Can modern tontines invigorate pensions?

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Overview of entire session

- Motivation
- One way of pooling longevity risk
- Discussion

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I. Motivation

- Background
- Focus on life annuity
- Example of a tontine in action

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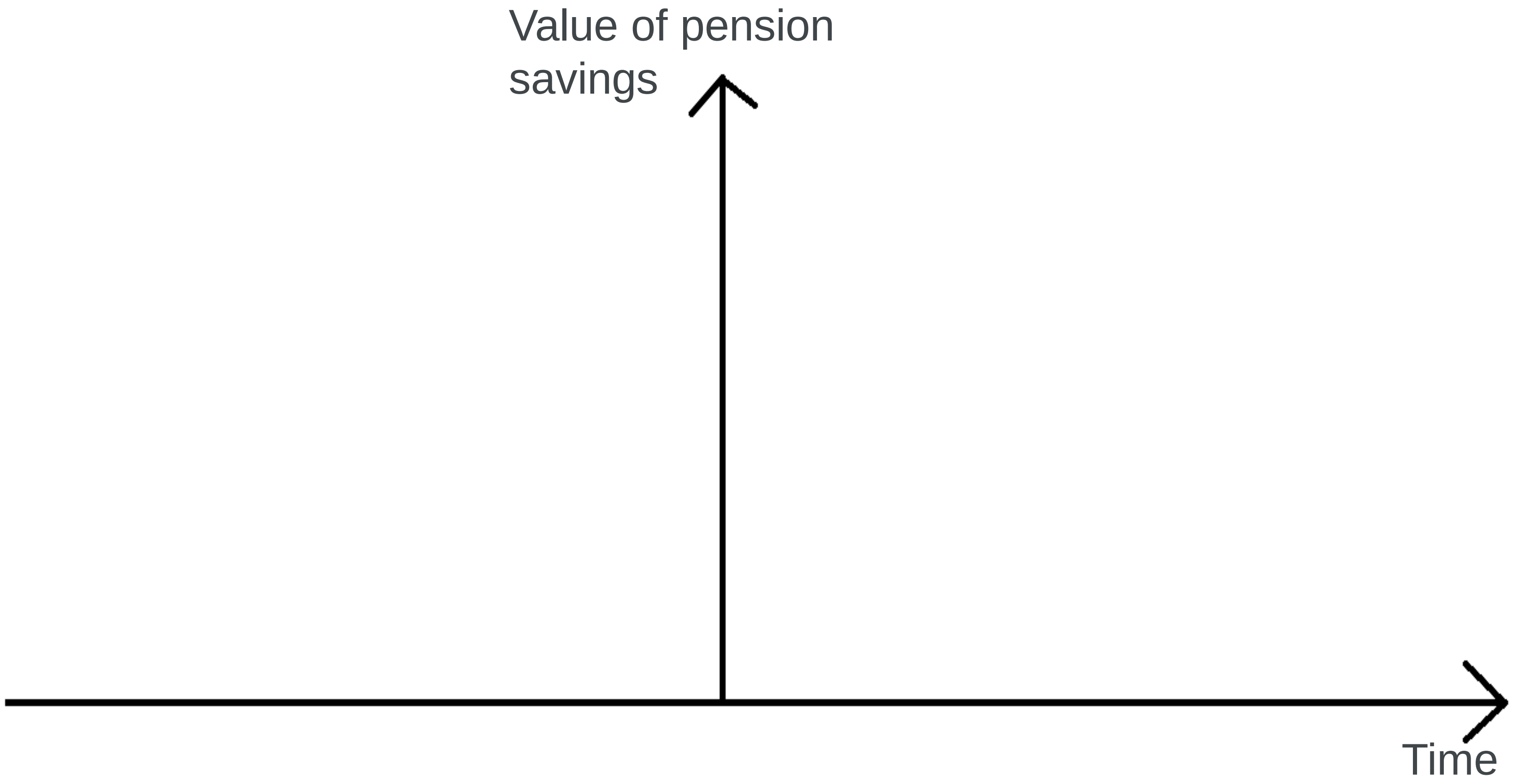
Setting



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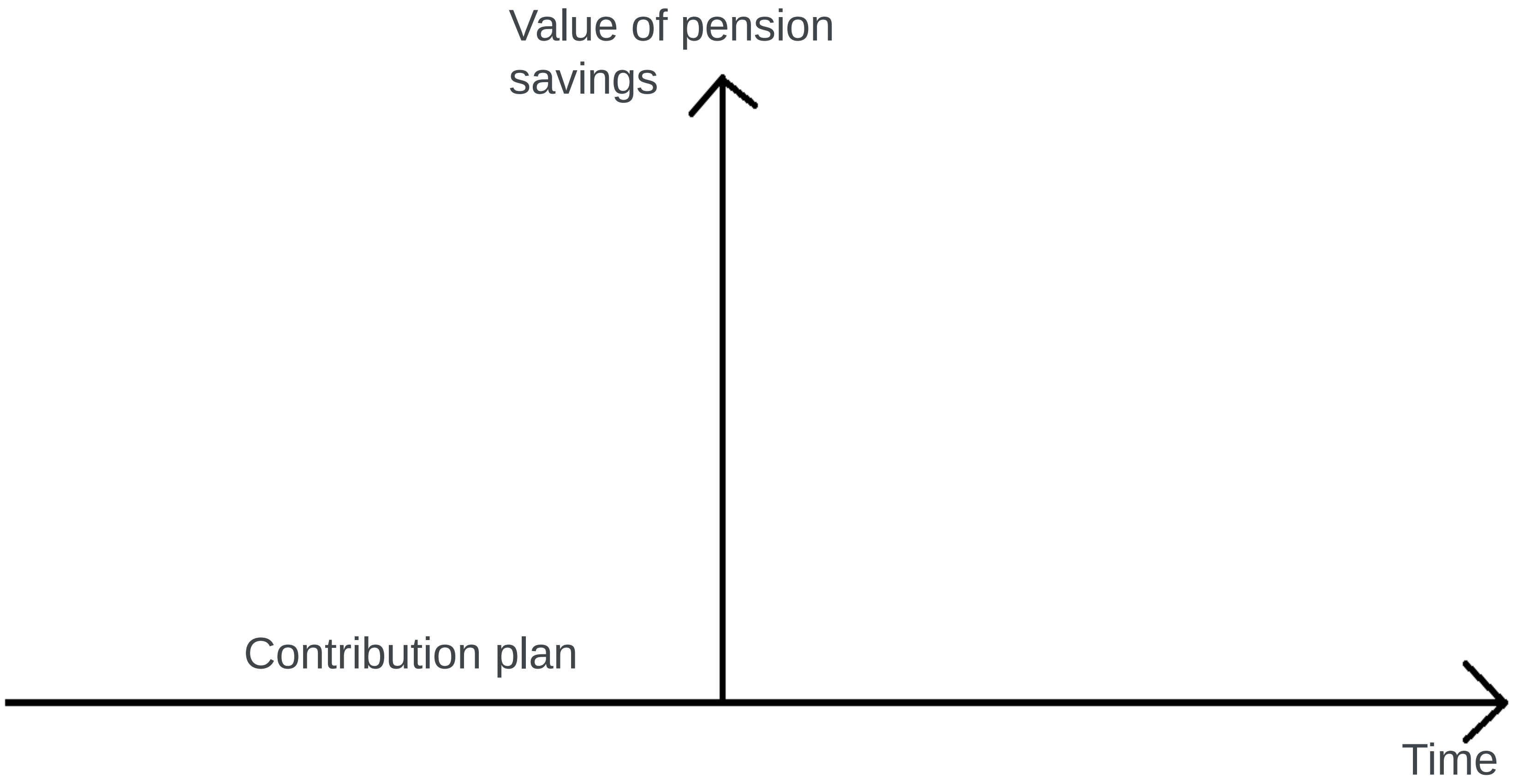

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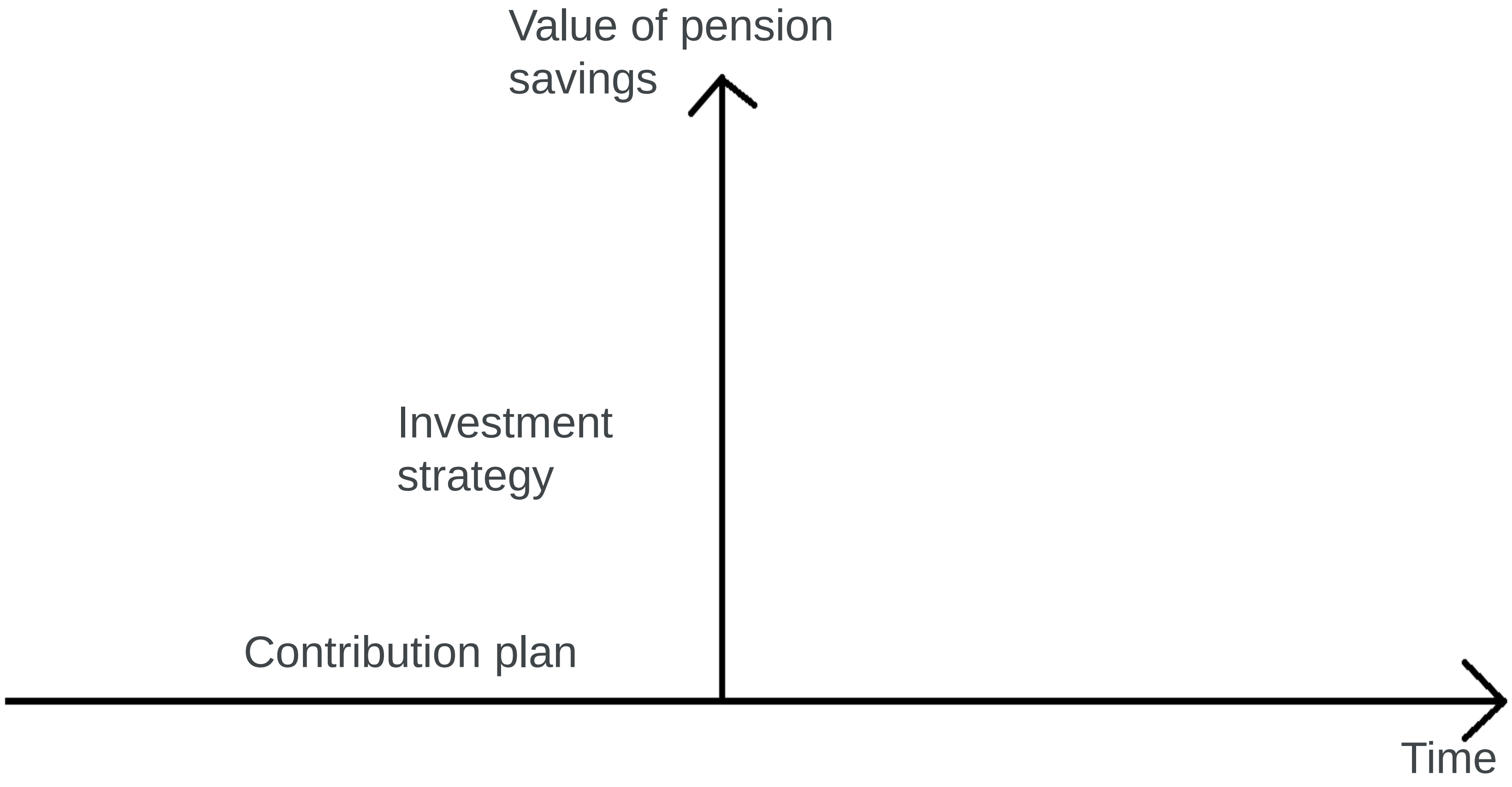
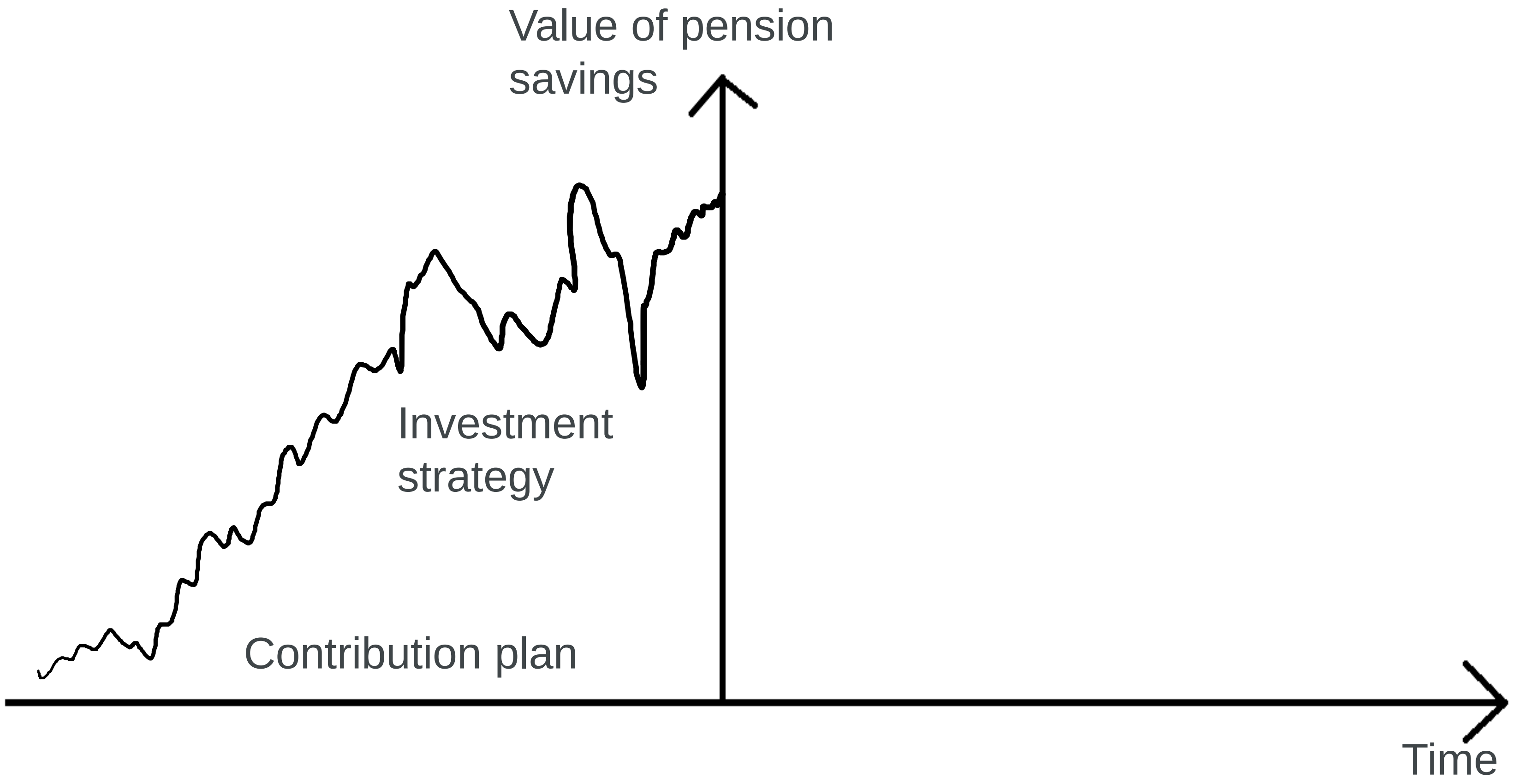


