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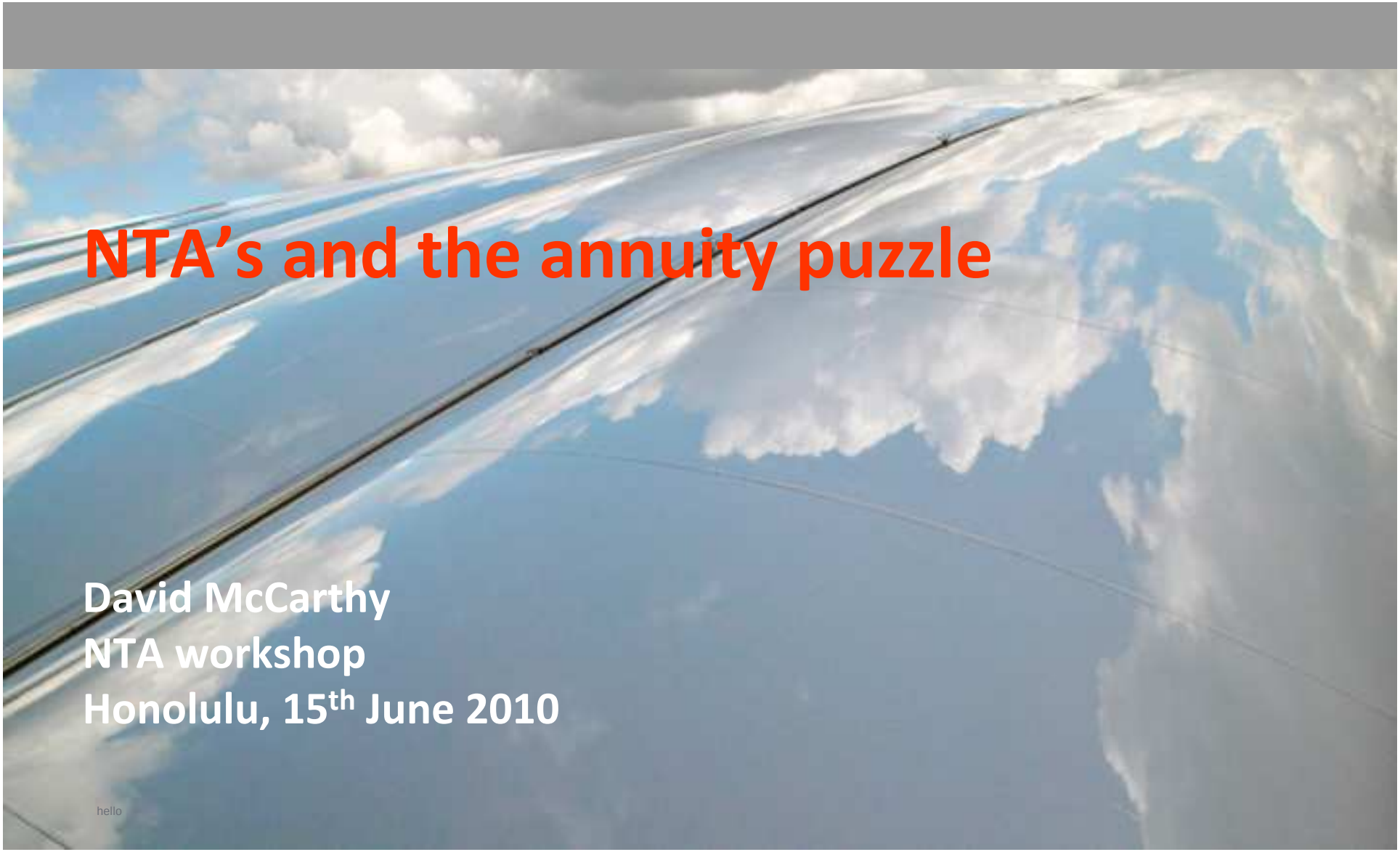

NTA's and the annuity puzzle

David McCarthy
NTA workshop
Honolulu, 15th June 2010

hello

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Today's lecture

- Was billed as "Pension Economics"
- But I teach a 70-hour course on pension economics and finance at Imperial and I have ~1200 slides
- So I will just briefly outline the borders of the field as I see them
- Then will focus on annuities markets, viewed using NTA methodology
- I hope this will be useful and interesting to the NTA community and also illustrate some potential applications (and even extensions) of NTA's

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Pension economics

- Demography and population economics
- Life-cycle theory (discrete time DP)
- Portfolio theory (continuous time DP)
- Labour and personnel economics
- Macro-economic modeling and general equilibrium
- Behavioural economics of pensions
- Agency theory and pensions
- Annuity markets

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What are life annuities?

- A financial product, usually sold by life insurance companies, which pay a monthly or yearly income for as long as the individual lives
- They allow individuals to pool their mortality risk, and thereby insure themselves against the risk of living *too long*
- Future retirees will be relying much more on unannuitised wealth (e.g. DC pensions) than on annuitised wealth (e.g. DB or state pensions)
- [*But annuity markets are un- (or under-) developed in all but a few countries*]

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Annuitisation and profiles

- In NTA, it might help to think about annuities as a way of using assets to shape a per-capita consumption or income profile
- So imagine someone who has financial assets of 1, faces a (constant) interest rate of 4% p.a. and must *choose* a profile of consumption with age
- (Although, we must remember that when individuals make decisions about how to consume they do so longitudinally rather than cross-sectionally)

