The Age of Reason: Financial Decisions Over the Lifecycle

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Abstract

The sophistication of financial decisions varies with age: middle-aged adults borrow at lower interest rates and pay fewer fees compared to both younger and older adults. We document this pattern in ten financial markets. The measured effects can not be explained by observed risk characteristics. The sophistication of financial choices peaks at about age 53 in our cross-sectional data. Our results are consistent with the hypothesis that financial sophistication rises and then falls with age, although the patterns that we observe represent a mix of age effects and cohort effects. (JEL: D1, D4, D8, G2, J14).

Keywords: Household finance, behavioral finance, behavioral industrial organization, aging, shrouding, auto loans, credit cards, fees, home equity, mortgages.

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1 Introduction

Performance tends to rise and then fall with age. Baseball players peak in their late 20s (Fair 2005b, James 2003). Mathematicians, theoretical physicists, and lyric poets make their most important contributions around age 30 (Simonton 1988). Chess players achieve their highest ranking in their mid-30s (Charness and Bosnian 1990). Autocratic rulers like Queen Elizabeth I are maximally effective in their early 40' (Simonton 1988). Authors write their most influential novels around age 50 (Simonton 1988).[1]

The present paper studies an activity that is relevant to the entire adult population: personal financial decision making. Most financial products are complex and difficult to understand. Fees are shrouded and the true costs of a financial services are not easily calculated. Making the best financial choices takes knowledge, intelligence, and skill.

This paper documents cross-sectional variation in the prices that people pay for financial services. We find that younger adults and older adults borrow at higher interest rates and pay more fees than middle-aged adults controlling for all observable characteristics, including measures of risk.

The hump-shaped pattern of financial *sophistication* is present in many markets. We study *interest rates* in six different markets: mortgages, home equity loans, home equity credit lines, auto loans, personal credit cards, and small business credit cards. We study the failure to optimally exploit balance transfer credit card offers. Finally, we study three kinds of credit card *fees*: late payment fees, cash advance fees, and over limit fees. All of the evidence available to us implies a hump-shaped pattern of financial sophistication, with a peak in the early 50s.

Age effects provide a parsimonious explanation for the hump-shaped pattern of financial sophistication. We hypothesize that financial sophistication depends on a combination of analytic ability and experiential knowledge. Research on cognitive aging implies that analytic ability follows a declining (weakly) concave trajectory after age 20. We hypothesize that experiential knowledge follows an increasing concave trajectory due to diminishing returns. Adding together these two factors implies that financial sophistication should rise and then fall with age.

Cohort effects may also explain some of the effects that we observe. Differences in educational levels may explain why older adults are less financially sophisticated than middle-aged adults. Naturally, such education effects will not explain why young adults (around age 30) are less sophisticated than middle-aged adults. Additional work needs to be done to identify

[1] What about economists? To the best of our knowledge, only Nobel (Memorial) Prize winners seem to have been studied. Weinberg and Galenson (2005) find that "conceptual" laureates peak at age 43, and "experimental" ones at age 61.

the relative contributions of age effects and cohort effects.

The paper has the following organization. Section 2 discusses evidence on cognitive performance from the psychology literature. Section 3 describes the basic structure to the empirical sections. The next ten sections present results for interest rates on six different financial products, three different kinds of credit card fee payments, and on the use of balance transfer credit card offers. Section 14 uses all ten sets of results to estimate the age of peak sophistication. Section 15 discusses other findings on the effects of aging and the difficulty in separately identifying age effects and cohort effects. Section 16 concludes.

2 Aging and cognitive performance: Results from medical and psychological research

Analytic ability can be measured in many different ways, including tasks that measure memory, reasoning, spatial visualization, and speed (see Figure 1). Analytic performance shows a strong age pattern in cross-sectional datasets. Analytic performance is negatively correlated with age in adult populations (Salthouse 2005 and Salthouse forthcoming): on average analytic performance falls by two to three percent of one standard deviation[2] with every incremental year of age after age 20. This decline is remarkably steady from age 20 to age 90 (see Figure 2).

The measured age-related decline in analytic performance results from both age effects and cohort effects, but the panel data that is available implies that the decline is primarily driven by age effects (Salthouse, Schroeder and Ferrer 2004).[3] Medical pathologies represent one important pathway for age effects. For instance, dementia is primarily attributable to Alzheimer's Disease (60%) and vascular disease (25%). The prevalence of dementia doubles with every five additional years of lifecycle age (Fratiglioni, De Ronchi, Agüero-Torres, 1999).

Age-driven declines in *analytic* performance are partially offset by age-driven *increases* in experience. If general task performance is a function of *both* analytic ability and experiential knowledge, then general task performance should first increase with age (as people accumulate more early life experience), and then decline (as experience saturates).[4] Figure 3 illustrates this mechanism.

The current paper tests the hypothesis that general task performance should follow a hump-shaped pattern with age. We focus on financial decision-making. Because our financial market

[2] This is a standard deviation calculated from the entire population of individuals.

[3] See Flynn (1984) for a discussion of cohort effects.

[4] Suppose Analytic Performance (AP) $= a - b \times age$, and Experience $= c + d \times age$, while total performance is AP$\times$Experience. Then, if $ad > bc$, total performance first rises, then declines, with age.

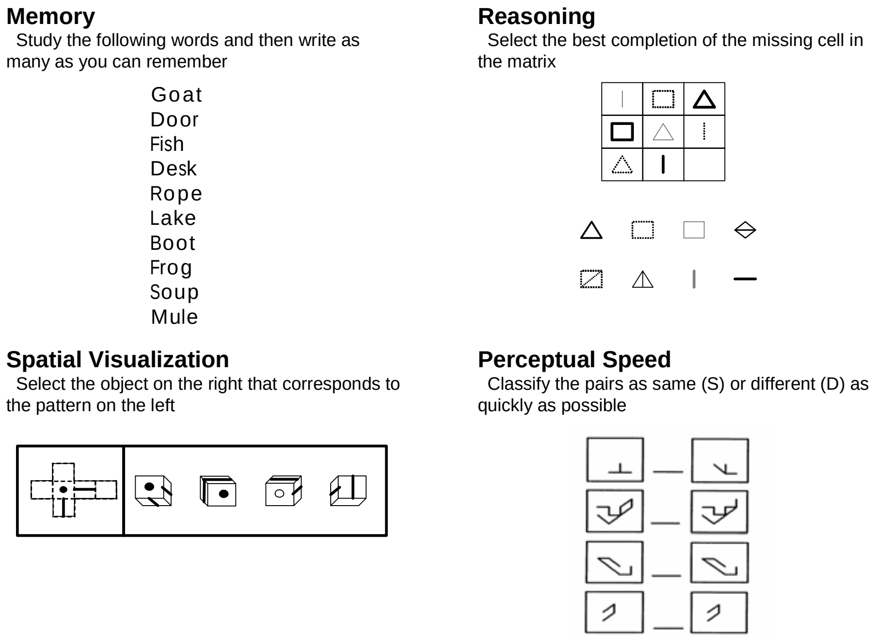

Figure 1: Four IQ tests used to measure cognitive performance. Source: Salthouse (forthcoming).

data span a short number of years, we are unable to decompose the relative contributions of age and cohort effects.

3 Overview

We document a U-shaped curve in financial "mistakes" over the lifecycle in ten separate contexts: home equity loans and lines of credit; auto loans; credit card interest rates; mortgages; small business credit cards; credit card late payment fees; credit card over limit fees; credit card cash advance fees; and use of credit card balance transfer offers.

We diagnose mistakes in three forms: higher APRs (interest rates); higher fee payments; and suboptimal use of balance transfer offers.

For each application, we conduct regression analysis that identifies age effects and controls for observable factors that might explain patterns of fee payments or APRs by age. Thus, unless otherwise noted, in each context we estimate a regression of the type:

$$F = \alpha + \beta \times Spline(Age) + \gamma \times Controls + \epsilon. \tag{1}$$

Here F is the level of the APR paid by the borrower (or the frequency of fee payment), $Controls$

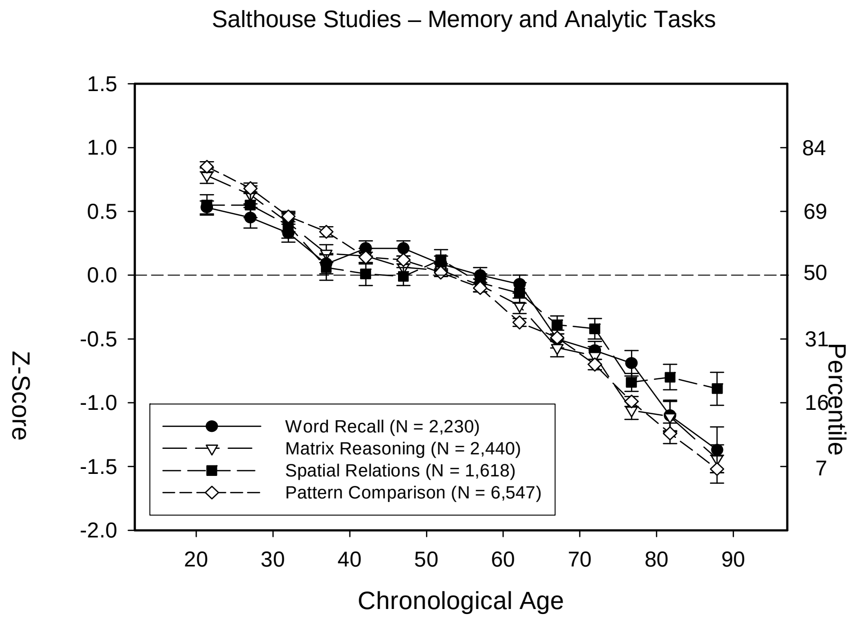

Figure 2: Age-normed results from four different cognitive tests. The Z-score represents the age-contingent mean, measured in units of standard deviation relative to the population mean. More precisely, the Z-score is (age–contingent mean minus population mean) / (population standard deviation). Source: Salthouse (forthcoming).

