

**SURVIVE THRIVE**



# Natural Selection

**Financial Services Forum**

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**Actuarial  
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# Metrics for Comparing Retirement Strategies: a Road Test

**Nick Callil, Hadas Danziger and Tom Sneddon**

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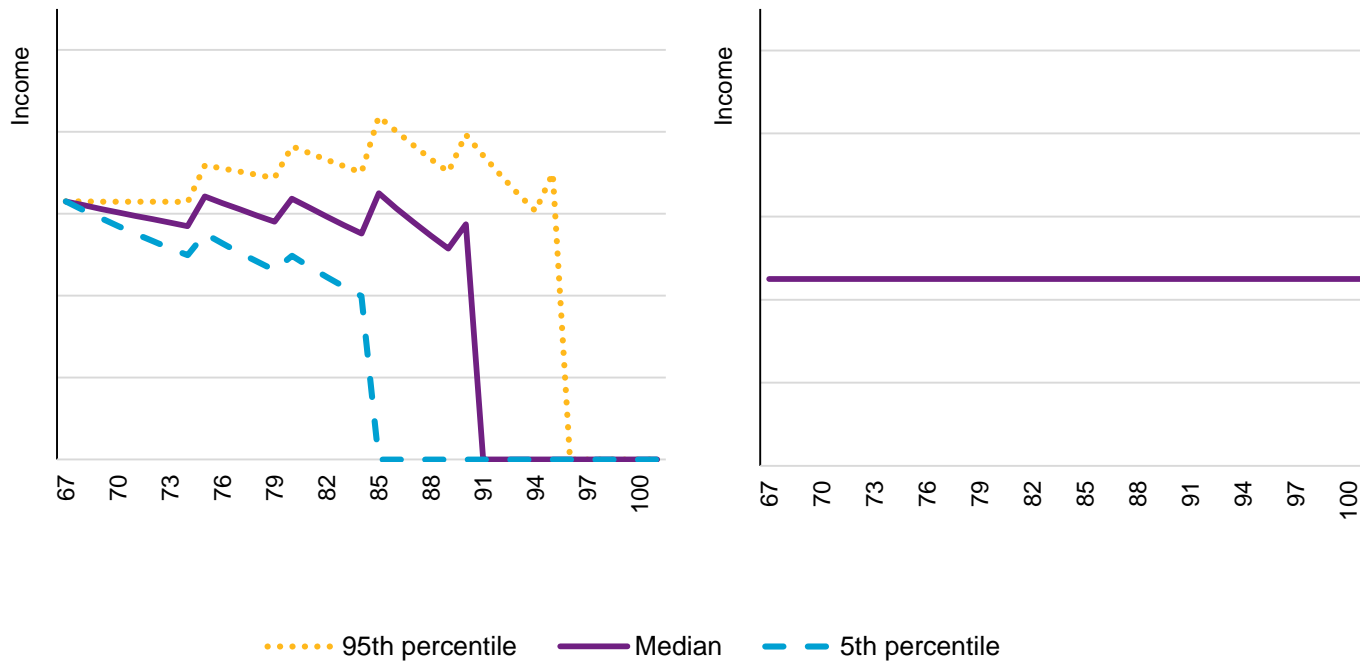
# Motivation – why we need retirement metrics

“Annuities don’t return enough to fund a full retirement”




“A shift away from account-based pensions is needed to combat longevity risk”

“Group self annuities deliver the best of both worlds – high returns and longevity protection”

# Motivation – why we need retirement metrics



# The Road Test: Metrics considered

Metric Type		Metric	Form of output	Allows for target income?	Allows for residual?
Entry-Level		Probability and average age at ruin	probability	✗	✗
		Probability of income inadequacy	probability	✓	✗
		Depth and duration of income misses	\$ & time horizon	✓	✗
Proportion measures		NPV (total retirement income) / Money's Worth	\$ / %	✗	✓
		Desired income attainability	%	✓	✗
		Goodness of Fit index	% between 0 & 100	✓	✗
Utility-based		Risk-adjusted income	\$	✗	✗
		MDUF Score	\$	✗	✓