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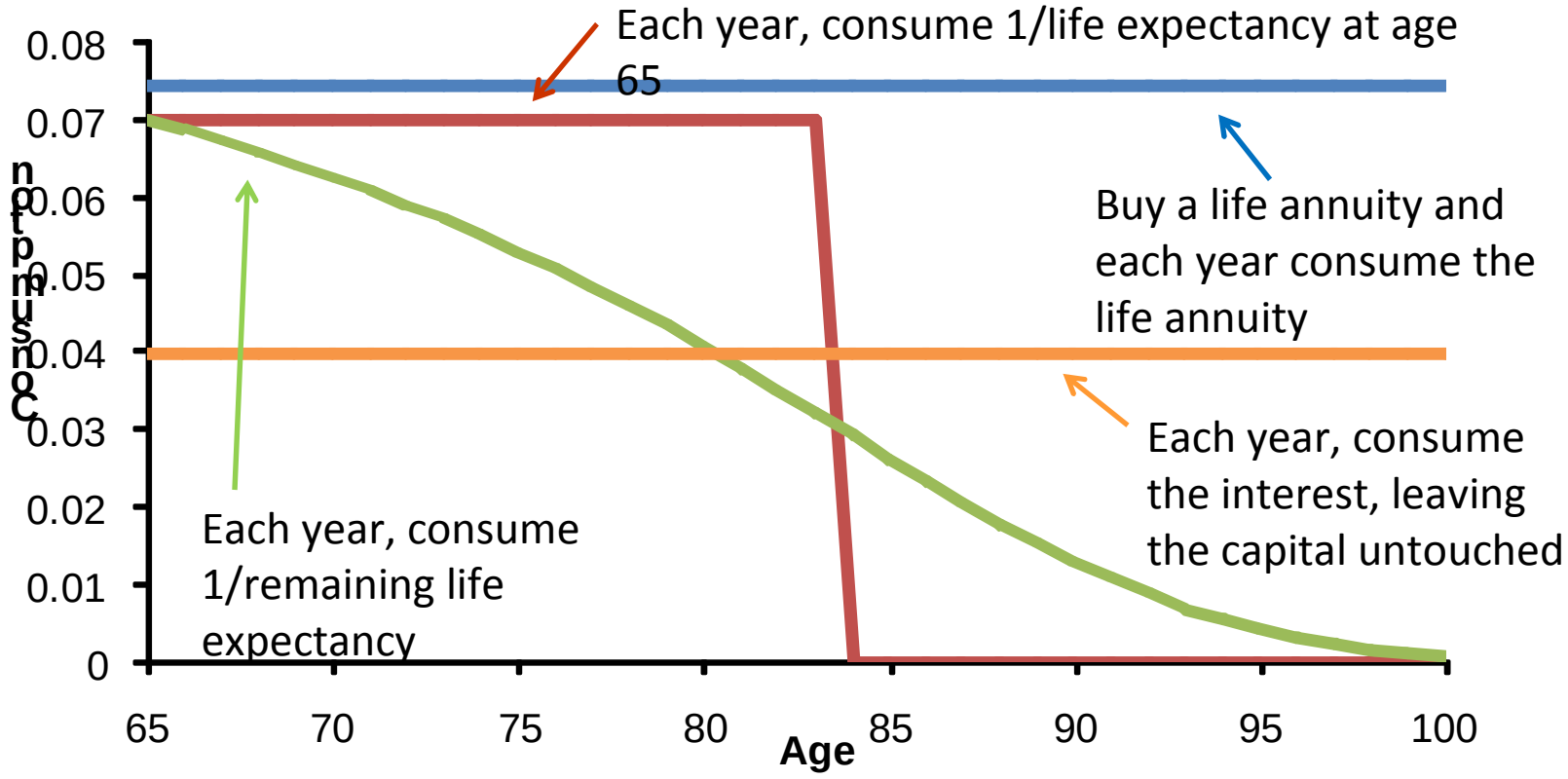
Alternative (longitudinal) consumption profiles



- How to choose the "best" consumption profile?

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Alternative consumption paths

- Each one leaves a different bequest
- Each one exposes the person to a different risk of outliving their savings
- There is a direct trade-off between consumption in retirement and the probability of outliving your assets
  - The higher your consumption, the higher the probability you outlive your assets
  - The lower your consumption, the higher the expected value of unintended bequests
- Life annuities offer a way out of this conundrum

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Simplest life cycle model of annuity demand

- No bequest motives, constant interest rates, no transfers, perfect annuity markets, no risky assets
- The agent must decide how much annuity to purchase at time 0, and thereafter how much to consume each time period, conditional on receiving the annuity

$$V(w) = \max_{\{c_i, y\}} \sum_{i=0}^{\omega} \rho^i \pi_i u(c_i)$$

$$w_{t+1} = (w_t - c_t + y)(1+r)$$

Budget constraint

$$w_0 = w - y\ddot{a}_x^r$$

Buy annuity at time 0 at an actuarially fair price

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How do we solve this problem?

- Use the same maths that Miguel taught us last week, but with the added complication that we don't know how much annuity the individual decided to buy at time 0 when we start solving the problem in the last period
- Therefore we have to use y (annuity income) as a second state variable (so it is now a two state variable problem)
- We re-write the value function at time j>0 as

$$V(w_j, y) = \max_{\{c_i\}} \sum_{i=j}^{\omega} \rho^{i-j} \frac{\pi_i}{\pi_j} u(c_i)$$

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Derive the Euler equation

- We derive the Euler equation following exactly the same recipe as Miguel (take first order conditions and use the Envelope theorem, so I won't go through it), but the answer is:

$$u'(\hat{c}_i(w_i, y)) = \frac{\pi_{i+1}}{\pi_i}\rho(1+r)u'(\hat{c}_{i+1}(w_{i+1}, y))$$

Optimal consumption at time *i* which depends on wealth at time *i* and annuity income

Optimal consumption at time *i+1* which depends on wealth at time *i+1* and annuity income

