Turning pension plans into pension planes: What investment strategy designers of defined contribution pension plans can learn from commercial aircraft designers

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Motivation

- Use aircraft design and airline journey to provide lessons to explain investment strategy in DC pension plan:
  - During both accumulation and decumulation stages
- Recognise individuals are not ‘intelligent consumers’
  - Therefore constructive role for regulation

Please fasten your seatbelts: Lessons from the aviation industry

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Airline journeys are safe

Table 1 Passenger deaths by mode of transport (Rate per billion passenger kilometres, Great Britain)	
	Average 1981 - 2003
Motorcycle	95.83
Walking	66.07
Pedal cycle	44.60
Car	3.76
Van	2.03
Water	1.95
Rail	0.66
Bus or coach	0.37
Air	0.12
Sources: Table 12.21, *Social Trends 30* (2000) and *Social Trends 36* (2006)	

Risks by stage of flight are known

Table 2 Distribution of accidents and fatalities by stage of flight, 1996-2005			
	Percentages		
	Accidents[a]	Fatalities[b]	Exposures[c]
Taxi, load, parked	8	1	-
Takeoff	12	11	1
Initial climb	5	16	1
Climb (flaps up)	8	26	14
Cruise	6	14	57
Descent	2	3	11
Initial approach	7	14	12
Final approach	6	13	3
Landing	46	2	1
Notes: a) Hull loss and/or fatal accidents, b) Onboard fatalities, c) Percentage of flight time (based on flight duration of 1.5 hours)			
Source: Boeing Commercial Airlines (2006, p 16)			

Sources of risk are known

Table 3 Distribution of accidents by primary cause, 1996-2005	
	Percentages
Flight crew	55
Airplane	17
Weather	13
Airport/air traffic control	5
Maintenance	3
Other (including running out of fuel)	7
Source: Boeing Commercial Airlines (2006, p 17)	

Why so much effort into design of commercial aircraft?

- Because of *immediate* and very public reputational damage to both designer and operator from catastrophic design failure
- Airline passengers might not know much about technical issues of aircraft design
- But they can certainly identify a catastrophic design failure when they see one
- They can be classified as ‘intelligent consumers’

How are DC pension plan investment strategies currently designed?

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DC plans have three stages

- Initial marketing stage
- Accumulation stage
- Decumulation stage

- There is currently very little connection between them

- Current design of DC plans is VERY poor

- No equivalent of MDO!
  - Multi-disciplinary design optimisation

Why?

- Because potential pension plan member generally has poor understanding of:
  - each stage
  - resources required and risks involved in delivering adequate pension in retirement

- So NOT dealing with ‘intelligent consumers’

As a consequence..

- Plan providers have very little incentive to give much thought to pension plan design:
  - let alone take an integrated approach to it

As a consequence..

- Sales staff:
  - no further interest once member signed up
- Fund manager:
  - no target retirement lump sum to reach
- Annuity provider:
  - just annuitises realised lump sum
  - but no concern about standard of living this might provide to plan member

Let's look at typical current investment strategy

(Remember – no target retirement fund level!)

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Fund manager will try to invest contributions in portfolio of assets in accordance with plan member's attitude to risk

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Single-period investment strategy

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Simplest asset allocation model in academic literature is myopic or single-period portfolio choice model

$$Weight\ in\ equities = \frac{Equity\ premium}{Risk\ penalty}$$

$$Equity\ premium = Expected\ return\ on\ equities - Return\ on\ cash$$

$$Risk\ penalty = Risk\ aversion' Volatility\ of\ equities$$

$$Weight\ in\ cash = 1 - Weight\ in\ equities$$

Pension fund is in existence for many periods

Therefore need to extend our analysis to multi-period setting

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Multi-period investment strategy with time-varying investment opportunities and mean reversion

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Strategic asset allocation

- Mean reversion ⟹
  - high equity weighting
  - due to time diversification

- Time-varying investment opportunities ⟹
  - investors should engage in market timing

How relevant is all this to a DC plan member?

Not much!

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Fund managers poor market timers!

Table 5 Performance of UK Pension Funds in Comparison with the Market, 1986-1994 (Percentages)					
	Average market return	*Average pension fund return*	*Average out-performance*	*Average pension fund portfolio weight*	*Percentage out-performers*
UK equities	13.30	12.97	-0.33	53.7	44.8
International equities	11.11	11.23	0.12	19.5	39.8
UK bonds	10.35	10.76	0.41	7.6	77.3
International bonds	8.64	10.03	1.39	2.2	68.8
UK index bonds	8.22	8.12	-0.10	2.7	51.7
Cash/other investments	9.90	9.01	-0.89	4.5	59.5
UK property	9.00	9.52	0.52	8.9	39.1
Total	12.18	11.73	-0.45		42.8
Note: International property is excluded since no market index was available. *Source:* Blake et al (1999; 2002, Table 2)					

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Returns to active fund management

Component	*Percentage*
Myopic buy-and-hold	99.47%
Stock picking	2.68%
Market timing	-1.64%
Other	-0.51%
Total	100.00%

Also difficult to maintain performance over time

Table 6 Consistency of Pension Fund Performance
(Percentages)

Years above average	*Total Fund*				*UK Equities*				
	1980-84	*1985-89*	*1992-96*	*Mean*	*1980-84*	*1985-89*	*1992-96*	*Mean*	*Pure chance*
5	3	3	5	4	2	5	5	4	3
4	25	18	17	20	14	18	21	18	16
3	26	28	28	27	35	26	28	30	31
2	25	34	35	31	31	27	26	28	31
1	15	14	13	14	15	18	15	16	16
0	6	3	2	4	3	6	5	4	3

Note: *The table shows the percentage of funds achieving the stated number of years of above average performance during each five year period. The final column shows the percentages that would be expected if fund performance was purely random.*

Source: CAPS *General Reports* 1985, 1989, 1996

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Need to return to our airline analogy for guidance and ask..

