Asset Market Participation and Portfolio Choice over the Life-Cycle

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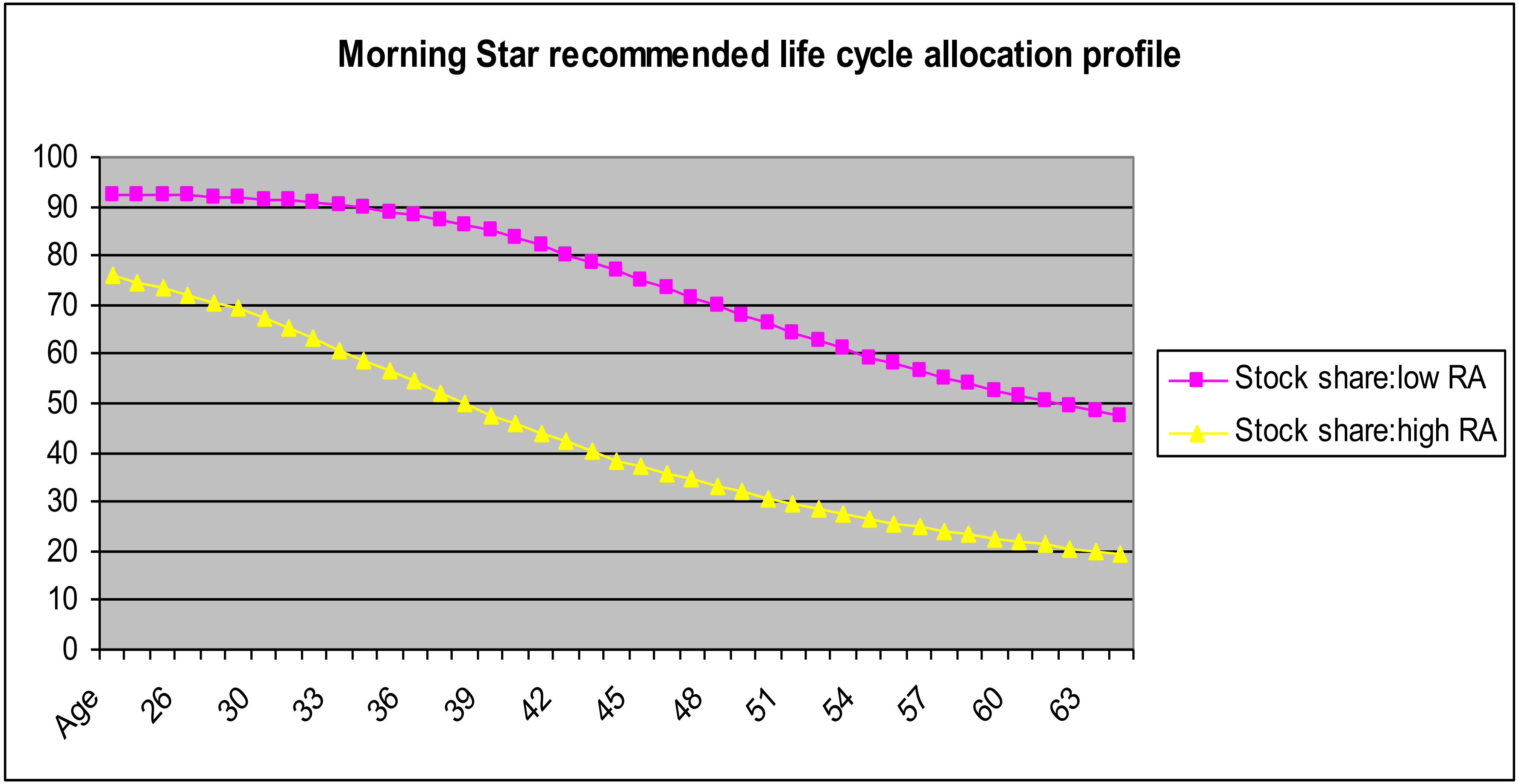
Background questions

- How should households allocate their wealth over his life cycle?
- Do they actually conform to normative behavior?
- Long lasting debate confronting practitioners and normative economic models
  - Relevant for the design of retirement plans
  - Relevant for sound financial advice

Practitioners recommendation: Invest a high share in risky assets when young and rebalance away from stocks as you age



Jack Bogle's simple practical rule suggests $\alpha(a) = 100 - a$

Economist view: early models

- Early normative models challenge this view (Samuelson (1969), Mossin (1968), Merton (1969)):
- Two sharp predictions :
  1. At all ages all investors should participate in the stock market
  2. The portfolio share in stocks exhibits no life cycle pattern
- They assume complete markets, no trading frictions, no labor income, CRRA preferences, time independent returns=> closed form solution $\alpha = \frac{\mu - r}{\lambda \sigma^2}$