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Using the Euler equation

- By applying the Euler equation recursively, starting at the final period we can derive an *optimal* consumption profile for every level of initial wealth and annuity income, as well as
- A score which ranks different combinations of wealth and annuity income

$$V_0(w_0, y) = \sum_{i=0}^{\omega} \rho^i \pi_i u(\hat{c}_i(w_i, y))$$

Expected discounted lifetime utility of optimal consumption profile if initial wealth equals w_0 and annuity income is y

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Solving the optimal annuitisation problem

- Now, we need to derive the value function which is only a function of wealth:

$$V(w) = \max_{y} V_0(w - y\ddot{a}_x^r, y)$$

- The solution to this equation is the optimal level of annuity purchase in a world in which there are no risky assets, constant interest rates, perfect annuity markets, no other transfers

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Yaari (1965)

- Was the first to discover the classic result on demand for life annuities
- If annuities are fairly priced, then individuals should be willing to purchase them with all their money
  - Annuities eliminate unintended bequests
  - Annuities pool idiosyncratic longevity risk
  - These two points allow a much higher level of lifetime consumption, with less risk, than individuals could obtain without life annuities

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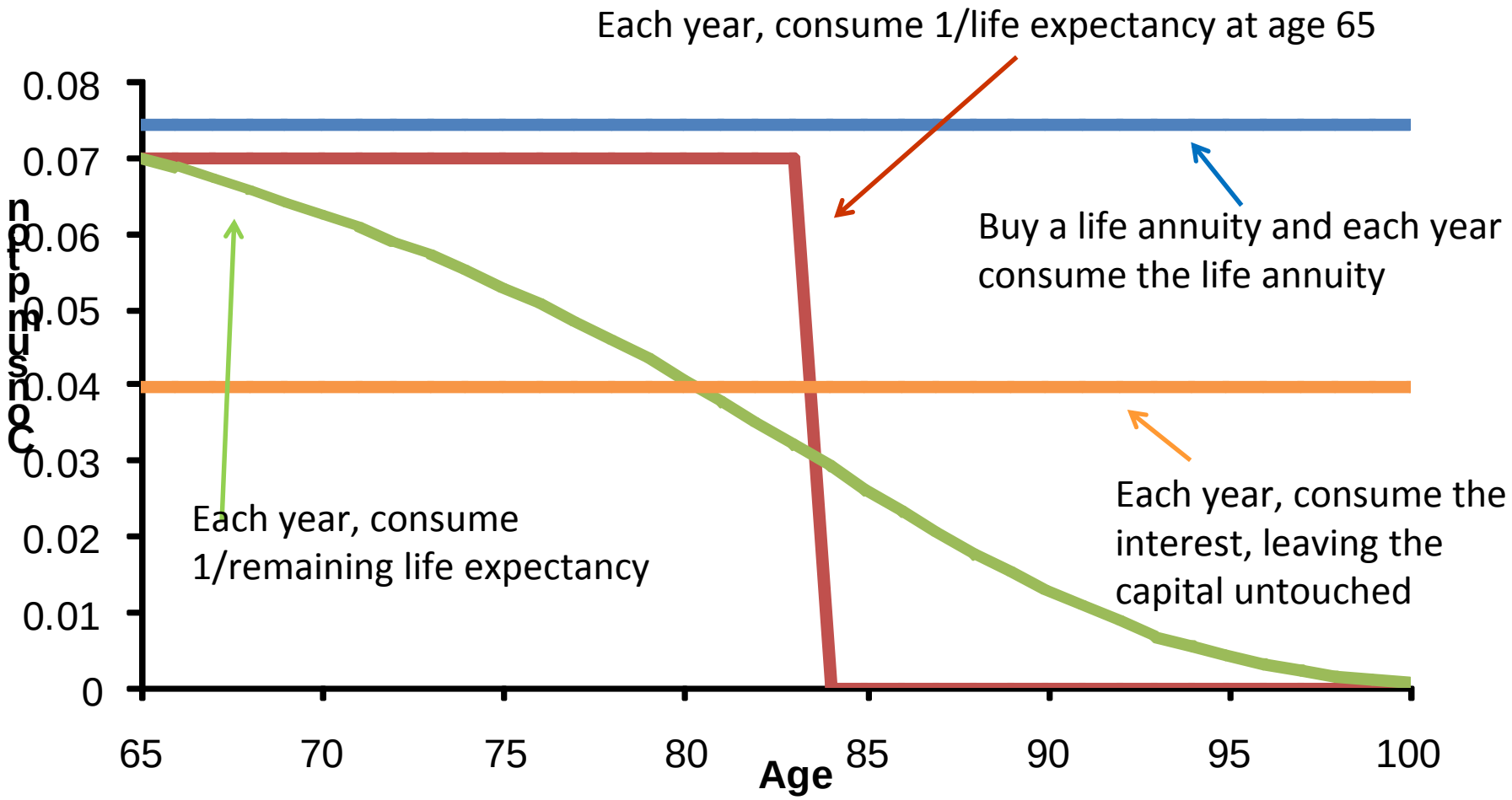
Alternative consumption profiles



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What do we observe in practice?

- In virtually every country, individuals only purchase life annuities if they are forced to do so
- Very few countries have an active, voluntary, annuity market (UK almost alone in this)
- In the UK, the voluntary annuity market is very small relative to the compulsory annuity market (in 2004, SP(Comp)=~7bn; SP(Vol)=~60mn or around 1% of the size)
- In the US, there is no market in compulsory annuities because annuitisation is not compulsory, and hence the market in life annuities generally is very small (variable annuities are not, in general, life annuities)

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What explanations for this difference?

