The Age of Reason: Financial Decisions Over the Lifecycle

April 25 2007

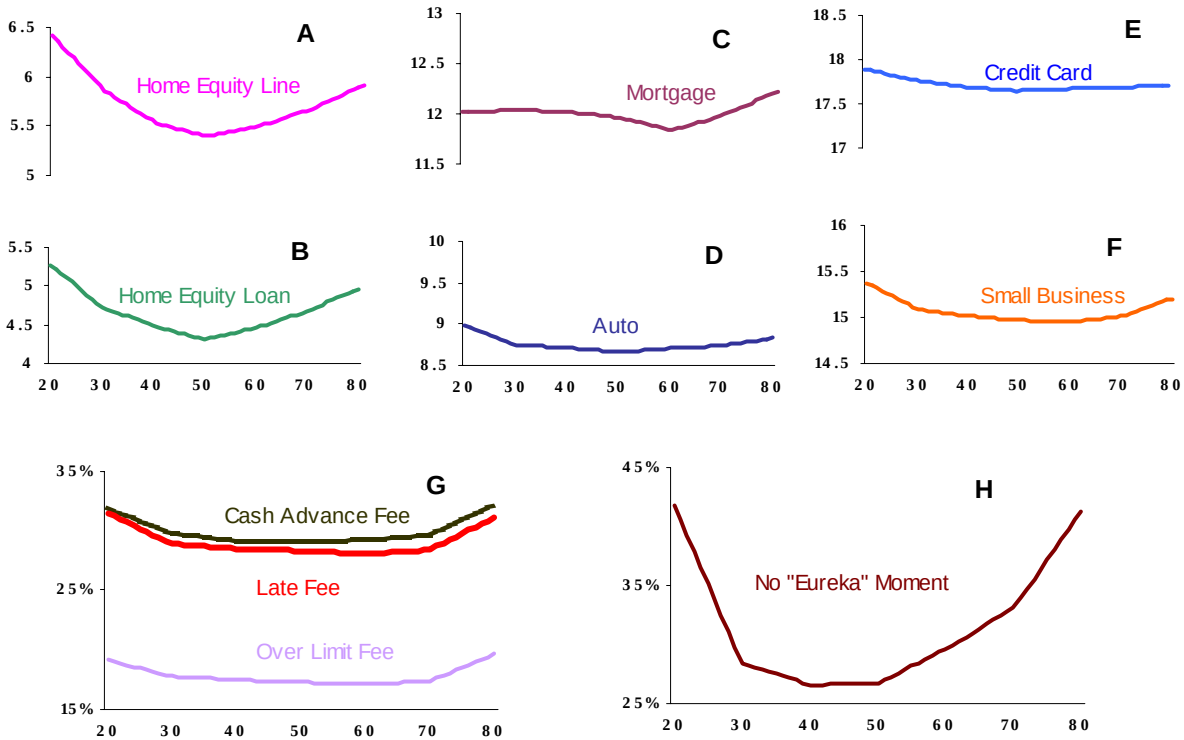
Sumit Agarwal, Federal Reserve Bank of Chicago
John Driscoll, Federal Reserve Board of Governors
Xavier Gabaix, MIT, Princeton and NBER
David Laibson, Harvard and NBER

Overview

- In most areas of life, “performance” rises then declines.
- The peak has been measured in many domains:
  - Baseball: 29 (Fair 2005b, James 2003)
  - Mathematicians, theoretical physicists, and lyric poets: age 30 (Simonton 1988).
  - Chess players achieve their highest ranking in their mid-30s (Charness and Bosnian 1990).
  - Autocratic rulers: early 40s (Simonton 1988).
  - Novelists: age 50 (Simonton 1988).
  - Nobel Prize winning economists: “Conceptual" laureates peak at age 43, and “Experimental" ones at age 61. (Weinberg and Galenson 2005)

Overview

- We turn to personal financial decision-making
- We do find that financial “performance” rises then declines in the cross-section (we can’t tease out cohort vs age effects). Confirmed in 10 studies.



Motivation: Psychological evidence on aging

- Analytic cognitive abilities peak at age 20 and decline approximately linearly thereafter.
  - The median 20 year-old is at the 70th percentile of the adult population.
  - The median 80 year-old is at the 10th percentile of the adult population.
- Experiential cognitive abilities peak later in life.
- By age 65 all measure of cognitive ability are declining.

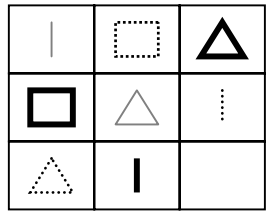
Memory

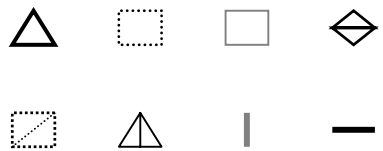
Study the following words and then write as many as you can remember

Goat
Door
Fish
Desk
Rope
Lake
Boot
Frog
Soup
Mule

Reasoning

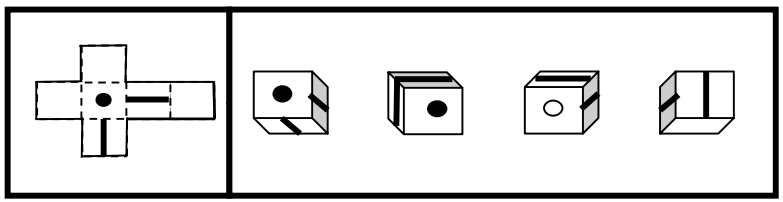
Select the best completion of the missing cell in the matrix





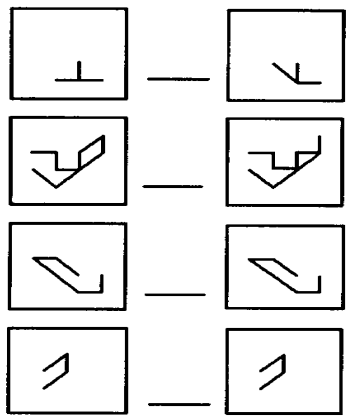
Spatial Visualization

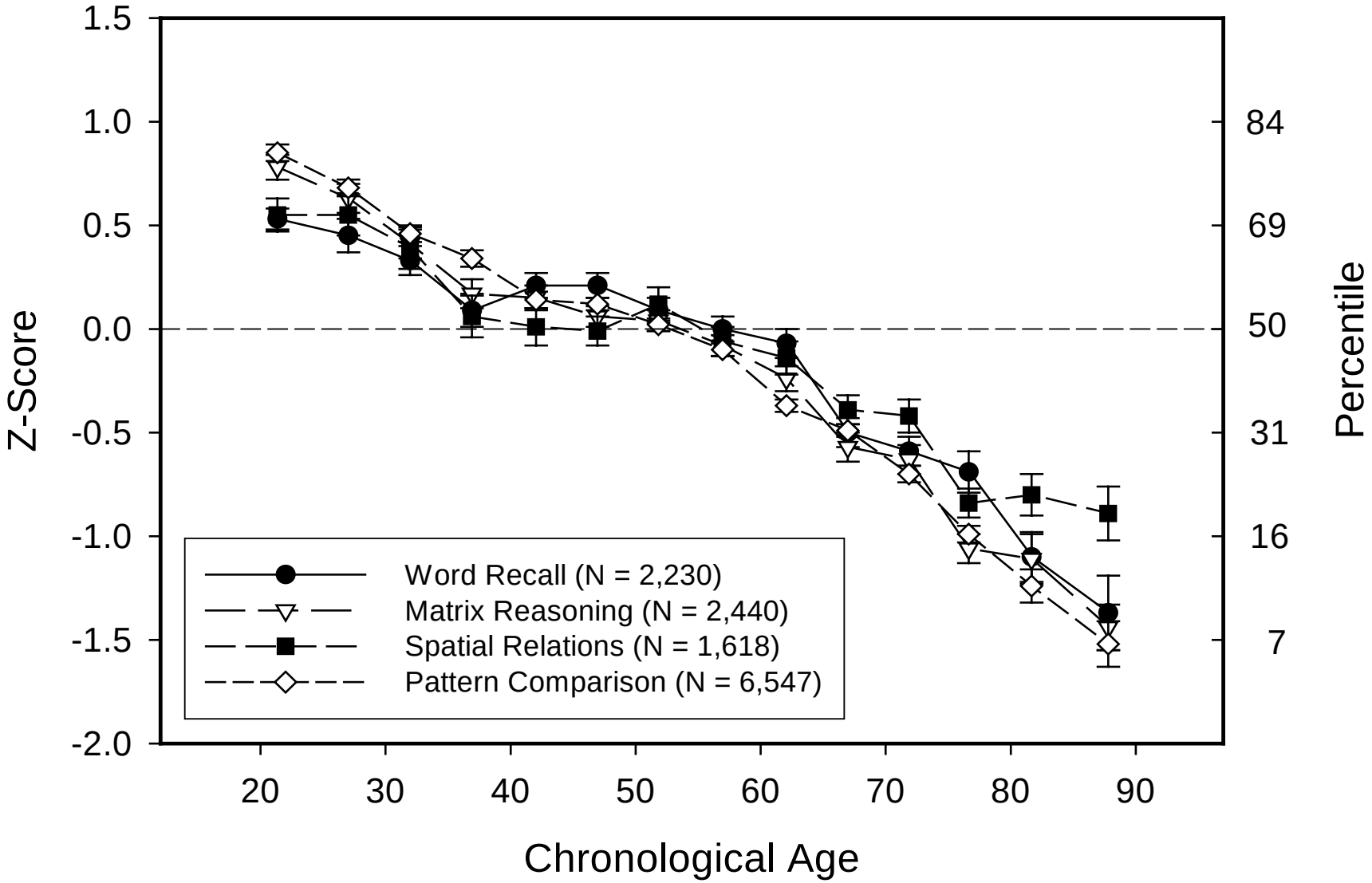
Select the object on the right that corresponds to the pattern on the left



