# Aging and Equilibrium

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# 1 Cognition effects in the cross-section

Cognitive ability – particularly analytic ability – shows sharp age-based declines in the cross-section.

Three mutually compatible contributing factors:

- Cohort effects driven by variation in nutrition and education (Flynn effect)
- "Normal" age-based declines in reasoning and other analytic abilities.
- Cognitive pathologies – dementias – associated with diseases like Alzheimer's.

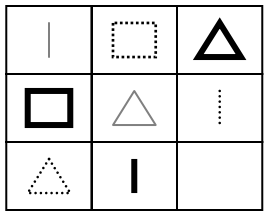
## Memory

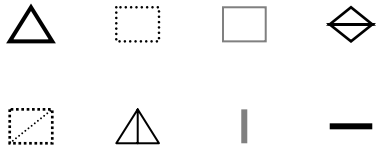
Study the following words and then write as many as you can remember

Goat
Door
Fish
Desk
Rope
Lake
Boot
Frog
Soup
Mule

## Reasoning

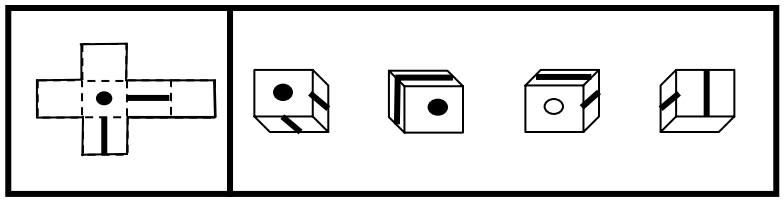
Select the best completion of the missing cell in the matrix





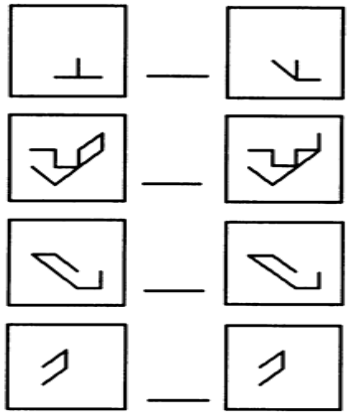
## Spatial Visualization

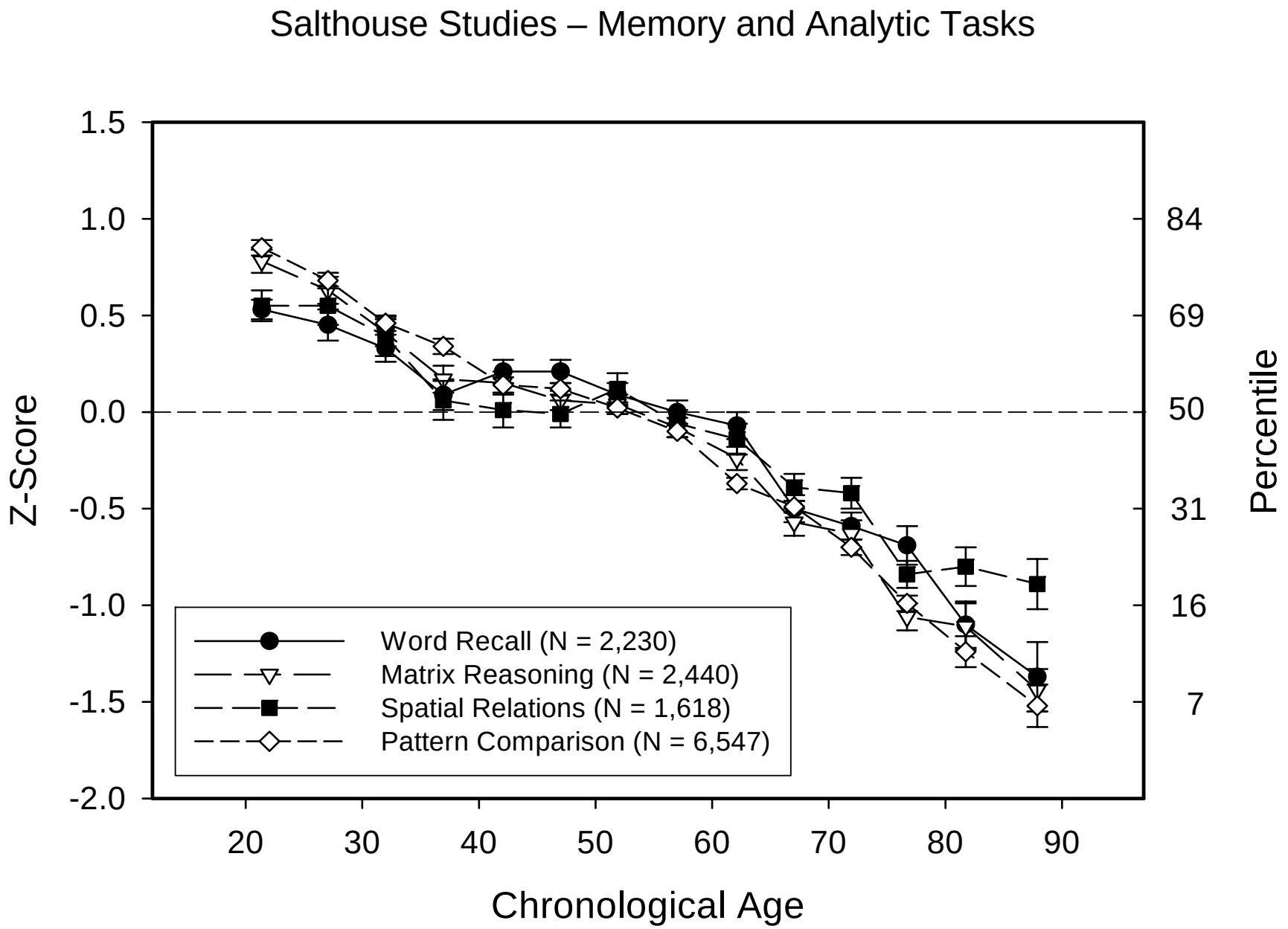
Select the object on the right that corresponds to the pattern on the left