- The result of Yaari (1965) is strikingly different from observed reality
- It got economists thinking (for 40 years now)
- Why would individuals NOT want to purchase annuities?
- NTA's provide a really great way of visualising the answer to this question, which most of you have probably guessed, is "transfers"

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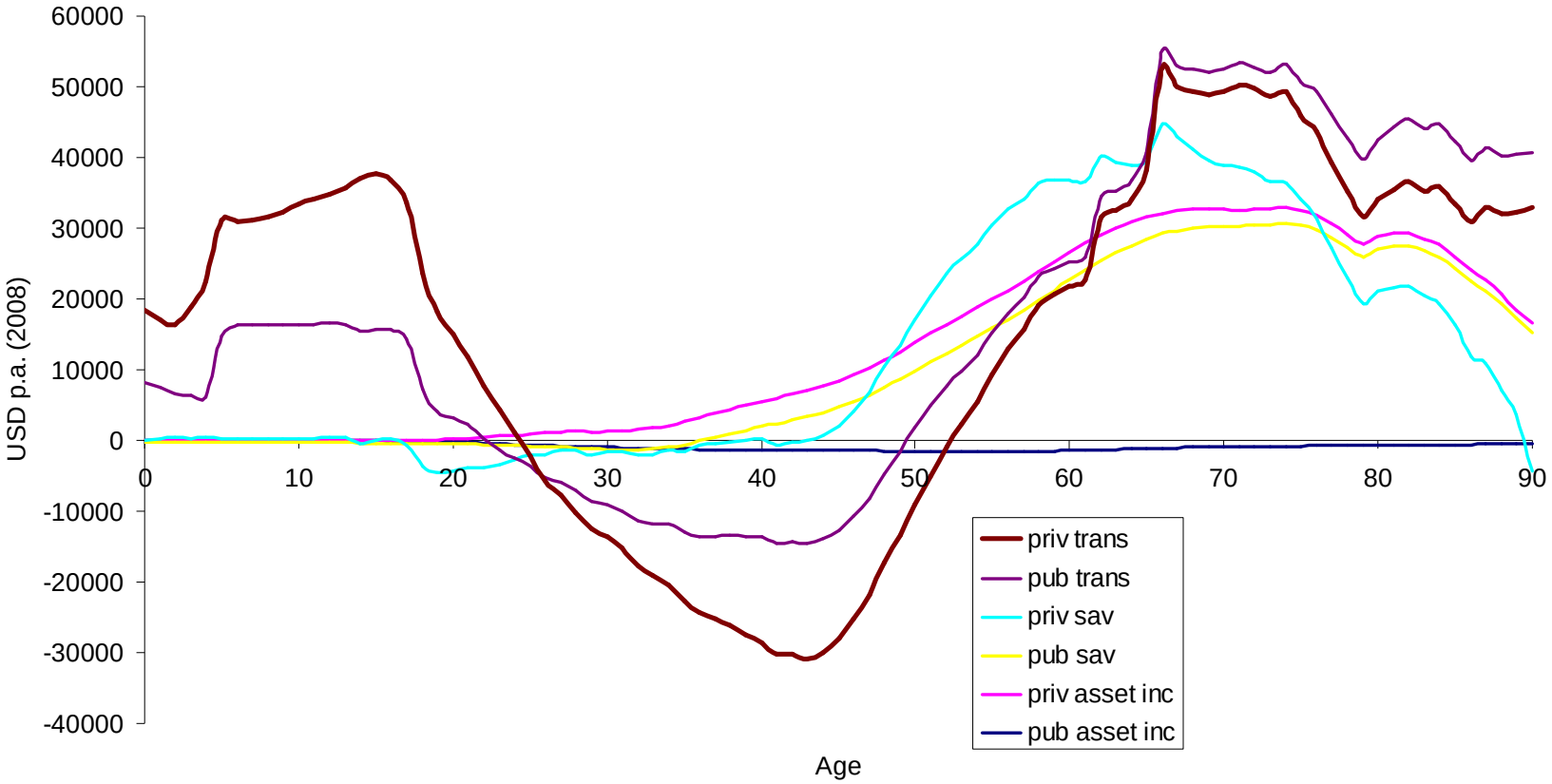
US LCD & its components (2008), from Gretchen



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Disadvantages of purchasing annuities

- Over-annuitisation
  - Individuals already have a substantial amount of wealth in the form of annuities
    - State pensions
    - Occupational pensions in some countries (DB and DC pensions)
- Ability to self-annuitise
  - Families already diversify some mortality risk between themselves
- Bequest motives (?)
  - (Annuities protect bequests from longevity risk as well)

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Disadvantages of investing in annuities

- Imperfections in annuities markets
  - Annuities may be too expensive (more on this later)
- Loss of equity risk premium
  - Individuals optimally invest some assets in equities even in retirement
- Other consumption shocks (e.g. health)
  - Particularly important where health care is privately provided (so not Europe)
- Credit risk of insurer (?)
  - Annuity contracts are long term and insurer may go bankrupt

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Annuity equivalent wealth

- To estimate how different factors affect theoretical demand for annuities, we can estimate the ratio of unannuitised wealth to annuitised wealth which gives individuals the same level of lifetime satisfaction
- First we solve the equation

$$V_0(w,0) = V_0(0,y)$$

- And then examine the ratio

$$AEW = \frac{w}{\ddot{a}_0^r y}$$

- If annuities are in demand, then AEW>1

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Assumptions in deriving AEW

- We can make any assumptions we like in estimating the value functions we use to calculate AEW – for instance, including spouses, access to equity markets, bequest motives and state pension wealth
- We just need to make our basic life-cycle model more complicated and be careful to perform the calculations correctly

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Modelling annuity demand

- Theoretical annuity demand is much lower when risk assets, high pre-annuitised wealth, bequest motives, ability to diversify risks within households, asymmetric information are incorporated
  - Brown and Poterba (2000)
  - Brown (2001)
  - Inkman et al (2007)
- In NTA-speak, “transfers” (& asset-based re-allocations) explain a lot of the lack of demand for annuities

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Importance of health status

- Brown found that self-reported health status was a very important predictor of annuitisation patterns
  - Good self-reported health raises the probability of voluntary annuitisation
- This raises some very important questions about the efficiency of annuities markets, because health is correlated with life expectancy which is correlated with the correct price of an annuity
  - Adverse selection!