Perceptual Speed

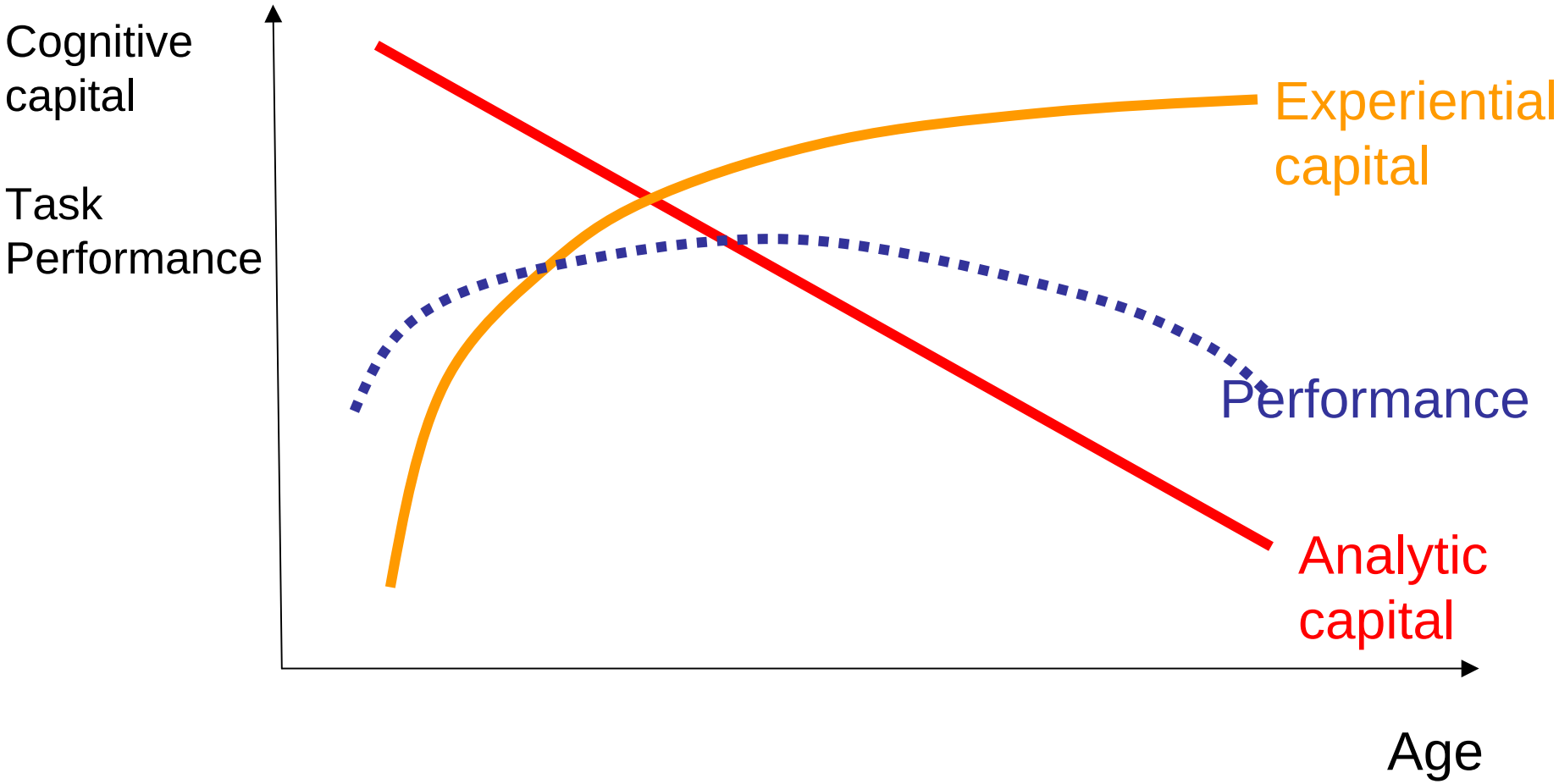
Classify the pairs as same (S) or different (D) as quickly as possible




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

Summary of Cognitive Dynamics

- After age 20, analytic ability *declines* approximately linearly.
- However, rising experience *increases* cognitive performance.
- These two effects are opposite in sign.
- If experience has diminishing returns, then cognitive performance is likely to have a peak over the lifecycle.
- Hence, cognitive *mistakes* are likely to be U-shaped.


Cognitive capital
Task Performance
Experiential capital
Performance
Analytic capital
Age

Related literature

- “Household finance” (Campbell ’06)
- Korniotis and Kumar (’06): older adults doing less well. Also, Zinman (’06)
- Lusardi and Mitchell (’06,’07): decline in knowledge of basic financial concepts
- Gourinchas and Parker (’02): Labor Earnings peak around age 50
- Differences in rationality / IQ across people: Frederick (’05), Benjamin, Brown and Shapiro (’06), Massoud, Saunders and Sholnick (’06)
- Personal finance: Bernatzi and Thaler (’02,’07)
- Credit cards: Agarwal, Chomsisengphet, Liu and Souleles (’06)

Growing interest in the decision-making of older adults

- Privatization of Social Security.
- Medicare Part D.
- Banks and Oldfields (2006): Older adults are less financially numerate
- Aguiar and Hurst (2006): Older adults do more home production
- Research of the NBER Aging group

Motivation from behavioral IO

- Growing interest in the interaction between rational firms and boundedly rational consumers
- DellaVigna and Malmendier (2005,2006): hyperbolic discounters
- Ellison (2006): search costs
- Gabaix and Laibson (2006): equilibrium with “shrouded attributes” and the curse of debiasing
- Spiegler (2006): boundedly rational updaters
- -> The whole premise is that some people make mistakes, and some people more than others. It’s nice to have evidence on that

Caveat

- Each one of our studies finds a U shape for financial mistakes
- Age-dependent financial sophistication is our preferred unified explanation for the phenomena
- However, age dependent financial sophistication is probably not the only mechanism affecting these U-shaped profiles.
- We will try to address the alternative explanations for the U shape of financial mistakes:
  - Selection, Cohort, Discrimination, Risk, and Time Cost.

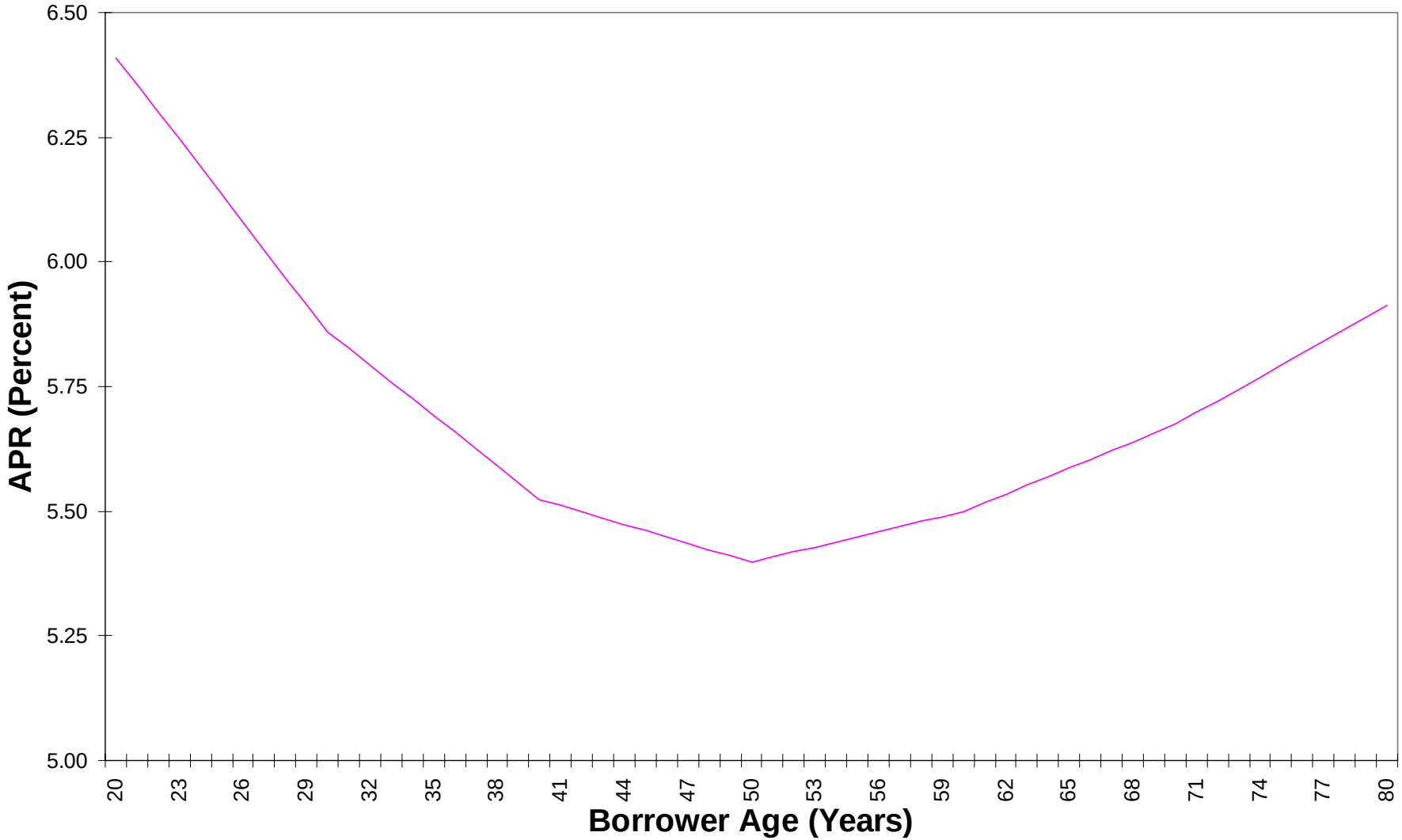
(1,2) Home Equity Loans and Home Equity Credit Lines

- Proprietary data from a large financial institution
- 75,000 contracts for home equity loans and lines of credit, from March-December 2002
- We observe:
  - Contract terms: APR and loan amount
  - Borrower demographic information: age, employment status, years on the job, home tenure, home state location
  - Borrower financial information: income, debt-to-income ratio
  - Borrower risk characteristics: FICO (credit) score, loan-to-value (LTV) ratio