Merton’(1971): adds labor income

- Lifetime wealth = accumulates assets (*W*(*a*) + human wealth *H(a)*

- Optimal share in stocks as a fraction of financial wealth is

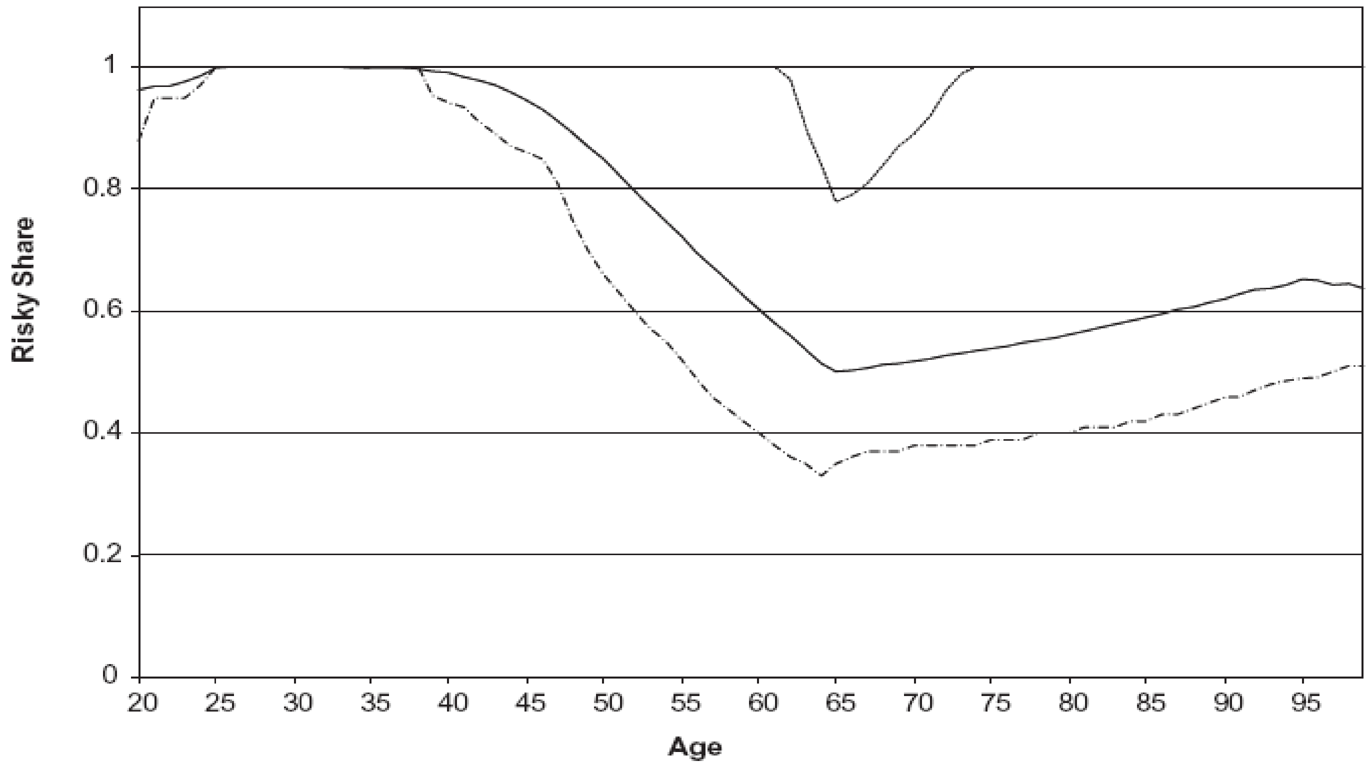
$$\alpha(a) = \frac{(\mu - r)}{\lambda\sigma^2}(1 + \frac{H(a,T)}{W(a)})$$

  – Varies with age becasue $\frac{H(a,T)}{W(a)}$ varies with age

  – Investors participate in stocks at all ages

- Optimal portfolio share in stocks high when young and declines with age
- Intuition: Human capital acts as a bond
- Rationalizes practitioners advice but very different implications
  - rebalancing depends on life cycle of human capital

Does it generalize?



0140 **Figure 26 Life cycle profiles of portfolio risky share.** The figure reproduces the simulations of the life cycle of the portfolio risky share of Cocco et al. (2005)—baseline Figure 3 panel c.

- Basic Merton implication holds in more general contexts with Uncertain labor income, Incomplete markets, Non-standard preferences, Bequests, Correlated stock returns
- No closed forms, need computational models
- NB: a) predictes very high shares when young; b) participation at all ages

What do the data tell?

- If the risky share over the life cycle is driven by shrinking human capital one would expect a strong evidence of rebalancing. That is not the case
- Summarizing evidence for several countries, Haliassos et al (2001) argue that "the age profile of risky share is relatively flat, though in some instances there does seem to be some moderate rebalancing"
- But how solid is the evidence?

Several reasons to doubt

1. Mostly based on cross sectional data=> harder to separate cohort from age
2. Primarily from surveys=> subject to measurement problems.
   1. Measurement and reporting error may be correlated with age hiding age patterns when present
   2. Since stocks are less widely held, lying about them in surveys is more likely and more rewarding for those who have a lot (The young?)
3. Studies ignore the participation is a choice=> uncontrolled selection may be responsible for the failure to find evidence of rebalancing in the share

This study: two tasks

1. Deal with the shortcomings of the empirical evidence
   - Rely on data that should be free of most of the above concerns
   - Accounting for time and cohort effects
   - Account for the endogenous participation

Þ Produces empirical age profiles for the portfolio share and participation with distinct patterns of adjustment

Þ Strong evidence of rebalancing along different margins

2. Propose a calibrated model that can:
   1. come close to reproduce the age profile of share and participation and the *timing of adjustment* along these two margins
   2. is consistent with the level of the share for the stockholders

Our data

1. Data from Norwegian Tax Registry
2. Norway has a wealth tax => individuals have to report their financial (and real) assets for the tax to be levied
3. Data at the level of the single instrument for each taxpayer
4. Assets ownership and value reported to the tax authority by the bank, employers of broker where the claim sits
    1. => more difficult to conceal information (no under or non-reporting)
    2. => absence of standard measurement error
5. Very long panel (available since 1995, for, 15 years)
6. Covers the whole population (no attrition due to tracking)

Features of data:3

1. Extract randomly 20% of the households from 1995 population: 164,000 households, 916,000 obs
2. Follow them for next 15 years
3. Those who exit are not replaced=> some attrition because
    1. Die (main reason 62%)
    2. Divorce (25%)
    3. Leave the country (13%)
4. Focus on two assets model: stocks and bonds (aggregate info at household level)