How similar are pension plans and commercial airline journeys?

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Much in common between pension plan and commercial airline journey

- Aircraft = strategic investment strategy
- Aircraft operator = pension plan provider
- Aircraft's fuel = contributions to plan
- Climb stage = accumulation stage of plan
- Descent stage = decumulation stage
- Pilot's actions (e.g., in dealing with turbulence and cross winds) = market timing or TAA
- Air traffic controllers = pension regulators

Much in common between pension plan and commercial airline journey

- Both seek to get you to a destination:
  - in one case, a safe landing
  - in the other case, comfortable retirement until death
- Both involve commitment of significant resources
- Both involve managing risks
- Both involve climb and descent stage

How can we apply these lessons in the design of DC pension plans?

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What is important in DC?

- Decumulation or descent stage of pension plan journey should be of most interest to the pension plan member:
  - discovers whether or not he has been a member of good pension plan or not

- Test will be whether he enjoys comparable standard of living in retirement as in work

A good pension plan must be designed from back to front, like an airline journey

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Key factors in design

- Consumption profile desired by plan member in retirement
- Target date for drawing pension
- Value of fund needed to deliver desired consumption profile
- Vehicle for delivering pension:
  - can either be life annuity
  - or drawdown facility from fund which remains invested in stock market

Key factors in design

- Contribution amount and investment strategy needed during accumulation phase to build up required lump sum:
  - taking into account plan member's attitude to risk
- Value of plan member's human capital:
  - discounted present value of lifetime labour income
  - needed to determine both:
    - required value of fund at retirement date
    - required contribution amount during accumulation phase

Use dynamic programming as design tool

- First need to know:
  - what consumption profile do pension plan members desire in retirement?
- Expected present value of consumption = value of fund needed at retirement
- Then working backwards need to find combination of contributions and investment strategy most likely to deliver fund:
  - taking into account plan member's attitude to risk

What type of consumption profile do members want from their pension plan?

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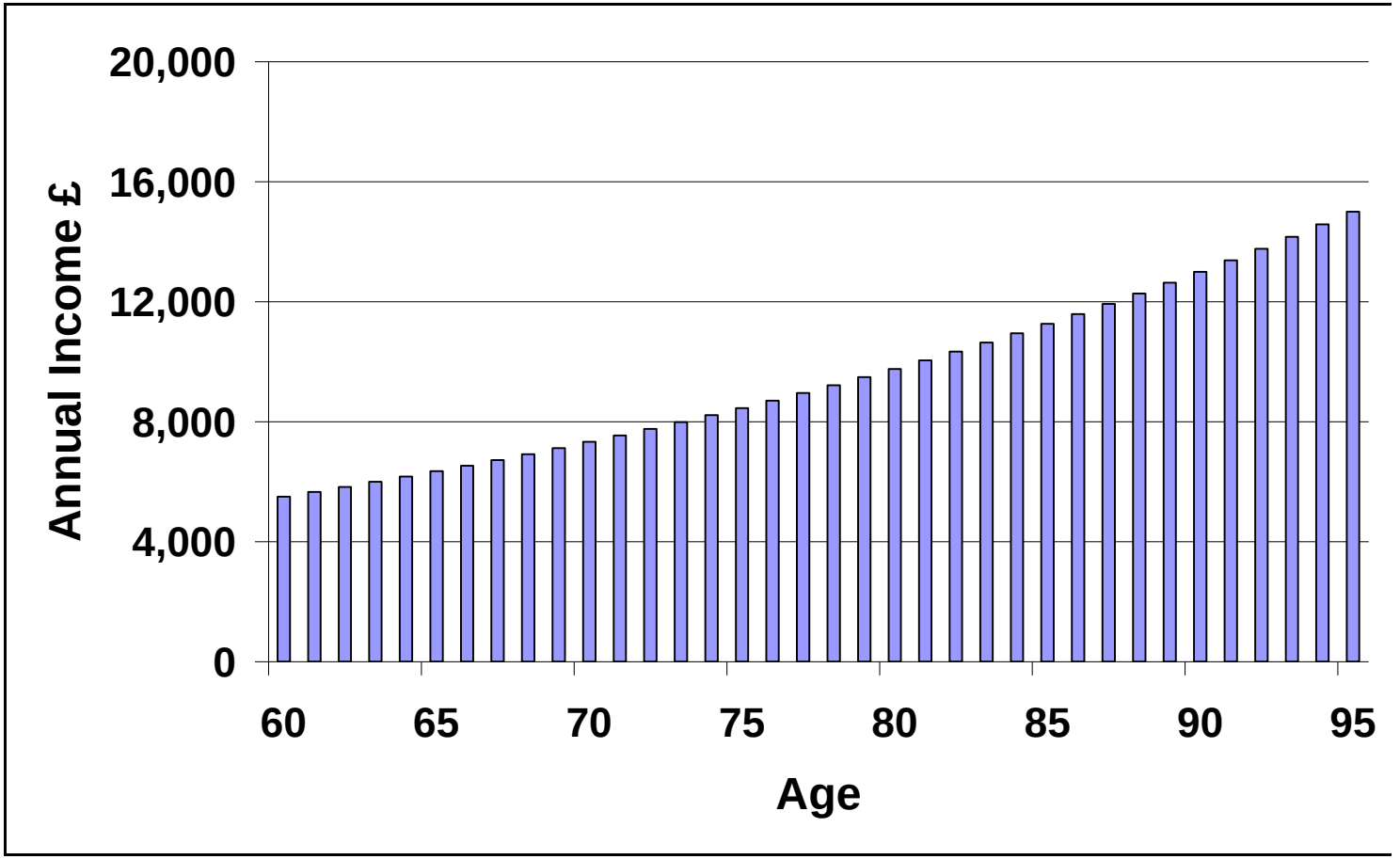
Most people prefer rising profile



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Accumulation phase

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How should contributions during accumulation phase should be invested?