# Retirement Strategies Modelled

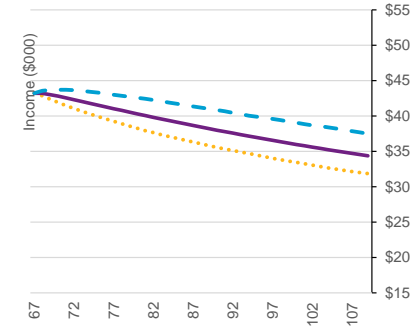
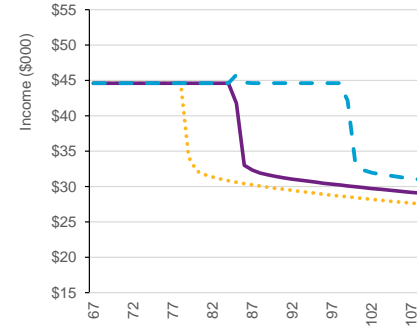
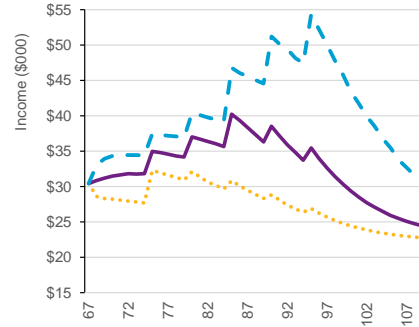
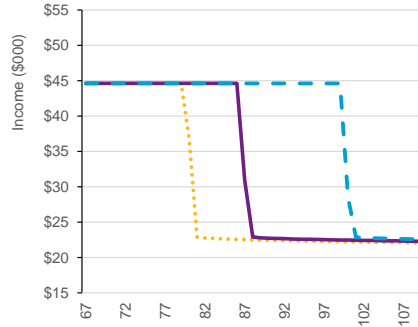
- “Strawman” retiree with \$450,000 initial retirement assets

ABP (target)

ABP (min DD)

50/50 ABP/LA

100% LA



..... 5th percentile    
 ———— Median    
 - - - - 95th percentile

# Entry-Level



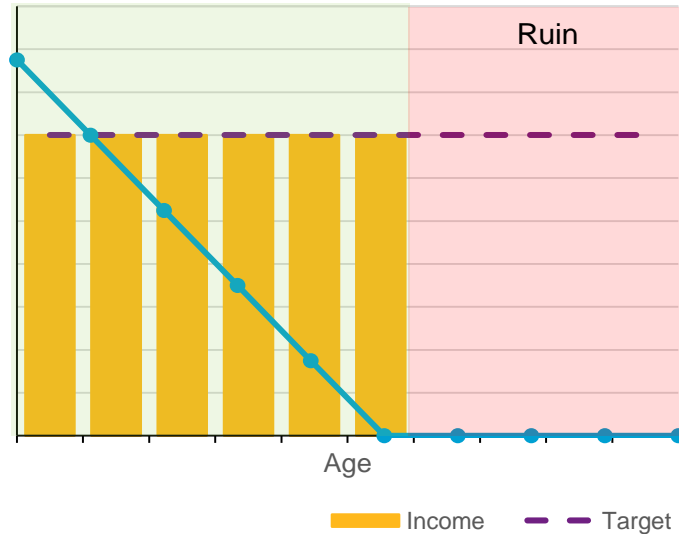
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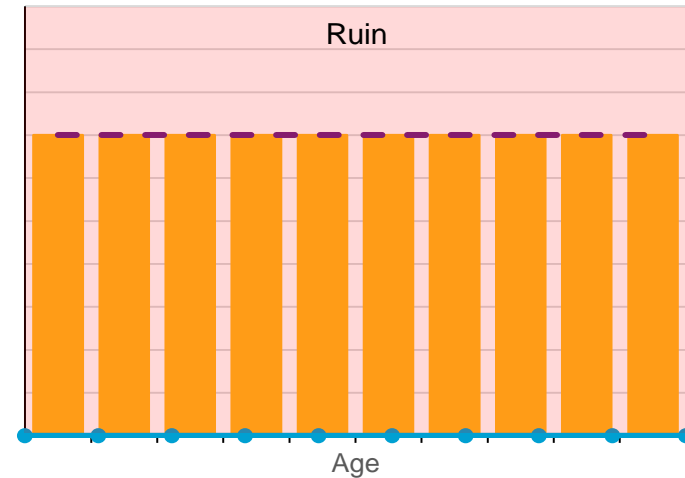
# Probability/age at ruin