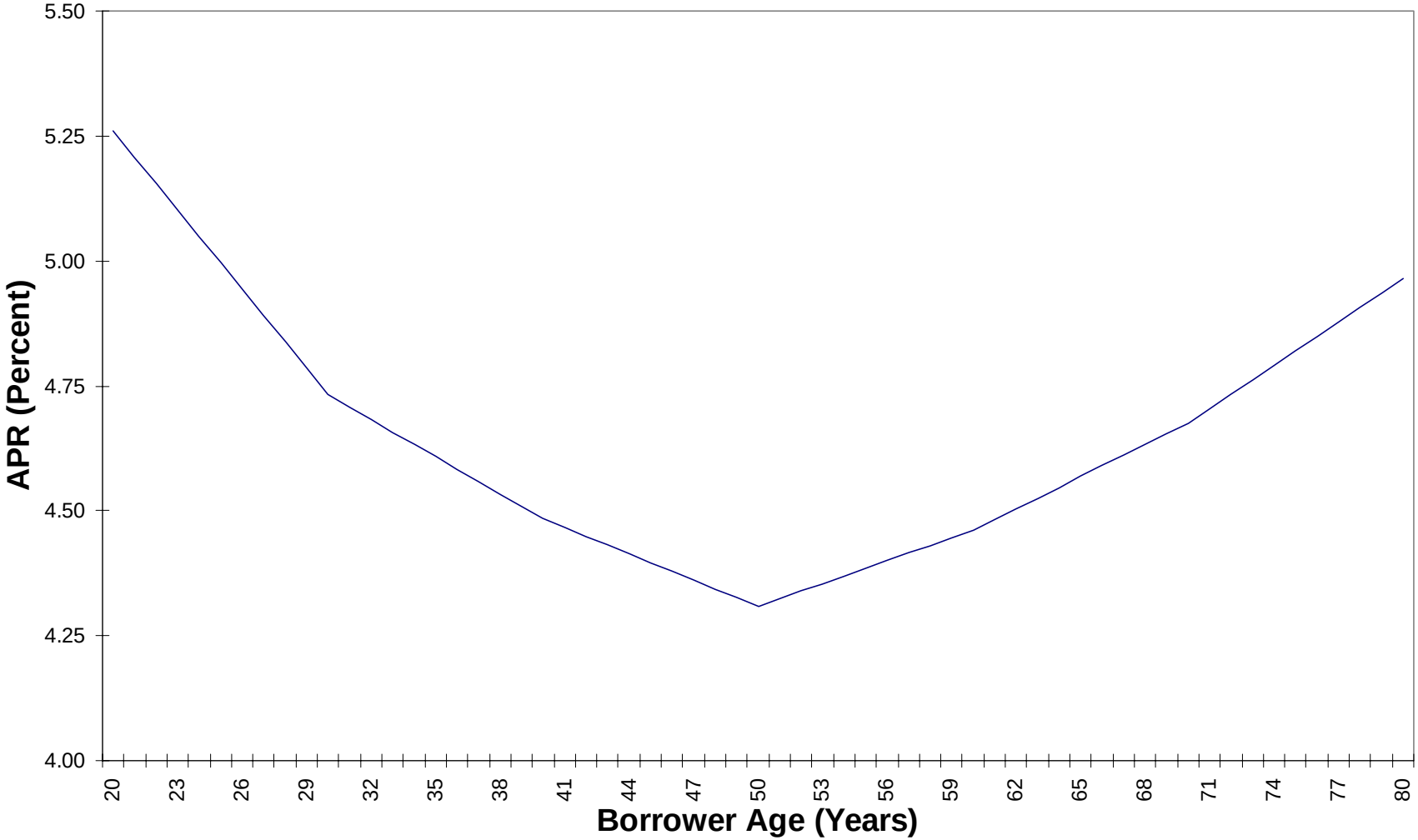
Home Equity Regressions

- We regress APRs for home equity loans and credit lines on:
  - Risk controls: FICO score and LTV
  - Financial controls: Income and debt-to-income ratio
  - Demographic controls: state dummies, home tenure, employment status
  - Age spline: piecewise linear function of borrower age with knots at age 30, 40, 50, 60 and 70.
- Next slide plots fitted values on age splines

Home Equity Loan APR by Borrower Age



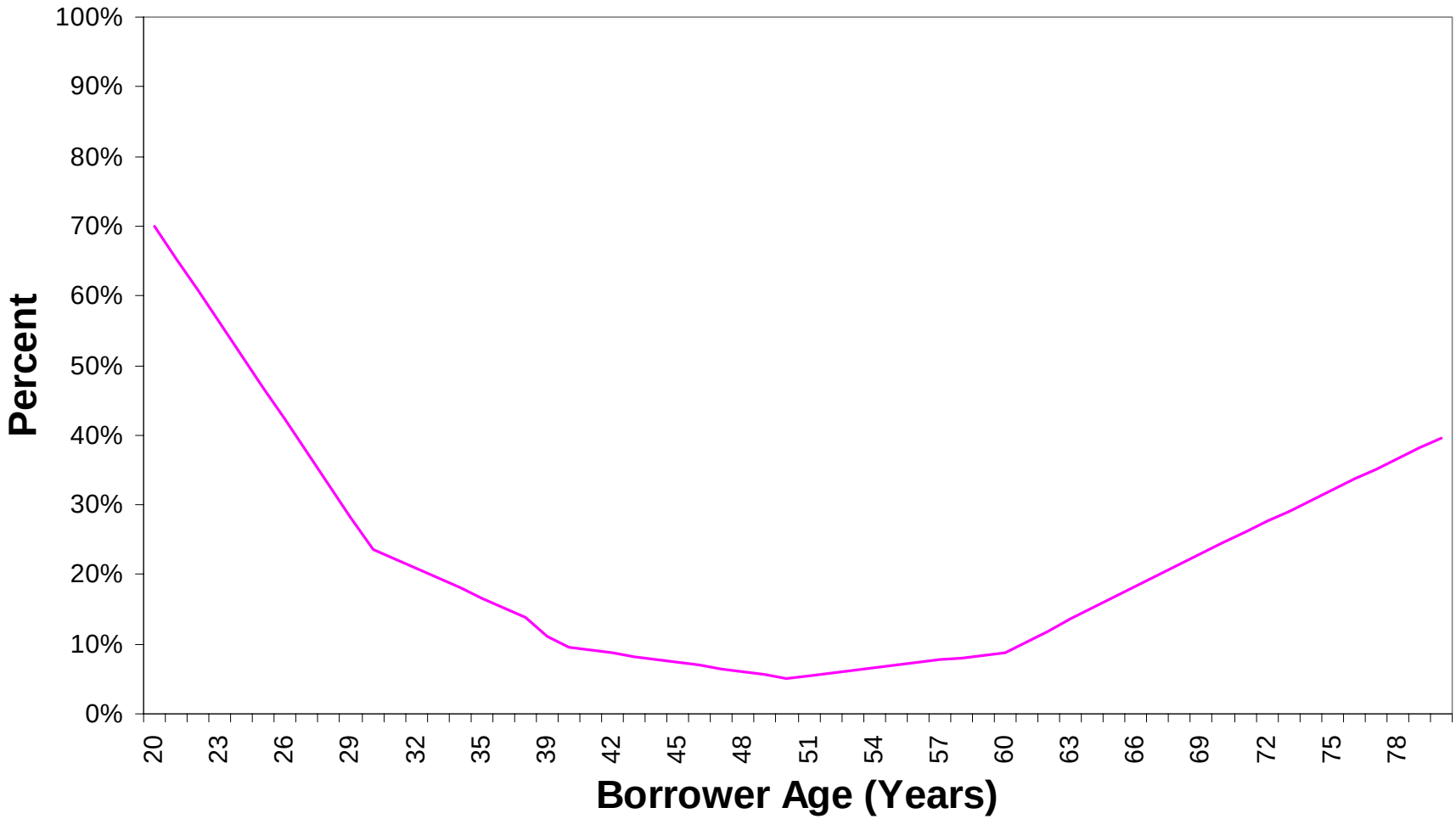
Home Equity Credit Line APR by Borrower Age