- Depends on:
  - plan member's degree of risk aversion
  - riskiness of labour income and hence human capital

Labour income

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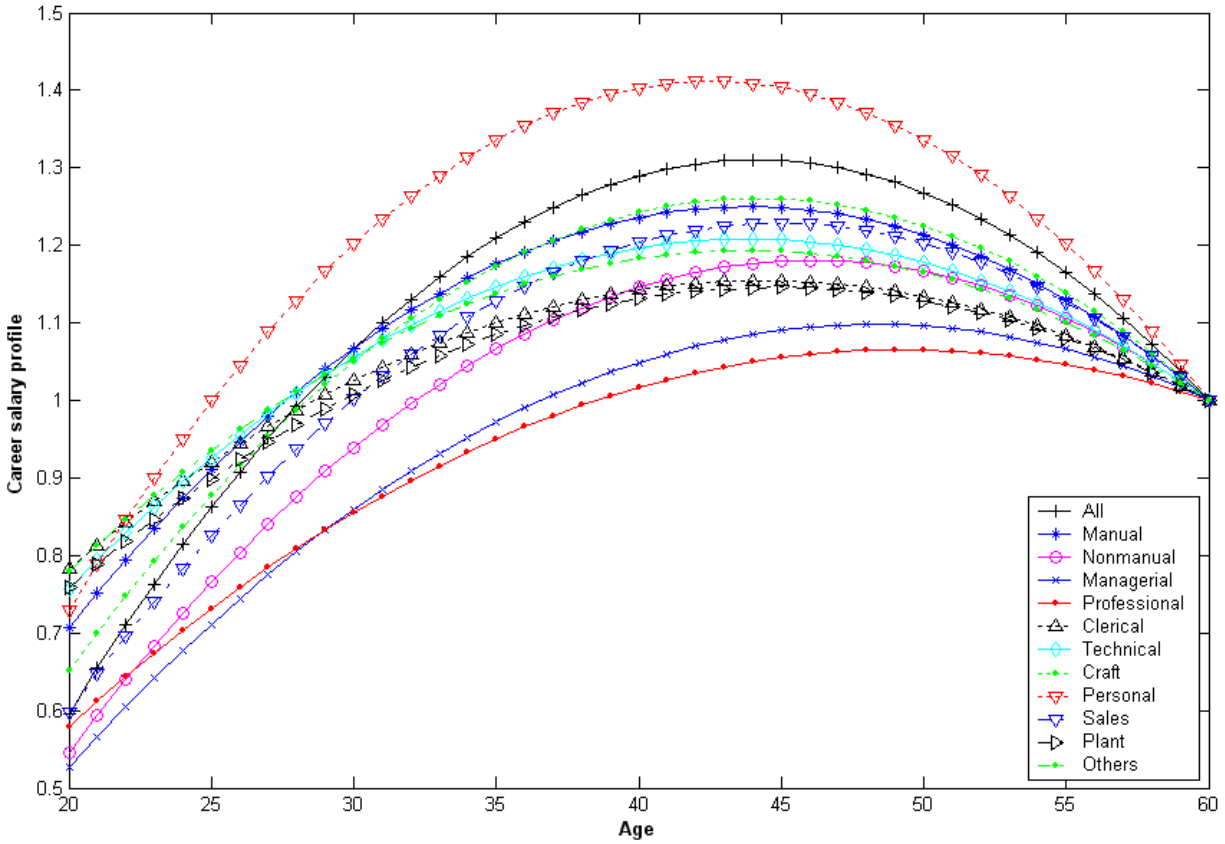
Career salary profiles of UK males



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Optimal investment strategy with riskless labour income

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Optimal investment strategy with riskless labour income

$$Weight\ in\ equities = \frac{Equity\ premium}{Risk\ penalty}\left(1+\frac{H_t}{W_t}\right)$$