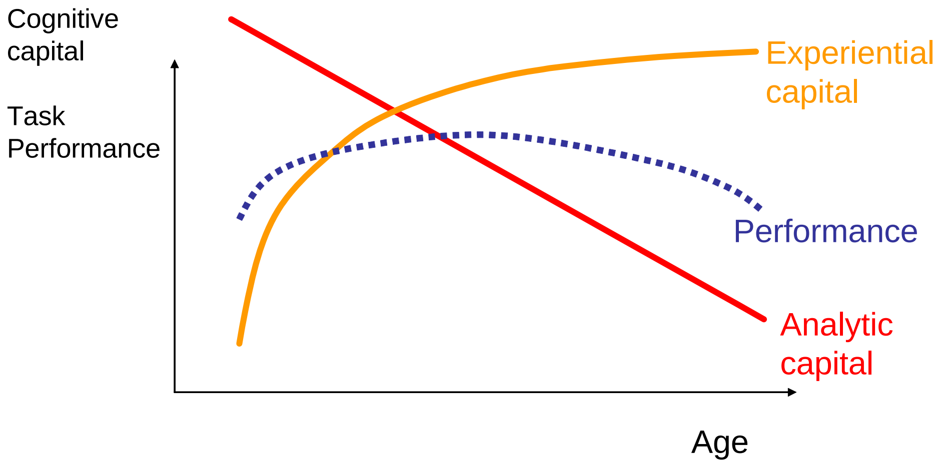

Figure 3: Hypothesized relation between general task performance and age. Analytical capital declines with age and experiential capital increase with age. This generates the hypothesis that general task performance (which uses both analytical and experiential capital) first rises and then declines with age.

is a vector of control variables intended to capture alternative explanations in each context (for example, measures of credit risk), and $Spline(Age)$ is a piecewise linear function that takes consumer age as its argument (with knot points at ages 30, 40, 50, 60 and 70).[5] We then plot the fitted values for the spline on age. Regressions are either pooled panel or cross-sectional, depending on the context.

Each section discusses the nature of the mistake, briefly documents the datasets used, and presents the regression results and graphs by age. We provide summary statistics for the data sets in the Appendix.

4 Home Equity Loans

4.1 Data Summary

We use a proprietary panel dataset from a large financial institution that issued home equity loans and home equity lines of credit nationally. Between March and December 2002, the lender offered a menu of standardized contracts for home equity credits. Consumers could choose between a credit loan and line; between a first and second lien; and could choose to pledge different amounts of collateral, with the amount of collateral implying a loan-to-value (LTV) ratio of less than 80 percent, between 80 and 90 percent, and between 90 an 100 percent) In effect, the lender offered twelve different contract choices. For 75,000 such contracts, we observe the contract terms, borrower demographic information (age, years at current job, home tenure), financial information (income and debt-to-income ratio), and risk characteristics (credit (FICO) score, and LTV). We also observe borrower estimates of their house values and the loan amount requested.

4.2 Results

Table 1 reports the results of estimating regressions of APRs (interest rates) on home equity loans on a spline for age and control variables. As controls, we use all variables observable to the financial institution that might affect loan pricing, including credit risk measures, house and loan characteristics, and borrower financial and demographic characteristics. The control variables all have the expected sign, and most are statistically significant, although some of them lack economic significance, perhaps surprisingly so in some cases. The measure of credit risk, the log of the FICO score (lagged three months because it is only updated quarterly), comes in statistically significant but with a negligible magnitude. Our understanding from discussions with people who work in the industry is that financial institutions generally use the

[5] For instance, in Table 1, the "Age 30-40" spline is: $\max(30, \min(40, Age))$, the "Age $<$ 30" spline is $\min(30, Age)$, and the "Age $>$ 70" spline is $\max(70, Age)$.

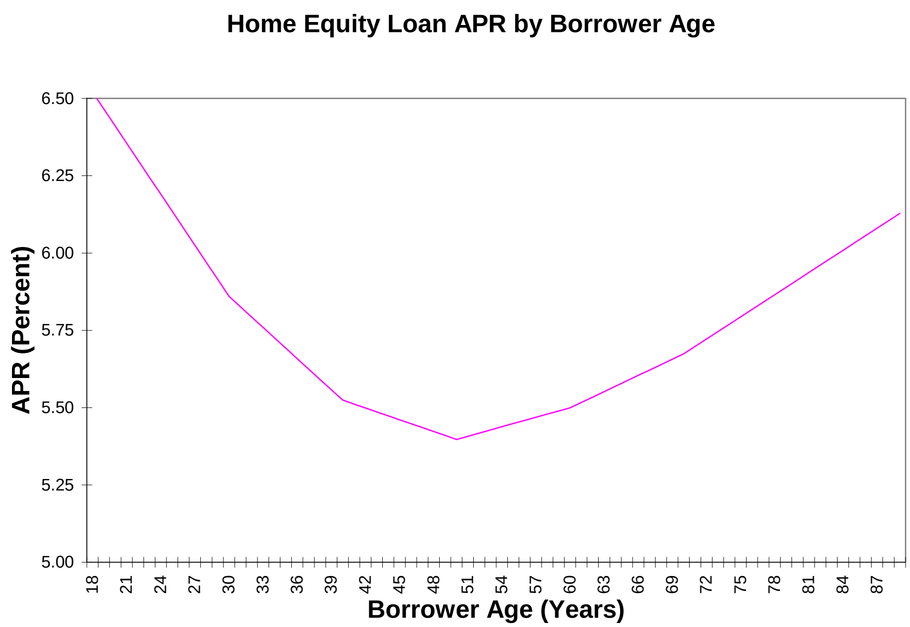

Figure 4: Home equity loan APR by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

FICO score to determine whether a loan offer is made, but conditional on the offer being made, do not use the score to do risk-based pricing. The results here, and for the other consumer credit products discussed below, are consistent with this hypothesis. Loan APRs do depend strongly on the absence of a first mortgage (reducing the APR), and whether the property is a second home or a condominium. The absence of a first mortgage reduces the probability of default and raises the amount that might be recovered conditional on a default. Second homes and condominiums are perceived as being riskier properties. Log income and log years on the job also have large and negative effects on APRs, as expected, since they indicate more resources available to pay off the loan, and perhaps less risk in the latter case. The largest effects on APRs come from dummy variables for LTV ratios between 80 and 90 percent and for ratios greater than 90 percent. This is consistent with different LTV ratios corresponding to different contract choices.

Even after controlling for these variables, we find that the age splines have statistically and economically significant effects. Figure 4 plots the fitted values on the spline for age for home equity loans. The line has a pronounced U-shape, with some younger and older borrowers paying 100 basis points more than borrowers in their late forties and early fifties. For this and the nine other studies, we present in section 14.2 a formal test for the U-shape, which the data will pass.

Home Equity Loan APR		
	Coefficient	Std. Error
Intercept	8.1736	0.1069
Log(FICO Score)	-0.0021	0.0001
Loan Purpose–Home Improvement	0.0164	0.0138
Loan Purpose–Rate Refinance	-0.0081	0.0113
No First Mortgage	-0.1916	0.0097
Log(Months at Address)	0.0021	0.0039
Second Home	0.3880	0.0259
Condominium	0.4181	0.0165
Log(Income)	-0.0651	0.0077
Debt/Income	0.0034	0.0002
Log(Years on the Job)	-0.0246	0.0039
Self Employed	0.0106	0.0161
Home Maker	-0.0333	0.0421
Retired	0.0355	0.0225
Age < 30	-0.0551	0.0083
Age 30-40	-0.0336	0.0043
Age 40-50	-0.0127	0.0048
Age 50-60	0.0102	0.0039
Age 60-70	0.0174	0.0076
Age > 70	0.0239	0.0103
LTV 80-90	0.7693	0.0099
LTV 90+	1.7357	0.0111
State Dummies	YES	
Number of Observations	16,683	
Adjusted R-squared	0.7373	

Table 1: The first column gives coefficient estimates for a regression of the APR of a home equity loan on a spline with age as its argument, financial control variables (Log(FICO) credit risk score, income, and the debt-to-income-ratio), and other controls (state dummies, a dummy for loans made for home improvements, a dummy for loans made for refinancing, a dummy for no first mortgage on the property, months at the address, years worked on the job, dummies for self-emplyed, retiree, or homemaker status, and a dummy if the property is a condominium).

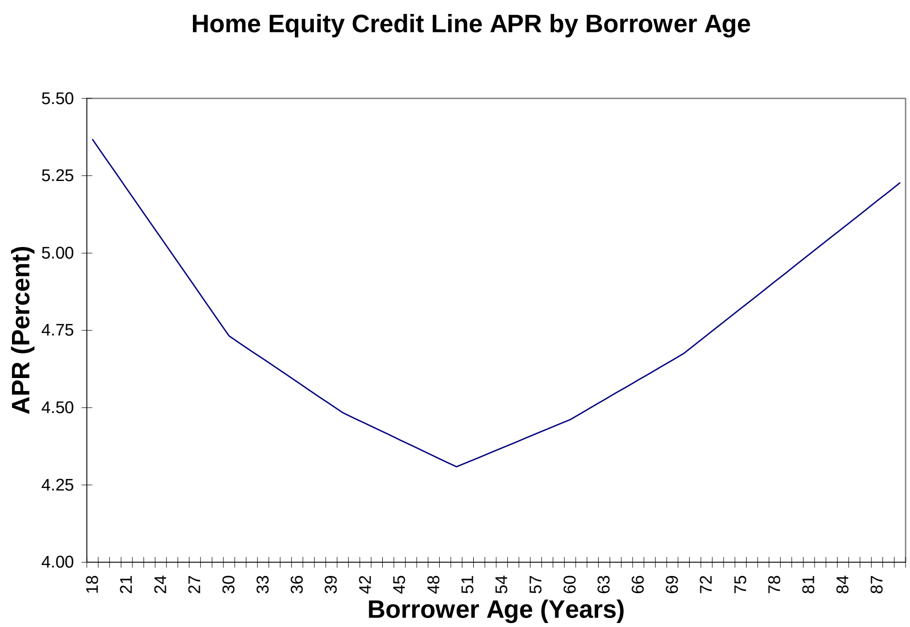

Figure 5: Home equity credit line APR by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

5 Home Equity Lines of Credit

5.1 Data Summary

Data are the same as described in the previous section.

5.2 Results

Table 2 reports the results of estimating regressions of APRs on home equity lines of credit on a spline for age and the same control variables used for the home equity loans regression. The control variables have similar effects on home equity line APRs as they did for home equity loan APRs.

Fitted values on the age splines, plotted in Figure 5, continue to have the same pronounced U-shape, with some younger and older borrowers again paying 100 basis point more than borrowers in their late forties and early fifties.