Value of pension savings
Investment strategy
Contribution plan
Time

Setting



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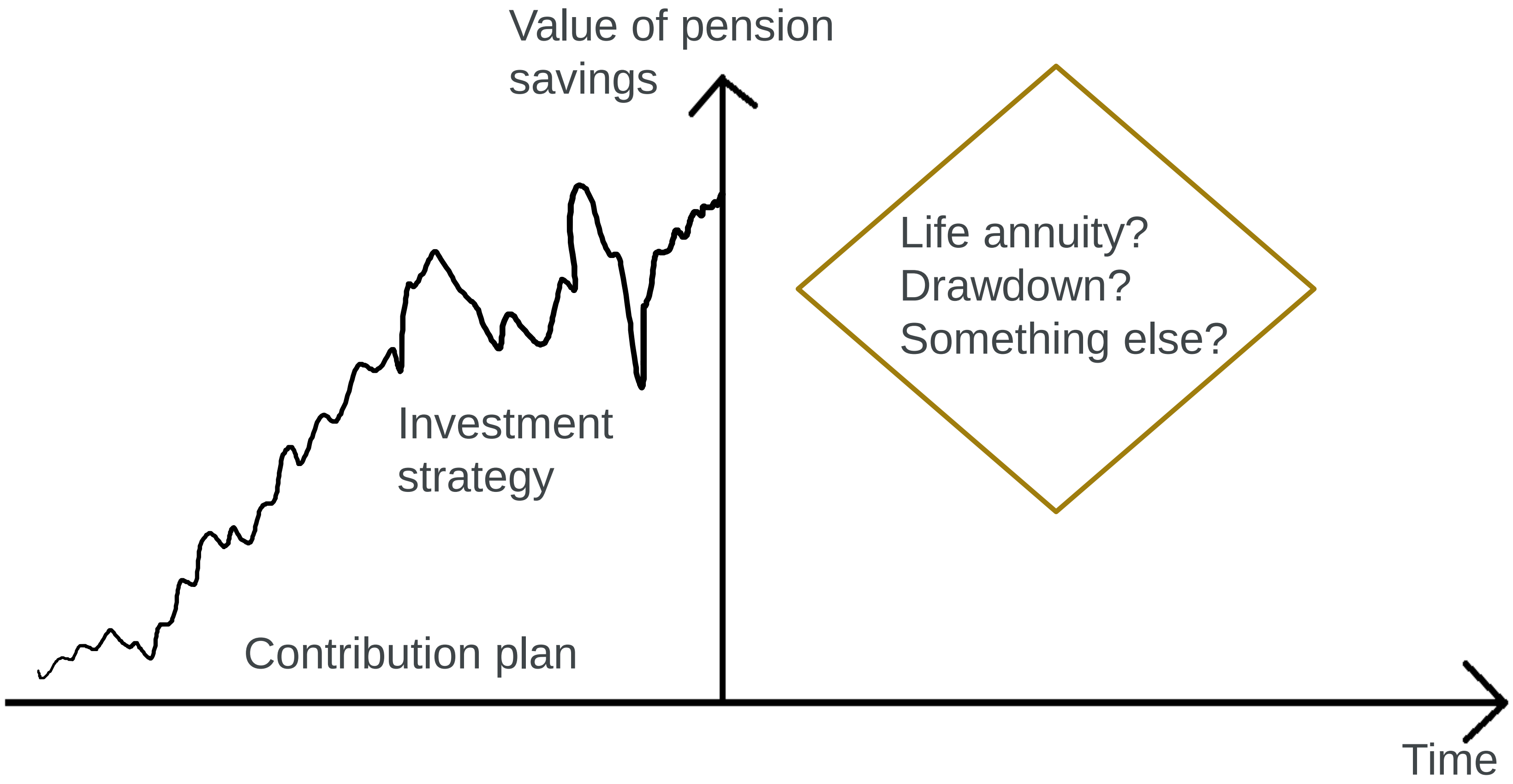

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The present in the UK – DC on the rise

- Defined benefit plans are closing (87% are closed in 2016 in UK).

- Most people are now actively in defined contribution plans, or similar arrangement (97% of new hires in FTSE350).

- Contribution rates are much lower in defined contribution plans

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Size of pension fund assets in 2016
(Willis Towers Watson)

Country	Value of pension fund assets (USD billion)	As percentage of GDP	Of which DC asset value (USD billion)
USA	22’480	121.1%	13’488
UK	2’868	108.2%	516
Japan	2’808	59.4%	112
Australia	1’583	126.0%	1’377
Canada	1’575	102.8%	79
Netherlands	1’296	168.3%	78