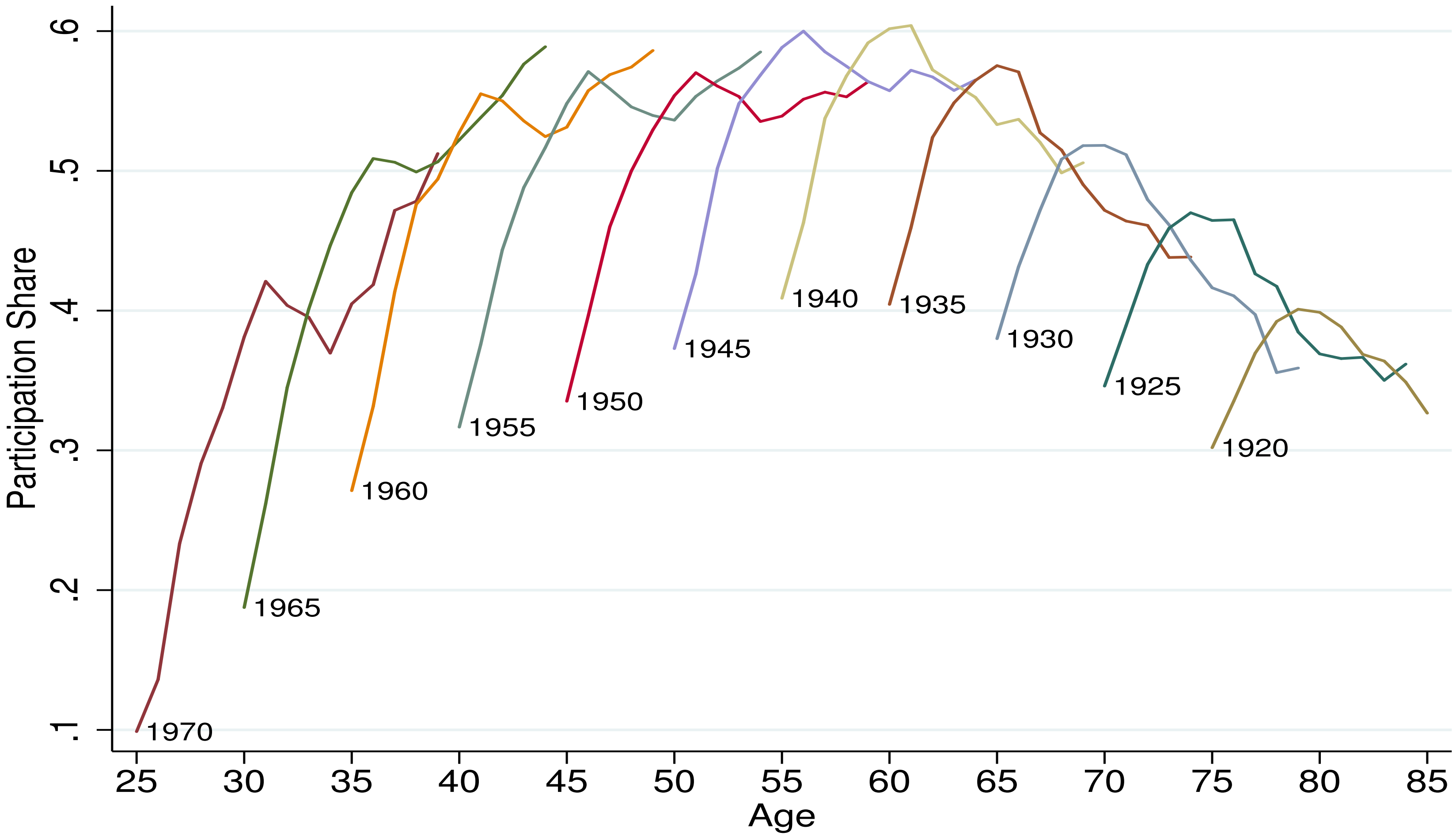
Summary stats

Table 3.1: **Descriptive Statistics - 1995**

	Full Sample				Balanced Panel Sample			
	Obs	Mean	Std Dev	Median	Obs	Mean	Std Dev	Median
Demographics:								
Age Husband	164,015	50.88	14.14	49	106,369	47.67	11.64	47
Age Wife	164,015	48.12	14.01	47	106,369	45.00	11.40	45
Share Less High School Education	164,015	0.22			106,369	0.18		
Share High School Education	164,015	0.53			106,369	0.55		
Share College Education	164,015	0.24			106,369	0.27		
Household Size	164,015	3.24	1.19	3	106,369	3.44	1.17	3
Asset Holdings in USD:								
Financial Wealth	164,015	38,270	106,975	11,884	106,369	38,169	111,865	11,348
Stocks	164,015	12,797	91,438	0	106,369	14,386	97,230	0
Mutual Funds	164,015	1,173	3,895	0	106,369	1,245	3,989	0
Safe Assets	164,015	24,297	37,678	9,734	106,369	22,536	35,575	9,139
Net worth	164,015	120,354	143,051	97,543	106,369	116,213	142,199	93,318
Participant share:								
Risky Assets	164,015	0.33	0.47	0	106,369	0.35	0.48	0
Stocks	164,015	0.23	0.42	0	106,369	0.25	0.43	0
Mutual Funds	164,015	0.22	0.41	0	106,369	0.23	0.42	0
Mean share participants:								
Risky Assets	54,519	0.32	0.30	0.20	37,770	0.33	0.31	0.22
Stocks	54,519	0.23	0.31	0.05	37,770	0.24	0.32	0.06
Mutual Funds	54,519	0.09	0.15	0.03	37,770	0.09	0.15	0.04
Attrition:	58,863							
Share Death		0.62						
Share Migration		0.13						
Share Divorce/Separation		0.25						
Mean yearly attrition rate:		0.030	0.000					
Age at Exit		62.63	16.83					