5.3 One Mechanism: Borrower Misestimation of Home Values

The amount of collateral offered by the borrower, as measured by the loan-to-value (LTV) ratio, is an important determinant of loan APRs. Higher LTVs imply higher APRs, since

Home Equity Line APR		
	Coefficient	Std. Error
Intercept	7.9287	0.0570
Log(FICO Score)	-0.0011	0.0000
Loan Purpose–Home Improvement	0.0551	0.0051
Loan Purpose–Rate Refinance	-0.0386	0.0047
No First Mortgage	-0.1512	0.0054
Log(Months at Address)	-0.0160	0.0019
Second Home	0.3336	0.0132
Condominium	0.4025	0.0079
Log(Income)	-0.1474	0.0037
Debt/Income	0.0044	0.0001
Log(Years on the Job)	-0.0164	0.0020
Self Employed	0.0135	0.0073
Home Maker	-0.0818	0.0215
Retired	0.0139	0.0109
Age $<$ 30	-0.0529	0.0050
Age 30-40	-0.0248	0.0023
Age 40-50	-0.0175	0.0022
Age 50-60	0.0152	0.0035
Age 60-70	0.0214	0.0064
Age $>$ 70	0.0290	0.0154
LTV 80-90	0.6071	0.0050
LTV 90+	1.8722	0.0079
State Dummies	YES	
Number of Observations	66,278	
Adjusted R-squared	0.5890	

Table 2: The first column gives coefficient estimates for a regression of the APR of a home equity lines of credit on a spline with age as its argument, financial control variables (Log(FICO) credit risk score, income, and the debt-to-income-ratio), and other controls (state dummies, a dummy for loans made for home improvements, a dummy for loans made for refinancing, a dummy for no first mortgage on the property, months at the address, years worked on the job, dummies for self-employed, retiree, or homemaker status, and a dummy if the property is a condominium).

the fraction of collateral is lower. At this financial institution, borrowers estimate their home values, and ask for a credit loan or line falling into one of three categories depending on the implied LTV. The categories correspond to LTVs of 80 percent or less; LTVs of between 80 and 90 percent; and LTVs of 90 percent or greater. The financial institution separately verifies the house value using an industry-standard methodology. Loan pricing depends on the LTV category the borrower falls into, and not on the specific value within that category; that is, a loan with an LTV of 60 has the same interest rate as a loan with an LTV of 70, holding borrower characteristics fixed.[6]

If the borrower has overestimated the value of the house, so that the LTV is in fact higher than originally estimated, the financial institution will direct the buyer to a different loan with a higher interest rate corresponding to the higher LTV. In such circumstances, the loan officer is also given some discretion to depart from the financial institution's normal pricing schedule to offer a higher interest rate than he or she would have to a borrower who had correctly estimated the LTV. If the borrower has underestimated the value of the house, however, the financial institution need not direct the buyer to a loan with a lower interest rate corresponding to the actual lower LTV; it may simply choose to offer the same, higher interest rate, for a lower-risk loan.[7]

Since the APR paid depends on the category the LTV falls in, and not the LTV, home value misestimation only leads to higher interest rate payments if it causes LTVs to change in such a way that the loan moves into a different category. If, in contrast, the borrower's estimated LTV were equal to 60, but the true LTV were 70, the borrower would still qualify for the highest quality loan category and would not suffer an interest rate penalty. We define a Rate Changing Mistake (RCM) to have occurred when a borrower's misestimation of house value causes a change in LTV category and potentially a change in interest rate paid.[8] We find that, on average, making an RCM increases the APR by 125 basis points for loans and 150 basis points for lines (controlling for other variables, but not age).

If the probability of making a rate-changing mistake is U-shaped with age, then a regression of APR on age conditioning on not having an RCM should show a nearly flat pattern.[9]

[6] We have verified this practice in our dataset by regressing the APR on both the level of the LTV and dummy variables for whether the LTV falls into one of the three categories. Only the coefficients on the dummy variables were statistically and economically significant.

[7] Note that even if the financial institution's estimate of the true house value is inaccurate, that misestimation will not matter for the borrower as long as other institutions use the same methodology.

[8] Specifically, RCMs occur when the borrower's estimation of his or her house value is such that the LTV is less than 80, while the true LTV is between 80 and 90; or the estimated LTV is less than 80 and the true LTV is greater than 90; or the estimated LTV is between 80 and 90, but the true is less than 80; or the estimated LTV is between 80 and 90, but the true LTV is greater than 90; or the estimated LTV is greater than 90, but the true LTV is less than 80; or the estimated LTV is greater than 90, but the true LTV is between 80 and 90.

[9] Bucks and Pence (2006) present evidence that borrowers do not generally have accurate estimates of their house values.

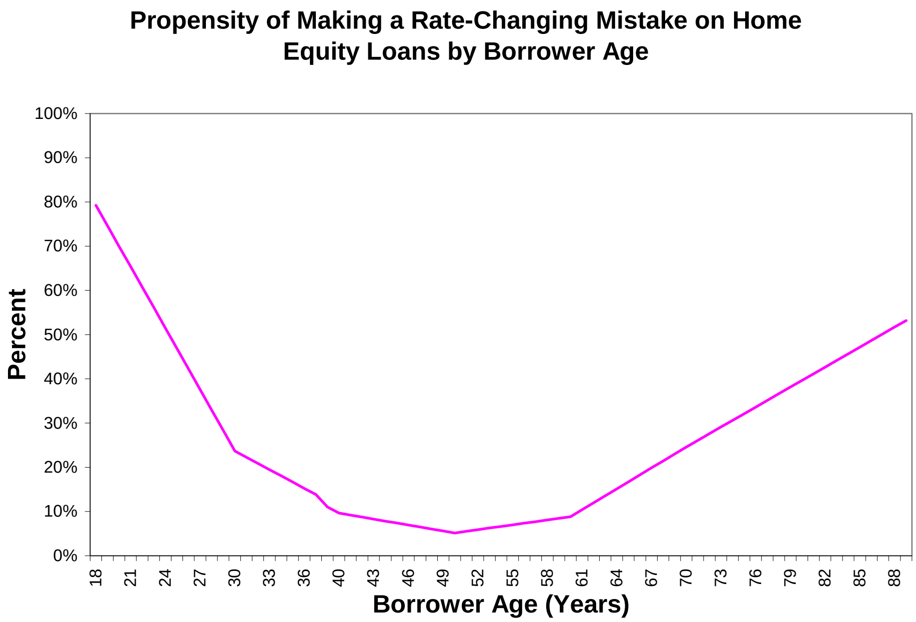

Figure 6: Propensity of making a Rate Changing Mistake on home equity loans by borrower age. We define a Rate Changing Mistake to have occurred when a borrower's misestimation of house value causes a change in LTV category and potentially a change in interest rate paid (see the text for a full definition). The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

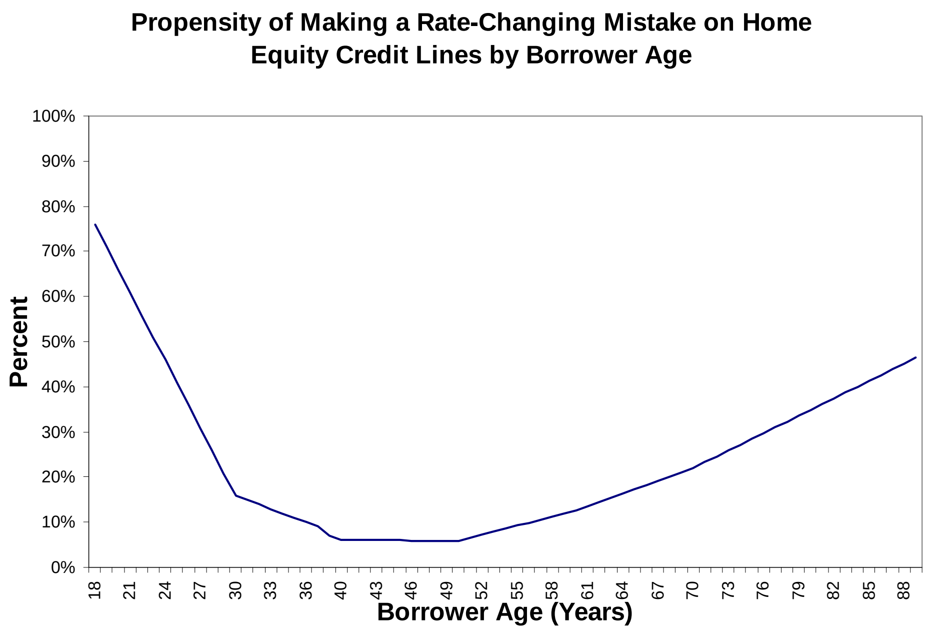

Figure 7: Propensity of making a Rate Changing Mistake on home equity credit lines by borrower age. We define a Rate Changing Mistake to have occurred when a borrower's misestimation of house value causes a change in LTV category and potentially a change in interest rate paid (see the text for a full definition). The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

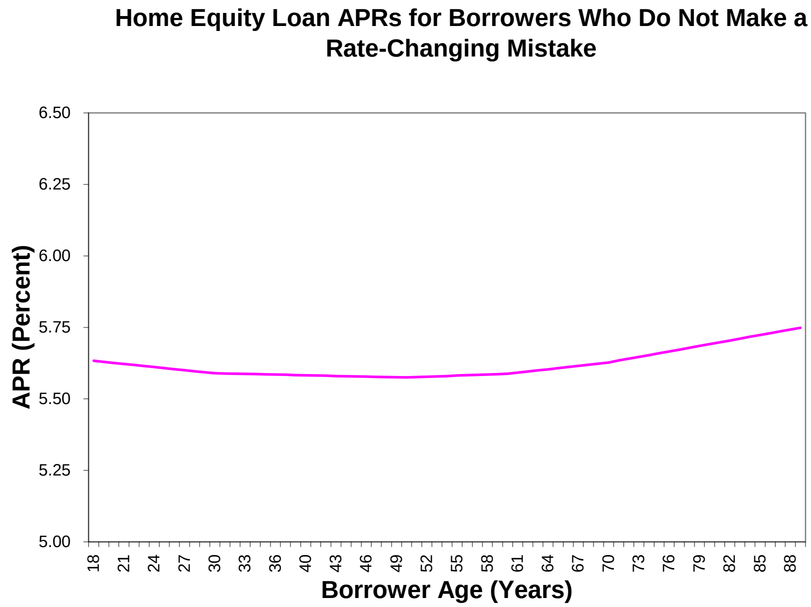

Figure 8: Home equity loan APRs for borrowers who do not make a rate-changing mistake. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

Figures 6 and 7 plots the probability of making a rate-changing mistake by age for home equity loans and home equity lines, respectively. The charts show U-shapes for both. Borrowers at age 70 have a 16(19) percentage point greater chance of making a mistake than borrowers at age 50 for home equity loans (lines); borrowers at age 20 have a 35(41) percentage point greater chance of making a mistake than borrowers at age 50. The unconditional average probability of making a rate-changing mistake is 24 percent for loans and 18 percent for lines.

Figures 8 and 9 plot the fitted values from re-estimating the regressions in table 3, but now conditioning on the borrower not making an RCM. The plots shows only slight differences in APR paid by age. The APR difference for a home equity loan for a borrower at age 70 over a borrower at age 50 has shrunk from 36 basis points to 8 basis points; for a home equity line of credit, it has shrunk from 28 basis points to 4 basis points. For a borrower at age 20, the APR difference over a borrower at age 50 has shrunk to 3 basis points for home equity loans and 3 basis points for home equity lines of credit.