## Perceptual Speed

Classify the pairs as same (S) or different (D) as quickly as possible




Salthouse Studies – Memory and Analytic Tasks
Z-Score
Percentile
Chronological Age
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
84
69
50
31
16
7
20
30
40
50
60
70
80
90
Word Recall (N = 2,230)
Matrix Reasoning (N = 2,440)
Spatial Relations (N = 1,618)
Pattern Comparison (N = 6,547)

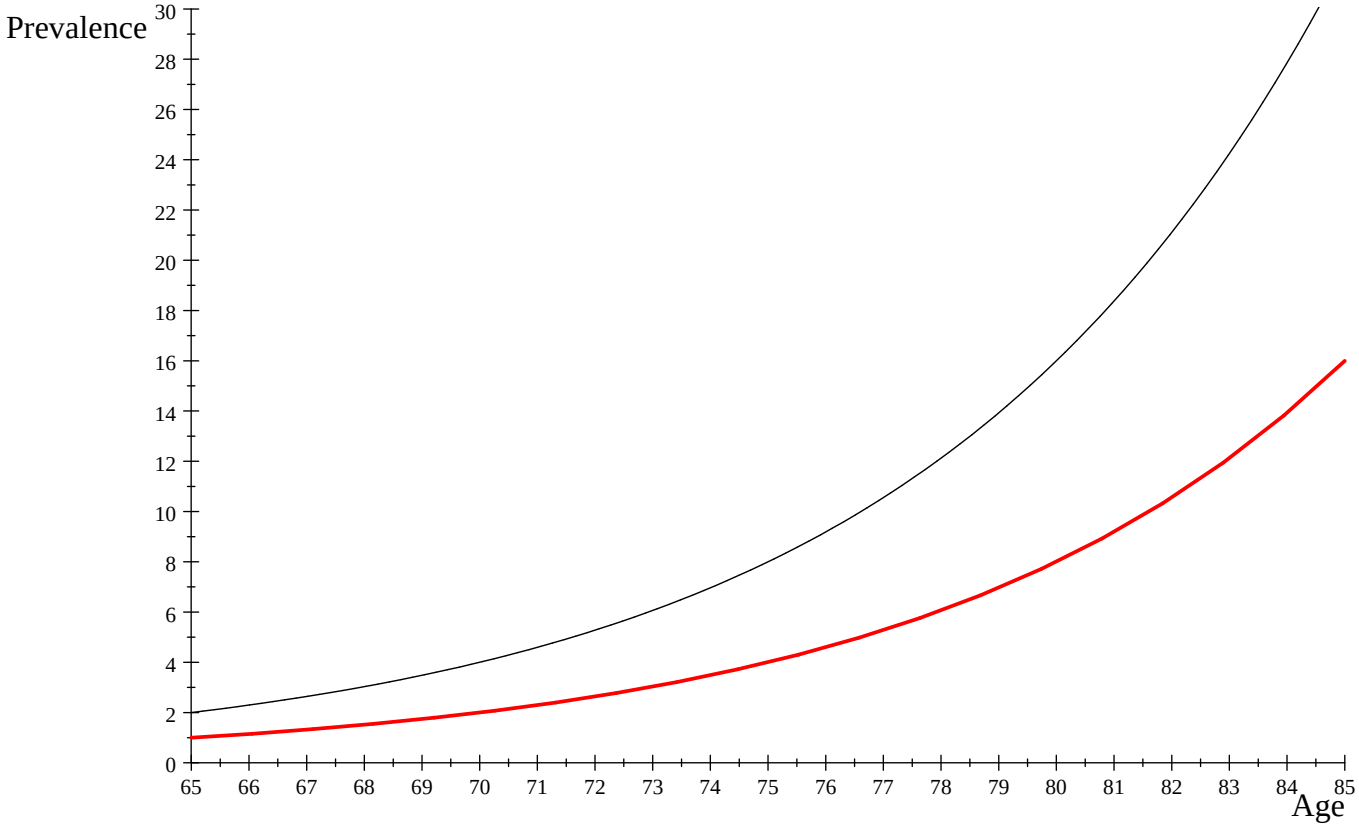
Cognitive pathologies play an important role in lowering means and raising variances.