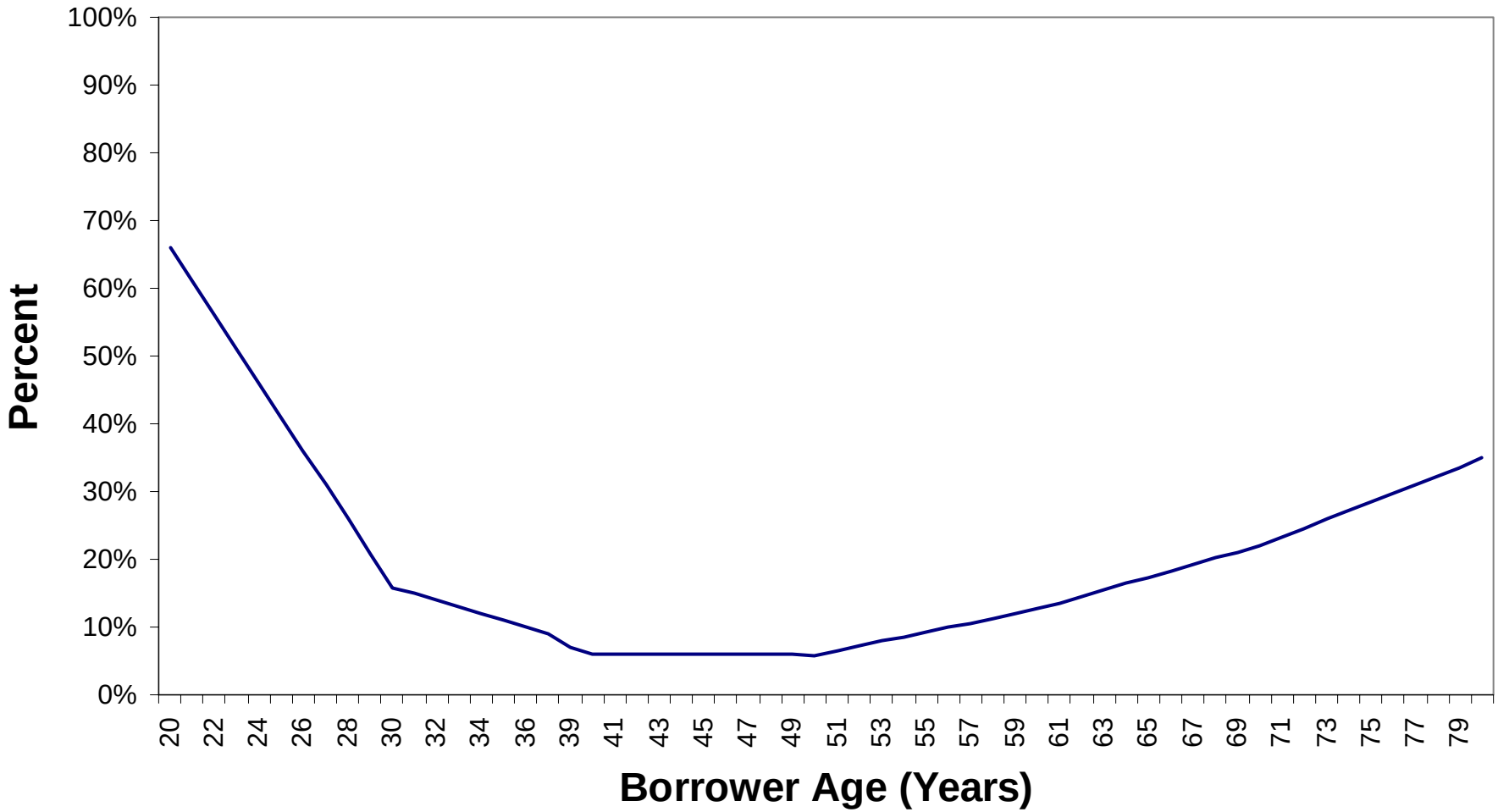
APRs, LTVs and Borrower Mistakes

- Banks offer different APRs when the loan-to-value (LTV) ratio is less than 80 percent; between 80 and 90 percent; and over 90 percent.
- Borrowers estimate their LTV by estimating their house value; banks form their own LTV estimates.
- Define a “rate-changing mistake” when borrower LTV and the bank LTV straddle two of these categories – for instance, borrower LTV<80, bank LTV >90.
- Rate changing mistakes generate two sources of disadvantage for the customer:
  - If I underestimate my LTV, the bank can penalize me by deviating from its normal offer sheet.
  - If I overestimate my LTV, the bank will penalize me by *not* correcting my mistake and allowing me to borrow at too high a rate.
- A Rate changing mistake costs 125 to 150 basis points.

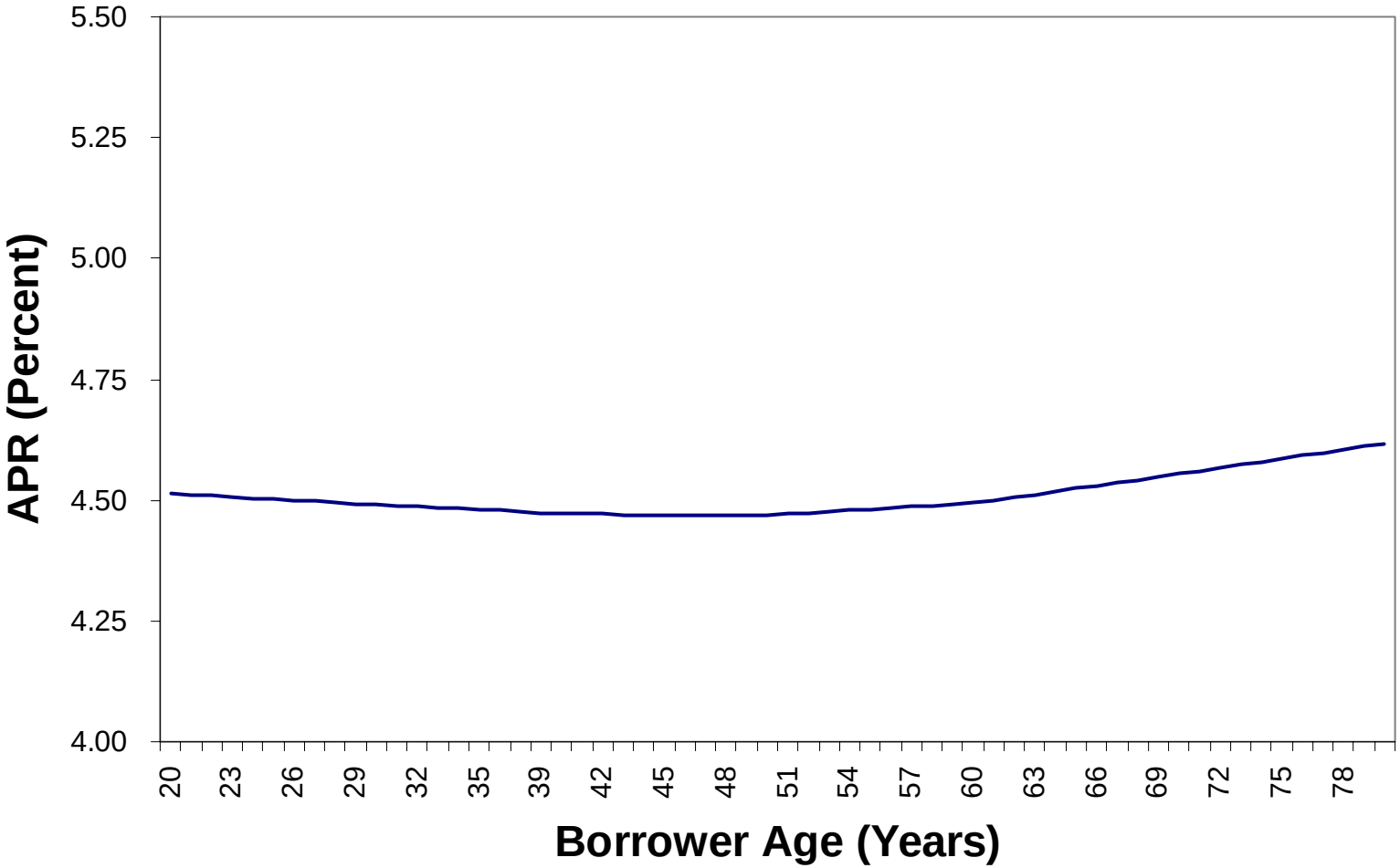
Propensity of Making a Rate-Changing Mistake on Home Equity Loans by Borrower Age



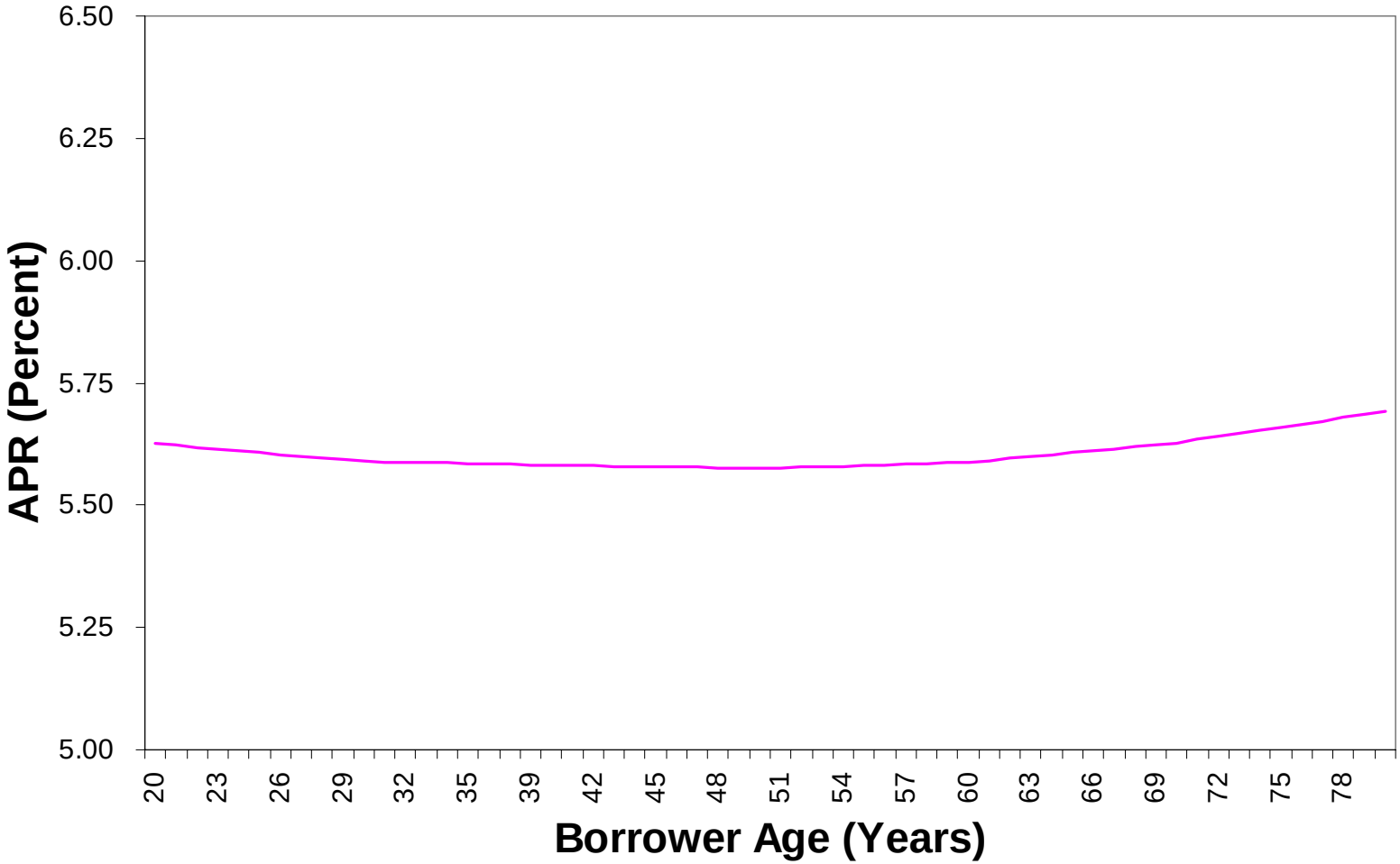
Propensity of Making a Rate-Changing Mistake on Home Equity Credit Lines by Borrower Age