This disappearance of the age effect is consistent with the cost of an RCM calculated above and the additional probability of making an RCM by age. For example, a 70-year old has a 16 and 19 percent additional chance of making an RCM for loans an lines. Multiplying this by the average APR cost of an RCM for home equity lines and loans of 150 and 125 basis points, respectively, gives an expected in APR paid of 26 and 23 basis points. These differences

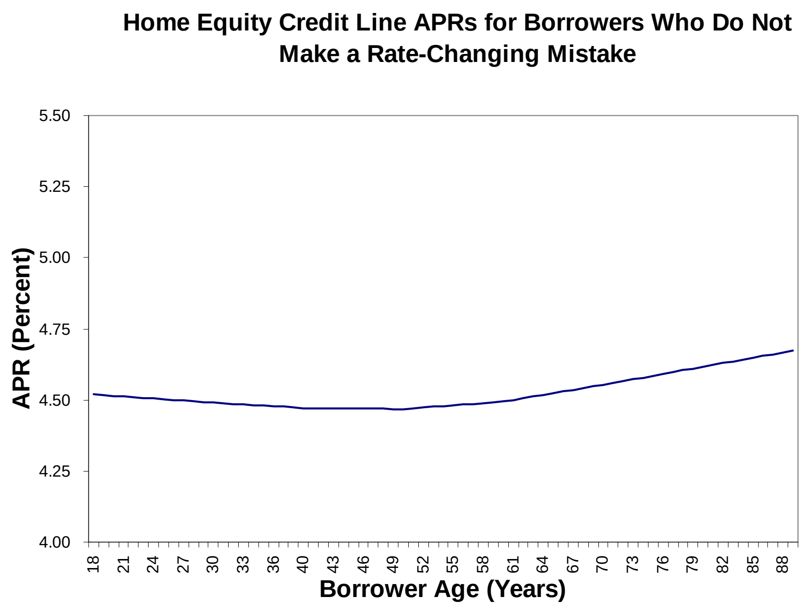

Figure 9: Home equity credit line APRs for borrowers who do not make a rate-changing mistake. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

are,very close to the estimated differences of 36-8=28 basis points for lines and 28-5=23 basis points for loans.

6 Credit Cards

6.1 Data Summary

We use a proprietary panel dataset from a large U.S. bank that issues credit cards nationally. The dataset contains a representative random sample of about 128,000 credit card accounts followed monthly over a 36 month period (from January 2002 through December 2004). The bulk of the data consists of the main billing information listed on each account's monthly statement, including total payment, spending, credit limit, balance, debt, purchases and cash advance annual percent rates (APRs), and fees paid. At a quarterly frequency, we observe each customer's credit bureau rating (FICO) and a proprietary (internal) credit 'behavior' score. We have credit bureau data about the number of other credit cards held by the account holder, total credit card balances, and mortgage balances. We have data on the age, gender and income of the account holder, collected at the time of account opening. Further details on the data, including summary statistics and variable definitions, are available in the data

Credit Card APR		
	Coefficient	Std. Error
Intercept	14.2743	3.0335
Age < 30	-0.0127	0.0065
Age 30-40	-0.0075	0.0045
Age 40-50	-0.0041	0.0045
Age 50-60	0.0023	0.0060
Age 60-70	0.0016	0.0184
Age > 70	0.0016	0.0364
Log(Income)	-0.0558	0.0803
Log(FICO)	-0.0183	0.0015
Home Equity Balance	0.0003	0.0022
Mortgage Balance	-0.0000	0.0000
Number of Observations	92,278	
Adjusted R-squared	0.0826	

Table 3: This table gives coefficient estimates for a regression of the APR of a credit card on a spline with age as its argument, financial control variables (Log(FICO) credit risk score, income, total number of cards, total card balance, home equity debt balance and mortgage balance).

appendix.

6.2 Results

Table 3 reports the results of regressing credit card APRs on a spline with age as the argument and other control variables. As controls, we again use information observed by the financial institution that may influence their pricing. As before, we find that credit scores have very little impact on credit card APRs. APRs rise with the total number of cards, though the effect is not statistically significant. Other controls, including the total card balance, log income, and balances on other debt, do not have economically or statistically significant effects on credit card APRs.

Figure **??** plots the fitted values on the spline for age. A U-shape is present, though much less pronounced than in the case of home equity loans.

7 Auto Loans

7.1 Data Summary

We use a proprietary data set of auto loans originated at several large financial institutions that were later acquired by another institution. The data set comprises observations on 6996 loans originated for the purchase of new and used automobiles. We observe loan characteristics including the automobile value and age, the loan amount and LTV, the monthly payment, the

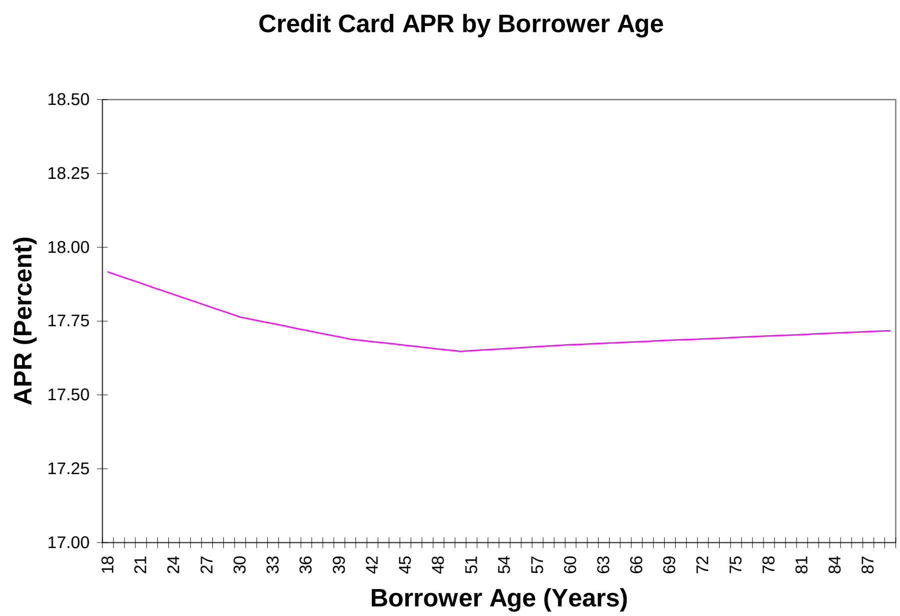

Figure 10: Credit card APR by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

contract rate, and the time of origination. We also observe borrower characteristics including credit score, monthly disposable income, and borrower age.

7.2 Results

Table 4 reports the results of estimating a regression of the APR paid on auto loans on a spline with age as the argument and control variables. FICO credit risk scores again have little effect on the loan terms. Higher incomes lower APRs and higher debt-to-income ratios raise them, though the magnitudes of the effects are neglige. We also include car characteristics, such as type and age, as one of us has found those variables to matter for APRs in other work (Agarwal, Ambrose and Chomsisengphet, forthcoming)–though we note that the financial institutions do not condition their loans on such variables. We also include loan age and state dummies.

Figure 11 plots the fitted values on the spline for age. The graph again shows a rather pronounced U-shape.

Auto Loan APR		
	Coefficient	Std. Error
Intercept	11.4979	1.3184
Age < 30	-0.0231	0.0045
Age 30-40	-0.0036	0.0005
Age 40-50	-0.0054	0.0005
Age 50-60	0.0046	0.0007
Age 60-70	0.0031	0.0017
Age > 70	0.0091	0.0042
Log(Income)	-0.3486	0.0176
Log(FICO)	-0.0952	0.0059
Debt/Income	0.0207	0.0020
Japanese Car	-0.0615	0.0270
European Car	-0.0127	0.0038
Loan Age	0.0105	0.0005
Car Age	0.1234	0.0031
State Dummies	YES	
Quarter Dummies	YES	
Number of Observations	6,996	
Adjusted R-squared	0.0928	

Table 4: This table gives coefficient estimates from a regression of the APR of an auto loan on a spline with age as its argument, financial control variables (Log(FICO) credit risk score, income, and the debt-to-income-ratio), and other controls (state dummies, dummies for whether the car is Japanese or European, loan age and car age).

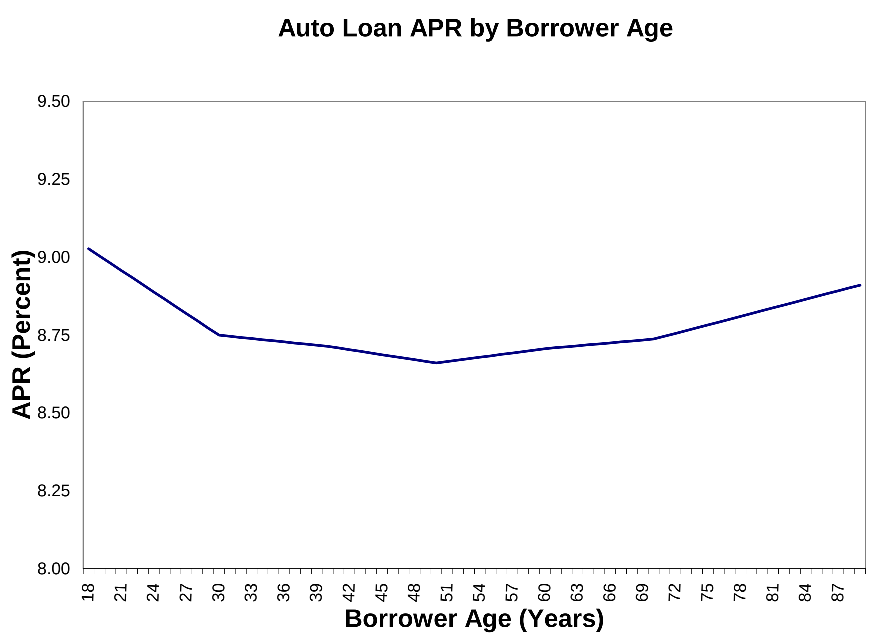

Figure 11: Auto loan APR by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

8 Mortgages

8.1 Data Summary

We use a proprietary data set from a large financial institution that originates first mortgages in Argentina. The data set covers 4,867 owner-occupied, fixed rate, first mortgage loans originated between June 1998 and March 2000, and observed through March 2004. We observe the original loan amount, the LTV and appraised house value at origination, and the APR. We also observe borrower financial characteristics (including income, second income, years on the job, wealth measures such as second house ownership and car ownership and value), borrower risk characteristics (Veraz score (a credit score similar to the U.S. FICO score) and mortgage payments as a percentage of after-tax income), and borrower demographic characteristics (age, gender and marital status).