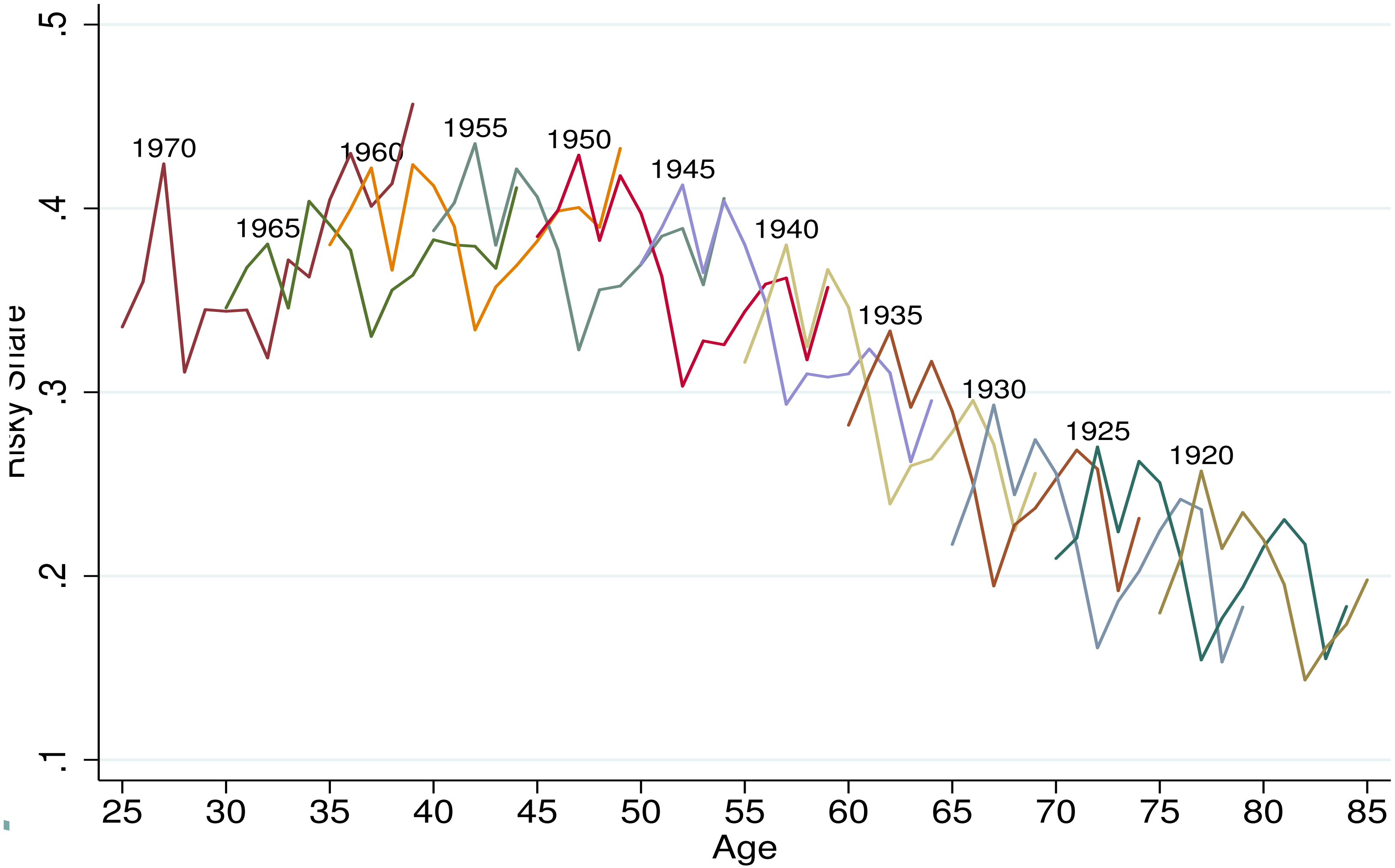
Participation rates by age an cohort

Figure 3.1: **Participation shares in Risky Asset markets, selected cohor**



Conditional risky share by age and cohort

Figure 3.3: **Risky Share of Financial Wealth by Cohort.**



Modeling

1. Two identification problems with the descriptive evidence

2. Separating age, time and cohort effects
   - Need some restriction to separate the three and identify the age profile
3. Selection into participation
   - Need some restriction to separate the decision to participate from the optimal share

Modeling time, age and cohort effects

1. Different strategies

2. No general rule of what is a good strategy=> Use three
   1. Deaton-Paxon: add a trend and impose that deviations from trend sum to 0
   2. Rely on theory: participation profile and share profile hump shaped=> age effects=0 around the peak
   3. Impose causal mechanism on cohort effects: affected by stock market returns during “impressionable years” (Malmendier, 2011)

Endogenous participation

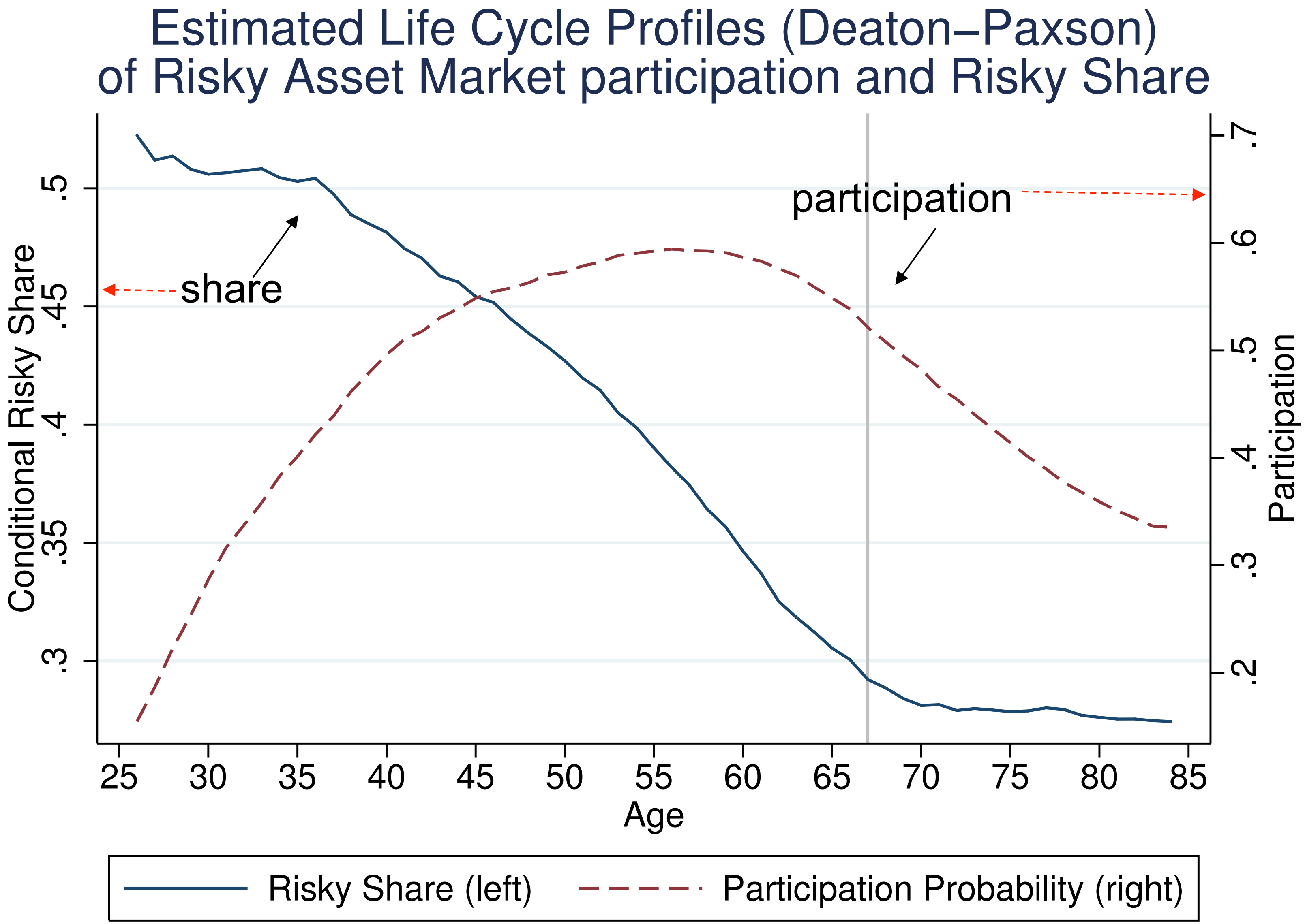
1. Estimate a two stage Heckman model
2. Identification restriction
   1. A measure of lifetime wealth (financial wealth + human capital) affects decision to participate but not the optimal share
3. Restriction is theory-informed=> Merton 1971:
   1. With fixed participation cost, decision to participate defined by a wealth threshold: investors with wealth above threshold participate
   2. Optimal financial share is independent of level of wealth though depends on ratio $H(a)/W(a)$, which is a function of age. Capture the latter with a set of age dummies
   3. literally true in Merton, approximately true relaxing Merton assumptions