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Drawdown

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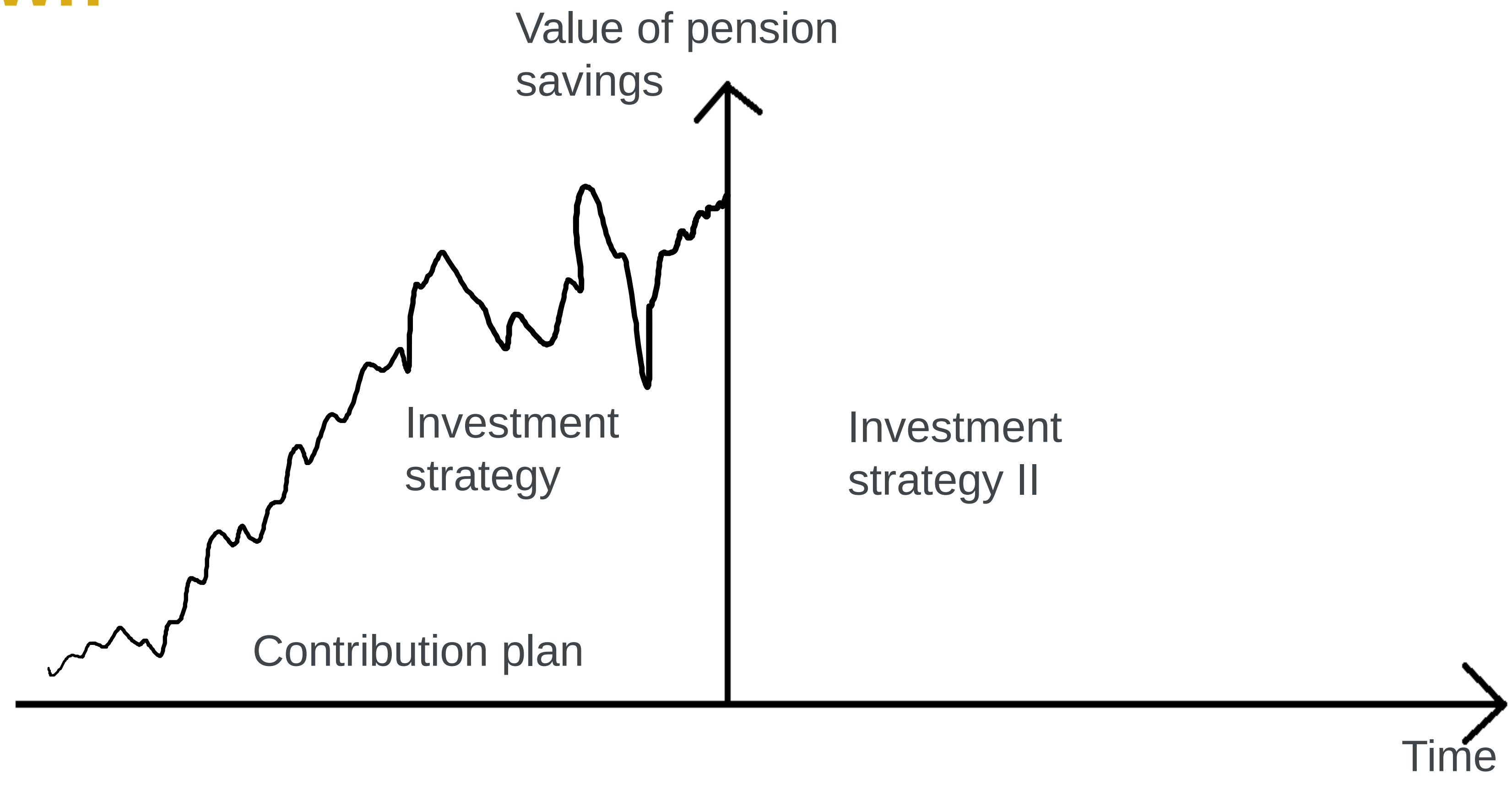
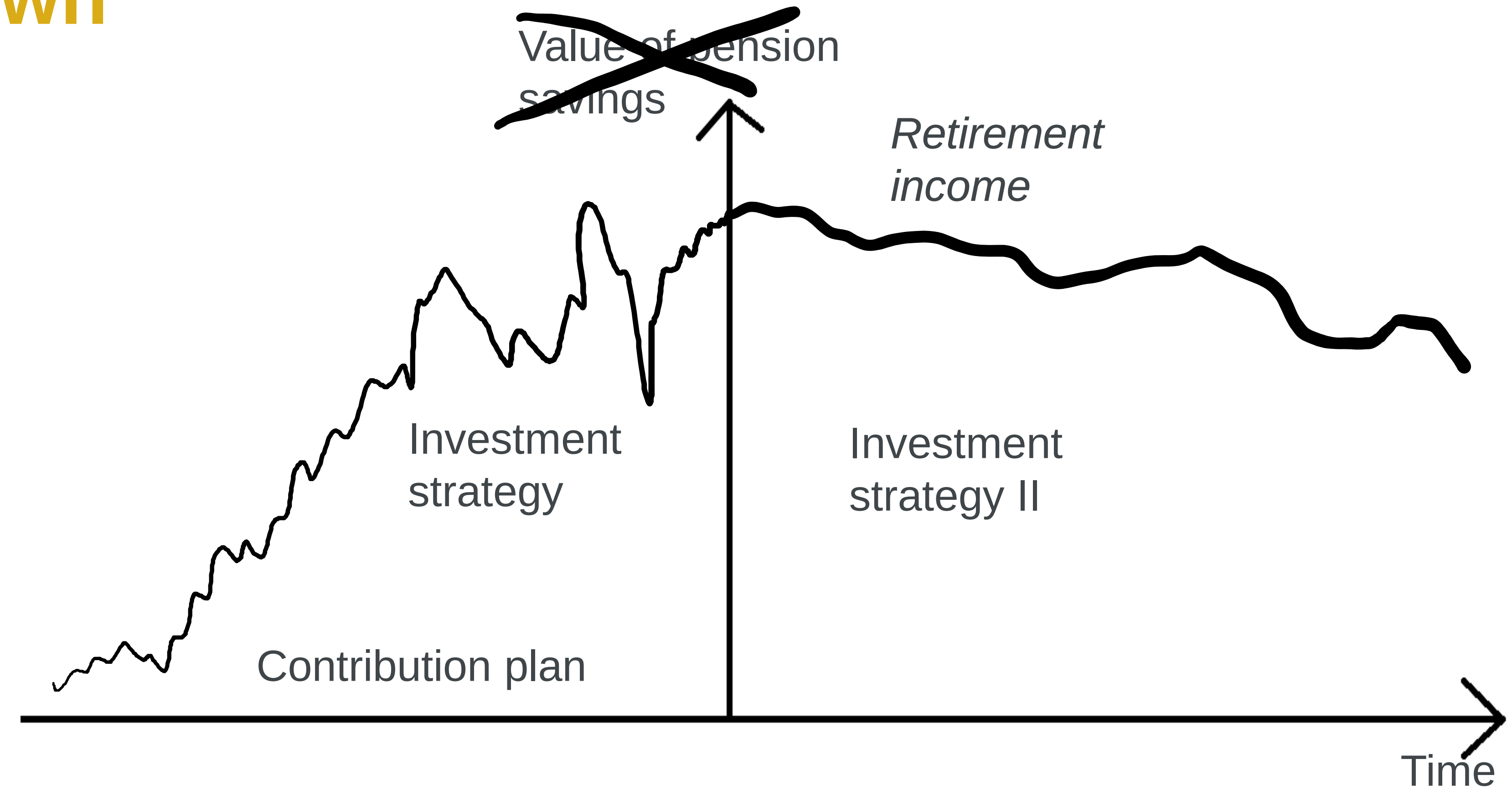
Drawdown


Value of pension savings
Investment strategy
Investment strategy II
Contribution plan
Time

Drawdown



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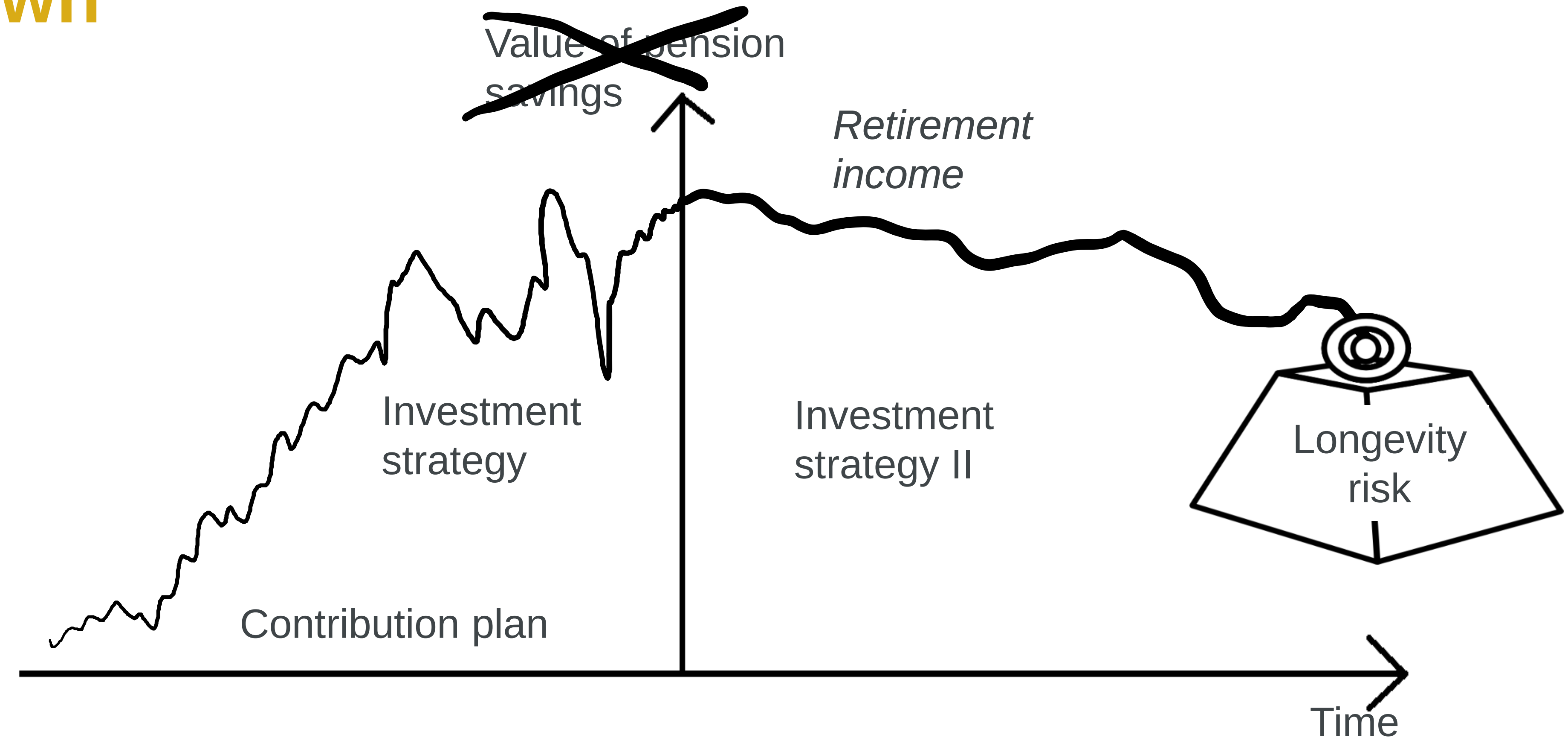
Drawdown



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Life insurance mathematics 101

- PV(annuity paid from age 65) = $a_{\overline{T}|}$

- Expected value of the PV is

$$a_{65} = vp_{65} + v^2\,{}_2p_{65} + v^3\,{}_3p_{65} + v^4\,{}_4p_{65} + \cdots$$

- To use as the price,
  - Law of Large Numbers holds,
  - Same investment strategy,
  - Known investment returns and future lifetime distribution.

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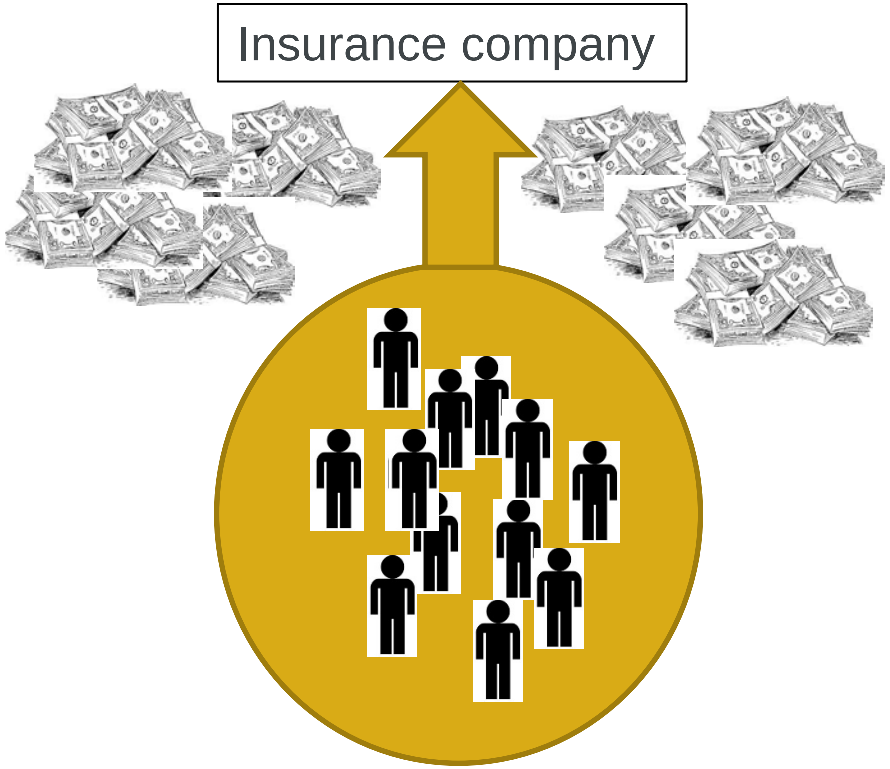
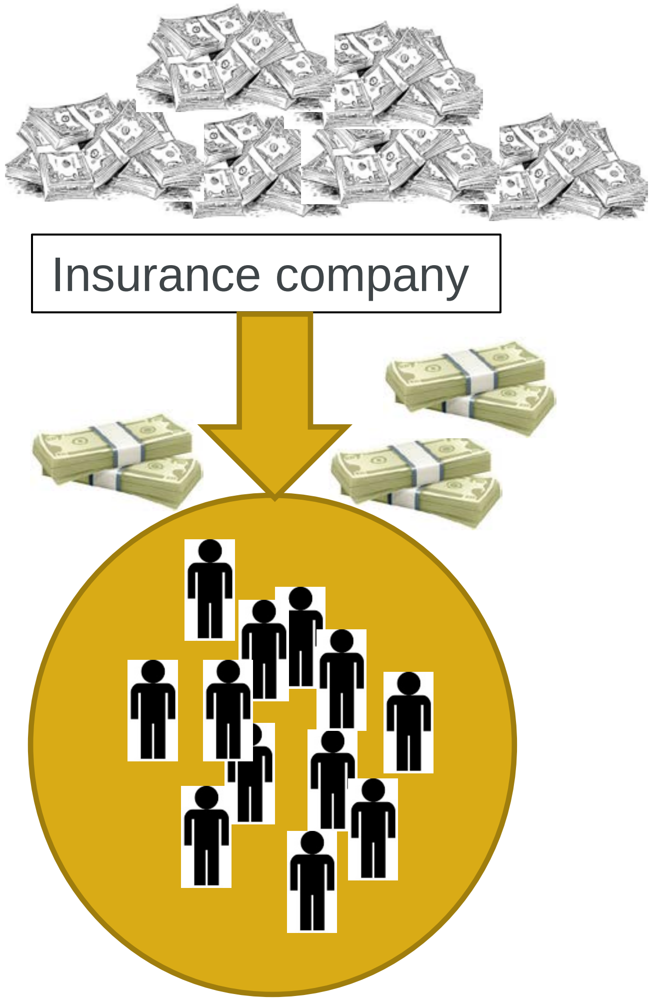
Life annuity contract