8.2 Results

Table 5 reports results of regressing the mortgage APR on a spline with age as an argument and control variables. As controls, we again use variables observable to the financial institution that may affect loan pricing, including risk measures (credit score, income, mortgage payment as a fraction of income, and LTV), and various demographic and financial indicators (gender, marital status, a dummy variable for car ownership, and several others; these coefficients are not reported to save space). The coefficients on the controls are again of the expected sign and generally statistically significant, though of small magnitude.

The coefficients on the age spline are positive below age thirty, then negative through age 60 and positive thereafter. Figure 12 plots the fitted values on the spline for age. The graph again generally shows a U-shape, though behavior for younger borrowers is rather different.

9 Small Business Credit Cards

9.1 Data Summary

We use a proprietary data set of small business credit card accounts originated at several large institutions that issued such cards nationally. The institutions were later acquired by a single institution. The panel data set covers 11,254 accounts originated between May 200 and May 2002. Most of the business are very small, owned by a single family, and have no formal financial records. The data set has all information collected at the time of account origination, including the borrower's self-reported personal income, years in business of the firm, and borrower age. Quarterly, we observe the account credit bureau score.

Mortgage APR		
	Coefficient	Std. Error
Intercept	12.4366	4.9231
Age < 30	0.0027	0.0046
Age 30-40	-0.0023	0.0047
Age 40-50	-0.0057	0.0045
Age 50-60	0.0127	0.0093
Age 60-70	0.0155	0.0434
Age > 70	0.0234	0.0881
Log(Income)	-0.2843	0.1303
Log(Credit Score)	-0.1240	0.0217
Debt/Income	0.0859	0.2869
Loan Term	-0.0114	0.0037
Loan Term Squared	-0.0000	0.0000
Loan Amount	-0.0000	0.0000
Loan to Value	0.1845	0.0187
Years on the Job	-0.0108	0.0046
Second Home	0.1002	0.1014
Auto	0.1174	0.0807
Auto Value	0.0000	0.0000
Gender (1=Female)	0.0213	0.0706
Married	-0.0585	0.0831
Two Incomes	-0.1351	0.1799
Married with Two Incomes	-0.0116	0.1957
Employment: Professional	-0.0438	0.1174
Employment:Non-Professional	0.0853	0.1041
Merchant	-0.1709	0.1124
Bank Relationship	-0.2184	0.1041
Number of Observations	4,867	
Adjusted R-squared	0.1004	

Table 5: This table reports the estimated coefficients from a regression of mortgage APR on a spline with age as its argument and financial and demographic control variables.

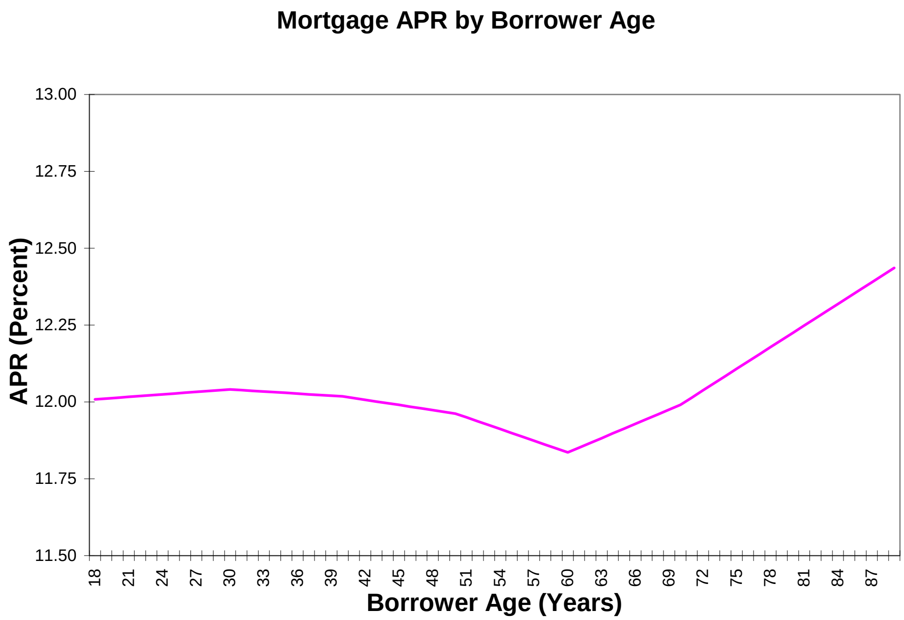

Figure 12: APR for Argentine mortgages by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

9.2 Results

Table 6 reports the results of regressing the APR for small business credit cards on a spline with age as the argument and control variables. As with individual credit card accounts, we control for the FICO score of the borrower, the total number of cards, card balance, and card limit. We also include dummy variables for years in business, and expect APRs to be decreasing in this variable. All controls variables are statistically significant and have the expected sign, though only the dummies for years in business have substantial magnitudes.

APRs are decreasing in the age of the borrower through age 60, and increasing thereafter. Figure 13 plots the fitted values on the spline for age. The graph shows a pronounced U-shape.

10 Credit Card Fee Payments: Late Fees

10.1 Overview

Certain credit card uses involve the payment of a fee. Some kinds of fees are assessed when terms of the credit card agreement are violated. Other kinds are assessed for use of services.

In the next three sections, we focus on three important types of fees: late fees, over limit

Small Business Credit Card APR		
	Coefficient	Std. Error
Intercept	16.0601	0.6075
Age < 30	-0.0295	0.0081
Age 30-40	-0.0068	0.0040
Age 40-50	-0.0047	0.0038
Age 50-60	-0.0017	0.0055
Age 60-70	0.0060	0.0209
Age > 70	0.0193	0.0330
Years in Business 1-2	-0.5620	0.1885
Years in Business 2-3	-0.7463	0.1937
Years in Business 3-4	-0.2158	0.1031
Years in Business 4-5	-0.5100	0.0937
Years in Business 5-6	-0.4983	0.0931
Log(FICO)	-0.0151	0.0008
Number of Cards	0.1379	0.0153
Log(Total Card Balance)	0.0000	0.0000
Log(Total Card Limit)	0.0000	0.0000
Number of Observations	11,254	
Adjusted R-squared	0.0933	

Table 6: This table reports the estimated coefficients from a regression of the APR for small business credit cards on a spline with the business owner's age as its argument and other control variables (dummies for years in business, log(FICO) credit risk score, number of cards, total card balance, and total card limit).

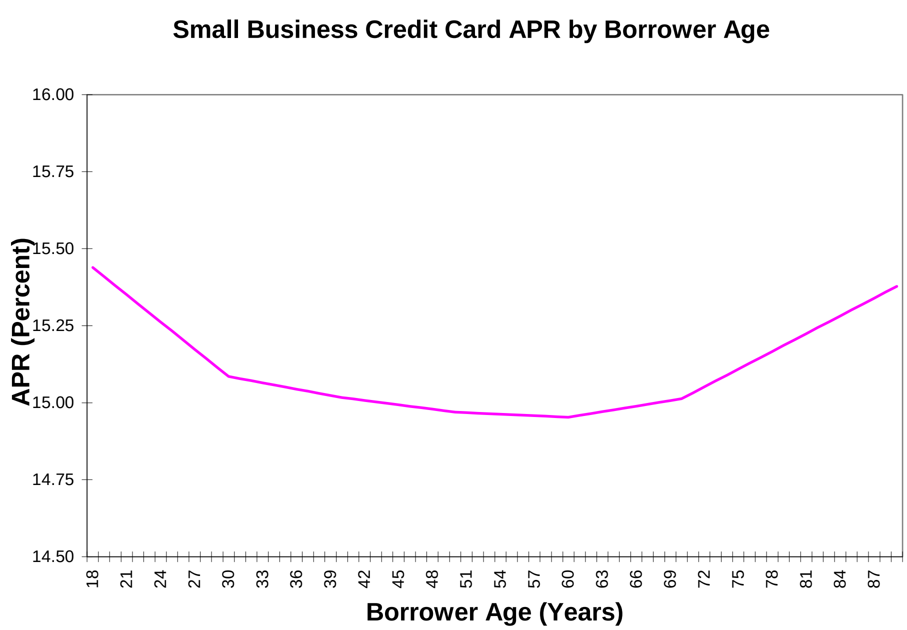

Figure 13: Small business credit card APR by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

fees, and cash advance fees.[10] We describe the fee structure for our data set below.

1. **Late Fee**: A late fee of between \$30 and \$35 is assessed if the borrower makes a payment beyond the due date on the credit card statement. If the borrower is late by more than 60 days once, or by more than 30 days twice within a year, the bank may also impose 'penalty pricing' by raising the APR to over 24 percent. The bank may also choose to report late payment to credit bureaus, adversely affecting consumers' FICO scores. If the borrower does not make a late payment during the six months after the last late payment, the APR will revert to its normal (though not promotional) level.

2. **Over Limit Fee**: An over limit fee, also of between \$30 and \$35, is assessed the first time the borrower exceeds his or her credit limit. The same penalty pricing as in the late fee is imposed.

3. **Cash Advance Fee**: A cash advance fee of the greater of 3 percent of the amount advanced, or \$5, is levied for each cash advance on the credit card. Unlike the first two fees, this fee can be assessed many times per month. It does not cause the imposition of penalty pricing on purchases or debt. However, the APR on cash advances is typically greater than that on purchases, and is usually 16 percent or more.

Payment of these fees may be viewed as mistakes in that fee payment may be avoided by small and relatively costless changes in behavior.

We use the same dataset as that used for the credit card APR case study discussed above.

10.2 Results

Table 7 presents panel regressions for each type of fee. In each of the three regressions, we regress a dummy variable equal to one if a fee is paid that month on a spline for age and control variables; hence the coefficients give the conditional effects of the independent variables on the propensity to pay fees. The control variables differ from those of the preceding six examples, since now we wish to control for other things that might affect the propensity to pay a fee, which are not necessarily the same as things that might lead borrowers to default or otherwise affect their borrowing terms. "Bill Existence" is a dummy variable equal to one if a bill was issued last month; borrowers will only be eligible to pay a late fee if a bill was issued. "Bill Activity" is a dummy variable equal to one if purchases or payments were made

[10] Other types of fees include annual, balance transfer, foreign transactions, and pay by phone. All of these fees are relatively less important to both the bank and the borrower. Few issuers (the most notable exception being American Express) continue to charge annual fees, largely as a result of increased competition for new borrowers (Agarwal et al., 2005). The cards in our data do not have annual fees. We study balance transfer behavior using a separate data set below. The foreign transaction fees and pay by phone fees together comprise less than three percent of the total fees collected by banks.

on the card; borrowers will only be eligible to pay over limit or cash advance fees if the card was used. "Log(Purchases)" is the log of the amount purchased on the card, in dollars; we would expect that the propensity to pay over limit and cash advance fees would be increasing with the amount of purchases. "Log(FICO)" is the credit risk score, and "Log(Behavior)" is an internal risk score created by the bank to predict late and delinquent payment beyond that predicted by the FICO score. Higher scores mean less risky behavior. The scores are lagged three months because they are only updated quarterly. We would expect the underlying behavior leading to lower credit risk scores would lead to higher fee payment. "Debt/Limit" is the ratio of the balance of credit card debt to the credit limit; we would expect that having less available credit would raise the propensity to pay over limit fees, and possibly other fees.