Result

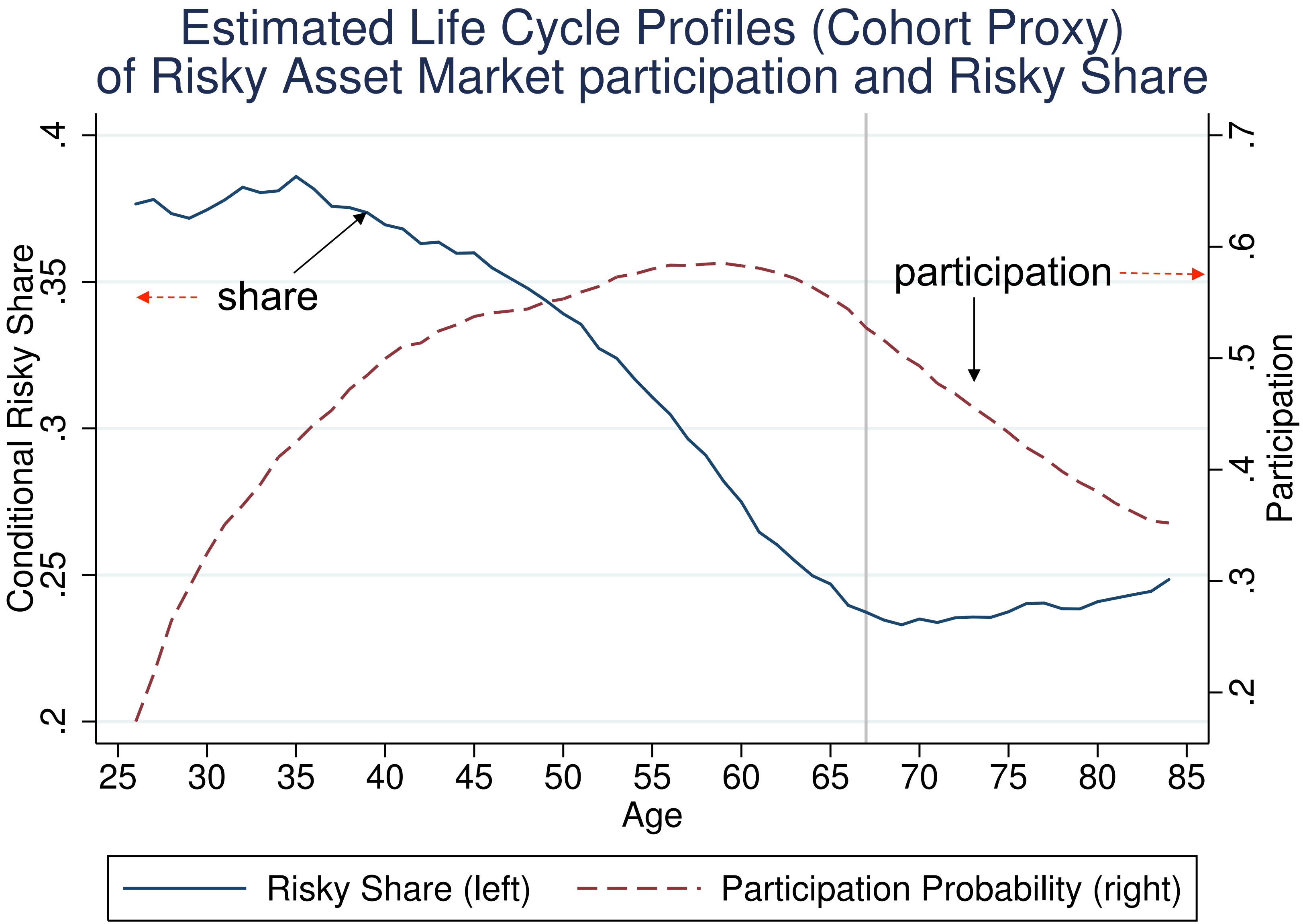
Table 4.1: **Heckman Selection Model**

	Deaton-Paxson		Cohort Proxy		Peak Restriction	
	Part Eq	RS Eq	Part Eq	RS Eq	Part Eq	RS Eq
Trend	0.012***	-0.003***				
	(0.001)	(0.001)				
Youth Stock Return			0.361***	-0.070		
			(0.017)	(0.080)		
Lag Total Wealth	4.107***		4.186***		3.597***	
	(0.1478)		(0.030)		(0.010)	
lambda		-0.186***		-0.186***		-0.185***
		(0.001)		(0,001)		(0.001)
Observations	1,804,115	886,189	1,804,115	886,189	1,804,115	886,189
Joint sign. tests						
Year χ^2 (12)	1575.79***	882.70***				
Cohort χ^2 (59)	7644.51***	19.17***			1641.10***	9.99***