- Dementia is primarily attributable to Alzheimer's Disease (60%) and vascular disease (25%).

- To a first approximation, dementia rates (prevalence) double every five years (Fratiglioni, De Ronchi, Agüero-Torres, 1999).

| Age | Prevalence of Dementia |
|---|---|
| 60-64 | 0.5% |
| 65-69 | 1.5% |
| 70-74 | 3.0% |
| 75-79 | 6.0% |
| 80-84 | 12% |

The curve that fits this data is plotted in red: $y = \exp\left[\frac{\ln 2}{5} \cdot (x - 65)\right]$.



The vertical distance between the red line and the black line is a measure of incipient cases of dementia – these individuals will have clinical dementia within the next five years.

These preclinical individuals are at significant "economic" risk, because they have not been diagnosed but are likely to already have symptoms.

They may not be aware – and their families may not be aware – that their decision-making capabilities are impared.

Outline for today's talk:

- One general question: will competition lead to an efficient outcome, even if people are prone to make mistakes?
  - Beckerian argument: even if people overestimate the probability of fire, the price of fire insurance should still be fair.
- For older adults, cognitive means are relatively low and cognitive variance is relatively high.
- Four welfare effects in equilibrium: (i) Cognitive costs, (ii) Allocative inefficiency (iii) Cross-subsidies from naives to sophisticates (iv) High markups
- Evidence from other decisions by older adults.

# 2 Cross-subsidies from naives to sophisticates

Sophisticated patients can extract extra resources from the medical system.

- Visit your primary care physician often.
- Ask for expensive assays and procedures.
- Ask for prescriptions.
- Ask for surgical interventions.

- Switch insurance carrier on a timely basis to maximize net benefits.
  - Switch Medicare Part D insurer annually as medical condition changes.
  - (analogous to refinancing a mortgage optimally)

## 2.1 Model (à la Gabaix and Laibson QJE '06)

- Consider an insurer that offers a Part D plan at price $p$
- Plan is optimal for type-$I$ consumers (suffering from a transitory illness)
- Type $II$ consumers are healthy, and shouldn't be on the plan.
- $\pi$ hazard of recovering – switching from type $I$ to type $II$.

- Sophisticated consumers switch plans as soon their type changes.
- Naive consumers switch only with hazard $\lambda$ — they're inert.
- Assume an infinite horizon, with interest rate $r$.

Firm's costs:

- To serve a type $I$ (suffering from a transitory illness) consumer: $c$.
- To serve a type $II$ (healthy right now) consumer: 0.

Consumer's surplus:

- Type $I$ consumer gets surplus: $\theta - p$.
- Type $II$ consumer gets surplus: $0 - p$.

Appendix: Producer surplus calculations for desined to serve type $I$ consumers.