$$H_t = Human\ capital$$

$$W_t = Pension\ assets$$

$$Weight\ in\ cash_t = 1 - Weight\ in\ equities_t$$

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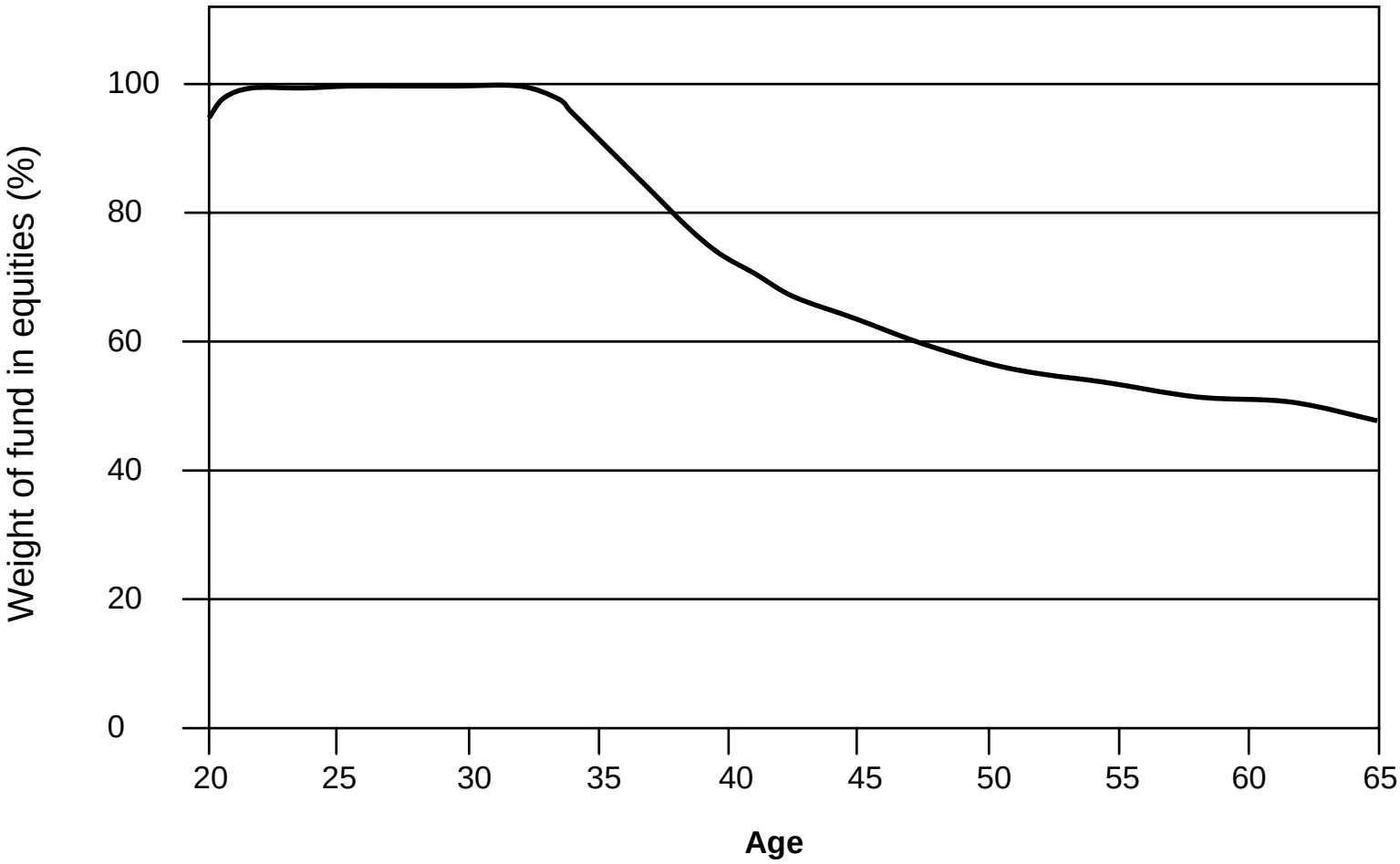
Optimal investment strategy with riskless labour income

- Optimal investment in equities is higher when investor has human capital than when he does not
- Early in adult life, ratio (H_t/W_t) likely to be very high because:
  - individual's human capital is high
  - his accumulated financial wealth is likely to be low
- Optimal for weight in equities to decline over time as human capital is depleted and financial wealth grows

Optimal weight in equities in presence of labour income



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Optimal investment strategy with risky labour income

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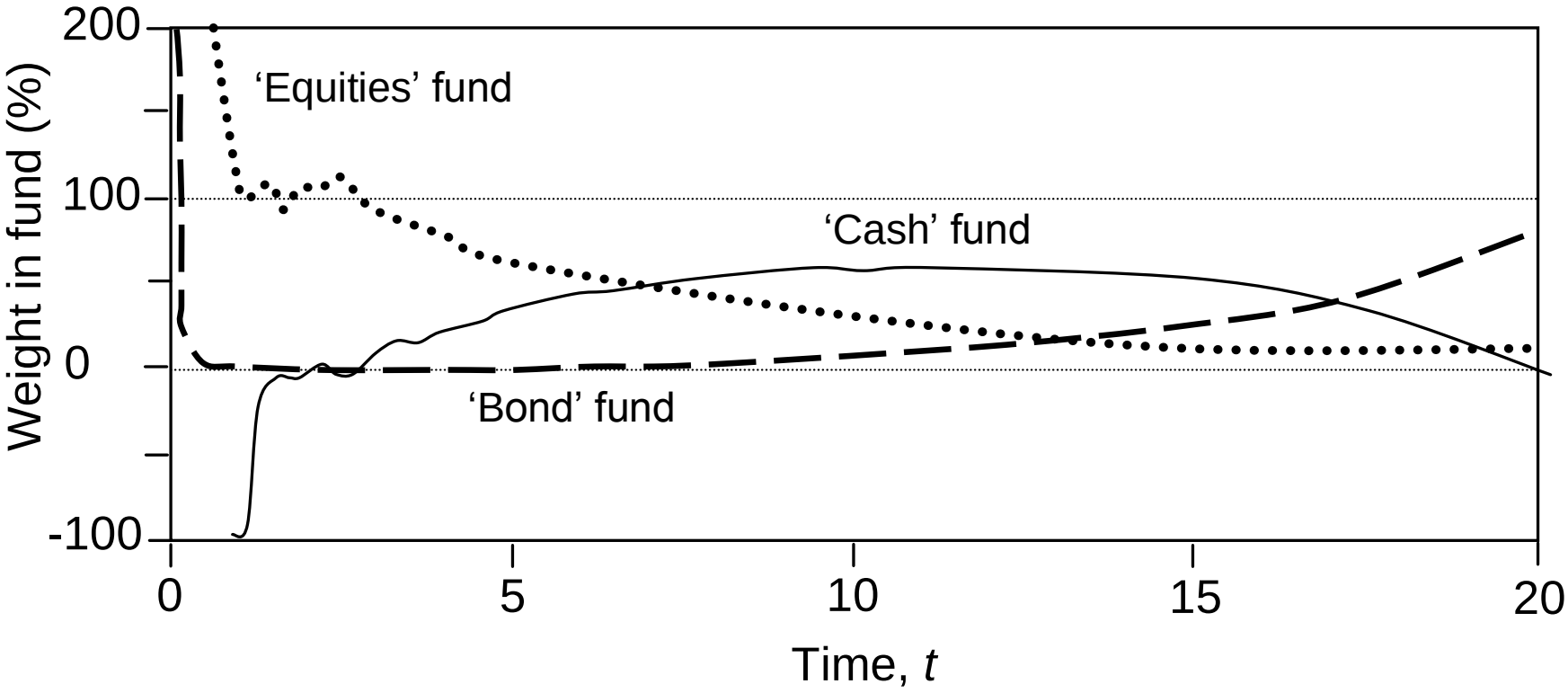
Stochastic lifestyling