Scenario 1: An account-based pension



Ruin = relying on age pension only

Scenario 2: A lifetime annuity



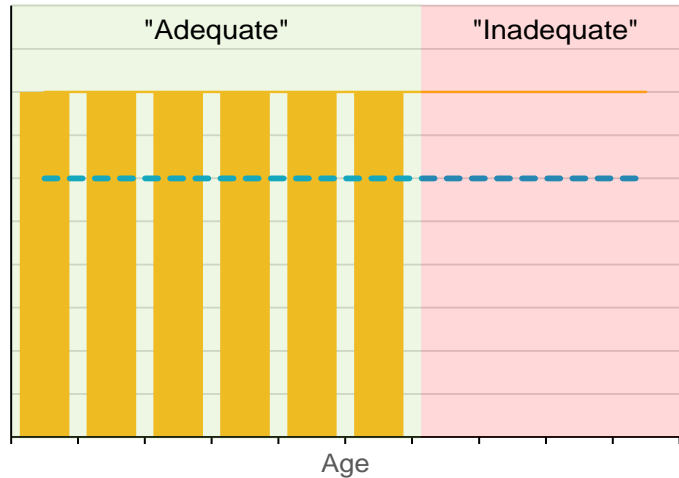
Ruin = still has income





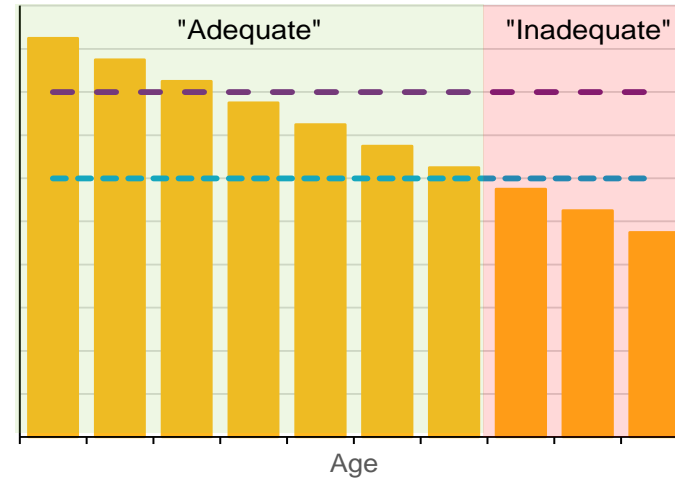
# Probability of inadequacy

Scenario 1



Inadequacy = ruin

Scenario 2



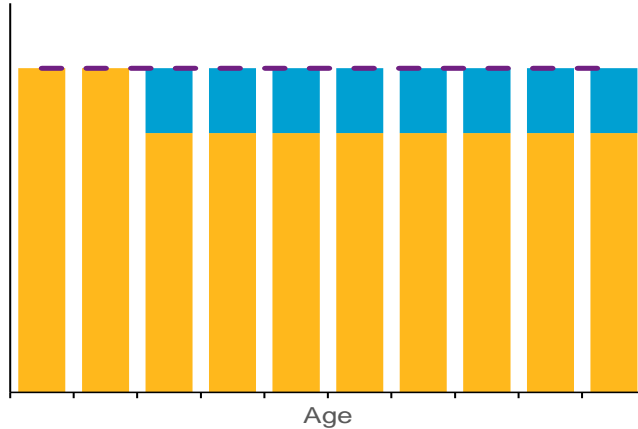
Inadequacy = low income

Income Target Income Adequate Income



# Duration and depth of income misses

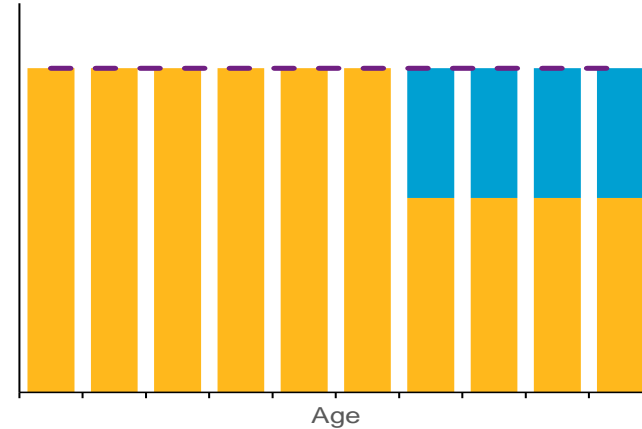
Scenario 1



Income Income misses Target income

Duration = 8, Depth = 0.5

Scenario 2



Duration = 4, Depth = 1



# Comparison

Metric Name		ABP (target)	ABP (min DD)	50/50 ABP/LA	100% LA