- The surplus from having a sophisticated insuree who is type II is zero, because he leaves the firm immediately

- The surplus from having a sophisticated insuree who is type I.

$$\text{producer surplus from type I sophisticate } = \frac{p-c}{r+\pi}.$$

- The surplus from having a naive insuree who is type II.

$$\text{producer surplus from a type II naive} = \frac{p}{r+\lambda}.$$

- The surplus from landing a naive who is type I.

$$\begin{aligned} \text{producer surplus from a type I naive} &= V = \frac{p - c + \pi p / (r + \lambda)}{r + \pi}. \\ rV &= p - c + \pi \left[ \frac{p}{r + \lambda} - V \right] \end{aligned}$$

Competitive equilibrium

- Assume that fraction $\alpha$ of the population is sophisticated.
- The equilibrium price is

$$p = \frac{c}{1 + \frac{(1-\alpha)\pi}{r+\lambda}} < c$$

- The firm loses money on ill consumers, makes money on inert consumers who should switch.
- Firm makes 0 money on average.

- Equilibrium *increases* inequality, generating transfers from naives to sophisticates.

- Advertising might fix the problem, but it is costly.

- There's also a potential "curse of debiasing":
  - debiasing naive consumers might make them sophisticated, which isn't profitable for the 'educating' firm.

# 3 Transfers from older adults to marketing firms (Gabaix, Laibson, and Li 2005)

- If consumers are confused, mark-ups can be high. But if competition is fierce, will mark-ups go down?

- Following Luce and McFadden, consumers pick good with highest perceived value

$$i = \arg\max_i \{(u_i - p_i) + \varepsilon_i\}$$

where $\varepsilon \sim \sigma f(\varepsilon)$. $\sigma =$"confusion", here.

- **Proposition** (Perloff-Salop '85): For identical firms

$$p - c = \frac{\sigma}{n\left(n-1\right)\int f\left(\varepsilon_i\right)^2 F\left(\varepsilon_i\right)^{n-2} d\varepsilon_i}$$

- **Proposition** (Gabaix, Laibson and Li '05):

$$p - c \sim \frac{\sigma}{nf\left(A_n\right)\Gamma\left(2+\xi\right)}$$

$A_n = F^{-1}\left(1 - 1/n\right)$ and $\xi = \lim_{x \to F^{-1}(1)} \left(\overline{F}/f\right)'(x)$.

- **Proposition**: For $u_i - p_i$ bounded, and $f$ in the domain of the logit:

$$D_i \sim \frac{\exp\left(\beta\left(u_i - p_i\right)\right)}{\sum_{j=1}^{n} \exp\left(\beta\left(u_j - p_j\right)\right)} \text{ wit } \beta = \frac{1}{B_n \sigma}$$

Does competition eliminate markups?

- Uniform noise (or Cournot competition):

$$p - c \sim 1/n$$

- Exponential, logit:

$$p - c \sim 1$$

- Which intuition applies in general?

- Bounded power law noise: $f(\varepsilon) = k(1-\varepsilon)^{\alpha-1}$, $\varepsilon \in [-1,1], \alpha \geq 1$

$$p - c \sim n^{-1/\alpha}$$

- Gaussian noise

$$p - c \sim \frac{1}{\sqrt{\ln n}}\sigma$$

- Exponential noise, $f(\varepsilon) = e^{-\varepsilon+1}1_{\varepsilon>-1}$,

$$p - c = \sigma$$

- Log normal noise:

$$p - c \sim e^{\sqrt{2\ln n}}\sigma$$

So $p - c$ is not sensitive to $n$. Competition/entry doesn't change markups.

**Mark-ups** as a function of the number of competitors, $n$, with Gaussian noise and with uniform noise (or Cournot).

| $n$ | Gaussian noise | Uniform noise |
|---|---|---|
| 10 | 1.00 | 1.00 |
| 100 | 0.61 | 0.1 |
| $1,000$ | 0.48 | 0.01 |
| $10,000$ | 0.40 | 0.001 |
| $100,000$ | 0.35 | 0.0001 |
| $1,000,000$ | 0.32 | 0.00001 |