Purchase of the
annuity contract



Annuity income

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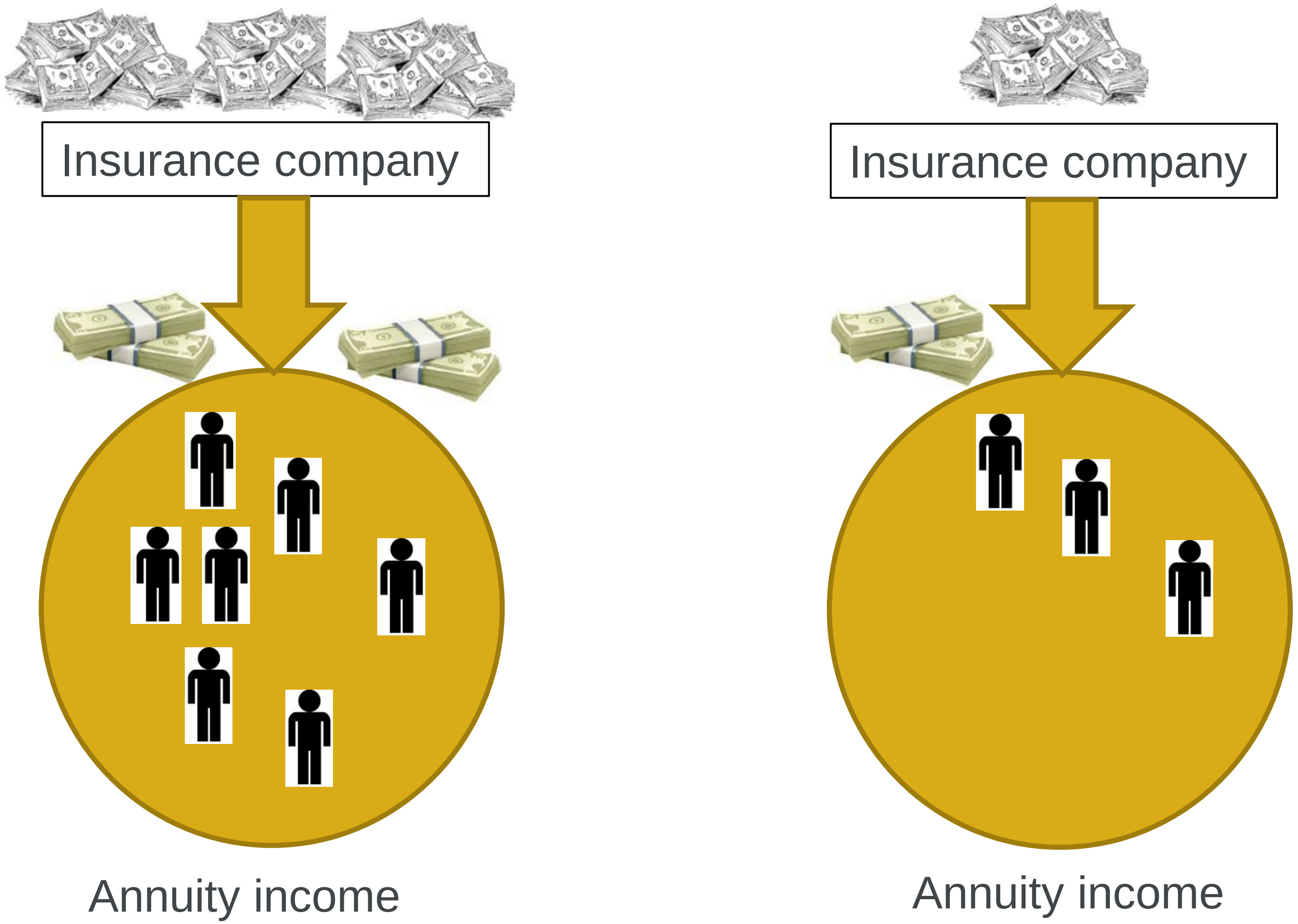
Life annuity contract



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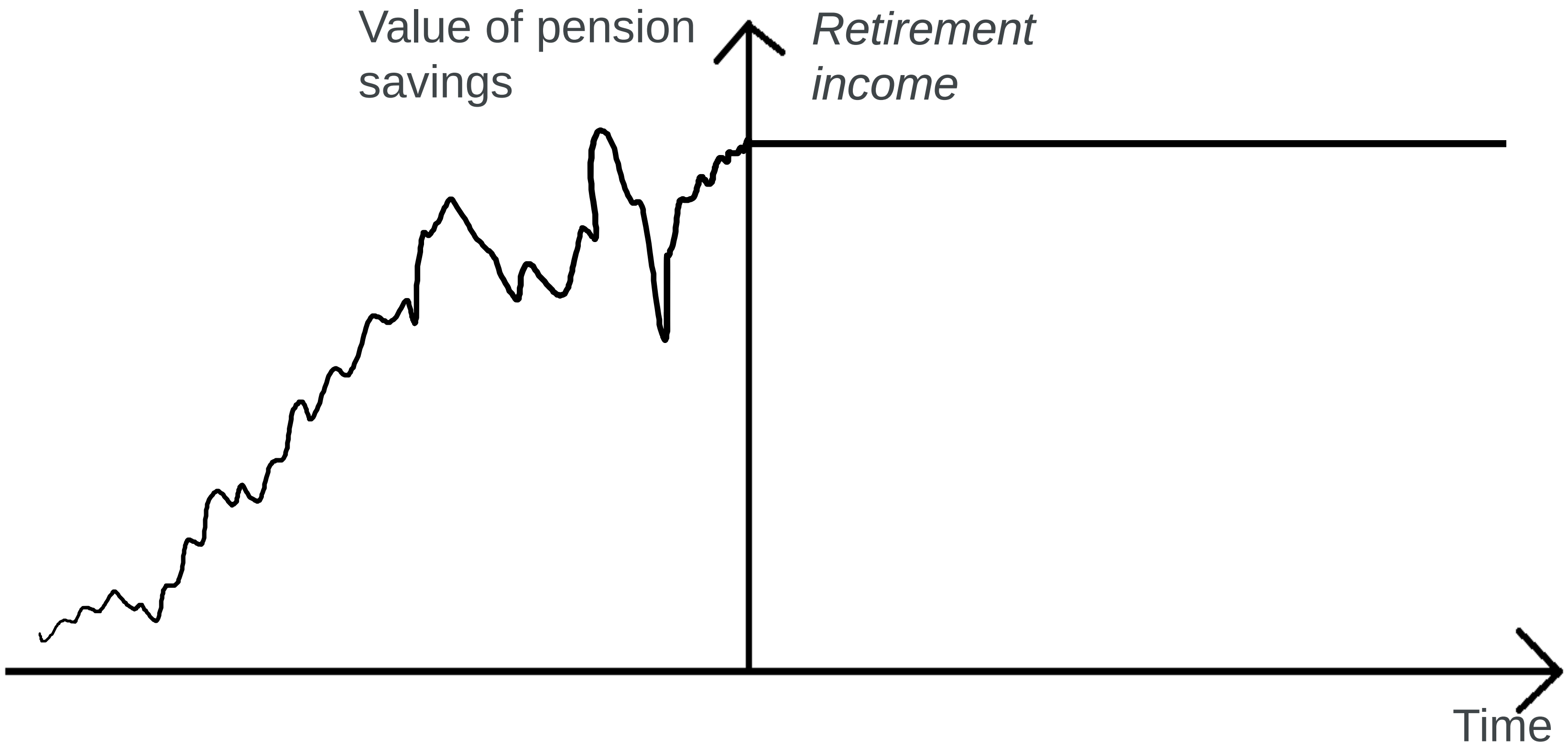
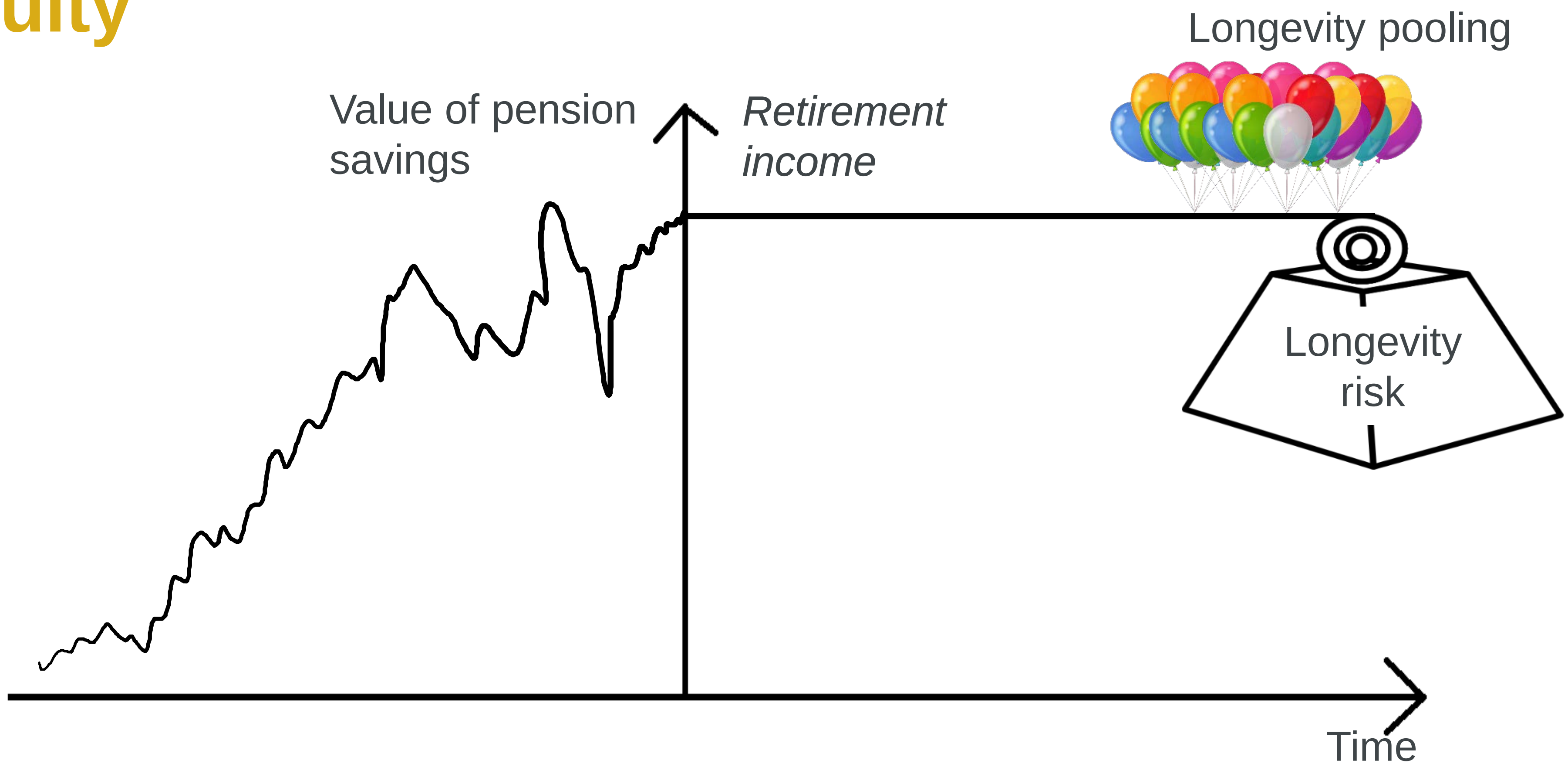
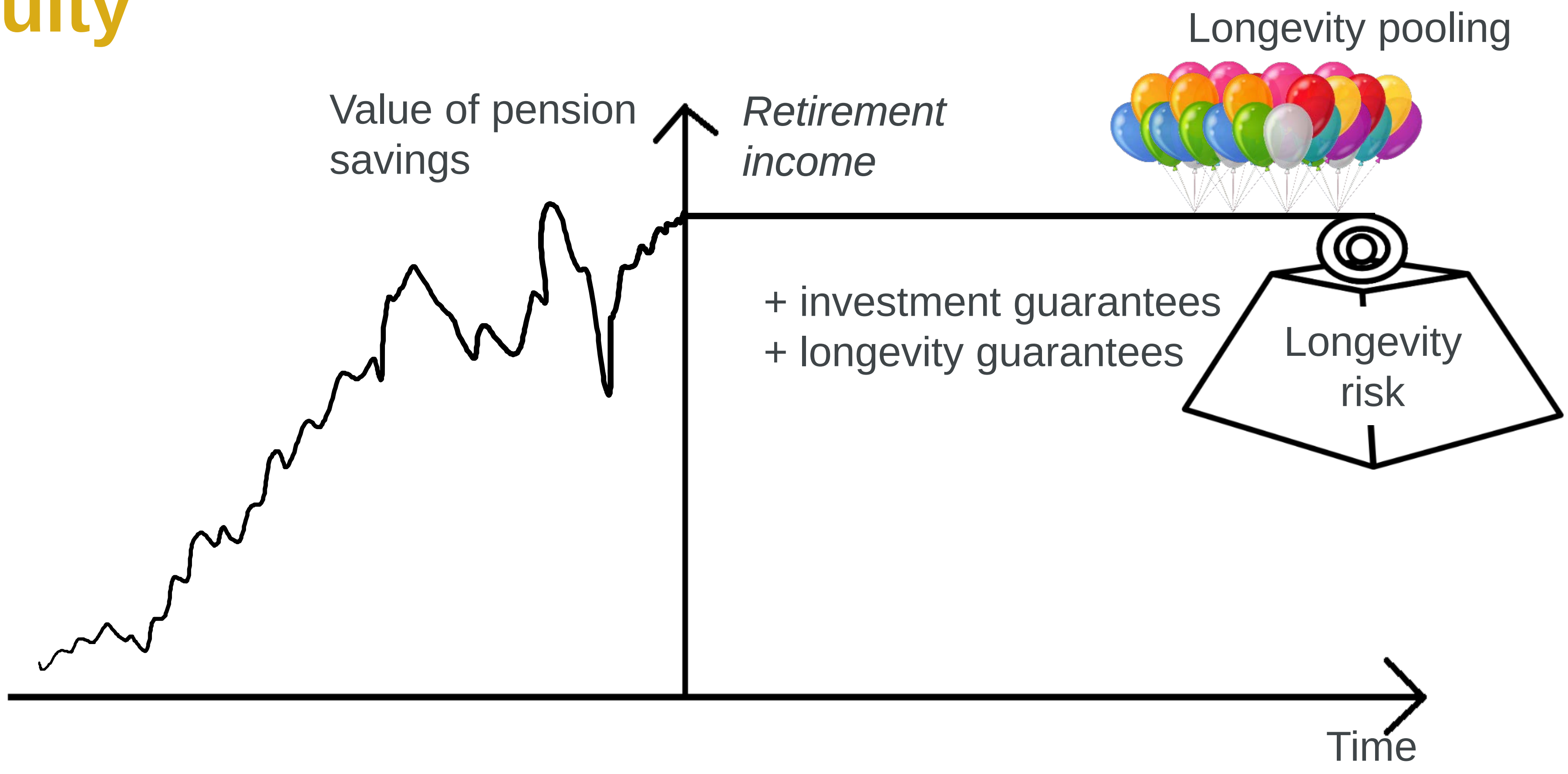
Life annuity