Probability of ruin	To age 90	59%	0%	68%	100%
	Mortality weighted	48%	0%	54%	100%
Age at ruin	Median	89	109	88	67
	5 <sup>th</sup> percentile	82	109	81	67
Probability of inadequacy	To age 90	59%	64%	9%	0%
	Mortality weighted	48%	64%	13%	0%
Depth of income misses (to age 90)	Median	\$17,038	\$9,940	\$11,456	\$3,935
	5 <sup>th</sup> percentile	\$21,603	\$13,086	\$13,583	\$5,461
Duration of income misses (to age 90)	Median	8	24	8	24
	5 <sup>th</sup> percentile	23	24	22	24



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# Proportion measures



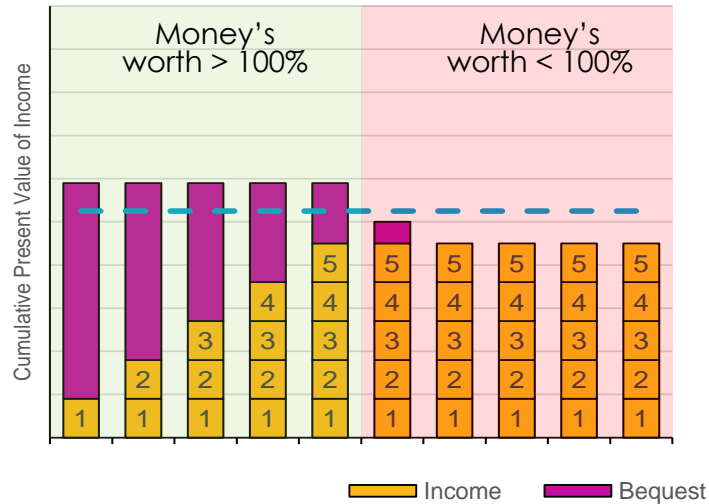
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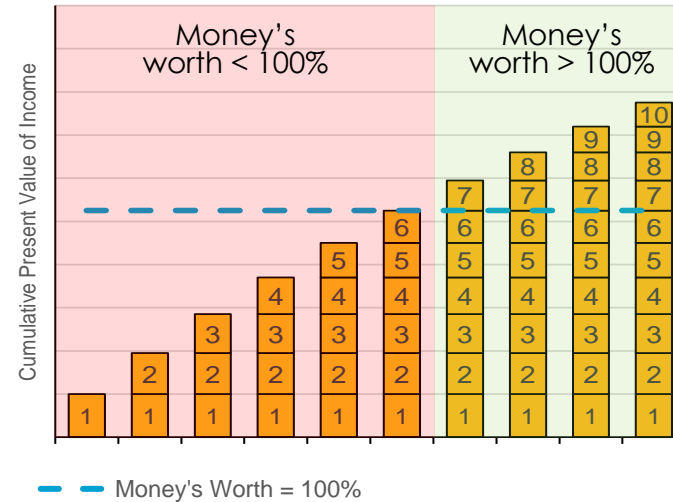


