$$G^X = \frac{\text{expected absolute difference between all possible pairs of values}}{2 \times \text{mean of the distribution}} = \frac{\Delta X}{2\bar{x}}$$

Relative (operational) effectiveness of pooling depends on...

1. Inequalities in wealth distributions
2. Inequalities in lifespan distributions
3. Pool composition
4. Pool size

Our work: Decomposing and disentangling inequalities

Gini Measure	Definition	Description
Wealth Gini (G^W)	$G^W = \frac{\Delta W}{2\sum_{k=1}^{K} \frac{n_k}{n} W_k}$	Measures inequality in wealth distribution
Lifetime Gini (G^{T_x})	$G^{T_x} = \frac{\Delta T_x}{2\sum_{k=1}^{K} \frac{n_k}{n} \mathbb{E}[T_{x_k}]}$	Measures inequality in lifespan distribution
Benefit Gini (G^B)	$G^B = \frac{\Delta B}{2\sum_{k=1}^{K} \frac{n_k}{n} \int_0^\infty f_{x_k}(a) \nu_k^B(x)\, dx}$	Measures inequality in benefit distribution

Adapting Gini Measure for Wealth, Lifetime, and Benefit Inequality

Decomposing Gini (Permanyer et al, 2023):

$$\underbrace{\Delta(d)}_{\text{total inequality}} = \underbrace{\sum_{g=1}^{G} S_g I_W^g}_{\text{within}} + \underbrace{\sum_{g=2}^{G}\sum_{h=1}^{g-1} S_{gh} I_B^{gh}}_{\text{between}} = \sum_{g=1}^{G} S_g I_W^g + \sum_{g=2}^{G}\sum_{h=1}^{g-1} S_{gh} \underbrace{(A_{hg} + A_{gh})}_{\text{inequitability}}.$$

Gini-based assessment framework

Lifespan Inequality: $\{f_{X_L}(t), f_{X_H}(t)\}$

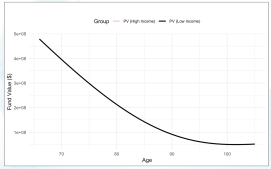
Age	Low	High
Low		
High		
Δ L		

Initial wealth Inequality : $\{W_L, W_H\}$

$	Low	High
Low		
High		
Δ W		

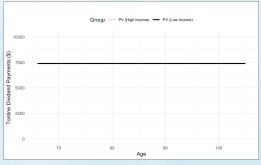
Pool composition: $\boldsymbol{p} = \{ p_1, 1\text{-} p_1 \}$
Pool size: $\boldsymbol{N} = \{ n_1, N\text{-} n_1 \}$

Payout rule



Longevity risk sharing rule

Benefit profile (Tontine payment)



Present Value of Benefits

$	Low	High
Low	Within Low transfers	**From High to Low**
High	**From Low to High (Inequitable)**	Within High transfers
Δ B		

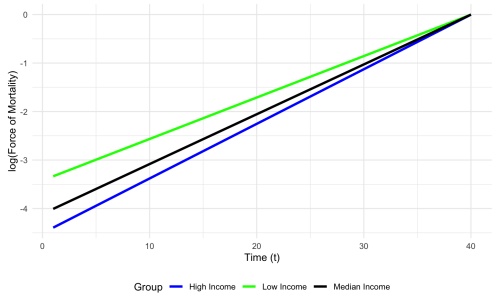
What is the dollar amount of transfers ?

Who is transferring to whom ?

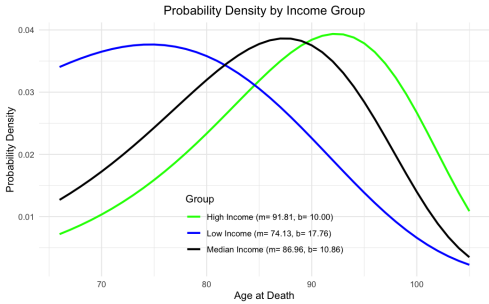
What is the best management strategy

Model setup: Capturing lifespan inequality

- Use data from Chetty et al. (2016) on income linked mortality heterogeneity
- Apply Gompertz-Makeham + Compensation Law of Mortality to obtain the (m, b) parametrization



Hazard Rates

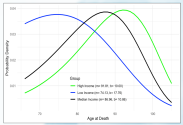


Age-at-death Distribution

Model setup: Capturing initial wealth inequality

- Initial investment: ($100,000,$100,000)
- Pool composition: (50%, 50%)
- Pool size: (2500,2500)
- Closed pool

Applying the assessment framework (Milevsky, 2015: Unpooled)



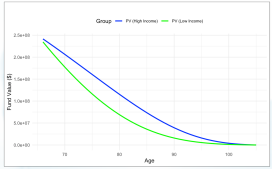
Age	Low	High
Low	11.02	5.71
High	5.13	9.79
Δ L	10.85	

Initial wealth W= {$100000, $100000)

$	Low	High
Low	0	0
High	0	0
Δ W	0	

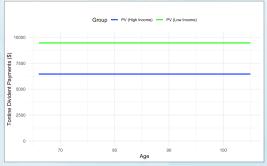
Pool composition: p ={ 0.5, 0.5}
Pool size: n={2500,2500}

Benefit rule

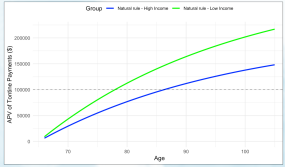


Sharing rule
Natural rule: Unpooled

Benefit inequality



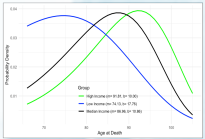
Cumulative Present Value of Benefits



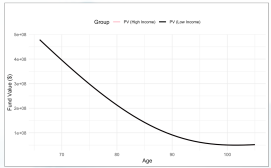
$	Low	High
Low	3225	0
High	0	1591
Δ G	4816	