Life annuity



Life annuity



Life annuity contract

- Income drawdown vs life annuity: if follow same investment strategy then life annuity gives higher income*

*ignoring fees, costs, taxes, etc.

- Pooling longevity risk gives a higher income.

- Everyone in the group becomes the beneficiaries of each other, indirectly.

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Annuity puzzle

- Why don't people annuitize?

- Can we get the benefits of life annuities, without the full contract?

- Example showing income withdrawal from a tontine.

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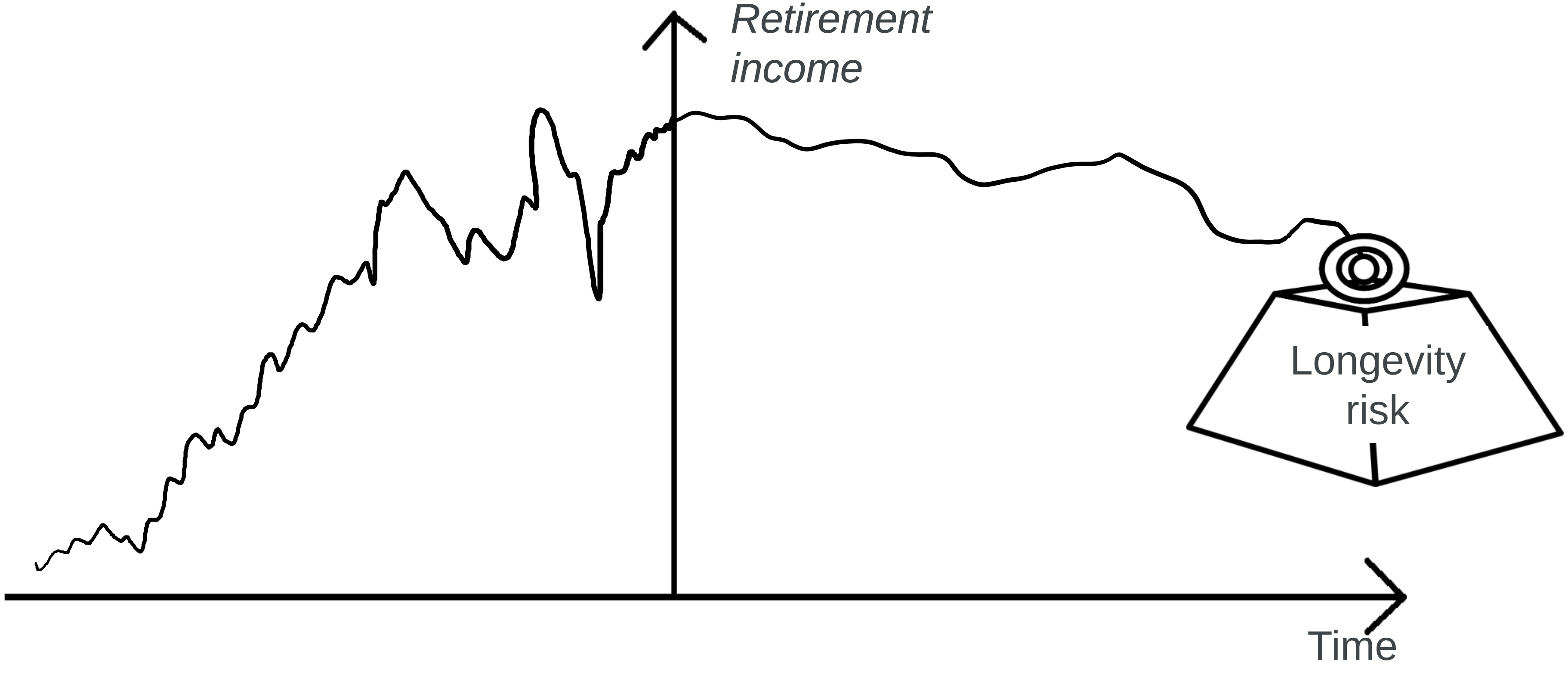
Drawdown



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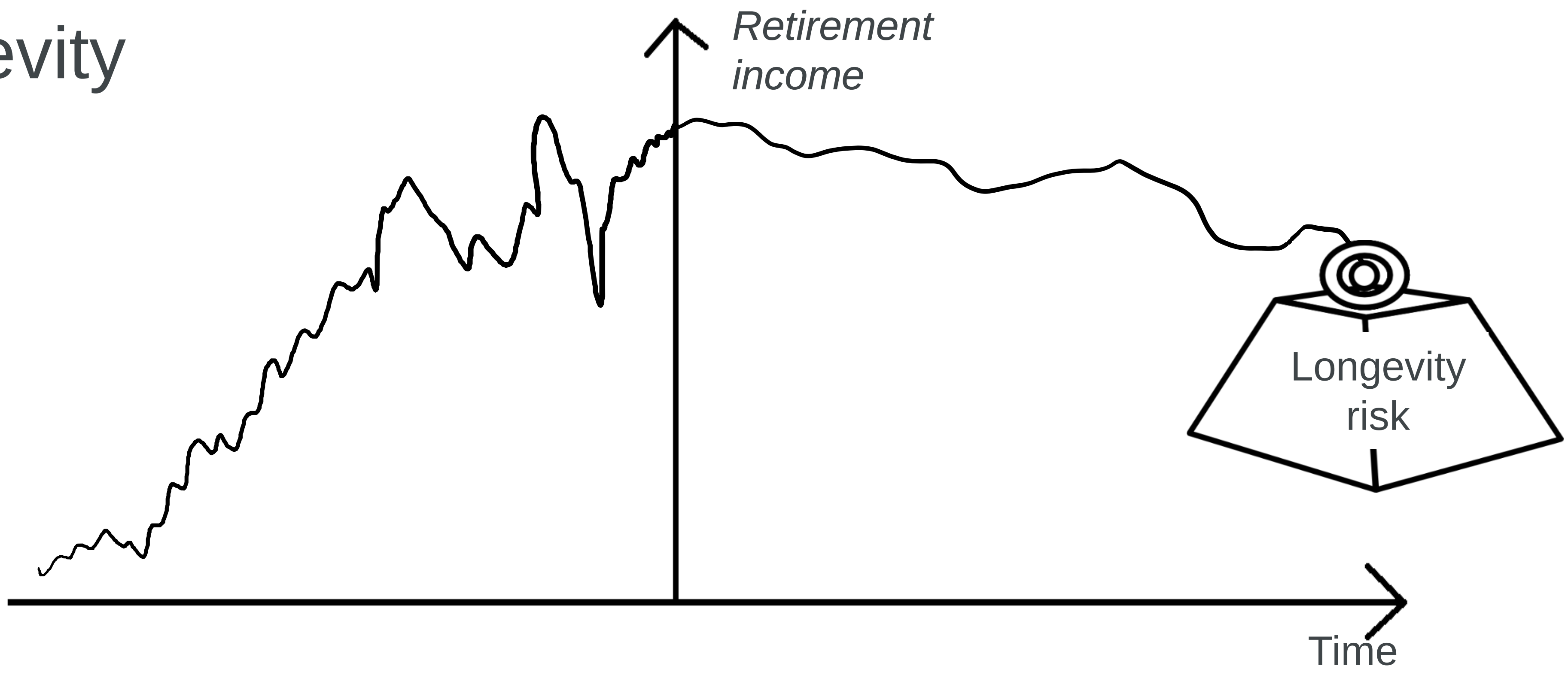
Drawdown