For late fee payments, column one of the table, all control variables have the expected signs and are statistically significant, though they are also small in magnitude. Note that some control variables may partly capture the effects of age-related cognitive decline on fees. For example, if increasing age makes borrowers more likely to forget to pay fees on time, that would both increase the propensity to pay late fees and decrease credit and behavior scores. Hence the estimated coefficients on the age splines may understate some age-related effects.

Coefficients on the age splines are uniformly negative for splines through age 50, negative or weakly positive for the spline between age 50 and 60, and positive with increasing slope for splines above age 50.

The top line in Figure 14 plots fitted values for the age splines for the late fee payment regression.

11 Credit Card Fee Payments: Over Limit Fees

The second column of Table 7 presents regression results for the over limit fee, on the same controls and age splines as for the late fee. Results are very similar to those for the late fee.

The bottom line in Figure 14 plots fitted values for the age splines for the over limit fee payment regression.

12 Credit Card Fee Payments: Cash Advance Fees

The second column of Table 7 presents regression results for the cash advance fee, on the same controls and age splines as for the late fee. Results are very similar to those for the late fee and over limit fee.

The middle line in Figure 14 plots fitted values for the age splines for the cash advance fee payment regression.

	Late Fee		Over Limit Fee		Cash Adv. Fee	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Intercept	0.2964	0.0446	0.1870	0.0802	0.3431	0.0631
Age < 30	-0.0021	0.0004	-0.0013	0.0006	-0.0026	0.0011
Age 30-40	-0.0061	0.0003	-0.0003	0.0001	-0.0004	0.0002
Age 40-50	-0.0001	0.0000	-0.0002	0.0000	-0.0002	0.0000
Age 50-60	-0.0002	0.0000	-0.0002	0.0000	-0.0003	0.0000
Age 60-70	0.0004	0.0002	0.0003	0.0001	0.0004	0.0000
Age > 70	0.0025	0.0013	0.0003	0.0001	0.0004	0.0000
Bill Existence	0.0153	0.0076	0.0104	0.0031	0.0055	0.0021
Bill Activity	0.0073	0.0034	0.0088	0.0030	0.0055	0.0021
Log(Purchases)	0.0181	0.0056	0.0113	0.0023	0.0179	0.0079
Log(Behavior)	-0.0017	0.0000	-0.0031	0.0012	-0.0075	0.0036
Log(FICO)	-0.0016	0.0007	-0.0012	0.0003	-0.0015	0.0005
Debt/Limit	-0.0066	0.0033	0.0035	0.0013	0.0038	0.0012
Acct. Fixed Eff.	YES		YES		YES	
Time Fixed Eff.	YES		YES		YES	
Number of Obs.	3.9 Mill.		3.9 Mill.		3.9 Mill.	
Adj. R-squared	0.0378		0.0409		0.0388	

Table 7: This table reports coefficients from a regression of dummy variables for credit card fee payments on a spline for age, financial control variables (log(FICO) credit risk score, internal bank behavior risk score, debt over limit) and other control variables (dummies for whether a bill existed last month, for whether the card was used last month, dollar amount of purchases, account- and time- fixed effects).

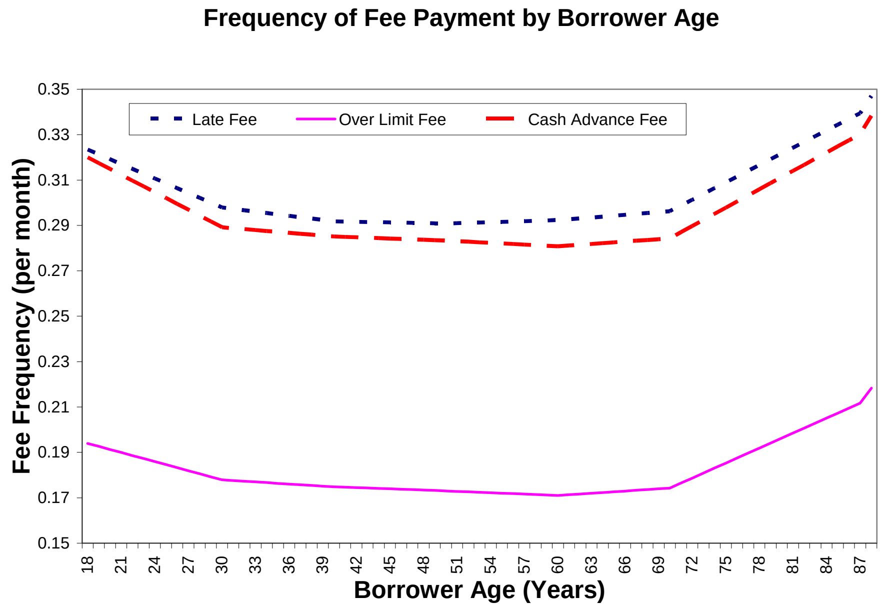

Figure 14: Frequency of fee payment by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

13 'Eureka' Moments: Balance Transfer Credit Card Usage

13.1 Overview

Credit card holders frequently receive offers to transfer account balances on their current cards to a new card. Borrowers pay substantially lower APRs on the balances transferred to the new card for a six-to-nine-month period (a 'teaser' rate). However, *new* purchases on the new card have high APRs. The catch is that *payments* on the new card go *first* towards paying down the (low interest) transferred balances, and only subsequently towards paying down the (high interest) debt accumulated from new purchases.

The optimal strategy for borrowers, is to make all new purchases on their *old* credit card and to make no new purchases with the new card to which balances have been transferred. We hypothesize that some borrowers will figure this out before making any purchases with the new card. Some borrowers may not initially understand the optimal strategy, and will only figure it out by observing their (surprisingly) high interest charges. Those borrowers will make purchases for one or more months, then have a 'eureka' moment, after which they will implement the optimal strategy. Some borrowers will never identify the optimal strategy.

13.2 Data summary

We use a proprietary panel dataset from several large financial institutions, later acquired by a single financial institution, that made balance transfer offers nationally. The data set contains 14,798 accounts which accepted such offers over the period January 2000 through December 2002, The bulk of the data consists of the main billing information listed on each account's monthly statement, including total payment, spending, credit limit, balance, debt, purchases and cash advance annual percent rates (APRs), and fees paid. We also observe the amount of the balance transfer, the start date of the balance transfer teaser rate offer, the initial teaser APR on the balance transfer, and the end date of the balance transfer APR offer. At a quarterly frequency, we observe each customer's credit bureau rating (FICO) and a proprietary (internal) credit 'behavior' score. We have credit bureau data about the number of other credit cards held by the account holder, total credit card balances, and mortgage balances. We have data on the age, gender and income of the account holder, collected at the time of account opening. Further details on the data, including summary statistics and variable definitions, are available in the data appendix.

13.3 Results

About one third of all customers who make a balance transfer do no spending on the new card, thus implementing the optimal strategy immediately. Slightly more than one third of customers who make a balance transfer spend every month during the promotional period, thus never experiencing a "Eureka" moment.

Figure 15 plots the frequency of Eureka moments for each age group. The plot of those who never experience a "Eureka" moment–that is, who never implement the optimal strategy–is a pronounced U-shape by age. The plot of those who implement the strategy immediately is a pronounced inverted U-shape by age. Plots for the other months are relatively flat.

Table 8 reports the results of a regression of a dummy variable for ever having a Eureka moment on a spline for age and controls for credit risk (log(FICO)), education, gender and log(income).[11]. Credit risk is included because higher scores may be associated with greater financial sophistication. Similarly, we would expect borrowers with higher levels of education to be more likely to experience Eureka moments The coefficients on the age spline imply that young adults and older adults are less likely to experience Eureka moments.

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Figure 16 plots fitted values for the age splines. Note that, unlike the other figures, higher values indicate a smaller propensity to make mistakes.

[11] Although we report an OLS regression for ease in interpreting the coefficients, we have also run the regression

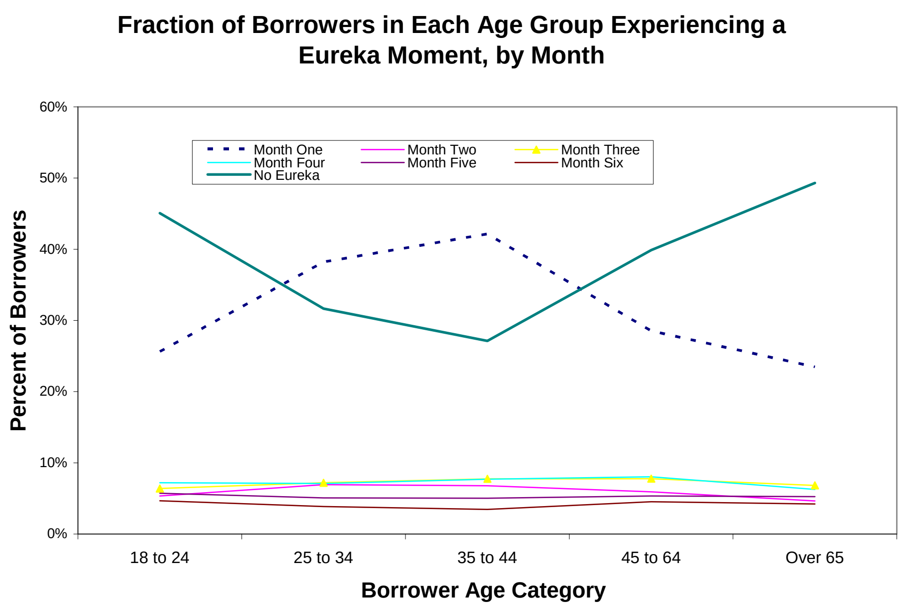

Figure 15: Fraction of borrowers in each age group experiencing specific delays. For example, the dashed-blue line plots the fraction of borrowers experiencing no delay to a Eureka moment. These sophisticated borrowers represent a large fraction of middle-aged households and a much smaller fraction of younger and older households.