# NPV lifetime income / Money's worth

Scenario 1: An account-based pension



Scenario 2: A lifetime annuity

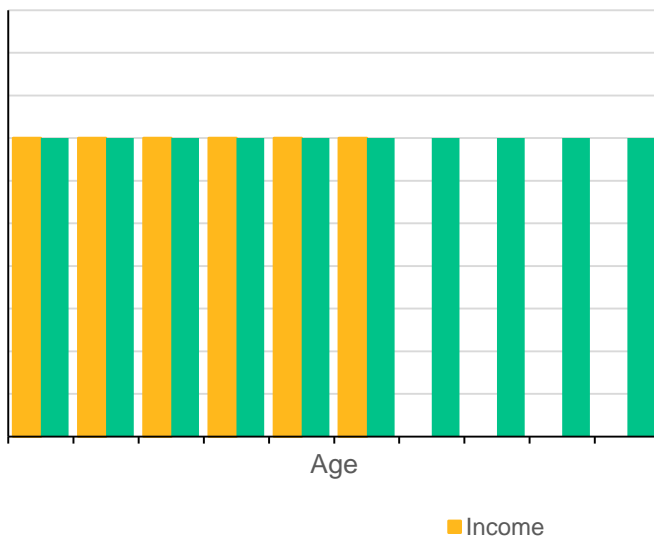






# Desired income attainability

Scenario 1: An account-based pension



DIA < 100%

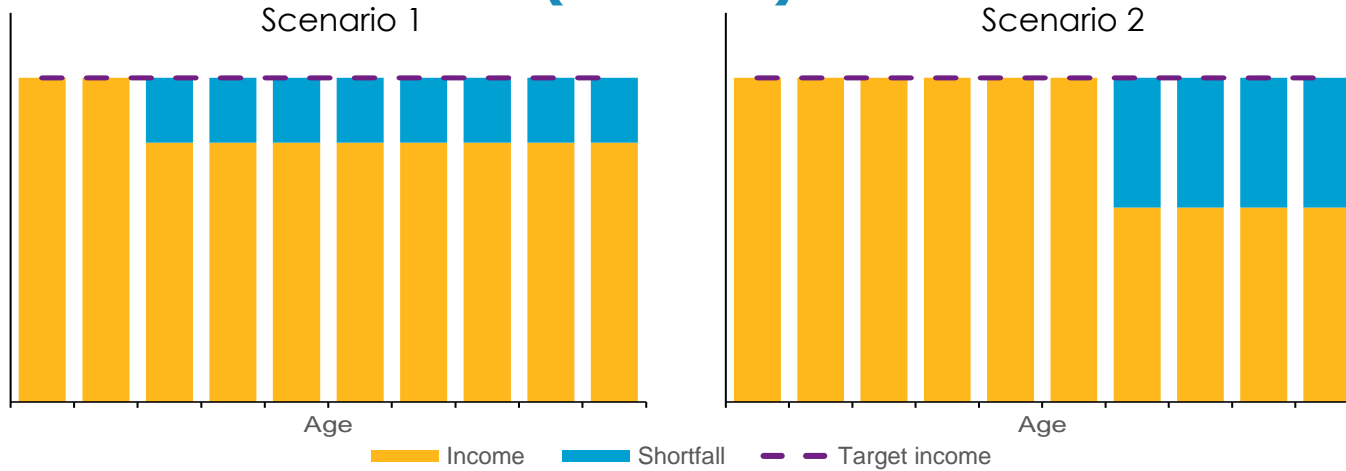
Scenario 2: A lifetime annuity



DIA > 100%



# Goodness of Fit Index ("GOFI")



	Scenario 1	Scenario 2
Total Target Income	\$500,000	\$500,000
Total Shortfall	\$80,000	\$80,000
Delivery ratio (D)	81.0%	81.0%
Actual Squared Shortfall ratio (A)	95.0%	82.2%
Optimal Squared Shortfall ratio (B)	96.4%	96.4%
GOFI	79.8%	69.1%



# Comparison

Metric Name		ABP (target)	ABP (min DD)	50/50 ABP/LA	100% LA
NPV (Lifetime income)	Median	\$1,007,192	\$1,011,488	\$999,428	\$942,774
	5 <sup>th</sup> percentile	\$810,877	\$791,756	\$829,179	\$793,208
Money's worth	Median	224%	225%	222%	210%
	5 <sup>th</sup> percentile	180%	176%	184%	176%
Desired Income Attainability (to age 90)	Median	93%	78%	94%	91%
	5 <sup>th</sup> percentile	79%	71%	85%	88%
GOFI	Median	92%	75%	94%	92%
	5 <sup>th</sup> percentile	81%	70%	88%	89%