Home Equity Credit Line APRs for Borrowers Who Do Not Make a Rate-Changing Mistake



Home Equity Loan APRs for Borrowers Who Do Not Make a Rate-Changing Mistake



Conclusion for Home Equity lines and loans

- For consumers who don't make a Rate changing mistakes, there is no age effect to speak of
- All the action is due to consumers who make a Rate changing mistake, i.e. people who initially think they have a low LTV, but end up having a high LTV, and are in the different bracket of LTV
- The propensity to make the mistake is U-shaped with age

(3) Eureka: Learning to Avoid Interest Charges on Balance Transfer Offers

- Balance transfer offers: borrowers pay lower APRs on balances transferred from other cards for a six-to-nine-month period
- New purchases on card have higher APRs
- Payments go towards balance transferred first, then towards new purchases
- Optimal strategy: make no new purchases on card to which balance has been transferred

Eureka: Predictions

- Borrowers may not initially understand / be informed about card terms
- Borrowers may learn about terms by observing interest charges on purchases
  - We should see “eureka” moments: new purchases on balance-transfer cards should drop to zero in the month after borrowers “figure out” the card terms

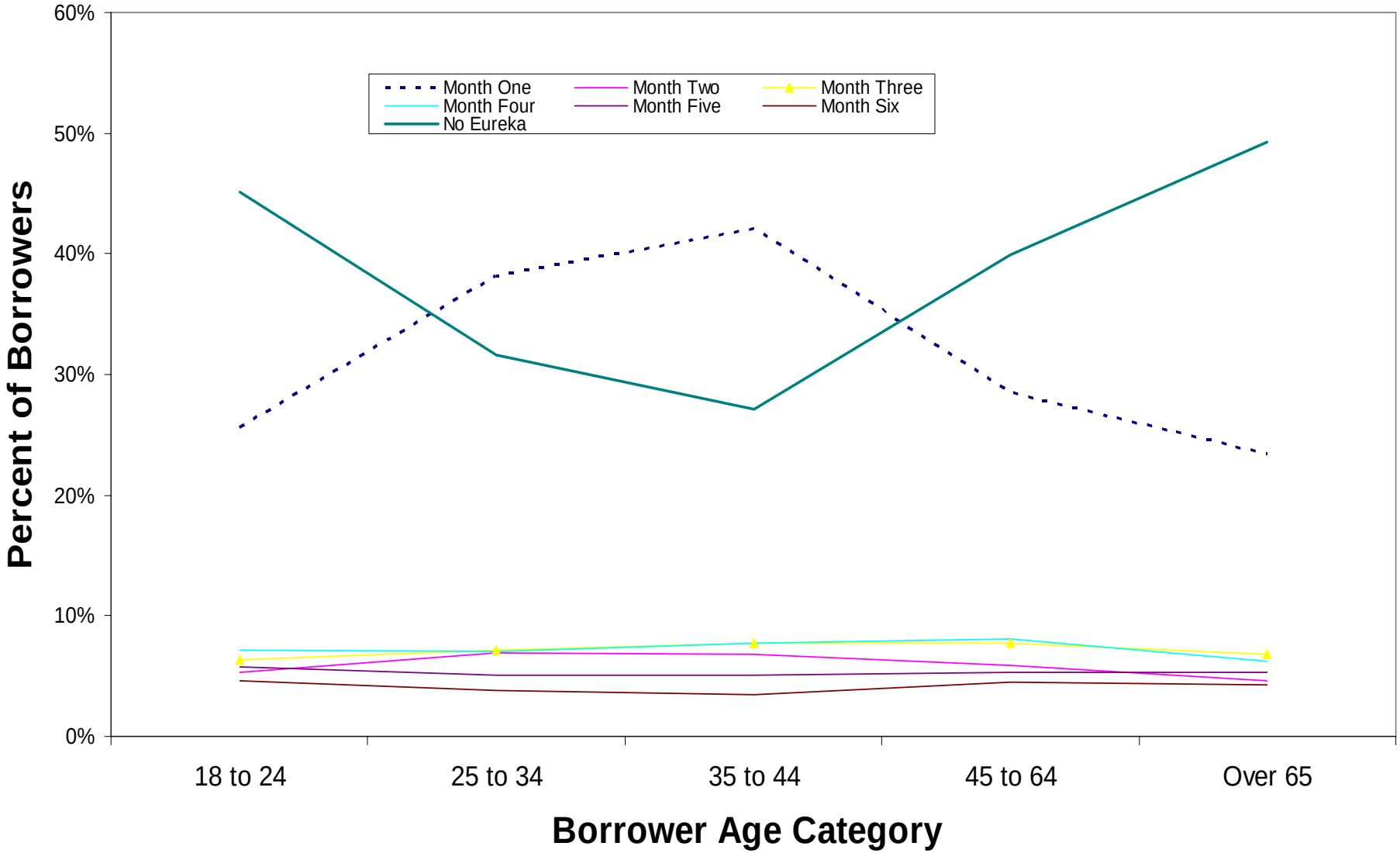
Eureka: Data

- Proprietary data from several large financial institutions that makes balance transfer offers nationally.
- 14,798 accounts which accepted such offers over the period January 2000 to December 2002
- We observe
  - Balance Transfer (BT) amount, BT start date, BT APR, and BT expiration date.
  - Additionally, we observe updated FICO and Behavior scores, credit limit, monthly payment history, monthly purchase history, monthly interest charges.

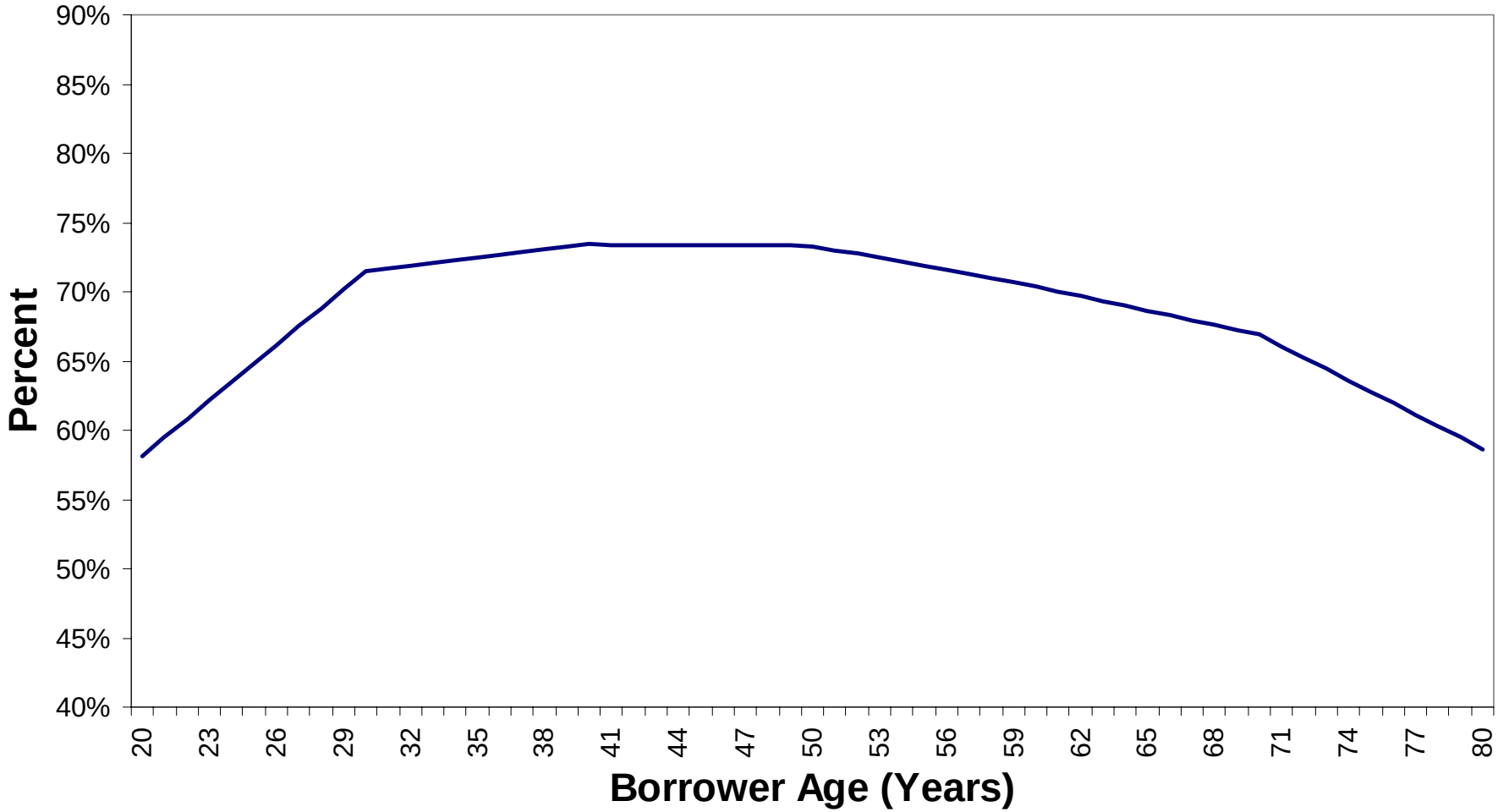
Eureka: Results

- We observe eureka moments at different months in the data:
  - 33% in the first month (i.e. from the beginning)
  - 6% in month two
  - 7% in month three
  - 5% in month four
  - 4% in month five
- 33% do not have a eureka moment
- Next slide plots frequency of month eureka moment is experienced by borrower age