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Annuity market efficiency

- Inefficiency of annuity markets may also underlie the low observed purchase of life annuities in most countries
- If annuities are more expensive than actuarially fair, then some individuals might be dissuaded from purchasing them
- So we will spend some time looking at the theory and empirical results regarding annuity market (in)efficiency

- But first, a stylised fact:

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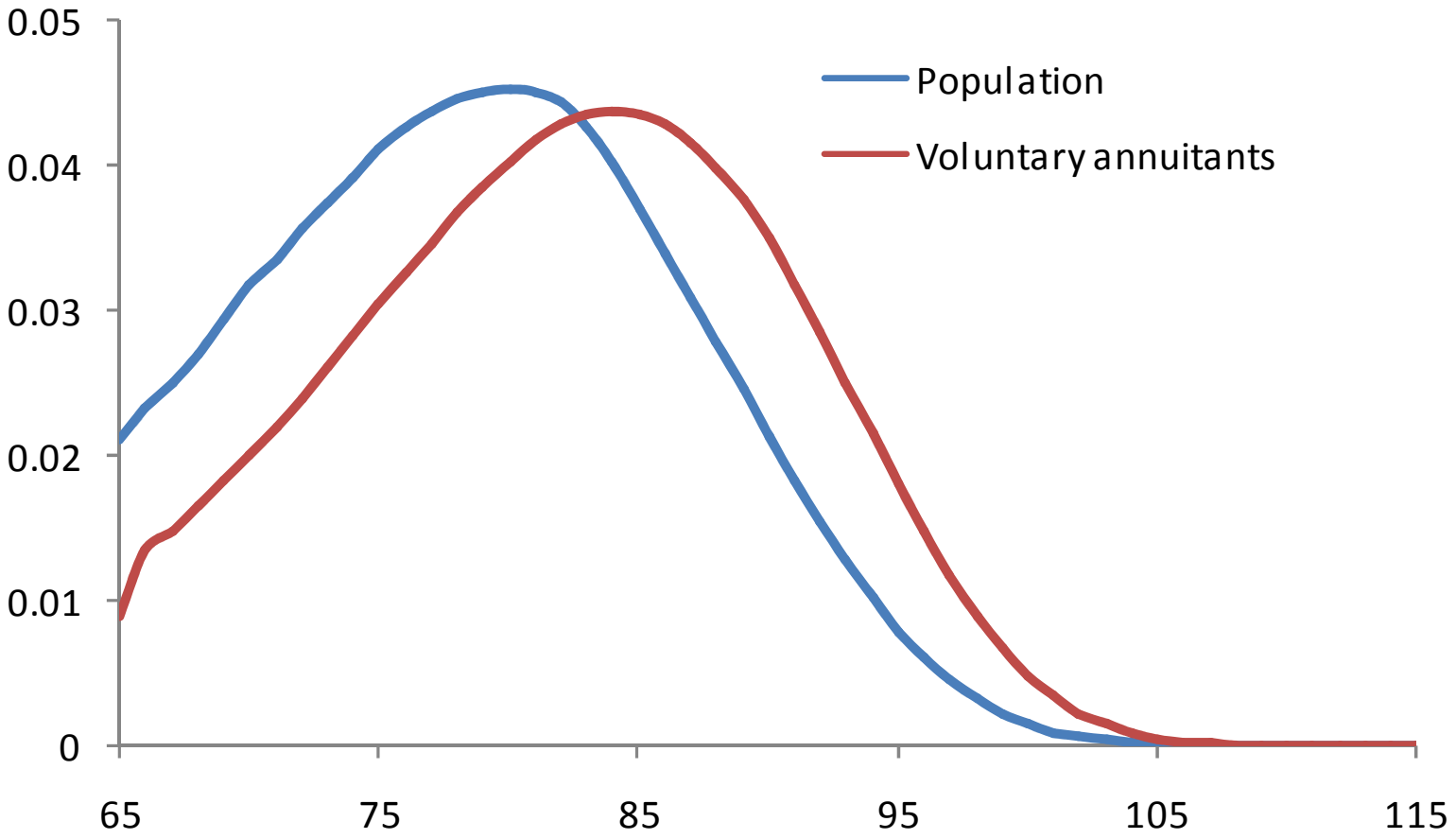
Distribution of age at death (UK)



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Mortality of life annuitants

- People who purchase life annuities live systematically longer than members of the general population
  - Should we be surprised?
  - People who purchase annuities are probably wealthier on average, and have some money to purchase annuities, and are probably more risk averse (?) and expect to live longer
  - Some of these could in principle be observed by life insurance companies, while some could not
  - Only unobservable information which is systematically correlated with life expectancy can cause adverse selection