Stochastic lifestyling

- 'Equities' fund:
  - hedges human capital
  - benefits from equity premium
- 'Cash' fund:
  - finances initial high leveraged positions in equities and bonds
    - i.e., cash is borrowed for this purpose
  - hedges inflation risk in labour income:
    - since nominal return on cash adjusts to reflect inflationary expectations
- 'Bond' fund:
  - hedges interest rate risk
    - given inverse relationship between bond/annuity prices and interest rates
    - towards end of investment horizon, annuity risk becomes more important risk to hedge than inflation risk:
      - so bonds rise and cash falls

Retirement decision and option to retire

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Retirement decision depends on..

- Accumulated amount of DC wealth and size of pension annuity it will purchase
- Other pension wealth:
  - especially social security wealth
- Other wealth, especially housing and financial wealth
- Employment status of member:
  - e.g., self-employed people tend to retire later than employees

Retirement decision depends on..

- Health status of member, might:
  - advance annuitisation in case of very ill health
  - delay annuitisation in order to have cash to pay medical expenses

- Member's partner's retirement, financial and health statuses

Option to retire

- If free to choose, individual will retire when:
  - value of continuing to work < value of retiring
- Means individual continues working so long as:
  - expected utility of doing so exceeds expected utility of retiring immediately

Decumulation phase

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Form of retirement income

- Should member keep pension fund invested in return-generating assets and draw income from fund?
  - known as drawdown or systematic withdrawal

- Should pension fund assets be sold and proceeds used to purchase life annuity?

Value of annuitisation

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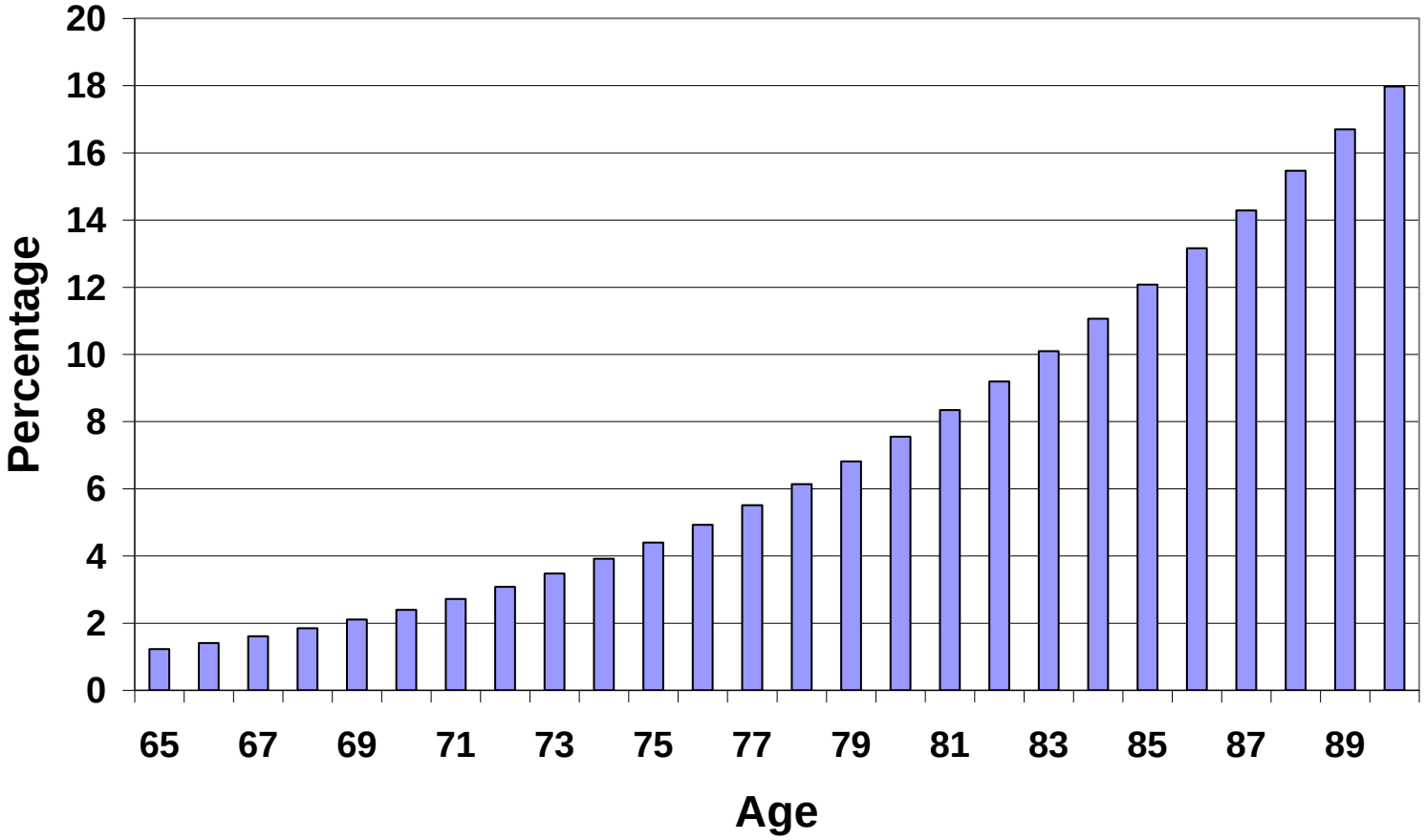
Annual survival credits for UK males from age 65



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Option to annuitise: when?