Fraction of Borrowers in Each Age Group Experiencing a Eureka Moment, by Month



Propensity of Ever Experiencing a Eureka Moment by Borrower Age



(4,5,6) Fee payments

- We examine payments of three types of credit card fees:
  - Late payment fees
  - Over credit limit fees
  - Cash advance fees
- In all three cases, we again see a U-shaped pattern by age
- The Cost of time view (younger and older adults have more time to avoid fees) would predict an inverse-U shape by age

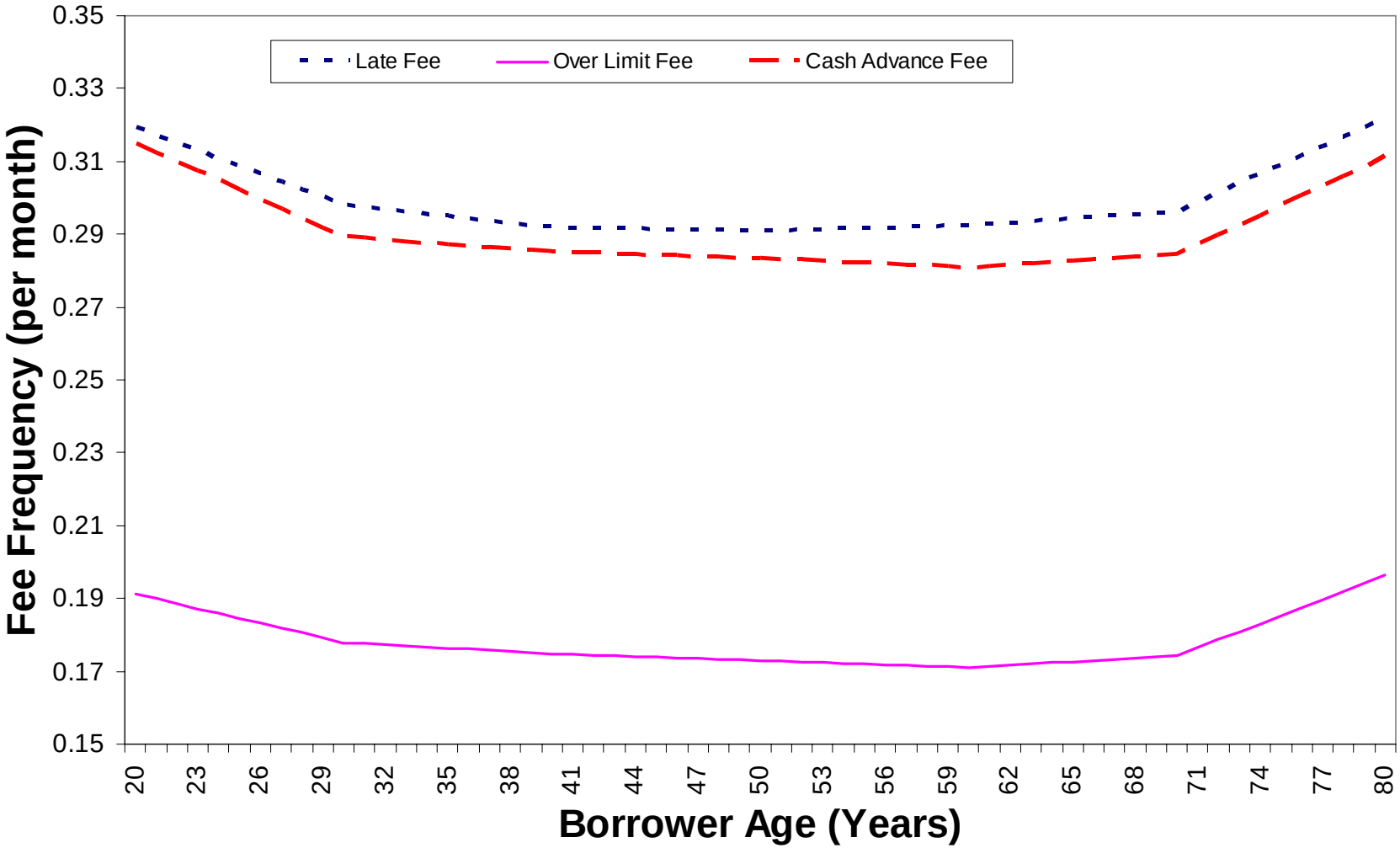
Credit card fee payments

- Proprietary data from a large financial institution that issues credit cards nationally
- 3.9 million month-borrower observations on credit card purchases from January 2002 through December 2004
- We observe:
  - Fees paid
  - Borrower demographic information: age, state of residence
  - Borrower financial information: income, debt-to-income ratio
  - Borrower risk characteristics: FICO (credit) score

Credit card fee regressions

- We regress fee payments for credit cards on:
  - Risk control: FICO (credit) score
  - Dummies for account activity
  - State- and time- fixed effects
  - Age spline: piecewise linear function of borrower age, with knot points at ages 30, 40, 50, 60 and 70.
- Next slide plots fitted values on age splines

Frequency of Fee Payment by Borrower Age

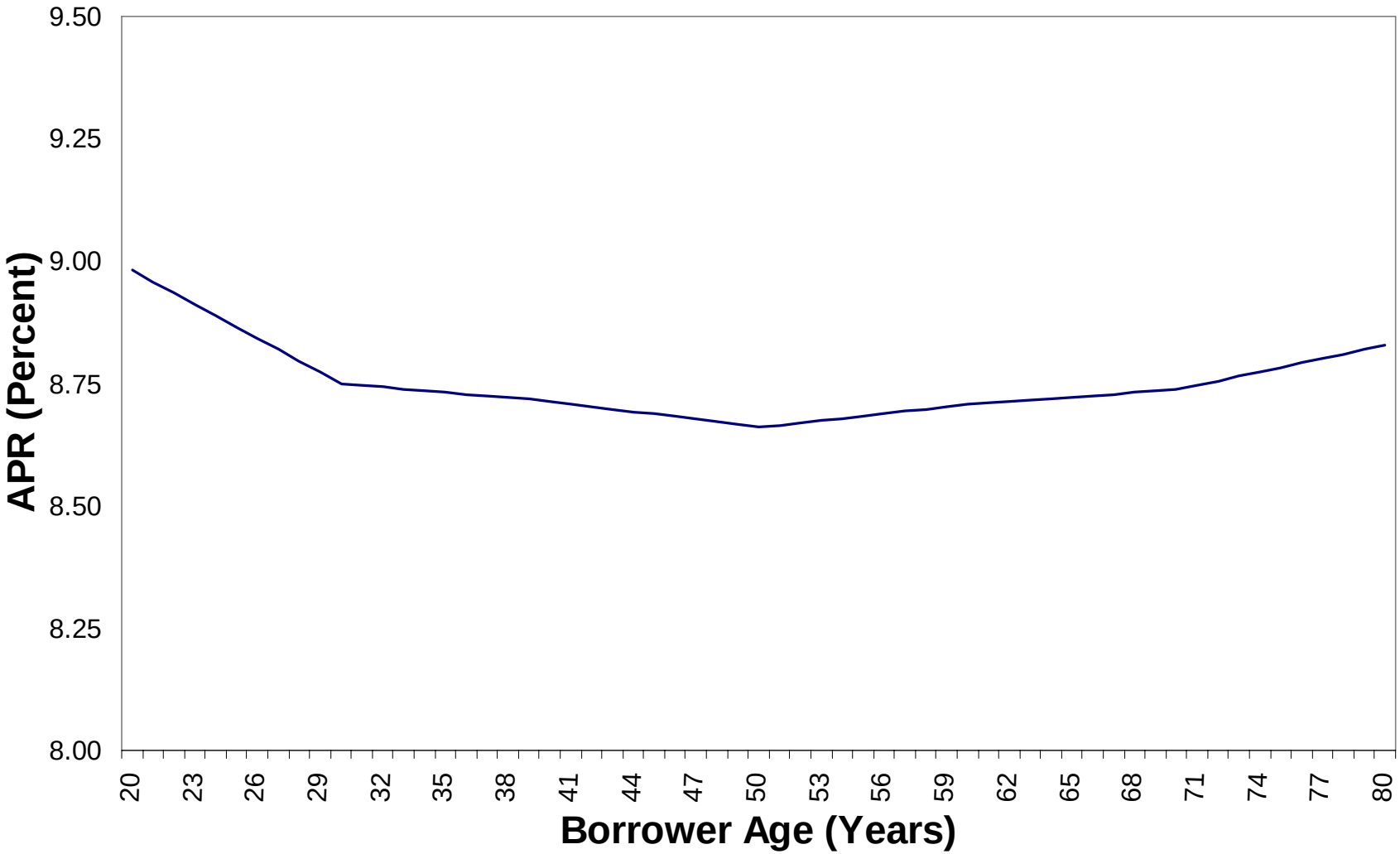


(7) Auto Loans

- Proprietary data from several large financial institutions
- 6,996 loans for purchase of new and used autos
- We observe:
  - Contract terms: APR and loan amount
  - Borrower demographic information: borrower age and state of residence
  - Borrower financial information: income, debt-to-income ratio
  - Borrower risk characteristics: FICO score
  - Automobile characteristics: value, age, model, make and year.