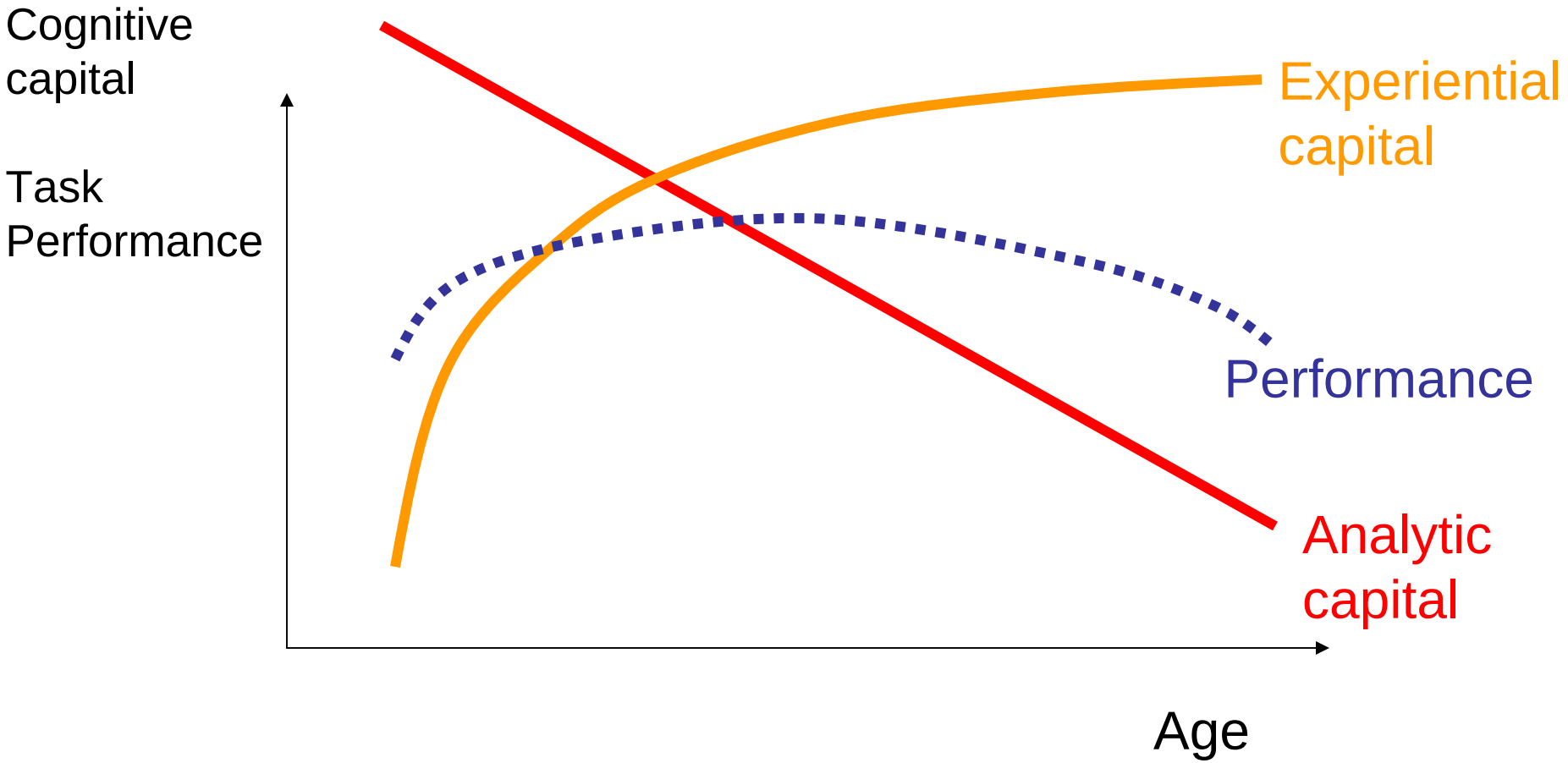
- Can firms exploit consumer confusion? $Yes.$ $p - c \propto \sigma$
- Will competition decrease mark-ups? $Barely.$ $p - c \sim \frac{1}{\sqrt{\ln n}}$
- Is this just a transfer from consumers to firms? *No. Excess profits lead to excess entry.*
- This also applies to financial services for older adults, e.g. fees for IRAs.