+ Longevity pooling



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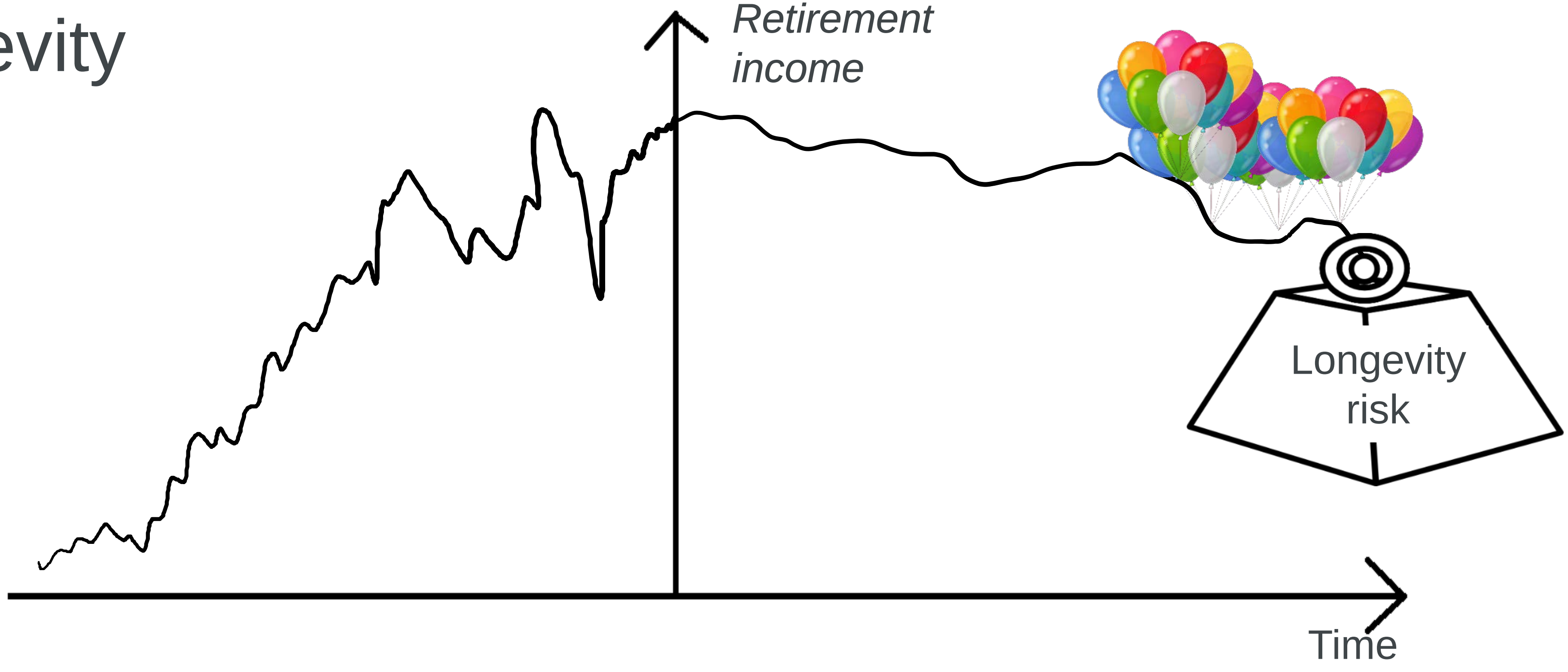
Drawdown

+ Longevity pooling



Drawdown

+ Longevity pooling

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Aim of modern tontines

- Aim is to provide an income for life.
- It is not about gambling on your death or the deaths of others in the pool.
- It should look like a life annuity.
- With more flexibility in structure.
- Example is based on an explicitly-paid longevity credit.

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Example 0: Simple setting of 4% Rule

- Pension savings = £100,000 at age 65.
- Withdraw £4,000 per annum at start of each year until funds exhausted.
- Investment returns = Price inflation + 0%.
- No longevity pooling.

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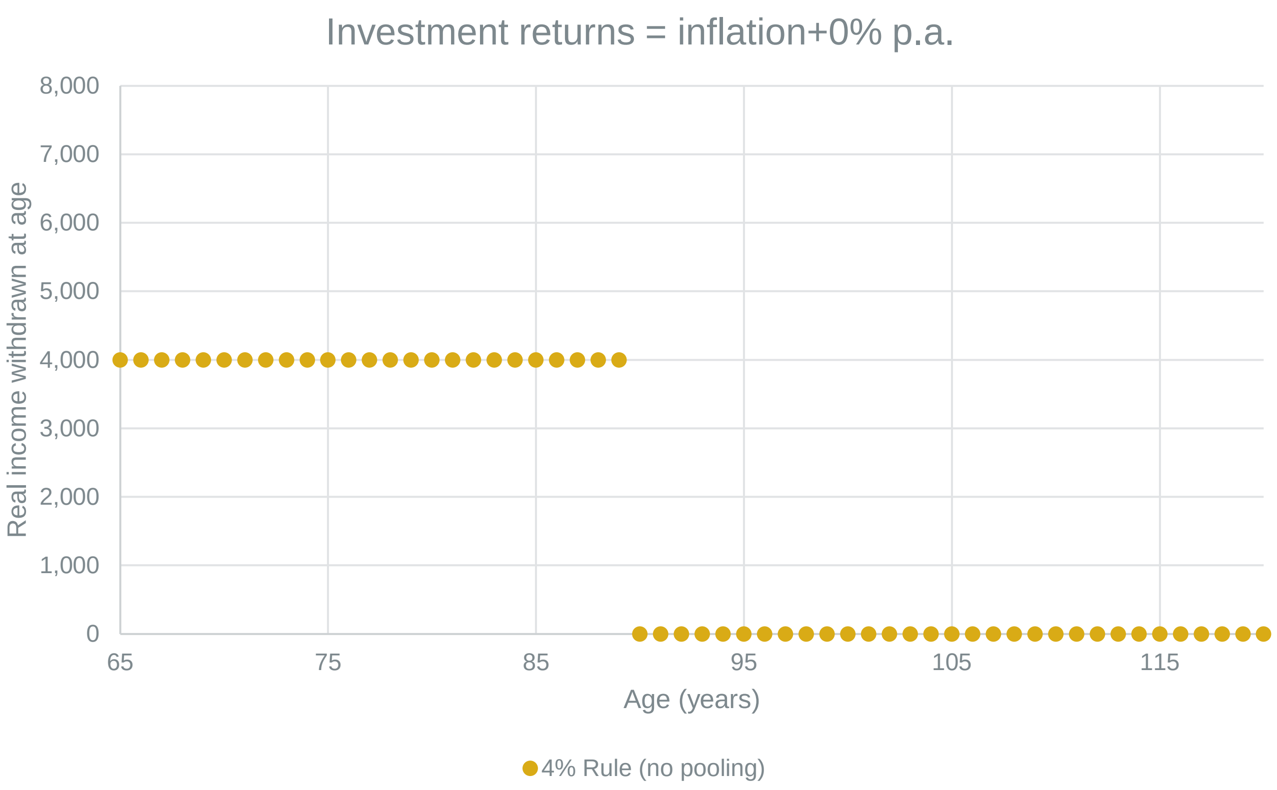
Example 0: income drawdown (4% Rule)



Example 1: Join a tontine

- Same setup except…pool all of asset value in a tontine for rest of life.

- Withdraw a maximum real income of £*X* per annum for life

(we show *X* on charts to follow).

- Mortality table S1PMA.

- Assume a perfect pool: longevity credit=its expected value.

- Longevity credit paid at start of each year.

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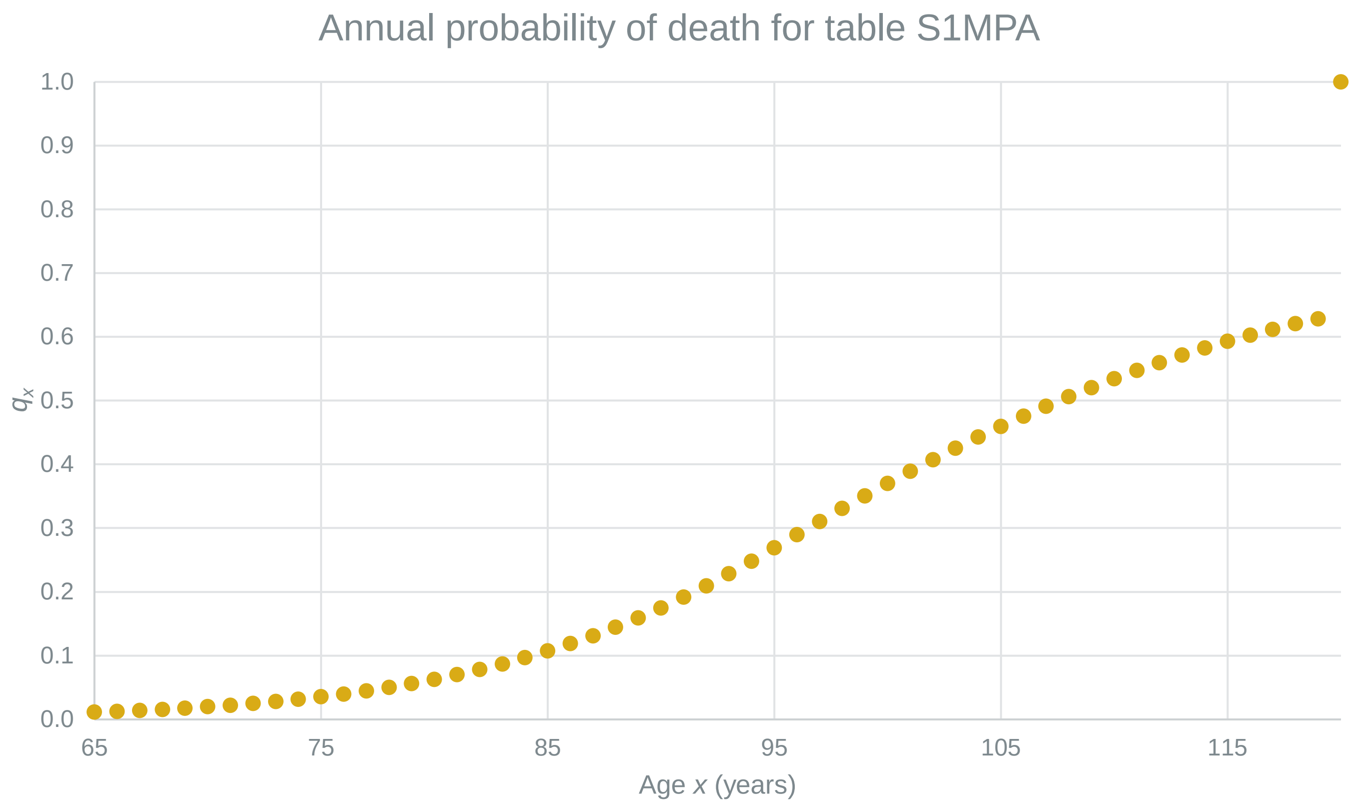
UK mortality table S1PMA