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Simple rule for determining optimal time to annuitise

- In absence of bequest motive, optimal to switch fully into annuities when:
  - survival credit > equity premium
- Equivalent to:
  - return on annuity:
    - which equals risk-free rate + survival credit

  >
  - return on equities
    - which equals risk-free rate + equity premium
- Occurs at age 79 when using the long-run historical risk premium of 7.43%

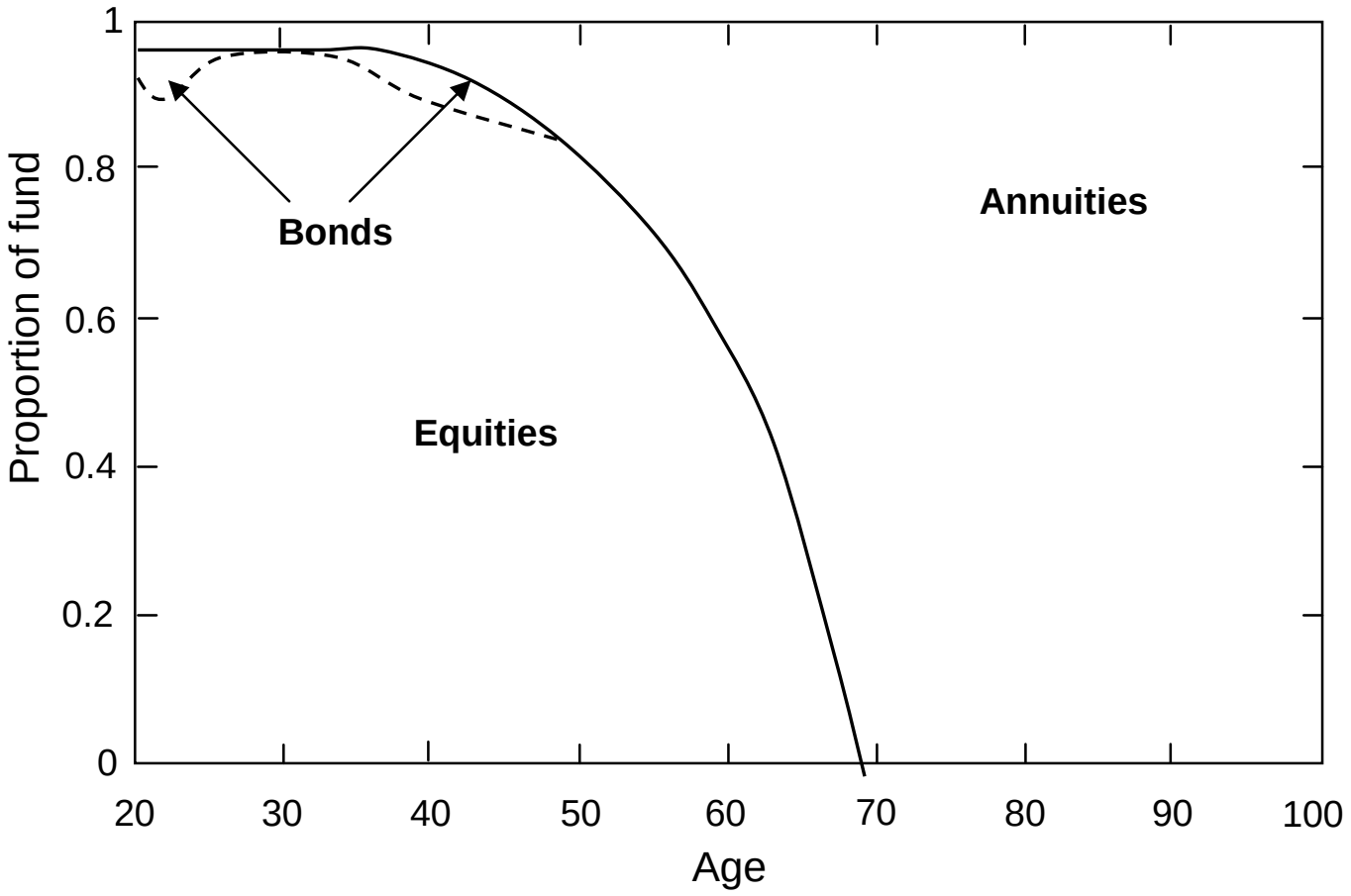
More generally..

- When risk aversion is taken into account:
  - higher levels of risk aversion lead to lower annuitisation ages

More generally..

- Optimal annuitisation decision is not once and for all, but gradual:
  - because of tradeoff between illiquidity of annuities and longevity risk insurance they provide
- Longevity risk insurance is valuable, but purchase decision irreversible

Optimal asset allocation with annuities



Option to annuitise: how much?