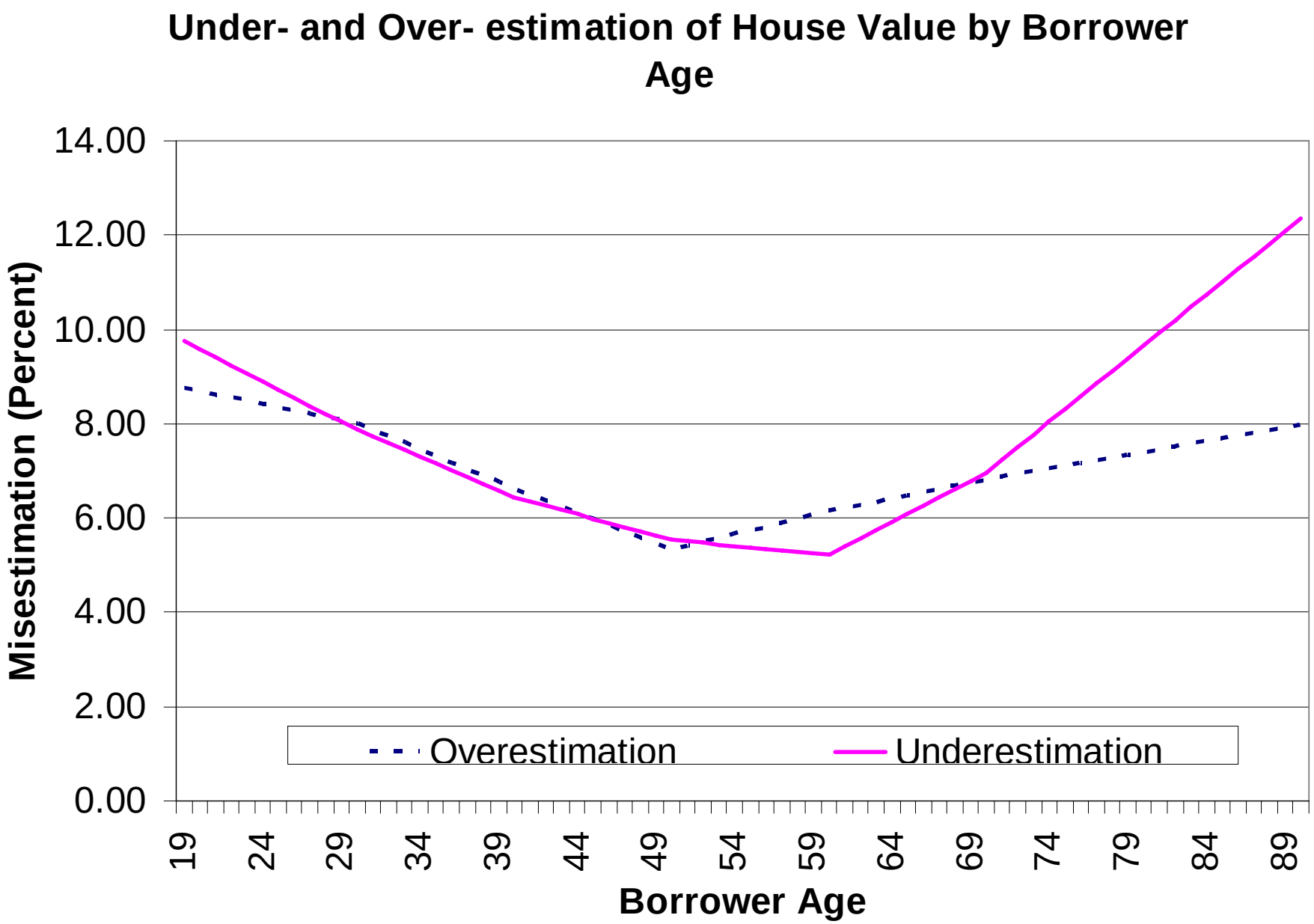
# 4 Some recent evidence on Aging and Equilibrium

- Agarwal, Driscoll, Gabaix, and Laibson, "Financial Mistakes Over the Life Cycle"