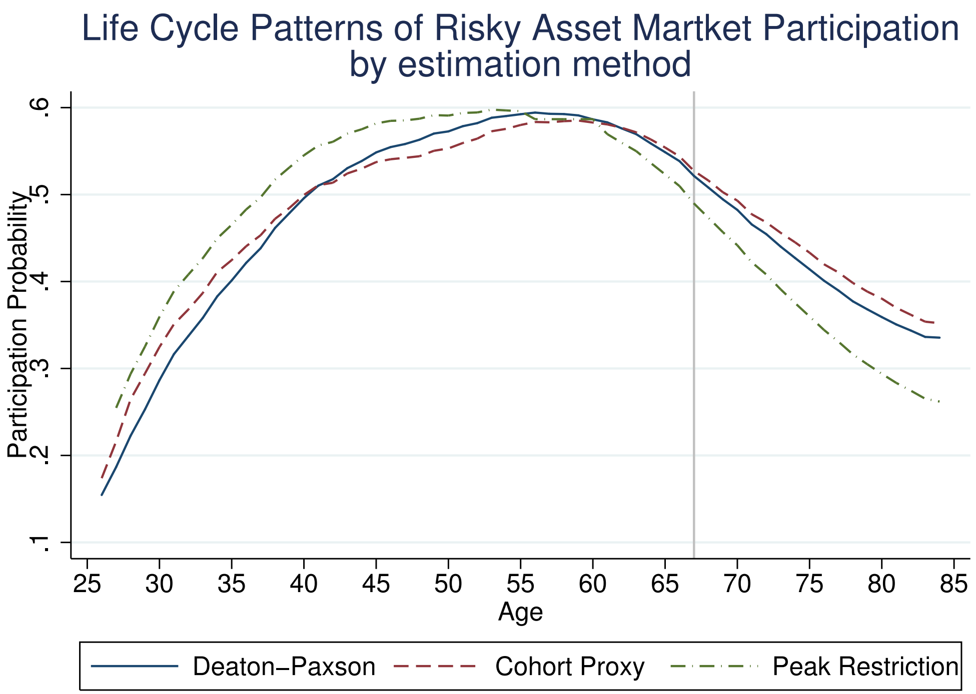
Result: Deaton-Paxon restriction

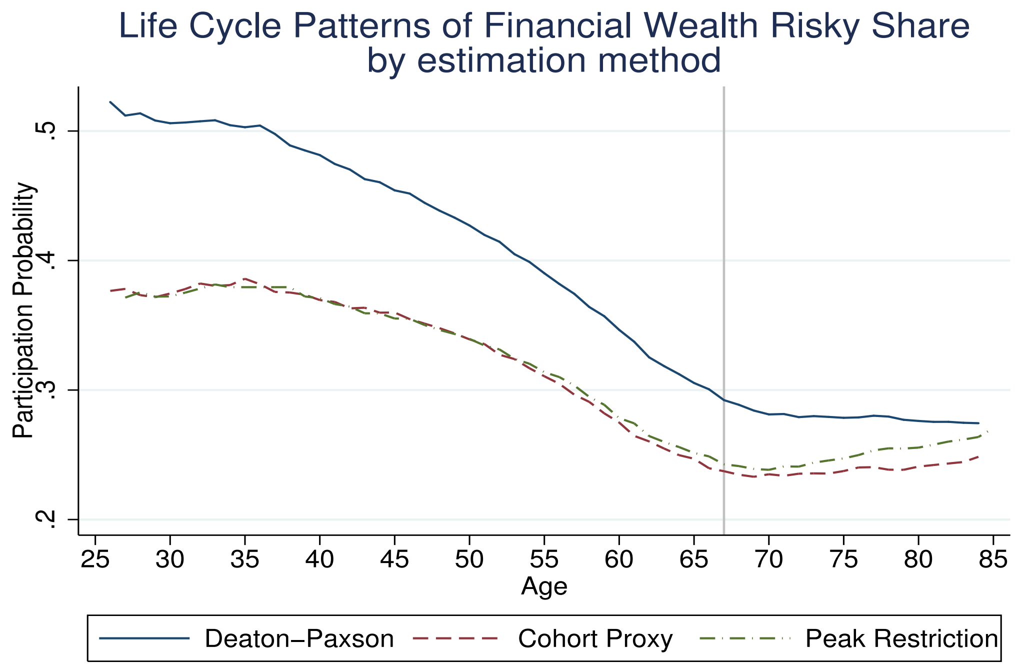


Result: restricting cohort effects to youth experience



Similar results across methodologies





- Share high when young, profile is concave until retirement
- Evidence of rebalancing. Speed 14 and 20 points in 20 years
- Share is constant or mildly increasing after retirement=>
  consistent with CGM (2005) : wealth and human capital are both run down, the first may decumulate faster => share in stocks may increase

Dual adjustment

- Hump shape in participation => people enter and exit the market
- Participation peaks around retirement
- As people leave the labor market they also start leaving the stock market=> inconsistent with a once and forever participation costs
- Adjustment takes place along two margins with a specific timing
  - Gradual rebalancing along the intensive margin well before retirement
  - Exit from stocks after retirement

Standard computational models

Two problems with most existing models

- Profile of the share consistent with that estimated by us but predicted level is too high
- Do not generate exit from the stock market and are silent about timing of exit over the life cycle
  - Focus has been on limited (low) participation among the young
  - Limited participation and exit among the elderly has been ignored (exception Allen Sue)
- Extend Cocco, Gomez and Menhaout (2005) to try account for these features

New ingredients

- Allow for a per-period participation cost
  - Can potentially produce exit if assets evolve (and shrink) over the life cycle
- Allow for “disasters” – low probability events with large consequences
  - Can contribute to lower the optimal share
  - May affect participation
- Model “disaster” as a probability of loosing the money invested in stocks
  - Interpretation 1: deception and risk of fraud
  - Interpretation 2: jumps in stock returns

Model

- Household problem
  - Choose consumption and portfolio allocation to maximize expected utility (time separable, CRRA)
  - Idiosyncratic labor income with a predictable (age dependent component) and idiosyncratic shocks
  - Initial endowment of wealth randomly drawn from a Pareto distribution (only accidental bequests), household face an age dependent probability of death
- Two assets: stocks (risky), bonds (safe)
- Stocks risky along two dimensions: (i) usual variability in return ; (ii) small probability of loosing whole investment
- Investing in stocks entails a fixed per period cost

Calibration

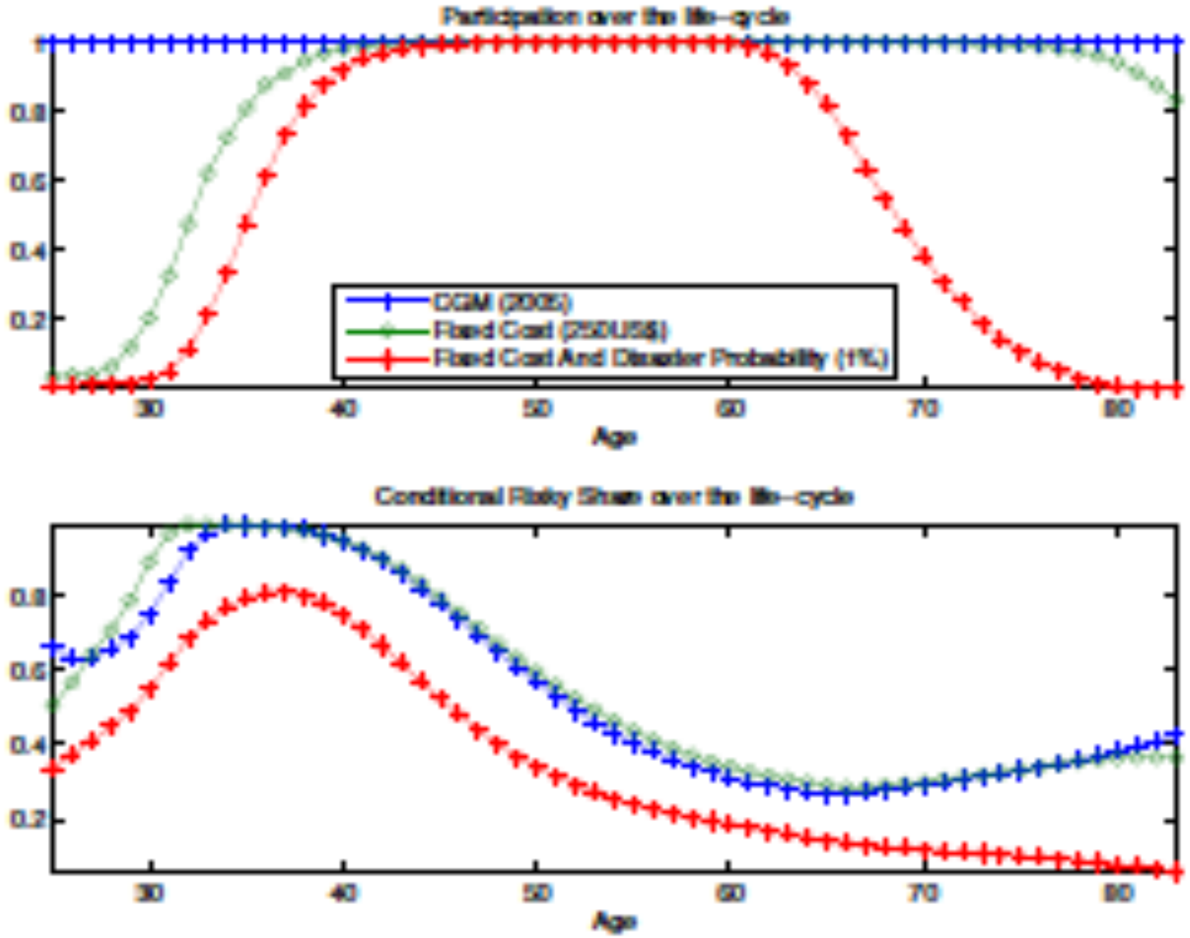
- Set a number of parameters from external estimation
- Labor income: model earnings as the sum of a systematic component dependent on age and observables characteristics and a residual shocks
  - Use systematic component to obtain predictable future earnings and human capital
  - Model residual as sum of a permanent and transitory shock and estimate their variances
- Others: equity premium, equity return SD,
- Calibrate remaining parameters so as to minimize distance between theoretical and estimated age-profile of asset share and participation
  - Preference parameters: risk aversion, subjective discount
  - Per period participation cost, probability of disaster