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Best in  
class

Best in  
Class

# Utility-based

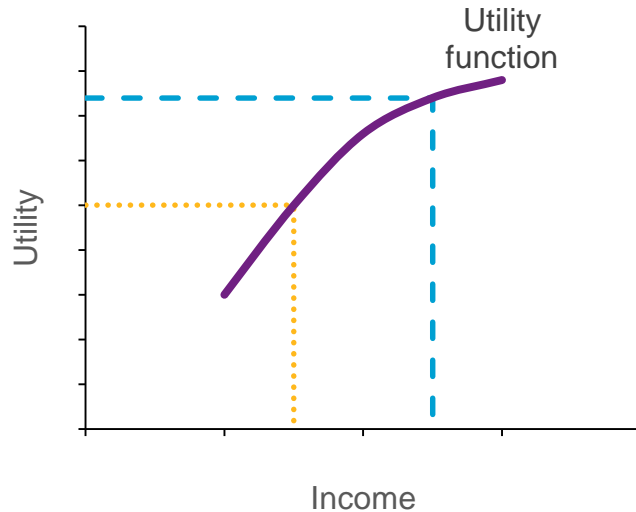


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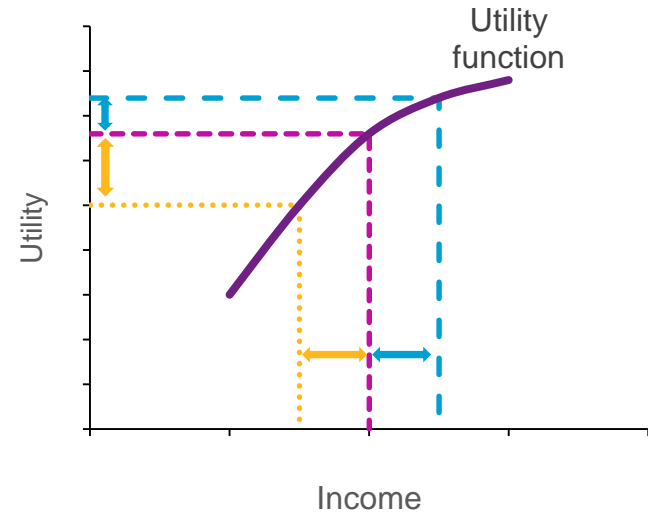




# Key Utility theory concepts



Higher income preferred



Risk aversion – losses penalizes more than gains





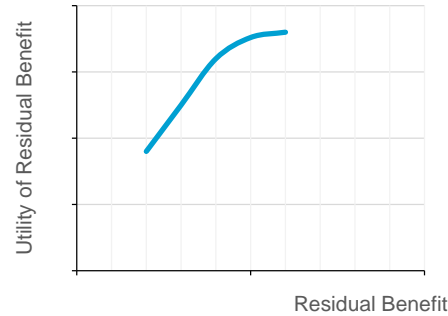
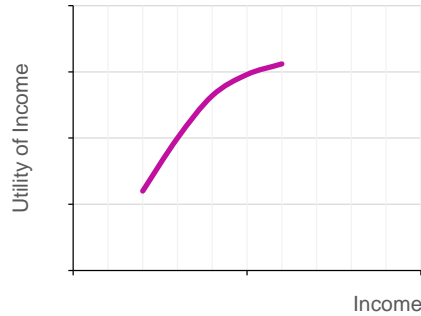
# MDUF including a bequest motive

 $U_C$ 

+

 $U_B$ 

=

 $U_O$ 



## MDUF Utility

$U_0 =$  *expected value of*

$$\sum_{t=0}^T \beta^t \left\{ {}_t p_x \frac{\text{income}_t^{1-\rho}}{1-\rho} + {}_{t-1|}q_x \frac{\text{bequest}_t^{1-\rho}}{1-\rho} \left( \frac{\phi}{1-\phi} \right)^\rho \right\}$$

$\rho =$  *risk aversion parameter*

$\phi =$  *residual bequest motive parameter*



# MDUF Utility

$U_0 = \text{expected value of}$

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Income  
utility  
( $U_c$ )



# MDUF Utility

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Income  
utility  
( $U_c$ )