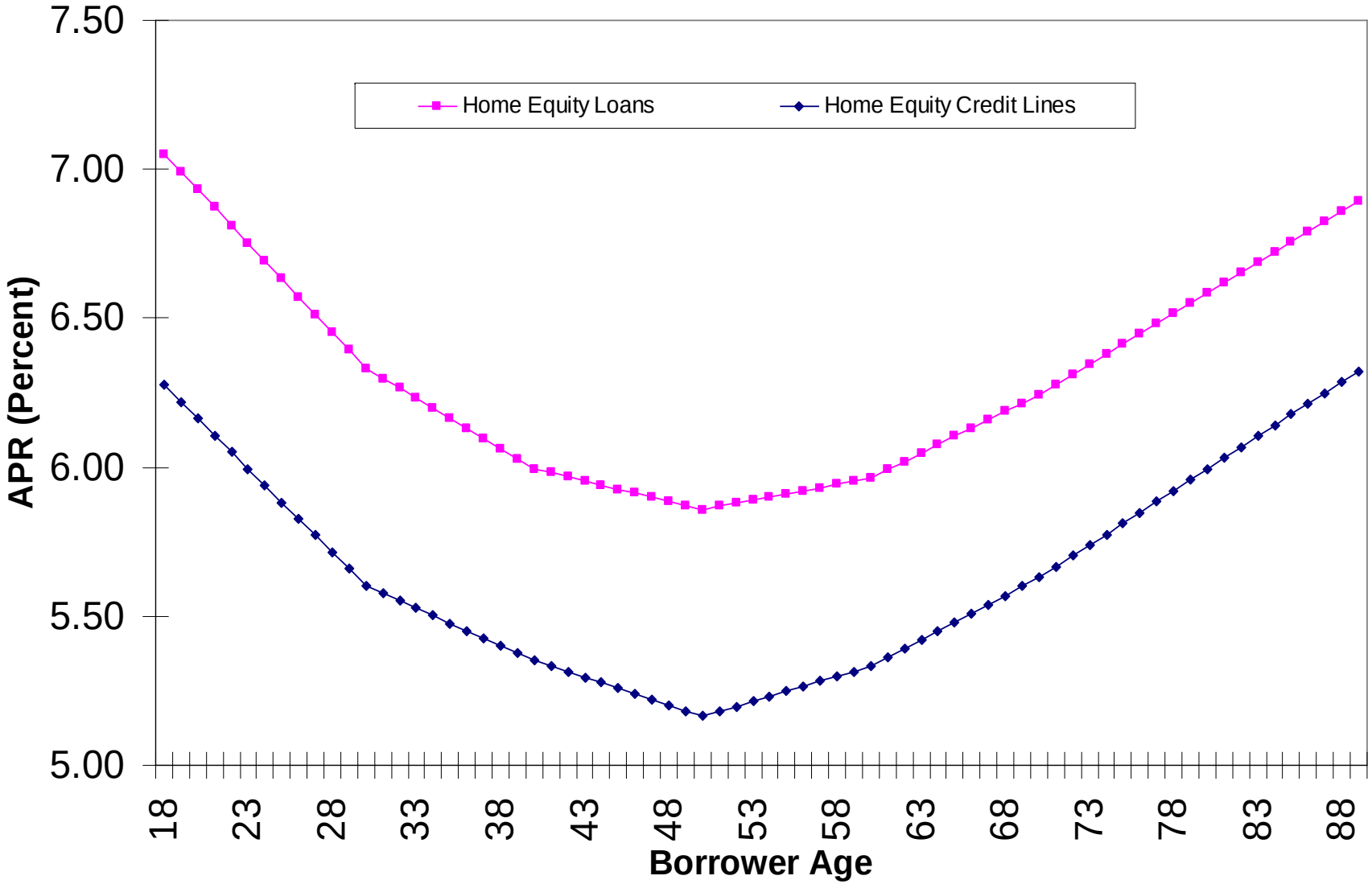
- Financial "mistakes" follow a U-curve over the lifecycle.