Propensity of Eureka Moment		
	Coefficient	Std. Error
Intercept	0.2587	0.0809
Age <30	0.0134	0.0026
Age 30-40	0.0019	0.0005
Age 40-50	-0.0001	0.0000
Age 50-60	-0.0029	0.0009
Age 60-70	-0.0035	0.0008
Age >70	-0.0083	0.0072
Some High School	-1.6428	0.9570
High School Graduate	-0.6896	0.8528
Some College	-0.4341	0.8944
Associate's Degree	-0.2439	0.4537
Bachelor's Degree	0.3280	0.5585
Graduate	0.6574	0.3541
log(FICO)	0.0102	0.0019
log(Limit)	0.0120	0.0022
log(Income)	-0.0044	0.0067
Number of Observations	3,622	
Adjusted R-squared	0.1429	

Table 8: This table reports estimated coefficients from a panel regression of the month in which the borrower did no more spending on the balance transfer card (the 'eureka moment') on a spline with age as its argument and other control variables.

14 Quantifying the Performance Peak

14.1 Locating the Peak of Performance

Visual inspection of the age splines for the ten case studies suggests that financial mistakes are at a minimum in the late forties or early fifties. To estimate the minimum more precisely, we re-estimate each model, replacing the splines between 40 and 50 and 50 and 60 with a single spline running from 40 to 60, and the square of that spline.

In other words, we run the following regression, where F is the outcome associated respectively with each of the 10 studies:

$$(2) \qquad \begin{aligned} F &= \alpha + \beta \times Spline(Age)_{Age \notin [40,60]} + \gamma \times Controls + \epsilon \\ &\quad + a \times Spline\,(Age)_{Age \in [40,60]} + b \cdot Spline\,(Age)^2_{Age \in [40,60]}\,. \end{aligned}$$

Here $Spline(Age)$ is a piecewise linear function that takes consumer age as its argument (with knot points at ages 30, 40, 60 and 70). $Spline(Age)_{Age \notin [40,60]}$ represents the splines outside of the $[40, 60]$ age range, while $Spline\,(Age)_{Age \in [40,60]}$ is the linear spline with knot points at

as a logit and found similar results.

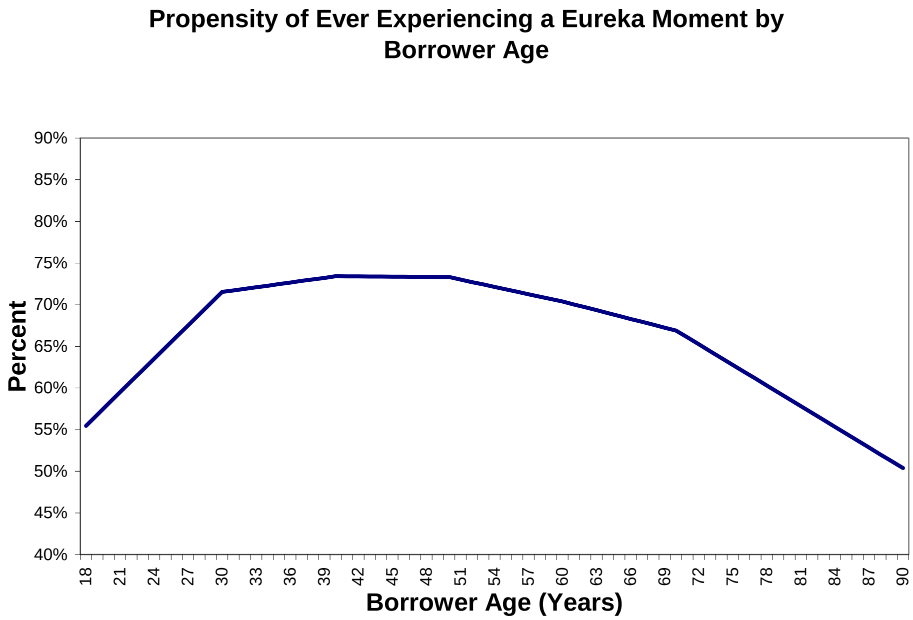

Figure 16: Propensity of ever experiencing a eureka moment by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income), education, and credit-worthiness.

40 and 60. Hence, for age between 40 and 60, the above formulation is just:

$$F = Controls + \ a \times Age + \ b \times Age^2$$

The peak of performance is the value that minimizes the above function, i.e.

$$Peak = -a/\,(2b) \qquad (3)$$

We calculate the asymptotic standard errors on $Peak$ using the delta method, so that $s.e.(Peak)$ is the standard error associated with the linear combination: $-1/(2b)\cdot$(Coefficient on age) + $a/(2b^2)\cdot$(Coefficient on age^2).

In Table 9, we report the location of the 'age of reason': the point at which financial mistakes are minimized. The mean age of reason appears to be at 53.3 years. The standard deviation across studies is 4.3 years.

Formal hypothesis testing (H_0: $a + 2b \times 53 = 0$) shows that only the location of the Eureka moment is statistically different from 53 years. Interestingly, the Eureka task is arguable the most "difficult" task, i.e. the most cognitively intensive one. It makes sense that the peak age for that task would be earlier than the other tasks. Since we do not have a rigorous measure

	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

of the "difficulty" of a task, the interpretation of the Eureka case remains speculative.

14.2 Formal Test of a Performance Peak Effect

Table 9 allows us do a formal test for a peak effect. In regression (2), the null hypothesis of a peak effect is: (i) $b > 0$, and (ii) $Peak = -a/(2b) \in [40, 60]$. Together these conditions imply that mistakes follow a U-shape, with a peak that is between 40 and 60 years of age.

For criterion (i), we note that the b coefficients are positive for all 10 studies. For 9 of the 10 studies b is significantly different from zero (the credit card APR study is the exception).[12] For criterion (ii), Table 9 shows that a peak in the 40-60 age range can not be rejected for all ten studies.

15 Discussion and Related Work

Age effects offer a unified parsimonious explanation for our findings in all ten case studies. However, our cross-sectional evidence does not *definitively* support this interpretation. In the current section, we review some possible alternative explanations.

Some results could be driven by unobserved variation in default risk. For instance, the U-shape of APRs, could be due to a U-shape of default by age. We test this alternative hypothesis by regressing default rates on age splines for credit cards, auto loans, and home equity loans and credit lines. We plot fitted values in Figure 17. None of the graphs is U-shaped. On the contrary, home equity loans and lines show a pronounced inverted-U-shape, implying that

[12] To save space, we only report the $t-$statistics associated with the b coefficients. Following the order of Table 9, they are: 2.20, 4.55, 7.80, 8.77, 17.05, 1.61, 4.57, 2.91, 3.08, 2.67.

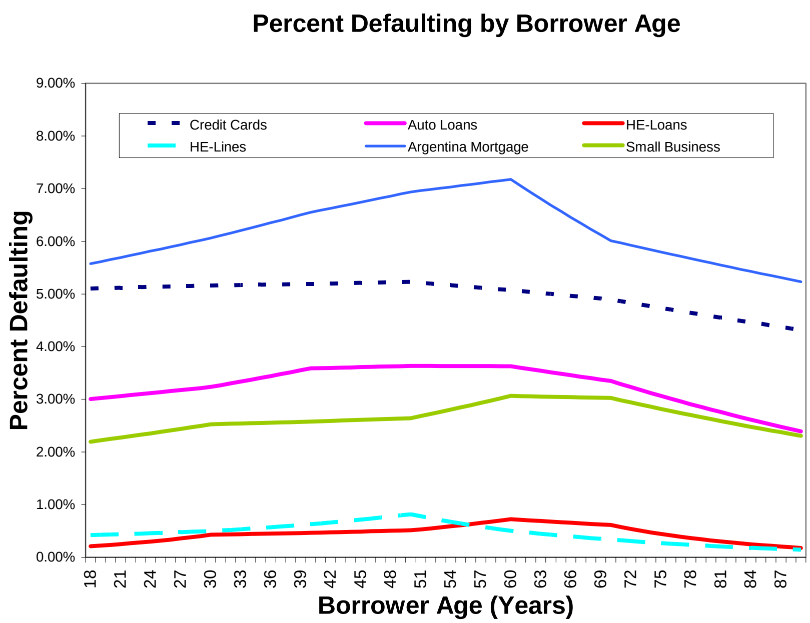

Figure 17: Default frequency by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as income and credit-worthiness.

the young and old have *lower* default rates. Credit cards and auto loans also show a slight inverted U-shape. Hence, Figure 17 contradicts the hypothesis that our results are driven by an unmeasured default risk. Also, note that age-dependent default risk could not explain the observed patterns in credit card fee payments or suboptimal use of balance transfers.

Some age effects could be generated by age-variation in the opportunity cost of time [Aguiar and Hurst 2005]. However, such opportunity-cost effects would predict that retirees make fewer mistakes, which is not what we observe in the data.

The presence of age effects might also be interpreted as evidence for some kind of age discrimination. We believe this to be unlikely, for two reasons. First, firms avoid age discrimination for legal reasons. Penalties for age discrimination from the Fair Lending Act are substantial (as would be the resulting negative publicity). Second, the U-shaped pattern shows up in contexts such as fee payments and misuse of balance transfer offers in which discrimination is not relevant (since all card holders face the same rules).

15.1 Related Work

Other authors have studied the effects of aging on the use of financial instruments. Korniotis and Kumar (2007) examine the performance of investors from a major U.S. discount brokerage house. They use census data to impute education levels and data from the Survey of Health, Aging and Retirement in Europe to estimate a model of cognitive abilities. They find that investors with cognitive declines earn annual returns between 3-5 percentage points lower on a risk adjusted basis. In a related paper, Zinman (2006) reports that older adults are more likely to borrow at high interest rates on credit card accounts, while simultaneously holding liquid assets in low-interest bank accounts.

In their work on financial literacy, Lusardi and Mitchel find evidence consistent with an inverse-U shape of financial proficiency. Lusardi and Mitchell (2006) find a decline in financial knowledge after age 50. Lusardi and Mitchell (2007) also find an inverse U-shape in the mastery of basic financial concepts, such as the ability to calculate percentages or simple divisions.

After some of our presentations other researchers have offered to look for age patterns of financial mistakes in their own data sets. Lucia Dunn has reported to us that the Ohio State Survey on credit cards shows a U-shaped pattern of credit card APR terms by age (Dunn, personal communication). Fiona Scott-Morton has reported that in her dataset of indirect auto loans (loans made by banks and finance companies using the dealer as an intermediary; see Scott-Morton *et al.*, 2003), loan APR terms show a U-shaped pattern (Scott-Morton, personal communication).

A relationship between earning and performance has been noted in many non-financial contexts. Survey data suggests that labor earnings peak around age 50 (Gourinchas and Parker, 2002) or after about 30 years of experience (Murphy and Welch, 1990). This is consistent with our hypothesis that economic performance depends on both analytic abilities and experience.

Turning to purely noneconomic domains, there is a literature on estimating performance peaks in professional athletics and other competitive areas. Fair (1994, 2005a, 2005b) estimates the effects of age declines in baseball and chess, among other sports. James (2003) estimates the age of peak performance in baseball to be 29.