Baseline

Variable Name	Variable	Value	Source
Retirement age	T^r	67	Norwegian Law
Risk free return	r_f	0.018	Dimson, Marsh, and Staunton (2008)
Risk premium	r_p	0.03	Dimson, Marsh, and Staunton (2008)
Std deviation stock return	σ_r	0.231	Data - Oslo Stock Exchange
Variance of transitory shocks	σ_t^2	0.023	Table A.1
Variance of persistent shocks	σ_p^2	0.012	Table A.1
Income share of retired HH	ϕ_{ret}	0.842	Table A.2
Shape of Pareto Distribution for x_0	μ_{x_0}	0.4521	Data - Wealth at age 25
Scale of Pareto Distribution for x_0	σ_{x_0}	5711.7	Data - Wealth at age 25

Other parameters	
Risk aversion	10
Discount factor	0.96
Probability tail event	1%
Per period participation costs	$250

Comparison with Cocco et al GO



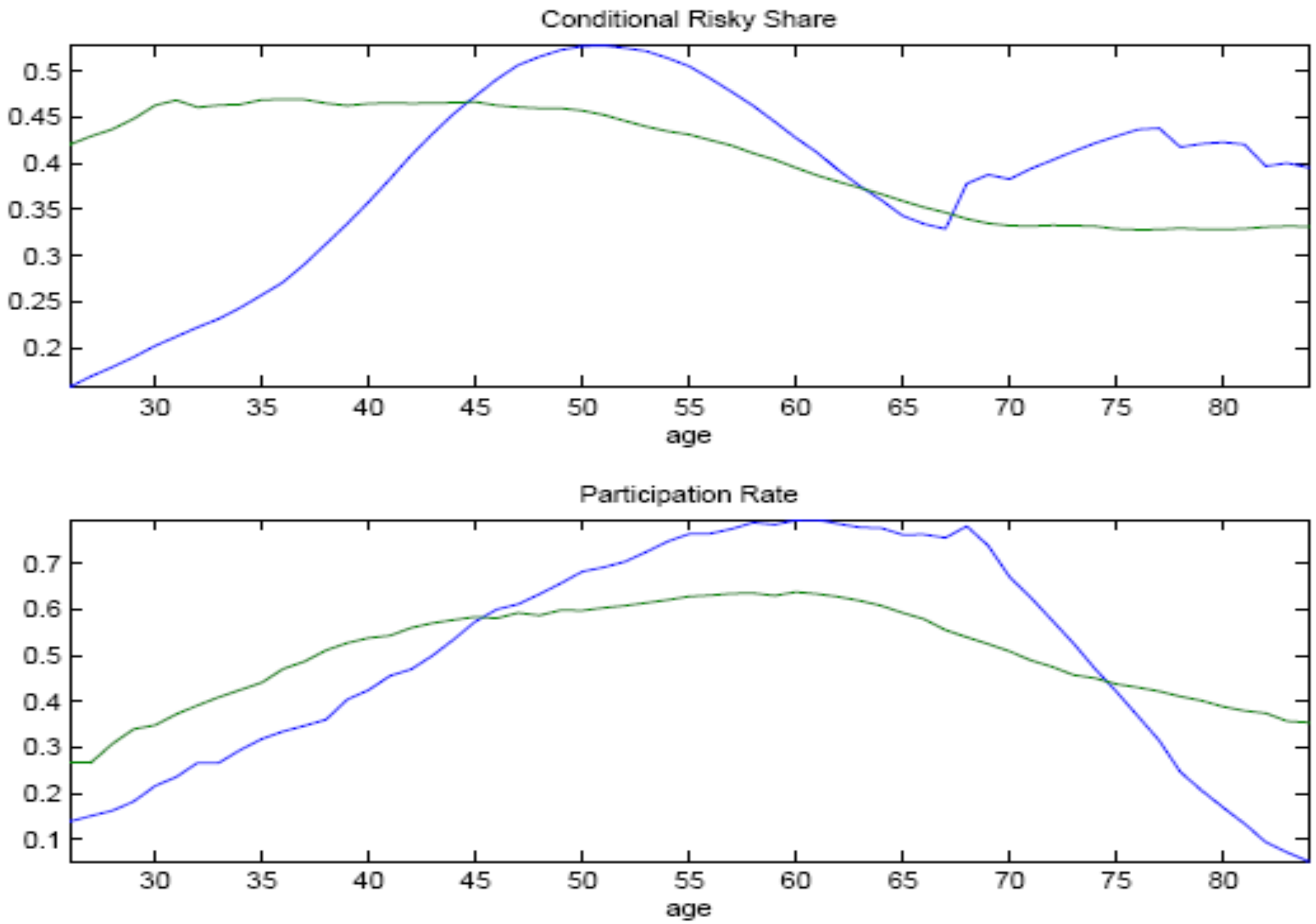
Per period cost not enough to generate timely exit, also prob “disasters” needed