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Optimal degree of annuitisation is reduced if…

- State pensions are high:
  - since these crowd out private annuitisation
- Risk pooling within family is efficient
- Risk aversion is low:
  - since such individuals prefer equity investments
- Equity premium is sufficiently high
- Investment volatility is low

Optimal degree of annuitisation is reduced if…

- Member is in poor health
  - in such a case, impaired life annuity will be optimal
- Member is male rather than female, given their shorter life expectancy
- Bequest motive

Optimal retirement-income programmes

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Optimal retirement income programmes

- *Programme 1 - Purchased life annuity* (PLA): benchmark
- *Programme 2 - Fixed income programme* (FIX) with life annuity purchased at age 75
- *Programme 3 - Flexible income programme* (FLX) with life annuity purchased at age 75
- *Programme 4 - Flexible income programme with a deferred annuity* (DEF) purchased at retirement age and payable at age 75

Optimal retirement income programmes

- *Programme 5 - Unit-linked programme* (UNI) with life annuity purchased at age 75
- *Programme 6 - Collared income programme* (COL) with life annuity purchased at age 75
- *Programme 7 - Floored income programme* (FLR) with life annuity purchased at age 75

Optimal retirement income programmes

- Income drawdown variation:
  - residual fund paid as *bequest* to plan member's estate if he dies before age 75
- Annuity variation:
  - residual fund reverts to insurer
  - in return for which insurer agrees to pay *survival credit* at start of each year:
    - while plan member is still alive

Optimal retirement income programmes

- For individual with low degree of risk aversion, optimal programmes are:
  - flexible income and unit-linked annuities
  - both paying survival credits
- For individual with high degree of risk aversion, annuitise immediately
- Bequest motive does not appear to be that strong

This is air traffic control, are you receiving me?
The role of the regulator

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Role of the regulator

- Little need for regulation when consumers are:
  - well informed
  - able to exercise and enforce their rights in a competitive market place
- Unfortunately, when it comes to financial matters, many consumers are clearly not well-informed or well-educated
- In this case, role for regulator to act on behalf of members as surrogate ‘intelligent consumer’

First task of the regulator..

- To recognise certain behavioural biases in individual decision making.
- In terms of pension planning, principal ones are:
  - contribution puzzle
  - investment puzzles
  - annuity puzzle

Contribution puzzle

- Behaviouralists explain this inadequate preparation for retirement in terms of lack of willpower
- People might want to save for retirement, but unable to do so
- To overcome this, individuals need *commitment devices:*
  - auto-enrolment
  - payroll deduction of contributions
  - ‘save more tomorrow’ plans

Investment puzzles

- Investors do not follow optimal investment strategies discussed above:
  - median US investor holds portfolio containing just two securities
  - excessive DC pension fund investment in sponsor's own shares

Investment puzzles

- Behaviouralists have put forward number of reasons for these puzzles:
  - Lack of firm preferences
    - equally happy with median investor's choice
  - Framing effects
    - menu design has bigger influence on investment choice than actual risk and return characteristics of the investments themselves
  - Anchoring effects, inertia and procrastination

Annuity puzzle

- Despite benefits of annuitisation, very few people choose to annuitise their pension wealth:
  - unless rules of plan oblige them
  - E.g., UK where more than half world's life annuities are sold

- Why is this?

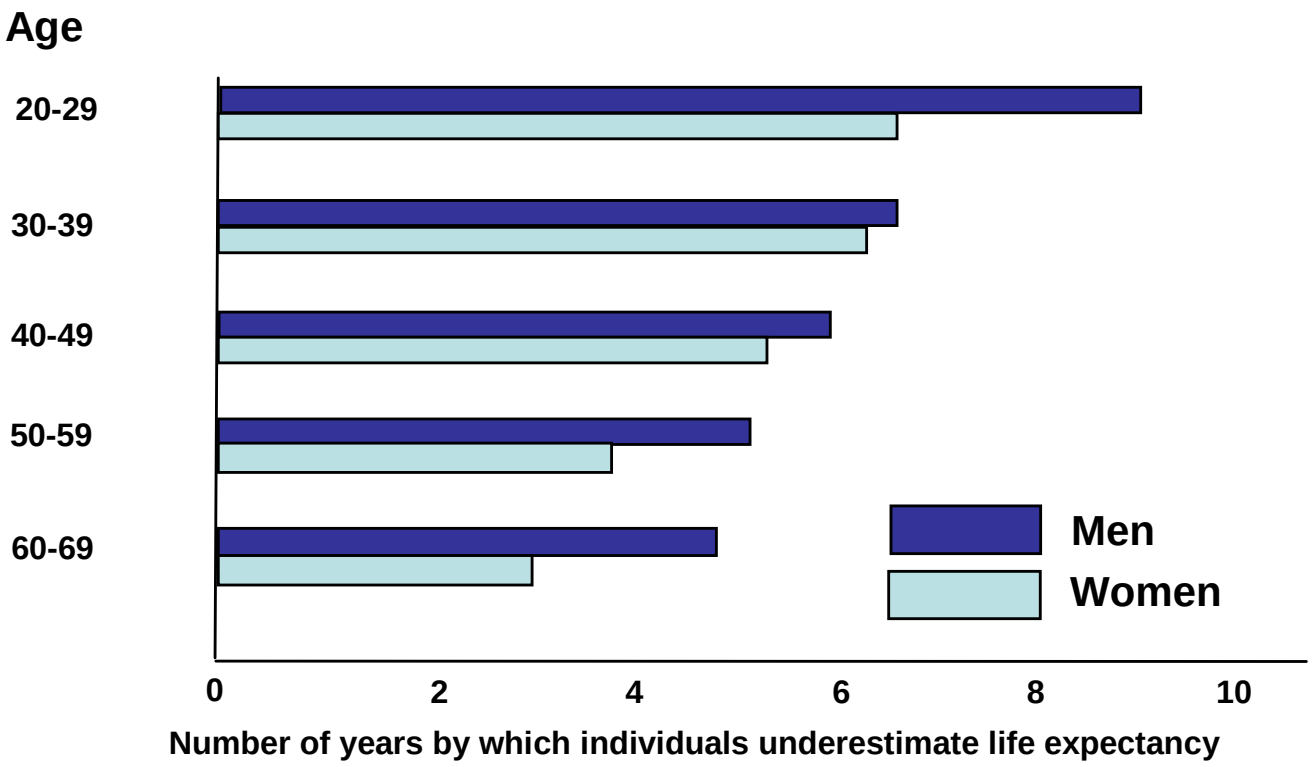
Why is this?