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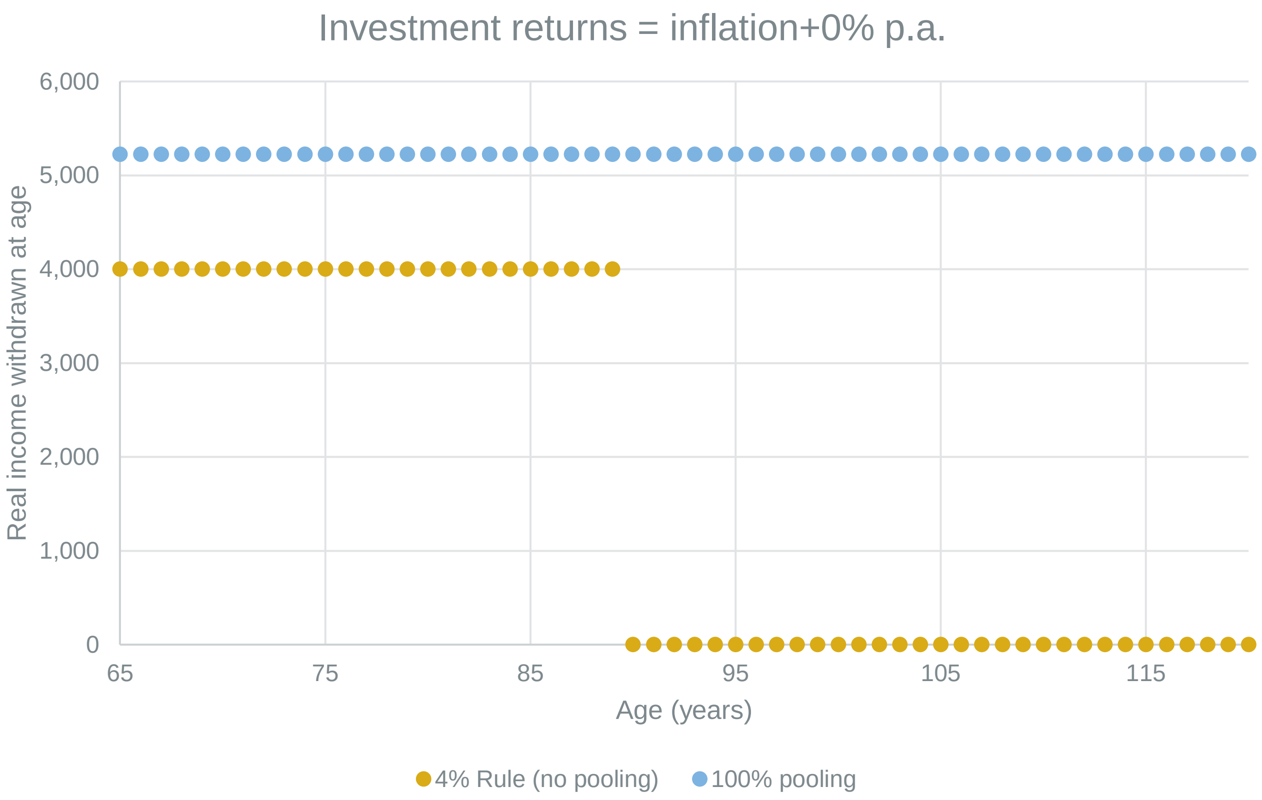
Example 1i:
0% investment returns above inflation



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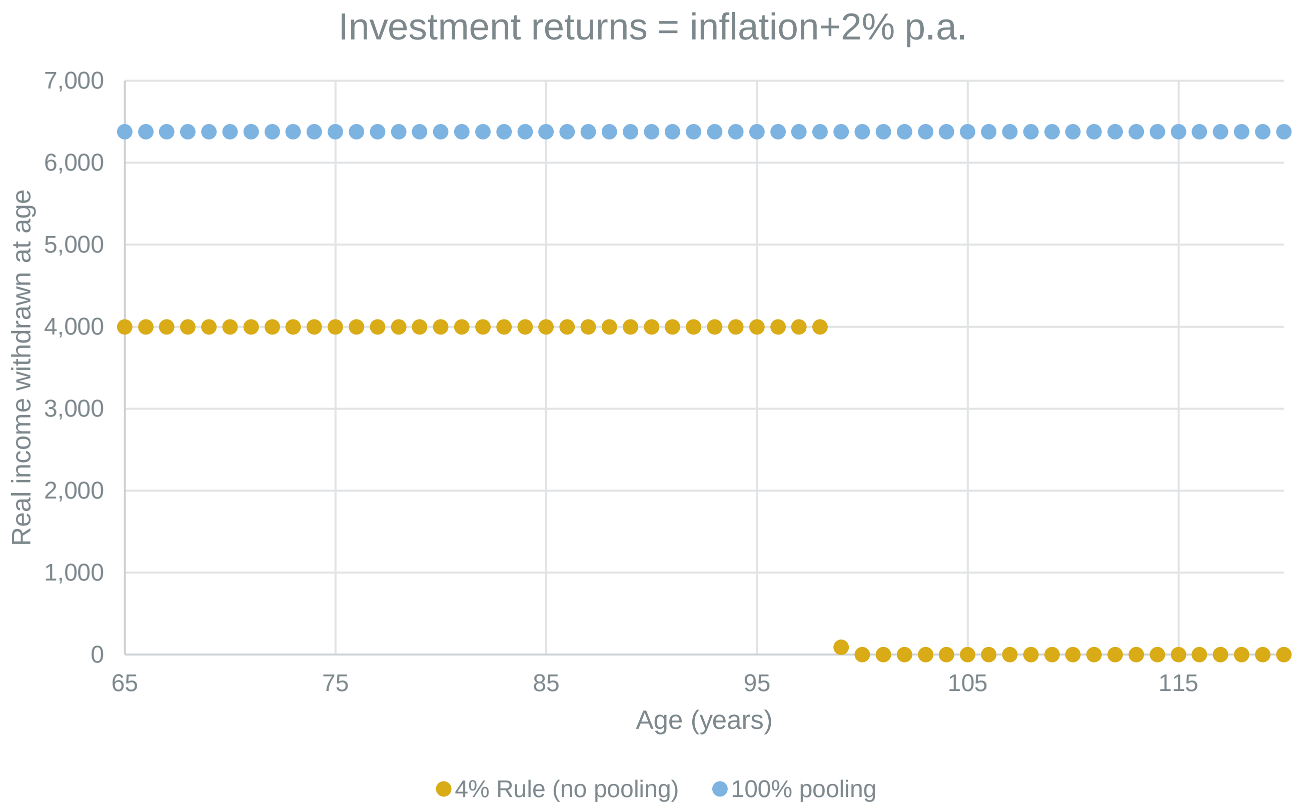
Example 1ii:
+2% p.a. investment returns above inflation



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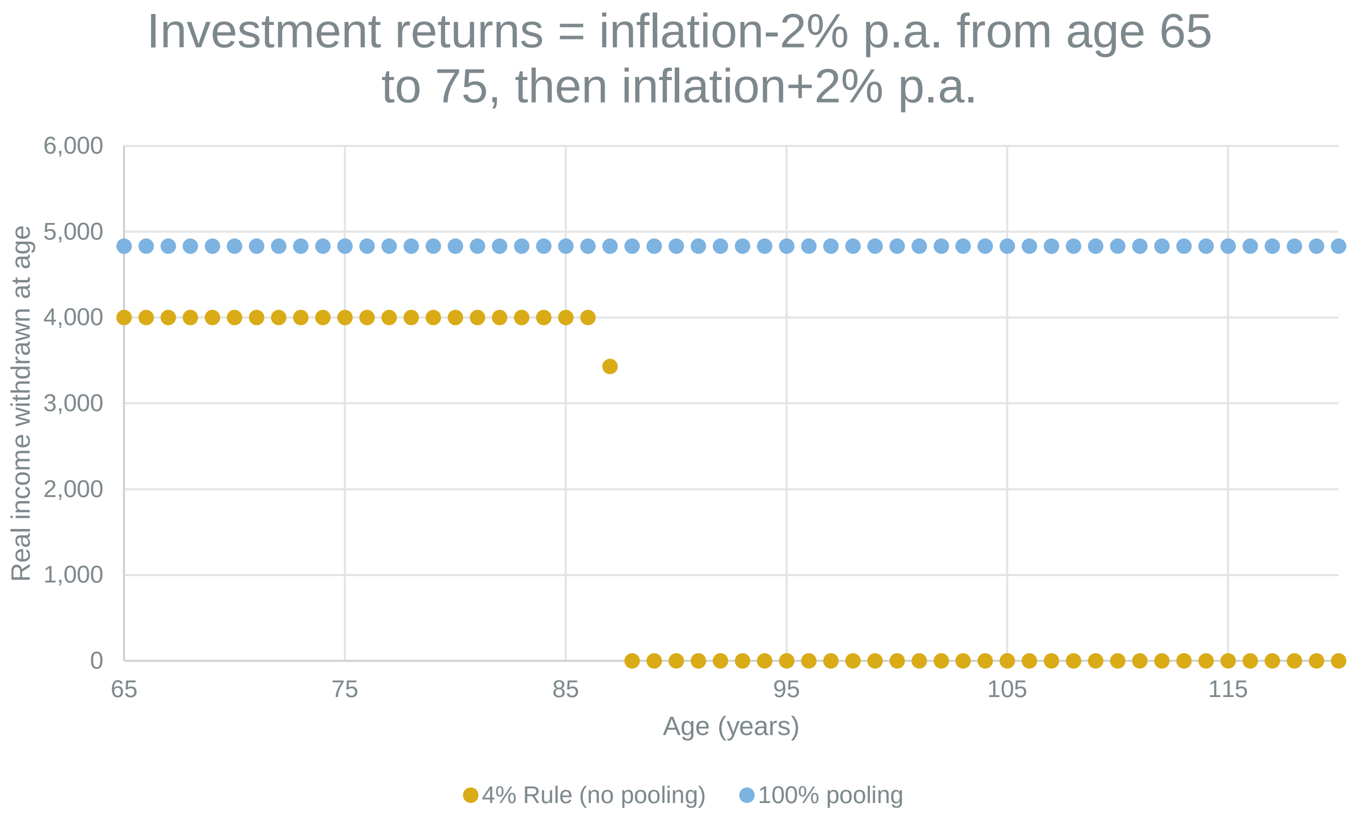
Example 1iii: Inv. Returns = Inflation – 2% p.a. from age 65 to 75, then Inflation +2% p.a.