Estimates

Variable	Data	CGM	Est. 1	Est. 2	Est. 3	Est. 4	Est. 5
Risk aversion (γ)	-	10	7.5	17.3	10.4	12.5	13.3
Participation cost (q) in *US$*	-	n/a	17.1	119.8	24.5	14.1	29.1
Discount factor (β)	-	0.89	0.91	0.86	0.89	0.85	0.86
Probability of tail event (p_{tail}) in%	-	n/a	1.75	0	1.3	1.4	1.34
Fraction of stock investment lost (θ) in%	-	n/a	100	n/a	100	100	78
Value of Objective Function	-	-	2.93	4.91	2.86	2.26	2.97
Target Data	-	-	DP	DP	DP	CP	DP
Mean wealth to income ratio (age 65)	1.62	2.23	1.74	3.07	1.75	1.71	1.81
Std. dev. of log wealth (age 65)	1.77	0.78	0.79	1.01	0.795	0.789	0.783

A combination of relatively high risk aversion, low fixed per period participation cost and a small disaster probability needed to get the model closer to the data

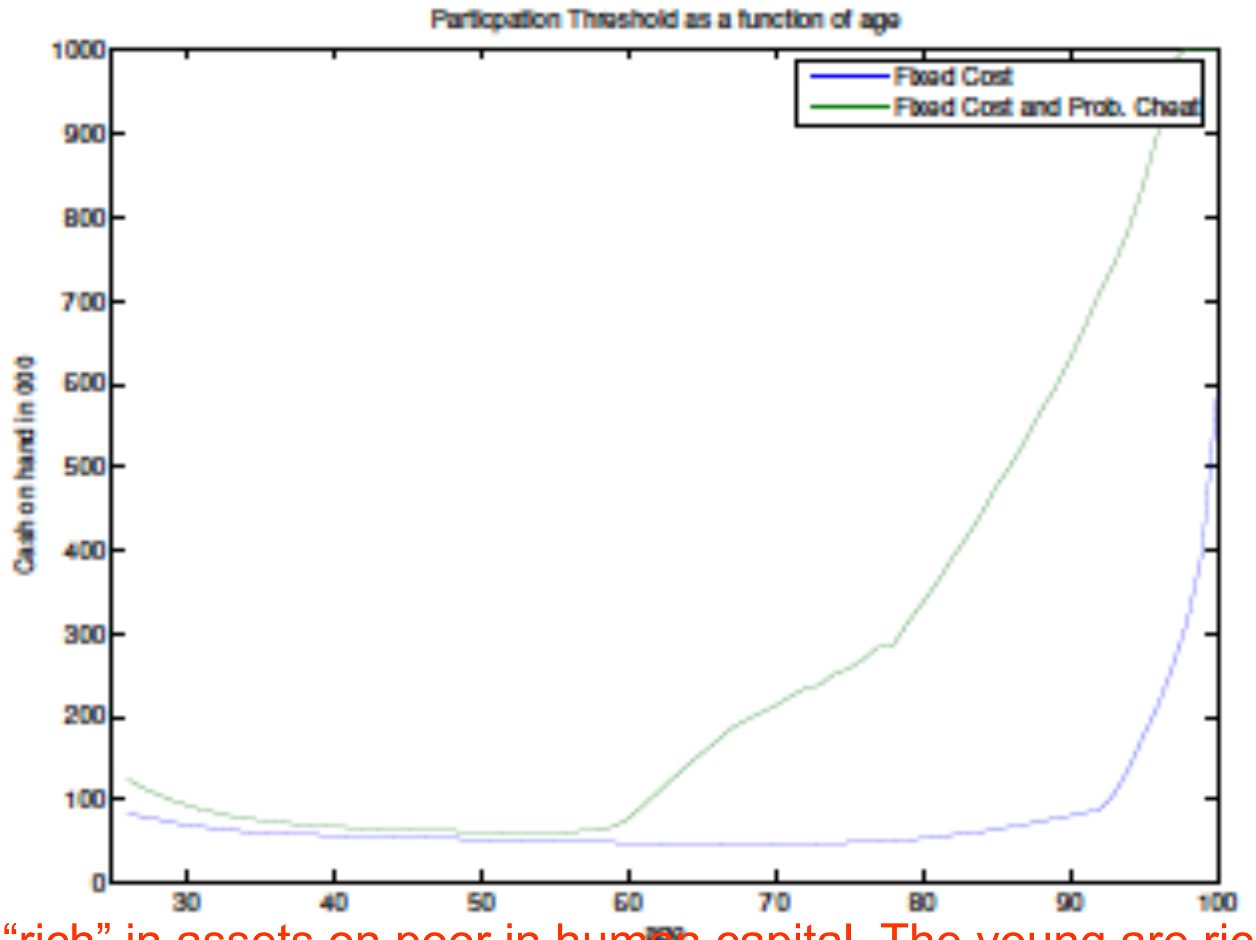
Fit: estimate risk aversion, discount factor, fixed cost and disaster probability



Summing up

- Robust evidence that investors do indeed rebalance over the life cycle
- Investors adjust along two margins with distinct timing
  - Lowering the share in stocks when retirement comes into sight
  - Exiting the stock market when they retire
- A model with a small per period participation cost a small age-invariant probability of disaster and relatively high risk aversion can come close to reproduce the dual pattern of adjustment and the level of the share over the life cycle

Wealth threshold for participation, disaster probability and age **Back**



Elderly are “rich” in assets on poor in human capital. The young are rich in human capital and poor in assets. This makes the elderly particularly sensitive to the disaster probability and the yoiung particularly insensitive

Two stage model

$$s_{iact} = \beta_a A_a + \beta_c C_c + \beta_t D_t + \beta_o Trend + \theta_1 Z_{iact} + \theta_2 \lambda_{iact} + \varepsilon_{iact}$$

$$prob(P^*_{act}=1 \mid x) = prob(P^*_{act} > 0 \mid x) = prob(\delta_a A_a + \delta_c C_c + \delta_t D_t + \delta_o Trend + \vartheta_1 Z_{iact} + \vartheta_2 L_{iact} + u_{iact} > 0$$

$$s.t. \quad \sum \beta_t = 0, \quad \sum \delta_t = 0 \quad \text{(Deaton-Paxon)}$$

$$or\ s.t. \quad C_c = S_{iact}, \text{ and } \beta_o = \delta_0 = 0 \quad \text{(Experienced stock ret)}$$

$$or\ s.t. \quad \beta_{peak-2} = \beta_{peak-1} = \beta_{peak} = \beta_{peak+1} = \beta_{peak+2} \text{ and } \beta_o = \delta_0 = 0 \quad \text{(Peak restr)}$$

$$\lambda_{iact} = \text{Mill's ratio}$$

$$A = \text{age}$$

$$C = \text{cohort}$$

$$D = \text{time}$$