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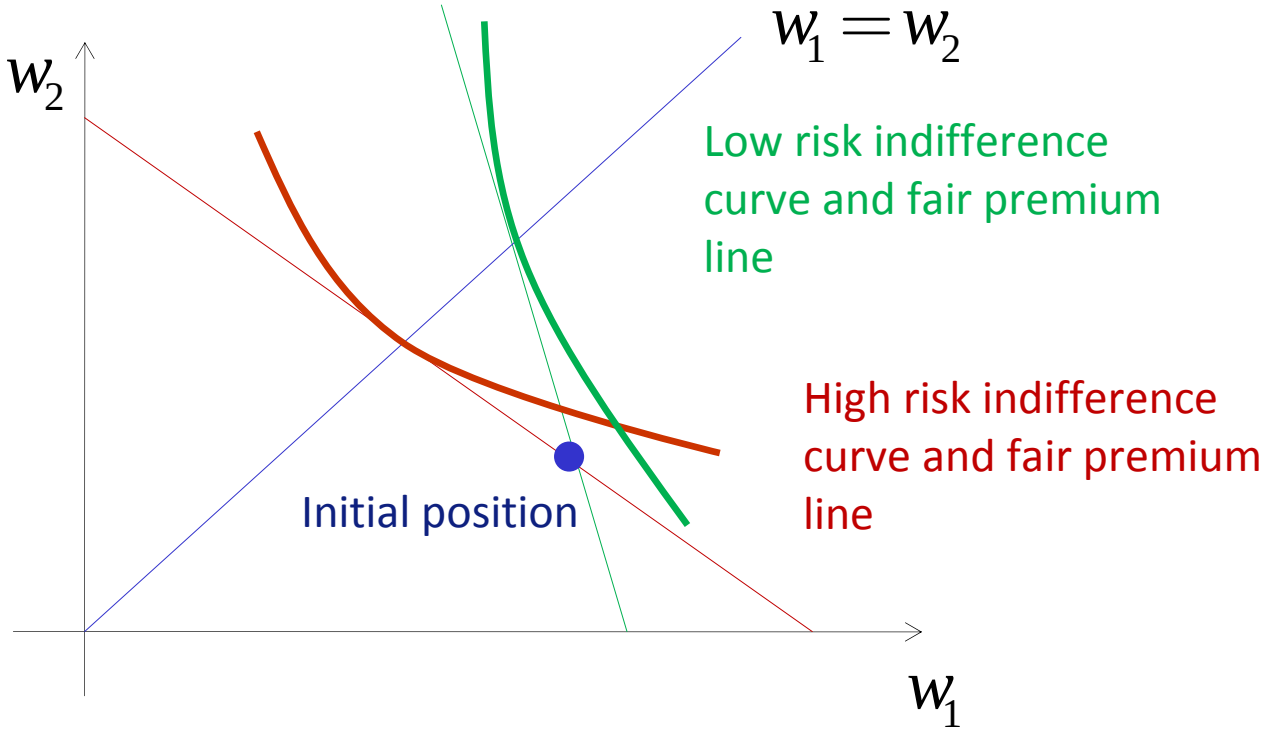
A Nobel Prize idea

- How contract design can be used to overcome the effect of asymmetric information on the operation of insurance markets



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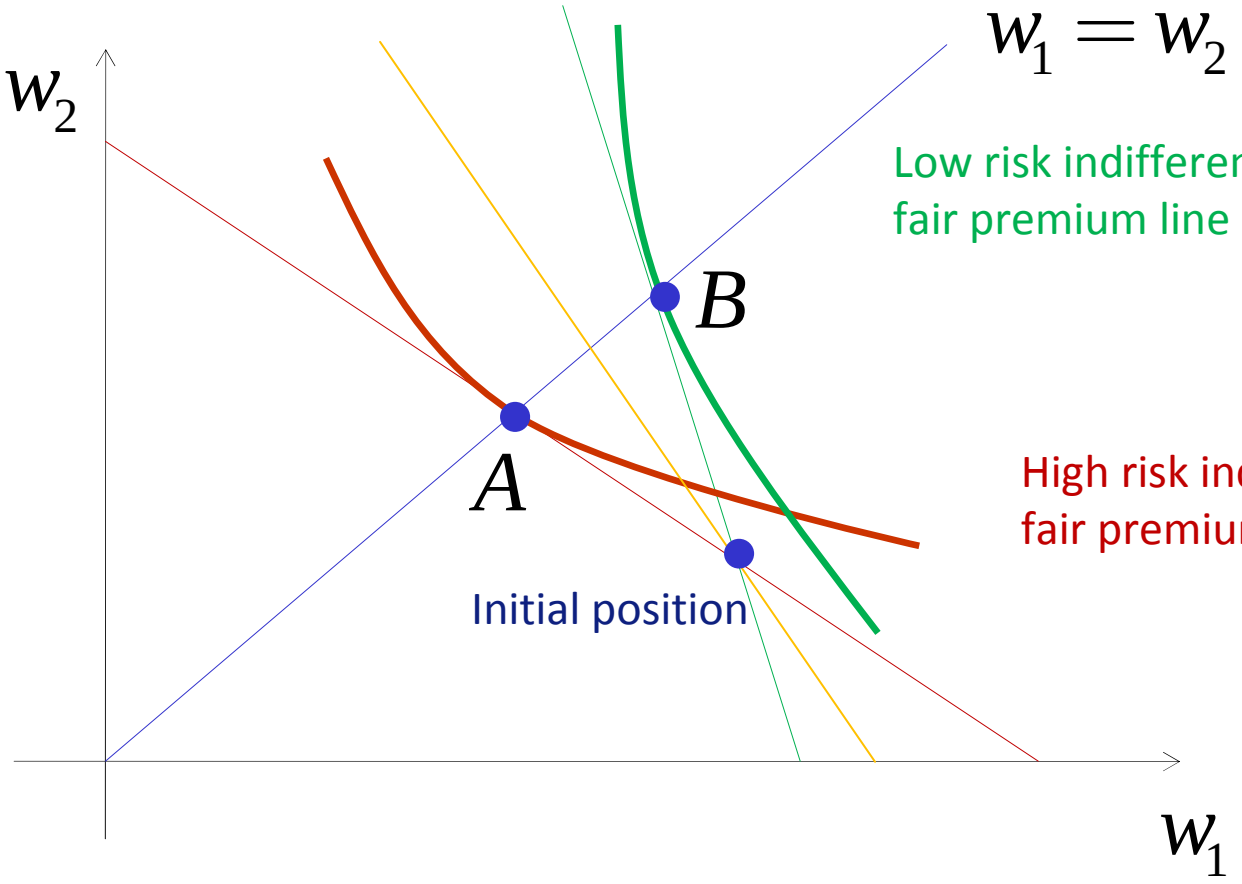
No pooling equilibrium