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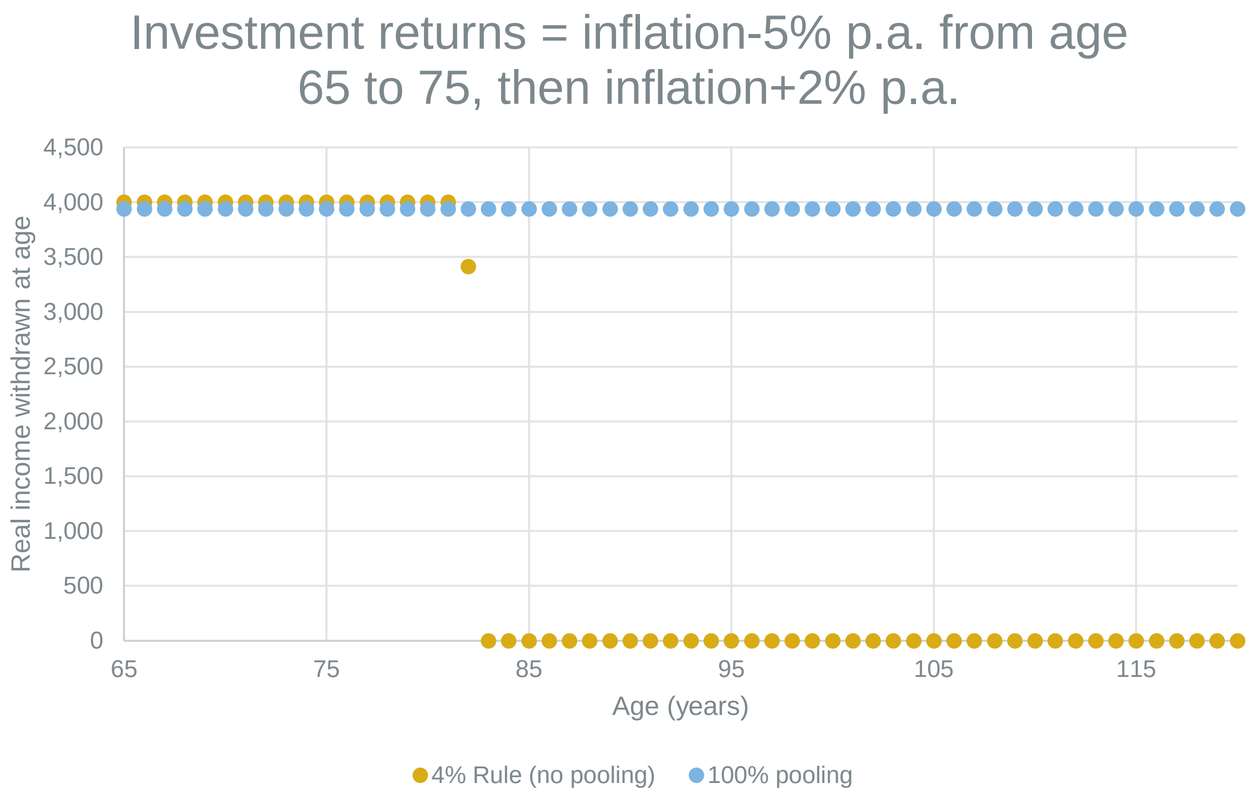
Example 1iv: Inv. Returns = Inflation – 5% p.a. from age 65 to 75, then Inflation +2% p.a.



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Overview of entire session

- Motivation
- **One way of pooling longevity risk**
- Discussion

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II. One way of pooling longevity risk

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

- [DGN] method of pooling longevity risk
  – Explicit scheme.
  – Everything can be different: member characteristics, investment strategy.

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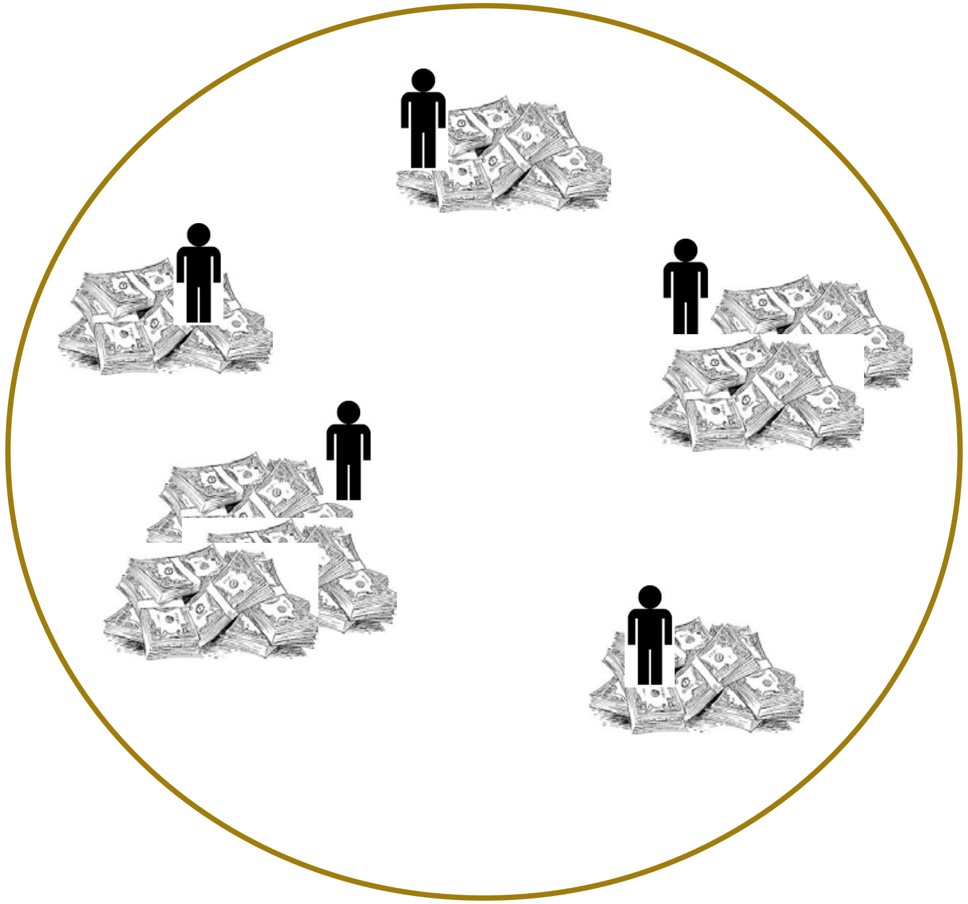
Longevity risk pooling



Pool risk over lifetime

Individuals make their own investment decisions

Individuals withdraw income from their own funds

However, when someone dies at time *T*…

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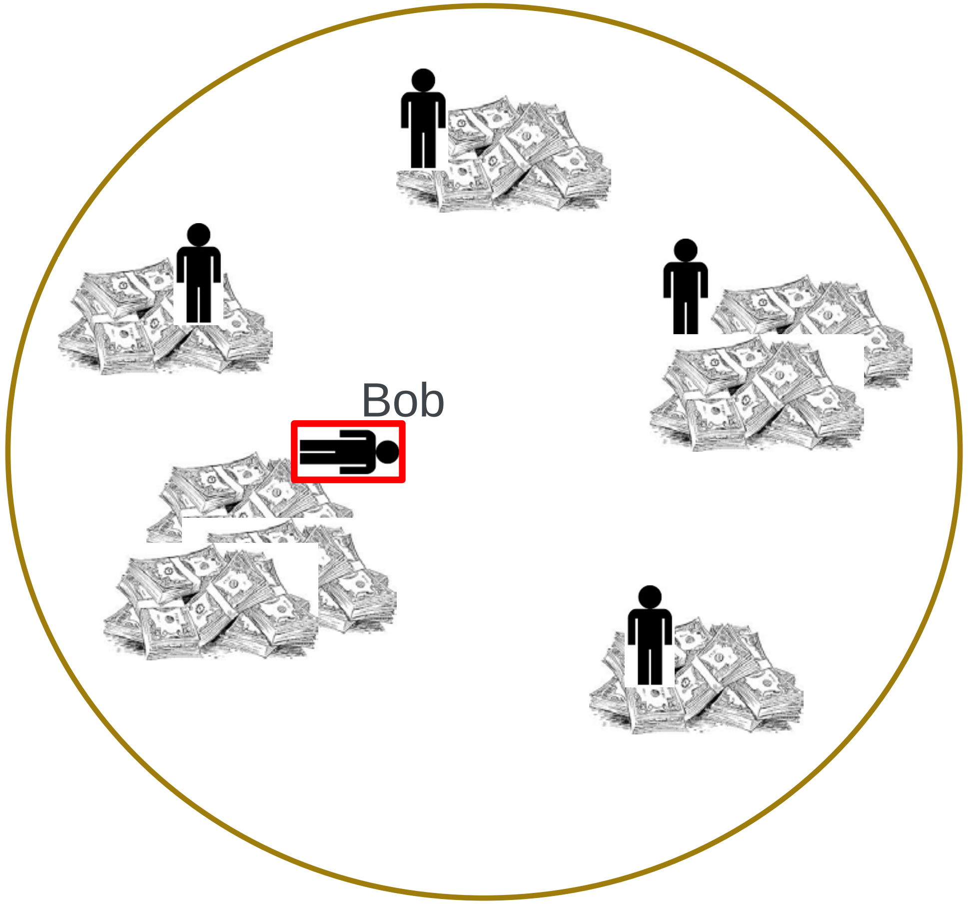
Longevity risk pooling



Share out remaining funds of Bob.

Longevity risk pooling rule [DGN]

- $\lambda^{(i)}$ = Force of mortality of i^{th} member at time T.

- $W^{(i)}$ = Fund value of i^{th} member at time T.

- Payment (longevity credit) to i^{th} member:

$$\frac{\lambda^{(i)} \times W^{(i)}}{\sum_{k \in Group} \lambda^{(k)} \times W^{(k)}} \times \{\text{Bob's remaining fund value}\}$$

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Longevity risk pooling [DGN] - features

- There will always be some volatility in the longevity credit:
  - Actual value ≠ expected value (no guarantees)
  - But longevity credit ≥ 0, i.e. never negative.
  - Loss occurs only upon death.

- Volatility in longevity credit can replace investment return volatility.

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Longevity risk pooling - features

- Increase expected lifetime income
- Reduce risk of running out of money before death
- Non-negative return, except on death
- Update force of mortality, periodically.

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Longevity risk pooling - features

- Actuarially fair for any group of people (via payment to Bob, too)

- ``Cost'' is paid upon death, not upfront like life annuity.

- Mitigates longevity risk, but does not eliminate it.

- Anti-selection risk remains, as for life annuity.

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Longevity risk pooling - features

- Under certain conditions*, can re-create a life annuity.

*e.g. correct forces of mortality, Law of Large Numbers holds,...

- Comparing:
  a) Longevity risk pooling, versus
  b) Equity-linked life annuity, paying actuarial return $(\lambda^{(i)} - \text{Fees}) \times W^{(i)}$.

Fees have to be <0.5% for b) to have higher expected return in a moderately-sized (600 members), heterogeneous group [DGN].

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Longevity risk pooling - features

- Splits investment return from longevity credit to enable:
  - Fee transparency,
  - Product innovation.

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Longevity risk pooling – some ideas

- Insurer removes some of the longevity credit volatility, e.g. guarantees a minimum payment for a fee [DY].

- Allow house as an asset – monetize without having to sell it before death [DY].

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Longevity risk pooling – some ideas

Pay out a regular income with the features:

- Each customer has a ring-fenced fund value.
- Explicitly show investment returns and longevity credits on annual statements.
- Long waiting period before customer’s assets are pooled, to reduce adverse selection risk, e.g. 10 years.
- More income flexibility.
- Opportunity to withdraw a lumpsum from asset value.
- Update forces of mortality periodically.

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Summary

- Motivation is to provide a higher income in retirement.
- May also result in a higher bequest.
- Reduces chance of running out of money in retirement.
- Transparency may encourage more people to “annuitize”.

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- [DY] Donnelly, C. and Young (2017). J. Product options for enhanced retirement income. *British Actuarial Journal,* 22(3).
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Questions

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Example 3 – [DGN] rule in action

- Assume a very small group of four people: A, B, C and D.
- All have the same force of mortality.
- A has the lowest wealth, D has the highest.
- Look at what happens when one of them dies.
- This is for illustration only – I am not recommending operating a tontine with 4 people.

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Example 3(i): A dies

Member	Force of mortality	Fund value before A dies	Force of mortality x Fund value	Longevity credit from A's fund value = 100 x (4)/Sum of (4)	Fund value afer A dies
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
A	0.01	100	1	10	10 = 100-100+10
B	0.01	200	2	20	220 = 200+20
C	0.01	300	3	30	330 = 300+30
D	0.01	400	4	40	440 = 400+40
Total		**1000**	**10**	**100**	**1000**

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Example 3(ii): D dies

Member	Force of mortality	Fund value before D dies	Force of mortality x Fund value	Longevity credit from D's fund value = 400 x (4)/Sum of (4)	Fund value afer D dies
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
A	0.01	100	1	40	140 = 100+40
B	0.01	200	2	80	280 = 200+80
C	0.01	300	3	120	420 = 300+120
D	0.01	400	4	160	160 = 400-400+160
Total		**1000**	**10**	**400**	**1000**

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