Residual  
Benefit Utility



# MDUF Score

MDUF Score

$$= \left[ U_0 \times \frac{1 - \rho}{\left[ \sum_{t=0}^T \beta^t \left\{ {}_t p_x + {}_{t-1} | q_x \frac{\phi}{1 - \phi} \right\} \right]} \right]^{\frac{1}{1-\rho}}$$

= constant level of income which delivers the same level of overall utility (considering the income/bequest trade-off)



# Risk Adjusted Income

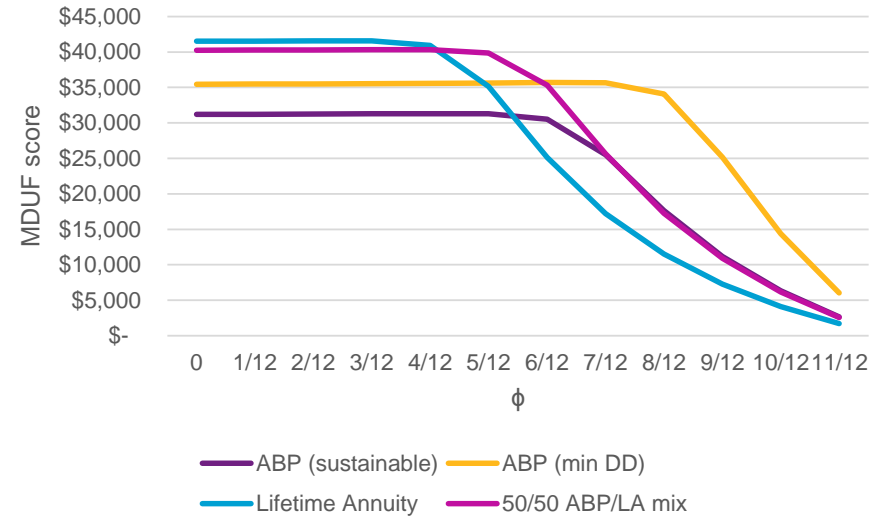
Risk adjusted income =

$$S_C = \left[ U_C \times \frac{1 - \rho}{[\sum_{t=0}^T \beta^t {}_t p_x]} \right]^{\frac{1}{1-\rho}}$$

= constant level of income which delivers the same level of income utility (i.e. with bequest motive parameter set to zero)

# MDUF for different $\phi$

- $\phi$  = choice in trade-off between income and bequest (proportion)
  - Higher  $\phi$  = more bequest
  - $0 < \phi < 1$
- More  $\phi$  = care more about expected bequest vs income
  - = want less annuity
  - = want more ABP
  - = want less ABP drawdown





# Comparison

Metric Name		ABP (target)	ABP (min DD)	50/50 ABP/LA	100% LA
Risk-adjusted income	Mean	\$30,881	\$32,764	\$38,201	\$40,333
	5 <sup>th</sup> percentile	\$25,967	\$30,573	\$34,294	\$38,557
MDUF Score	Mean	\$5,080	\$7,241	\$4,658	\$3,808
	5 <sup>th</sup> percentile	\$4,921	\$5,144	\$4,552	\$3,665





# Comparison




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# Metrics considered: A Road Test

Metric Type		'Best in class'		ABP (target)	ABP (min DD)	50/50 ABP/LA	100% LA
Entry-Level		Depth of income misses (to age 90)	Median	4	2	3	1
			5 <sup>th</sup> percentile	4	2	3	1
		Duration of income misses (to age 90)	Median	1	4	1	4
			5 <sup>th</sup> percentile	3	4	1	4
Proportion measures		GOFI	Median	2	4	1	2
			5 <sup>th</sup> percentile	3	4	2	1
Utility-based		MDUF Score (with bequest motive; $\phi = 0.83$ )	Median	2	1	3	4
			5 <sup>th</sup> percentile	2	1	3	4



## Concluding comments

- No metric 'dominates'
- Resonance with target audience will be a factor
  - Govt may mandate comparable metric for retirement products
- Exploring tail – not just expected – value is important particularly for CIPRs whose retirees may have been 'soft defaulted'



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# Paper available at

<https://www.actuaries.asn.au/microsites/financial-services-forum-2018/program/papers-and-pre-reading>

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