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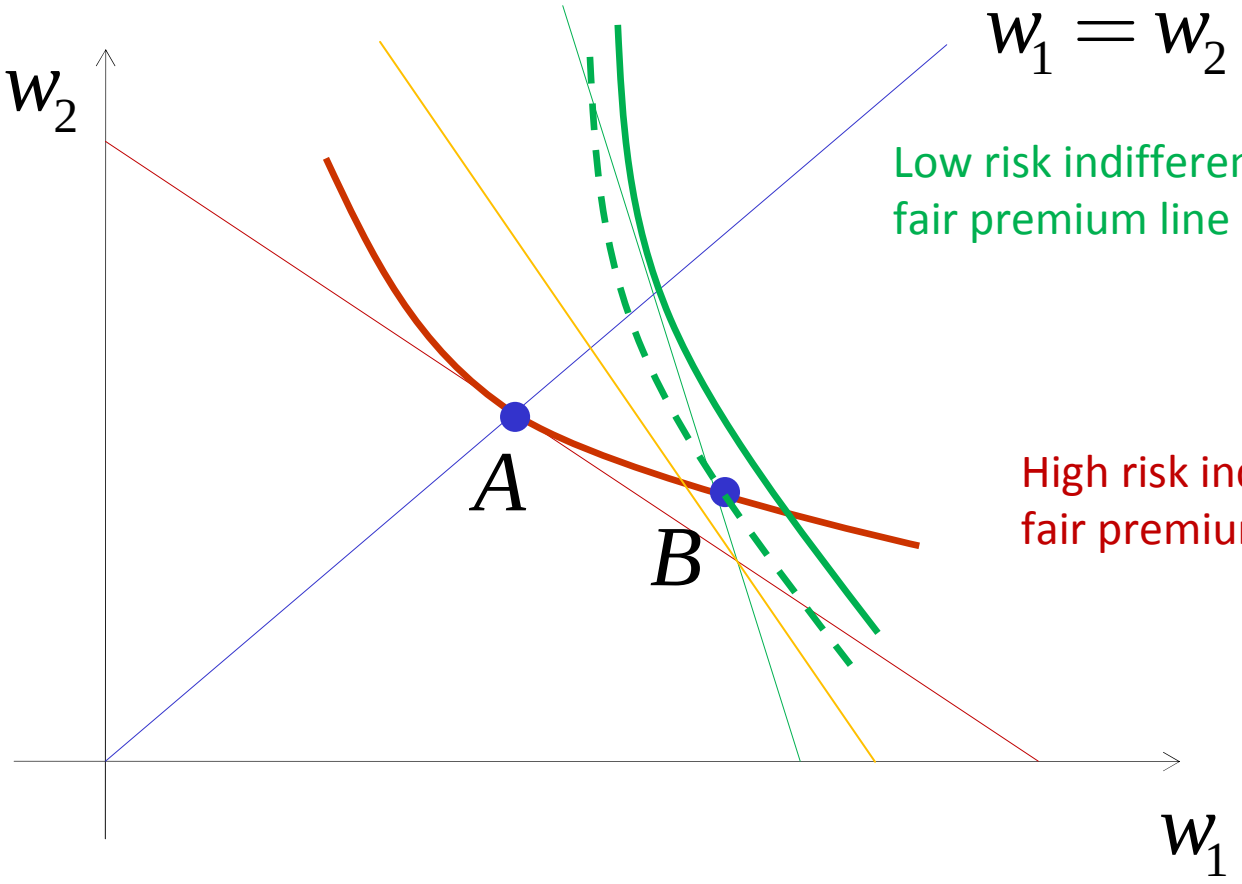
Separating equilibrium



Low risk indifference curve and fair premium line

High risk indifference curve and fair premium line

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Rothschild-Stiglitz separating equilibrium

- Insurance companies can design contracts to give agents an incentive to reveal their asymmetric information to the insurance company
- The high-risk types reveal themselves by purchasing full insurance
- The low-risk types reveal themselves by purchasing partial insurance
- Then you can charge each group accordingly and the equilibrium is maintained

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Other separating equilibria

- Bank loans (collateral vs. no collateral)
- Airline tickets (flexible vs. inflexible)
- Drug pricing (generic vs. brand name)

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Asymmetric information and annuities

- Some economists believe that asymmetric information problems might lie behind the failure of the voluntary annuities market (a lemons problem; "I wouldn't join a club that would have me as a member")
- Asymmetric information may drive annuity prices beyond the reach of most people, causing demand to fall
- We can do a number of tests to see if this is the case
  - See how expensive annuities actually are for most people
  - Test for separating equilibria

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Annuity money's worth

- This is a measure of how expensive annuities actually are

$$AMW = \frac{EDPV(\text{Annuity Payments})}{\text{Annuity Price}}$$

- Given reasonable assumptions about the interest rate and expected lifespan of purchasers, how does the expected discounted present value of annuity payments compare with the price that is actually charged for the annuities?