A burgeoning literature in psychology and economics reports systematic difference in "rationality" between groups of people. Benjamin, Brown and Shapiro (2006) find that subjects with higher test scores, or less cognitive load, display fewer behavioral biases. Frederick (2005) identifies a measure of "analytical IQ": people with higher scores on cognitive ability tasks tend to exhibit fewer/weaker psychological biases. While this literature is motivated by experimental data (where it is easier to control for unobservables), we rely on field data in our paper. Similarly, Massoud, Saunders and Schnolnick (2006) find that more educated people make fewer mistakes on their credit cards.

A number of researchers have written about consumer credit card use. Our work most closely overlaps with that of Agarwal *et al.* (2005), who use another large random sample of credit card accounts to show that, on average, borrowers choose credit card contracts that minimize their total interest costs net of fees paid. About 40 percent of borrowers initially choose suboptimal contracts. While some borrowers incur hundreds of dollars of such costs, most borrowers subsequently switch to cost-minimizing contracts. The results of our paper complement those of Agarwal *et al.* (2005), since we find evidence of learning to avoid fees and interest costs given a particular card contract.

Several researchers have looked at the response of consumers to low, introductory credit card rates ('teaser' rates), and at the persistence of otherwise high interest rates. Shui and Ausubel (2004) show that consumers prefer credit card contracts with low initial rates for a short period of time to ones with somewhat higher rates for a longer period of time, even when the latter is *ex post* more beneficial. Consumers also appear 'reluctant' to switch contracts. DellaVigna and Malmendier (2004) theorize that financial institutions set the terms of credit card contracts to reflect consumers' poor forecasting ability over their future consumption.

Bertrand *et al.* (2005) find that randomized changes in the "psychological features" of consumer credit offers affect adoption rates as much as variations in the interest rate terms. Ausubel (1991) hypothesizes that consumers may be over-optimistic, repeatedly underestimating the probability that they will borrow, thus possibly explaining the stickiness of credit card interest rates. Calem and Mester (1995) use the 1989 Survey of Consumer Finances (SCF) to argue that information barriers create high switching costs for high-balance credit card customers, leading to persistence of credit card interest rates, and Calem, Gordy and Mester (2005) use the 1998 and 2001 SCFs to argue that such costs continue to be important. Kerr and Dunn (2002) use data from the 1998 SCF to argue that having large credit card balances raises consumers' propensity to search for lower credit card interest rates. Kerr and Dunn (2004) use SCF data to argue that banks offer better lending terms to consumers who are also bank depositors, and about whom the bank would thus have more information.

Other authors have used credit card data to evaluate more general hypotheses about consumption. Agarwal, Liu and Souleles (2004) use credit card data to examine the response of consumers to the 2001 tax rebates. Gross and Souleles (2002a) use credit card data to argue that default rates rose in the mid-1990s due to declining default costs, rather than a deterioration in the credit-worthiness of borrowers. Gross and Souleles (2002b) find that increases in credit limits and declines in interest rates lead to large increases in consumer debt. Ravina (2005) estimates consumption Euler equations for credit card holders and finds evidence for habit persistence.

15.2 Some Open Questions for Future Research

Our findings suggest several directions for future research.

First, it would be useful to study age effects in other decision domains. We have presented a simple procedure for this: (1) identify the general shape of age effects, as in (1), using controls and age splines; (2) estimate a linear-quadratic form to localize the peak of performance, as in

(2)-(3).

Second, it may be possible to develop models that predict the location of peak performance. There is a growing consensus that analytically intensive problems are associated with younger peak ages – think about mathematics (see Simonton 1988, Galenson 2005, and Weinberg and Galenson 2006). Analogously, problems that are more experientially-relevant have older peak ages. For instance, Jones (2006) finds that the peak age for scientists has drifted higher in the twentieth century. More knowledge now needs to be accumulated to reach the cutting edge of the field.

In our last case study, we found that what is arguably the most analytically demanding task – deducing the best way to exploit "interest-free" balance transfers – is associated with the youngest age of peak performance. It would be useful to know if this association between analytically demanding problems and young peak ages is general.

Third, it would be useful to identify cost-effective regulations that would help improve financial decisions. Forced disclosure is not itself sufficient, since disclosing costs in the fine print will have little impact on distracted and boundedly rational consumers.[13] Good disclosure rules will need to be effective even for consumers who do not take the time to read the fine print or who have limited financial education. We conjecture that effective regulations would produce comparable and transparent products. On the other hand, such homogenization has the dynamic cost that it may create a roadblock to innovation.

Fourth, studying cognitive lifecycle patterns should encourage economists to pay more attention to the market for advice. Advice markets may not function efficiently because of information asymmetries between the recipients and the providers of advice (Dulleck and Kerschbamer 2006). It is particularly important to study the advice market for older adults who are now required to make their own financial decisions (e.g. by making decisions about 401(k) rollovers, asset allocation, and decumulation).

16 Conclusion

We find that middle-age adults borrow at lower interest rates and pay lower fees in ten financial markets. Our analysis suggests that this fact is not explained by age-dependent risk factors. For example, FICO scores show no pattern of age variation. Moreover, age variation in default rates actually predicts the *opposite* pattern from the one that we measure.

Age effects parsimoniously explain the patterns that we observe, but, cohort effects may also contribute to the observed findings. Whatever the mechanism, there appears to be a robust relationship between age and financial sophistication in cross-sectional data. Future

[13] See Gabaix, Laibson, Moloche and Weinberg (2006) and Kamenica (2007) for models of economic behavior under information overload.

research should untangle the different forces that give rise to these effects. If age effects *are* important, economists should analyze the efficiency of modern financial institutions – like defined contribution pension plans – that require older adults to make most of their own financial decisions.

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Appendix A: Data Summary Statistics

Table A1: Credit Cards			
Account Characteristics	Frequency	Mean	Std. Dev.
Purchase APR	Monthly	14.40	2.44
Interest Rate on Cash Advances (%)	Monthly	16.16	2.22
Credit Limit ($)	Monthly	8,205	3,385
Current Cash Advance ($)	Monthly	148	648
Payment ($)	Monthly	317	952
New Purchases ($)	Monthly	303	531
Debt on Last Statement ($)	Monthly	1,735	1,978
Minimum Payment Due ($)	Monthly	35	52
Debt/Limit (%)	Monthly	29	36
Fee Payment			
Total Fees ($)	Monthly	10.10	14.82
Cash Advance Fee ($)	Monthly	5.09	11.29
Late Payment Fee ($)	Monthly	4.07	3.22
Over Limit Fee ($)	Monthly	1.23	1.57
Extra Interest Due to Over Limit or Late Fee ($)	Monthly	15.58	23.66
Extra Interest Due to Cash Advances ($)	Monthly	3.25	3.92
Cash Advance Fee Payments/Month	Monthly	0.38	0.28
Late Fee Payments/Month	Monthly	0.14	0.21
Over Limit Fee Payments/Month	Monthly	0.08	0.10
Borrower Characteristics			
FICO (Credit Bureau Risk) Score	Quarterly	731	76
Behavior Score	Quarterly	727	81
Number of Credit Cards	At Origination	4.84	3.56
Number of Active Cards	At Origination	2.69	2.34
Total Credit Card Balance ($)	At Origination	15,110	13,043
Mortgage Balance ($)	At Origination	47,968	84,617
Age (Years)	At Origination	42.40	15.04
Income ($)	At Origination	57,121	114,375

Notes: The "Credit Bureau Risk Score" is provided by Fair, Isaac and Company. The greater the score, the less risky the consumer is. The "Behavior Score" is a proprietary score based on the consumer's past payment history and debt burden, among other variables, created by the bank to capture consumer payment behavior not accounted for by the FICO score.

Table A2: Home Equity Loans and Credit Lines				
	Loans		Credit Lines	
Description (Units)	Mean	Std. Dev.	Mean	Std. Dev.
APR(%)	7.96	1.16	4.60	0.88
Borrower Age (Years)	43	14	46	12
Income ($, Annual)	78,791	99,761	90,293	215,057
Debt/Income (%)	40	18	41	19
FICO (Credit Bureau Risk) Score	713	55	733	49
Customer LTV (%)	66	26	62	24
Appraisal LTV (%)	69	29	64	23
Borrower Home Value Estimate ($)	196,467	144,085	346,065	250,355
Bank Home Value Estimate ($)	186,509	123,031	335,797	214,766
Loan Requested by Borrower ($)	43,981	35,161	61,347	50,025
Loan Approved by Bank ($)	42,871	33,188	60,725	51,230
First Mortgage Balance ($)	79,496	83,560	154,444	112,991
Months at Address	92	122	99	129
No First Mortgage (%)	29	45	15	42
Second Home (%)	3	14	3	12
Condo (%)	8	18	6	17
Refinancing (%)	66	47	39	49
Home Improvement (%)	18	39	25	44
Consumption (%)	16	39	35	35
Self Employed (%)	7.9	27	7.8	27
Retired (%)	9.5	29	7.7	27
Homemaker (%)	1.4	12	1.3	11
Years on the Last Job	6.3	8.1	7.6	9.1

Table A3: Mortgage Loans		
	Loans	
Description (Units)	Mean	Std. Dev.
APR(%)	12.64	2.17
Borrower Age (Years)	40.54	9.98
Income ($)	2,624	2,102
Monthly Mortgage Payment/Income (%)	22.84	12.12
Veraz (Credit Bureau Risk) Score	686	253
LTV (%)	61	17
Loan Amount ($)	44,711	27,048
Years at Current Job	9.43	8.01
Second House (%)	15.54	5.18
Car Ownership (%)	73.56	44.11
Car Value ($)	5,664	13,959
Gender (Female=1)	30.96	46.24
Second Income (%)	20.44	40.33
Married (%)	71.32	45.23
Married with Two Incomes (%)	16.75	37.34
Self Employed (%)	13.87	34.57
Professional Employment (%)	15.78	36.46
Nonprofessional Employment (%)	52.78	49.93
Relationship with Bank (%)	10.40	30.52

Table A4: Auto Loan APRs		
Description (Units)	Mean	Std. Dev.
APR(%)	8.99	0.90
Borrower Age (Years)	40	21
Income ($, Monthly)	3416	772
LTV(%)	44	10
FICO (Credit Bureau Risk) Score	723	64
Monthly Loan Payment ($)	229	95
Blue Book Car Value ($)	11,875	4,625
Loan Amount ($)	4172	1427
Car Age (Years)	2	1
Loan Age (Months)	12	8

Table A5: Small Business Credit Cards APRs		
Description (Units)	Mean	Std. Dev.
APR(%)	13.03	5.36
Borrower Age (Years)	47.24	13.35
Line Amount ($)	9,623.95	6,057.66
Total Unsecured Debt	12,627.45	17,760.24
FICO (Credit Bureau Risk) Score	715.86	55.03
Mortgage Debt ($)	102,684.70	160,799.57