- People usually have state pension which implies some insurance against longevity risk
- In world of low interest rates, annuity rates also low:
  - so annuities appear to offer poor value for money
- Cost loading of annuity provider reduces return compared with pure investment:
  - *money's worth* of annuities is high

Why is this?

- People might have strong bequest motive
- Also concerned about future long-term care costs
- Adverse selection and asymmetric information between annuity buyer and seller:
  - Individuals hold private information about their health status
  - hard for annuity provider to identify
    - so add cost loading

Individual underestimates of life expectancy by age



Regulator should ensure..

- Sensible default choices in accumulation stage of DC plans
- Simplified menu design
- Workers and retirees limit exposure to company stock
- Sensible default choices at retirement.

Second task of the regulator..

- To insist there are governance structures in place that ensure:
- Effective targets for:
  - fund managers during accumulation phase
  - annuity providers during decumulation phase
- Safe custody of contributions and accumulating assets
- Charges not excessive, and strike appropriate balance between cost and efficiency

Completing the market in longevity risk transference. A role for government?

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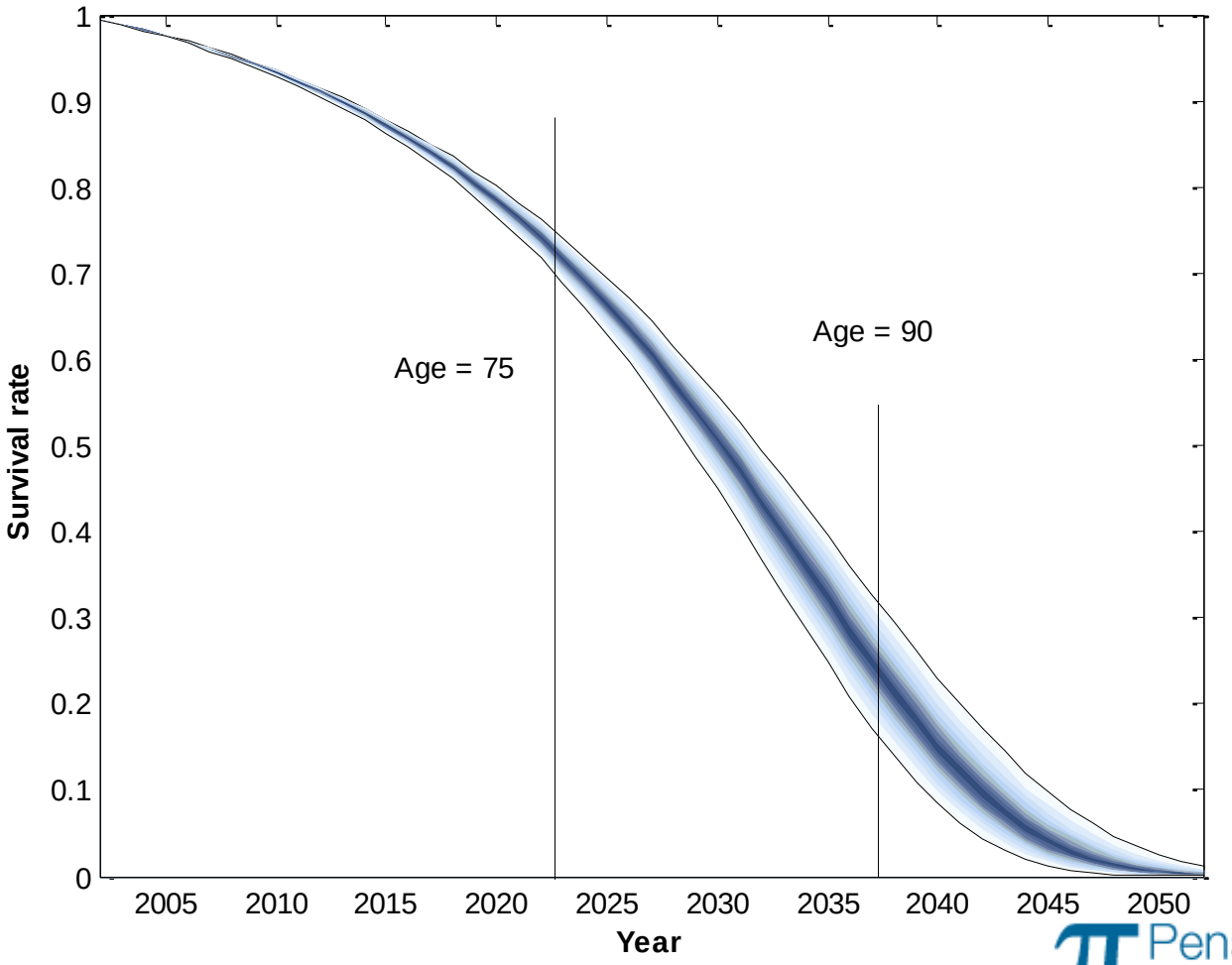
Survivor fan charts for 65-year old English and Welsh males



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Conclusions

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Conclusions

- Like aircraft journey, pension plan will be designed from back to front:
  - that is, from desired outputs to required inputs
- with goal of delivering adequate targeted pension with high degree of probability

Conclusions

- Given a few key parameters:
  - shape of career salary profile
  - desired retirement income profile
  - planned retirement date
  - degree of risk aversion
  - bequest intensity
- Plan provider can be left to do what is needed to get the plan safely to its destination:
  - so long as member:
    - believes in benefits of pensions journey he is making
    - is willing and able to maintain required contributions schedule

Conclusions

- Still risks, of course, but these will be as well understood and as well managed
- Once this has happened, we will be in a position to think not of pension plans, but of pension planes:
  - with equivalent safety instruction to ‘fasten your seat belts’ being ‘just sign up’