- What is the dollar amount of transfers ?
- Who is transferring to whom ?
- What is the best management strategy

Applying the assessment framework (Milevsky, 2015: Pooled)



Benefit rule



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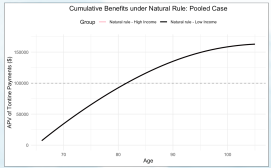


Age	Low	High
Low	11.02	5.71
High	5.13	9.79
Δ L	10.85	

Initial wealth W= {$100000, $100000)

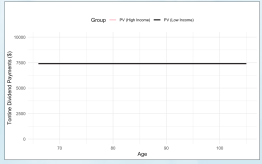
$	Low	High
Low	0	0
High	0	0
Δ W	0	

Pool composition: p ={ 0.5, 0.5}
Pool size: n={2500, 2500}

Sharing rule
Natural rule: Pooled
(Ignore inequalities)

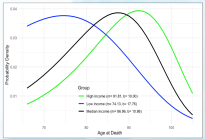
$	Low	High
Low	1570	472
High	1245	822
Δ G	4082	

Benefit inequality



- What is the dollar amount of transfers ?
- Who is transferring to whom ?
- What is the best management strategy

Applying the assessment framework (Milevsky, 2015: Proportional benefits)



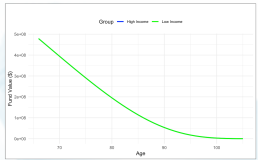
Age	Low	High
Low	11.02	5.71
High	5.13	9.79
Δ L	10.85	

Initial wealth W= {$100000, $100000)

$	Low	High
Low	0	0
High	0	0
Δ W	0	

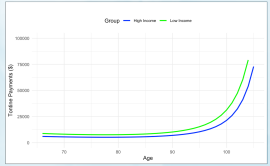
Pool composition: p ={ 0.5, 0.5}
Pool size: n={2500, 2500}

Benefit rule

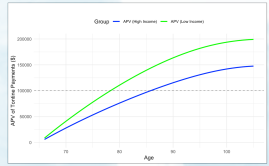


Sharing rule
Natural rule: Pooled
(Proportional benefit)

Benefit inequality



Cumulative Present Value of Benefits



$	Low	High
Low	1570	475
High	813	822
Δ G	3680	

What is the dollar amount of transfers ?

Who is transferring to whom ?

What is the best management strategy

Wealth transfers and equitability

	Pool size (Low, High)	(500,4500)		(2500,2500)		(4500,500)	
	Pool composition	10:90		50:50		90:10	
Natural rule (Unpooled)	Advantage (A_{gh})	0	0	0	0	0	0
	Wealth transfers ($S_{gh}A_{gh}$)	0	0	0	0	0	0
Natural rule (Pooled-ignored)	Advantage (A_{gh})	2489.87	471.82	2489.87	471.82	2489.87	471.82
	Wealth transfers ($S_{gh}A_{gh}$)	248.99	424.63	1244.93	235.91	2240.88	47.18
Natural rule (Prop. benefits)	Advantage (A_{gh})	1626.63	949.33	1626.63	949.33	1626.63	949.33
	Wealth transfers ($S_{gh}A_{gh}$)	**162.66**	854.39	**813.31**	474.66	**1463.96**	94.93

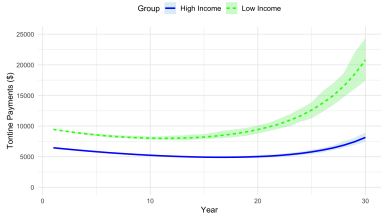
- Not accounting for income-linked inequalities leads to higher 'unfavourable' transfers
- Accounting during benefit sharing reduces 'unfavourable' transfers
- 'unfavourable' (inequitable) transfers increase with the proportion of the low-income group

Final Thoughts

To pool or not to pool?

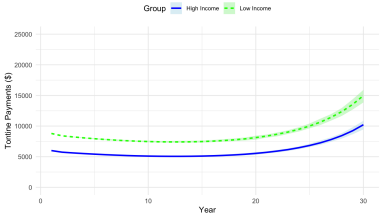
Decomposition	Low income	High income
Low income	3225	0
High income	0	1591
Inequitable transfer	0	

Unpooled Case



Decomposition	Low income	High income
Low income	1570	475
High income	813	822
Inequitable transfer	813	

Pooled Case



Key takeaways: Trade-off between equitability and volatility

- Pooling has the potential to reduce volatility
- Being mindful about 'unfavourable' transfers is also important

Conclusion

- Differences in lifespan behavior by socioeconomic status $\rightarrow$

  'Unfair' wealth transfers that disproportionately benefit some groups $\rightarrow$

  Inequitable distribution of benefits $\rightarrow$ Redistributive unfairness

- Novelty: We go beyond studying means for assessing longevity inequalities

- Contribution: We develop a coherent framework to assess the equitability

  1. Quantify the wealth transfers due to pooling participants with unequal wealth and lifespans
  2. Tell who is subsidizing whom
  3. Help detect whether a benefit structure leads to an equitable longevity pooling arrangement

- Research output: A practical assessment tool for retirement income providers and policymakers

Future work

1. Comprehensive analysis of other payout rules
2. Decide the best risk management strategy
   - Pool or not to pool
   - Optimum benefit payout rule
3. Who to pool with whom

Thank you

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References

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Discussion on practical implementation

Feasibility