Annuity money's worth

	United Kingdom		United States	
	Ann	Year	Ann	Year
Friedman and Warshawsky (1988)			0.868	1983
Mitchell *et al.* (1999)			0.865	1985
			0.926	1990
			0.927	1995
James and Vittas (1999)	0.966	1999		
	0.878	*1999*		
Murthi *et al.* (1999)	0.966	1999		
Finkelstein and Poterba (2002)	0.944	1998		
Brown *et al.* (2000)			0.937	1995
			0.929	1996
			0.938	1997
			0.974	1998
James and Song (2001)	0.983	1999	0.974	1999
	0.894	*1999*		
Cannon and Tonks (2003)	1.033	1964		
	1.004	1976		
	0.977	1984		
	0.976	1996		

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Testing for separating equilibria

- Finkelstein and Poterba (2002) find evidence of separating equilibria in the UK annuity market
- They examine the mortality experience of holders of different types of annuity policies (e.g. guaranteed, inflation-indexed etc) using data from a large UK annuity provider
- They then compare the differences in these observed mortality rates to the assumptions that they infer were used in pricing…
- … and demonstrate that these are equivalent
- Economically, their effect is pretty small, though

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NTA question (highly preliminary)

- In NTA's we see the sources of net financing of the LCD
- But we *don't* see the insurance value of the different transfers
- For instance, changes in family structure may provide insurance against bad events
- Could we use NTA's to quantify the value of this insurance / measure its efficiency / its effects on other markets?

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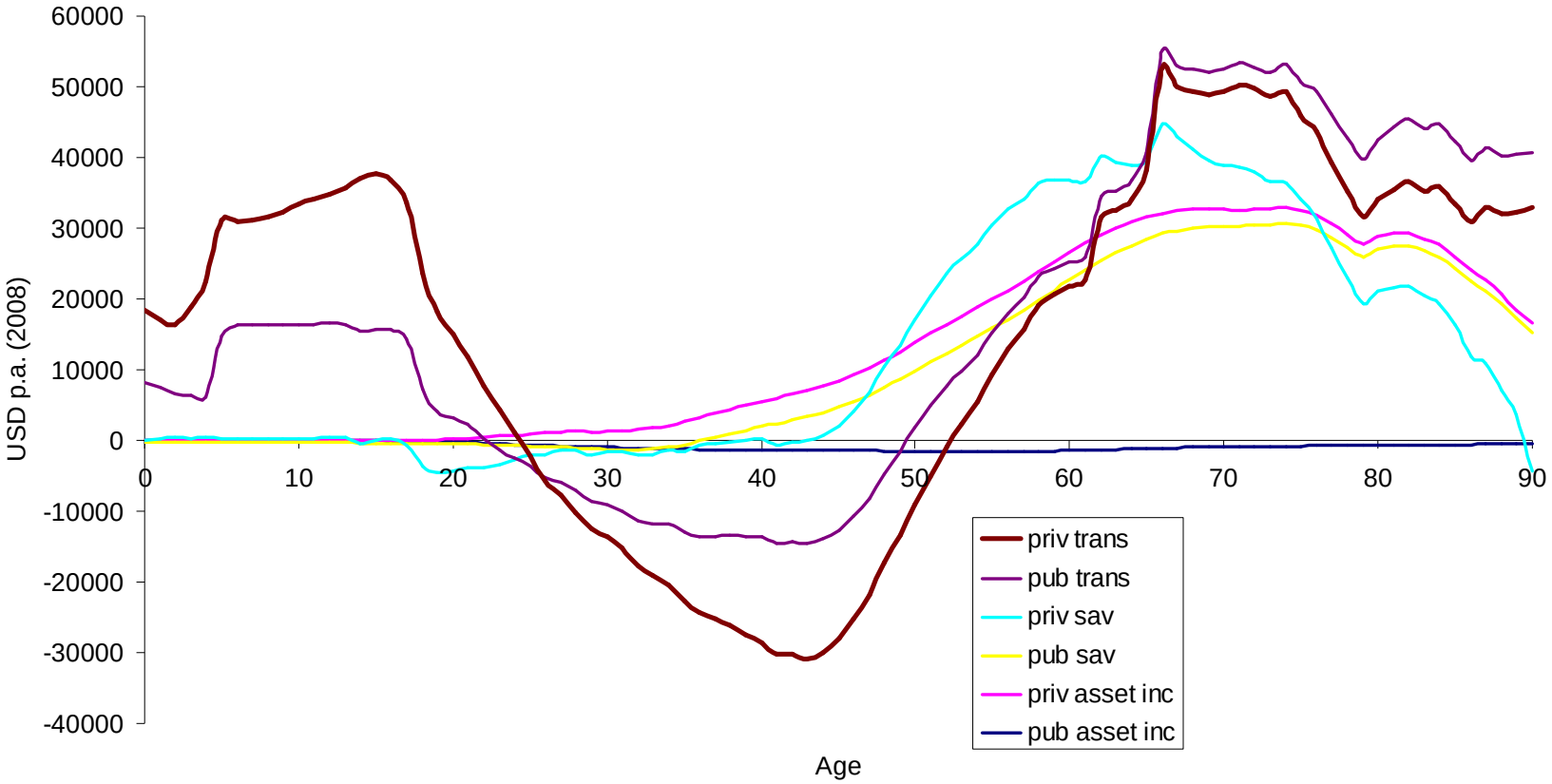
US LCD & its components (2008), from Gretchen



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Conclusion

- NTA's are a very illuminative way of analysing the economic life-cycle
- They illustrate quite well some of the reasons underlying low demand for annuities (although they are not the whole story)
- Potential projects
  - Incorporating uncertainty into NTA's (what is the insurance value of NTA transfers, how do we measure it)
  - Using NTA's more broadly to test asset pricing models