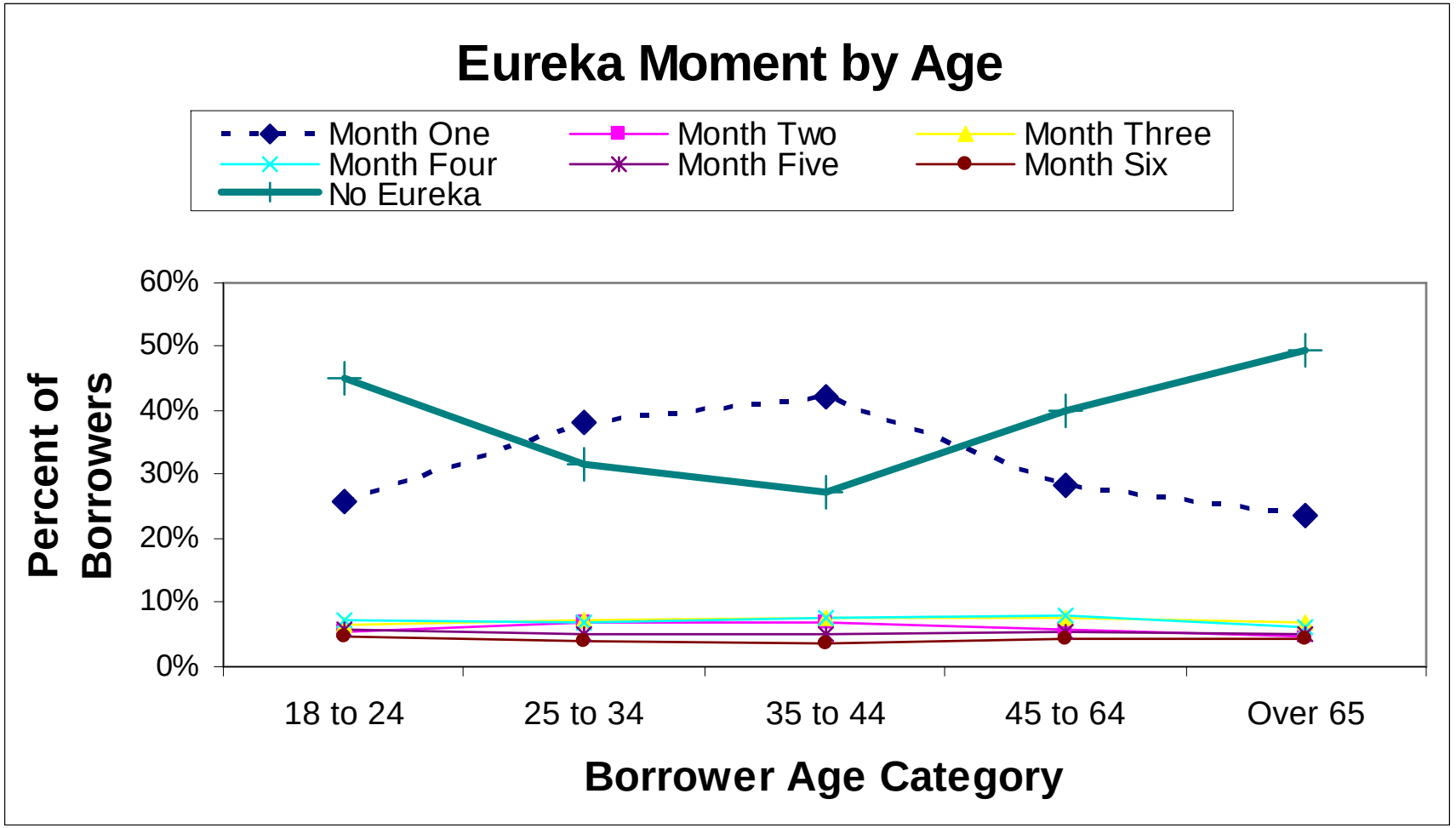
- This regularity is confirmed by over 10 separate studies: Home equity loans Home equity lines of credit, Eureka moments for balance transfers, Late payment fees, Over credit limit fees, Cash advance fees, Auto loans, Credit cards, Mortgages, Small business credit cards.


Cognitive capital
Task Performance
Experiential capital
Performance
Analytic capital
Age


Under- and Over- estimation of House Value by Borrower Age
Misestimation (Percent)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Overestimation
Underestimation
19
24
29
34
39
44
49
54
59
64
69
74
79
84
89
Borrower Age

## Home Equity Loan and Credit Line APRs by Borrower Age




Eureka Moment by Age
Month One
Month Two
Month Three
Month Four
Month Five
Month Six
No Eureka
Percent of Borrowers
60%
50%
40%
30%
20%
10%
0%
18 to 24
25 to 34
35 to 44
45 to 64
Over 65
Borrower Age Category

- Perhaps this regularity is present in the Heiss, McFadden, and Winter paper: older adults, who are more likely to benefit from Medicare Part D, buy less of it.

# 5 Conclusions: Equilibrium and Aging

- Cross-subsidies from naives to sophisticates are a robust equilibrium feature.

- With naive consumers, competition only weakly reduces mark-ups.

- Evidence from other domains that older adults make relatively suboptimal choices

- Need more empirical field work.
- Need a theory that successfully predicts the degree of consumer confusion.
- Need to understand whether markets for advice – e.g. financial advice – offset consumer confusion or add to it.
- Are regulations the solution or do they just generate problems of their own?
- What are the offsetting welfare gains from free (but imperfect) choice?