Auto Loan Regressions

- We regress APRs for auto loans on:
  - Risk control: FICO score
  - Financial controls: income, debt-to-income ratio
  - Demographic controls: state dummies
  - Age spline: piecewise linear function of borrower age, with knot points at ages 30, 40, 50, 60 and 70.
- Next slide plots fitted values on age splines


Auto Loan APR by Borrower Age
APR (Percent)
9.50
9.25
9.00
8.75
8.50
8.25
8.00
20
23
26
29
32
35
38
41
44
47
50
53
56
59
62
65
68
71
74
77
80
Borrower Age (Years)

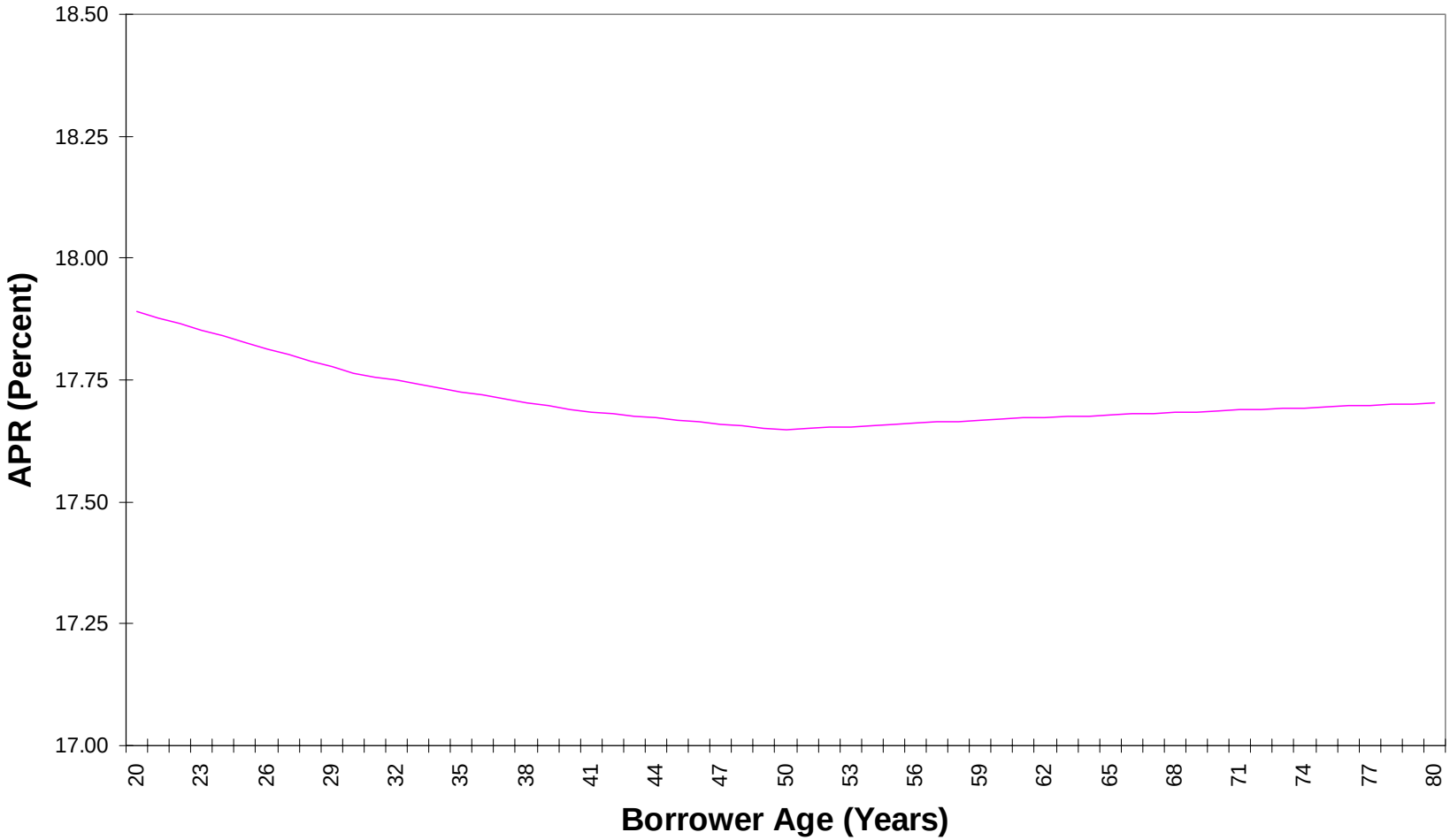
(8) Credit Card APRs

- Proprietary data from a large financial institution that issues credit cards nationally
- 128,000 accounts over a 36 month period from 1/2002 to 12/2004
- We observe:
  - Card terms: APR, fees paid
  - Borrower risk information: FICO (credit) score, card balances, other debt
  - Borrower demographic information: age, gender, income

Credit Card APR Regressions

- We regress APRs for credit cards on:
  - Risk controls: FICO score, total number of cards, card balance, home equity balance and mortgage balance
  - Financial controls: Income
  - Age spline: piecewise linear function of borrower age with knots at age 30, 40, 50, 60 and 70.
- Next slide plots fitted values on age splines

Credit Card APR by Borrower Age



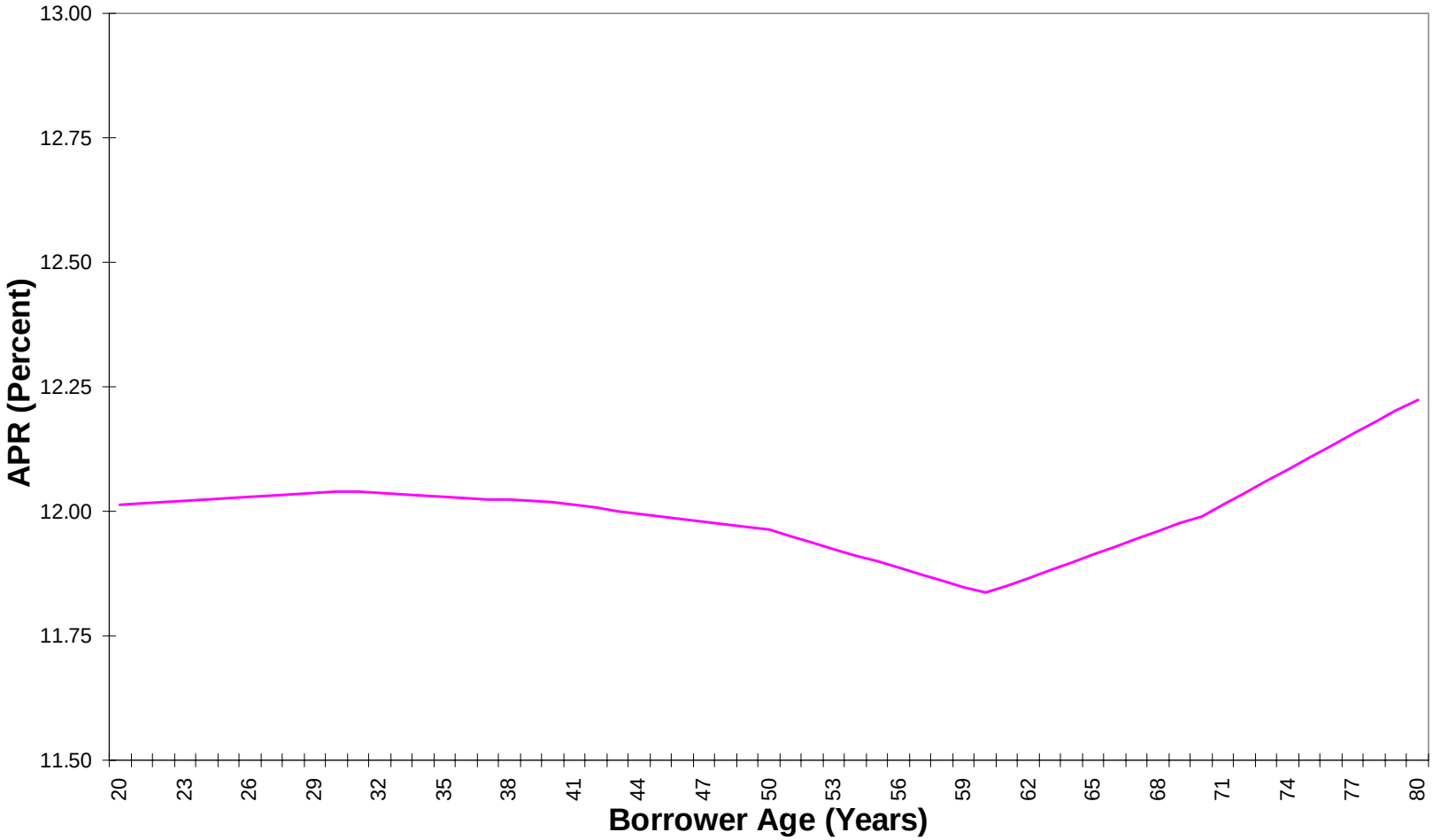
(9) Mortgage APRs

- Proprietary data from a large financial institution that originates first mortgages in Argentina
- 4,867 fixed-rate, first-mortgage loans on owner-occupied properties between June 1998 and March 2000
- We observe:
  - Contract terms: APR and loan amount
  - Borrower demographic information: age, employment status, years on the job, home tenure, home location
  - Borrower financial information: income, debt-to-income ratio
  - Borrower risk characteristics: Veraz (credit) score, loan-to-value (LTV) ratio

Mortgage APR regressions

- We regress APRs for mortgages on:
  - Risk control: Veraz (credit) score
  - Financial controls: income, debt-to-income ratio
  - Demographic controls: state dummies
  - Age spline: piecewise linear function of borrower age, with knot points at ages 30, 40, 50, 60 and 70.
- Next slide plots fitted values on age splines

Mortgage APR by Borrower Age



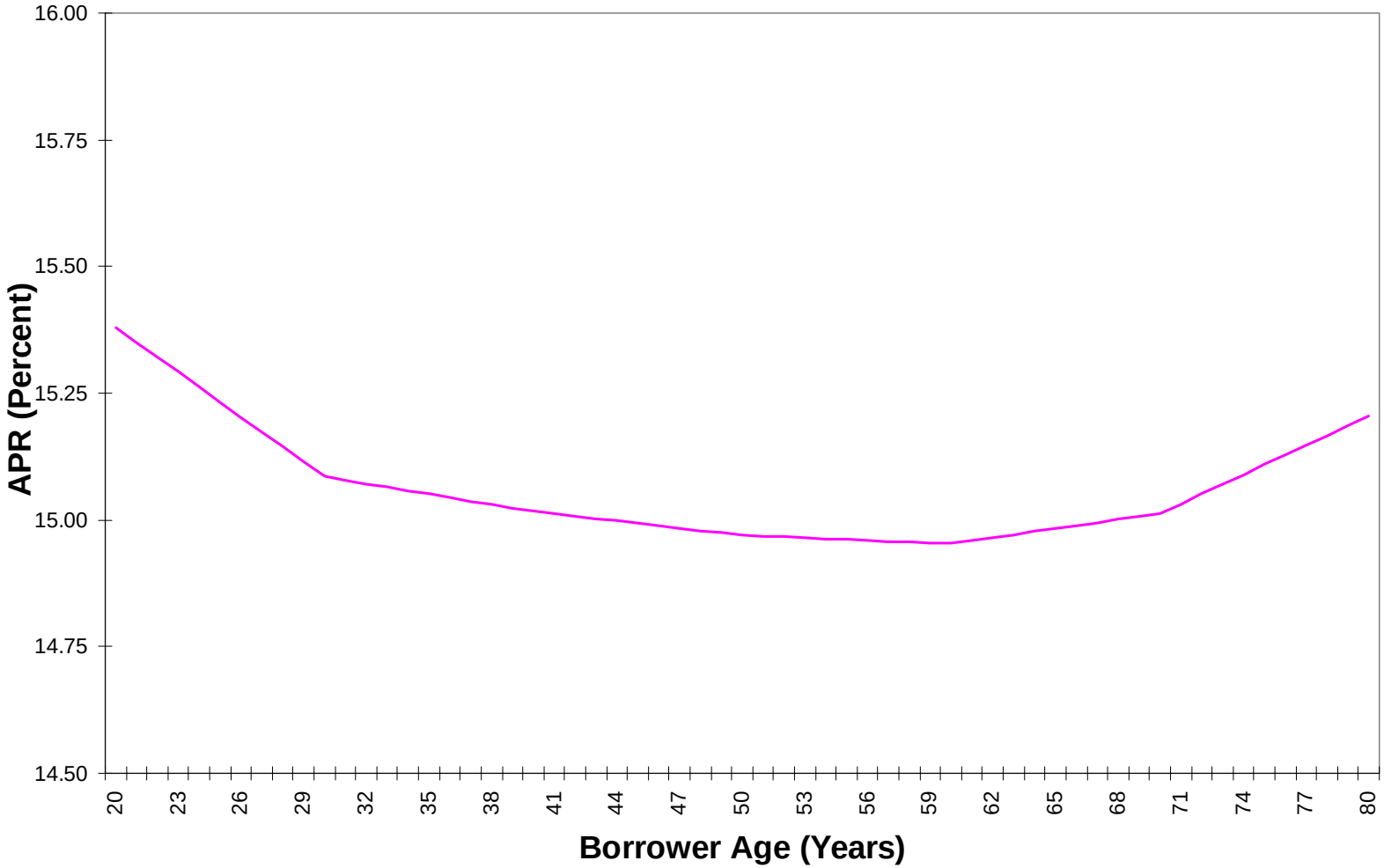
(10) Small Business Credit Card APRs

- Proprietary data set from several large financial institutions that issue small business credit cards nationally
- 11,254 accounts originated between 5/2000 and 5/2002
- Most businesses are small and owned by single families
- We observe:
  - Credit card terms: APR
  - Borrower demographic information: age
  - Borrower risk information: credit score, total number of cards, total card balance
  - Business information: years in business

Small Business Credit Card Regressions

- We regress APRs for small business credit cards on:
  - Borrower risk characteristics: FICO (credit) score, total number of cards, card balance, and card limit
  - Business characteristic: number of years in business
  - Age spline: piecewise linear function of borrower age with knots at age 30, 40, 50, 60 and 70.
- Next page plots fitted values on age splines

Small Business Credit Card APR by Borrower Age



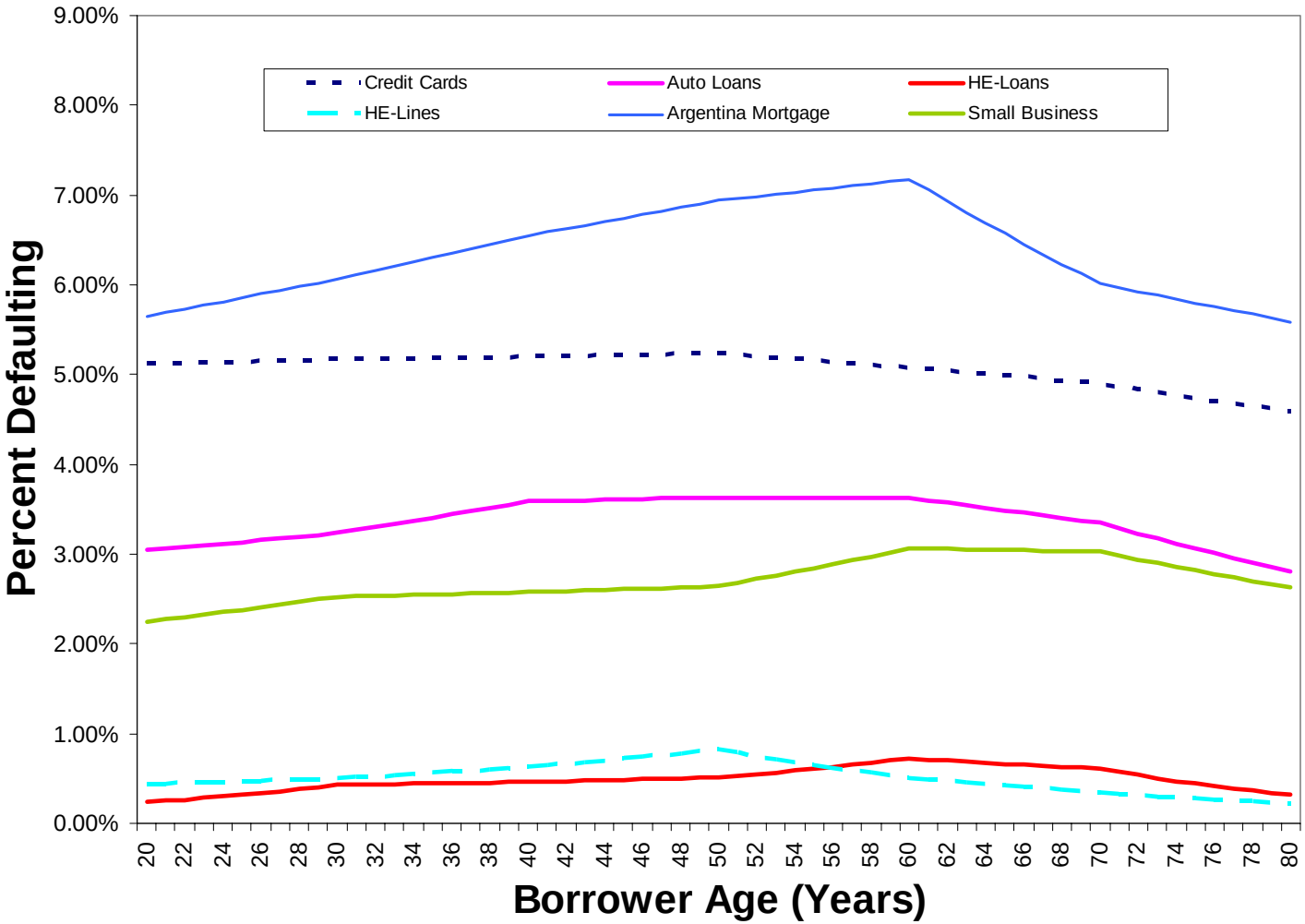
U-shape for financial mistakes in 10 examples

- 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

Interpretation

- Cost of time?
  - That would predict an inverse U shape of mistake (older adults have more time)
- Different default behavior as a function of age?
  - Default rates follow an *inverse* U (see next slide).
  - U-shaped pattern shows up even for fees and eureka (default is irrelevant in these cases)
- Discrimination?
  - Firms avoid age discrimination because of legal constraints.
  - U-shaped pattern shows up even for fees and eureka (discrimination is irrelevant in these cases).
- Selection?
  - Estimate the regressions by dropping 2/3 of the lowest interest paying middle age borrowers (age 40-60). Observe a mild U-shape curve.
  - Drop borrowers above age 60. Observe a U-shape curve.
- Cohort?
  - Separately estimate APR regressions by gender. If older male borrowers have more experience with financial product, less pronounced U. Not so.
- Our preferred interpretation: Age-dependent financial savvy
  - Mechanisms: older adults do not read the fine print, older adults are less aggressive in negotiations, older adults do not shop around, older adults do not buy the most favorable products even within a single financial institution

Percent Defaulting by Borrower Age



Default rates don't explain the U-shape of interest rates, since defaults predict an *inverse*-U shape of interest rates.

The Performance Peak

- To find when people peak, we run, for age between 40 and 60:
- Performance=a x Age + b x Age^2 + Controls
- Then Peak = -a / (2 b)
- Also, regressing on 10% quantile of age distribution:
- Peak = 33 + 0.71 x (10% quantile of Age)

  (5.7) (0.19), R^2=0.62

	Age of Peak Performance	Standard Error
Home Equity Loans–APR	55.85	4.24
Home Equity Lines–APR	53.30	5.23
Credit Card–APR	50.31	6.02
Auto Loans–APR	49.63	5.03
Mortgage–APR	61.75	7.92
Small Business Credit Card–APR	56.04	8.01
Credit Card Late Fee	51.94	4.87
Credit Card Over Limit Fee	53.97	5.02
Credit Card Cash Advance Fee	54.82	4.89
Eureka Moment	45.81	7.93
Average of the 10 Studies	53.34	

Table 9: Age at which financial mistakes are minimized, for each case study

Conclusion

- U-shape for mistakes with age, in all 10 examples
- The methodology is easy to replicate with other add age splines to the regressors, and check the shape.
  - Fiona Scott-Morton has confirmed this pattern too (auto loans).
  - Lucia Dun has confirmed this pattern too (credit cards).
- Our interpretation is that cognitive sophistication is hump-shaped with respect to age.
- And this has real consequences for (i) welfare of the young and the old, and (ii) the efficiency of equilibrium market outcomes (supports models with sophisticated and naïve consumers)