# Online Appendix: Additional Results and Summary Statistics for "The Age of Reason: Financial Decisions over the Life Cycle and Implications for Regulation"

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# 1 Summary Statistics

| Table 1: 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 2: 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 (FICO). 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 3: 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 4: 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 5: 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 |

| Table 6: Age Distribution by Product | | | | | |
|---|---|---|---|---|---|
| Product | Age Percentile | | | | |
| | 10% | 25% | 50% | 75% | 90% |
| Home Equity Loans | 34 | 40 | 48 | 59 | 71 |
| Home Equity Lines | 32 | 40 | 47 | 58 | 70 |
| "Eureka" | 24 | 34 | 44 | 53 | 63 |
| Credit Card | 25 | 34 | 44 | 57 | 68 |
| Auto Loans | 27 | 35 | 45 | 57 | 67 |
| Mortgage | 34 | 42 | 49 | 60 | 69 |
| Small Business Credit Card | 37 | 43 | 53 | 62 | 72 |
| Credit Card Late Fee | 25 | 35 | 45 | 58 | 67 |
| Credit Card Over Limit Fee | 26 | 34 | 43 | 56 | 65 |
| Credit Card Cash Advance Fee | 25 | 36 | 46 | 58 | 68 |

# 2 Regressions of APRs on Age and Other Characteristics

This section presents the regression results underlying the U-shaped plots in the paper.

## 2.1 Home Equity Loans and Lines of Credit

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 borrower-related variables observed by 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.[1]

[1]Note that although we include all observed variables on the borrower, R-squareds are not 100 percent. In part, this reflects the fact that bank loan pricing models also depend on other variables external to the borrower, such as the cost of funds. Banks may also reassess their lending standards, depending on macroeconomic or other factors. As long as such factors are not correlated with consumer age, the regression coefficients on age will correctly report the impact of age on APR. We have also formally tested this by including dummies for the month of loan origination in the regression, and found little difference in the results.

The measure of credit risk, the log of the FICO score, is statistically significant but with a negligible magnitude. Discussions with people who work in the industry reveal that financial institutions generally use the 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 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. [2]

Table 8 reports a regression of the APRs from home equity lines 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 on home equity loan APRs.

[2] We estimate three variants as a specification check. First, we allow the FICO scores, income, and LTV ratios to have quadratic and cubic terms. This allows us to make sure that the nonlinear effects with age that we see are not a consequence of omission of potential nonlinear effects of other control variables. Second and third, we allow the splines to have knot points at every five years, and have a dummy for each age, to ensure that the smoothing caused by the use of ten-year splines does not artificially create a U-shape. In all three cases, our results are not qualitatively or quantitatively changed.

| **Home Equity Loan APR** | | |
|---|---|---|
| | Coefficient | Std. Error |
| Intercept | 8.01105 | 0.1041 |
| Log(FICO Score) | -0.0021 | 0.0001 |
| Loan Purpose–Home Improvement | 0.0160 | 0.0136 |
| Loan Purpose–Rate Refinance | -0.0081 | 0.0113 |
| No First Mortgage | -0.1911 | 0.0097 |
| Log(Months at Address) | 0.0021 | 0.0039 |
| Second Home | 0.3870 | 0.0259 |
| Condominium | 0.4088 | 0.0165 |
| Log(Income) | -0.0636 | 0.0077 |
| Debt/Income | 0.0033 | 0.0002 |
| Log(Years on the Job) | -0.0242 | 0.0039 |
| Self Employed | 0.0104 | 0.0159 |
| Home Maker | -0.0330 | 0.0419 |
| Retired | 0.0350 | 0.0224 |
| Log(House Value) | 0.0010 | 0.0003 |
| Log(Loan Amount) | 0.0179 | 0.0059 |
| Age $< 30$ | -0.0542 | 0.0081 |
| Age 30-40 | -0.0334 | 0.0042 |
| Age 40-50 | -0.0125 | 0.0047 |
| Age 50-60 | 0.0100 | 0.0038 |
| Age 60-70 | 0.0173 | 0.0074 |
| Age $> 70$ | 0.0232 | 0.0102 |
| LTV 80-90 | 0.5583 | 0.0098 |
| LTV 90+ | 1.4982 | 0.0111 |
| State Dummies | YES | |
| Number of Observations | 16,683 | |
| Adjusted R-squared | 0.7938 | |

Table 7: 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).

| Home Equity Line of Credit APR | | |
|---|---|---|
| | Coefficient | Std. Error |
| Intercept | 7.8521 | 0.0567 |
| Log(FICO Score) | -0.0011 | <0.0001 |
| Loan Purpose–Home Improvement | 0.0543 | 0.0051 |
| Loan Purpose–Rate Refinance | -0.0384 | 0.0046 |
| No First Mortgage | -0.1480 | 0.0053 |
| Log(Months at Address) | -0.0159 | 0.0019 |
| Second Home | 0.3257 | 0.0131 |
| Condominium | 0.3929 | 0.0077 |
| Log(Income) | -0.1438 | 0.0037 |
| Debt/Income | 0.0044 | 0.0001 |
| Log(Years on the Job) | -0.0162 | 0.0020 |
| Self Employed | 0.0132 | 0.0071 |
| Home Maker | -0.0807 | 0.0211 |
| Retired | 0.0136 | 0.0107 |
| Log(House Value) | 0.0013 | 0.0004 |
| Log(Loan Amount) | 0.0156 | 0.0048 |
| Age $< 30$ | -0.0519 | 0.0049 |
| Age 30-40 | -0.0244 | 0.0023 |
| Age 40-50 | -0.0174 | 0.0022 |
| Age 50-60 | 0.0151 | 0.0034 |
| Age 60-70 | 0.0212 | 0.0062 |
| Age $> 70$ | 0.0284 | 0.0151 |
| LTV 80-90 | 0.4982 | 0.0049 |
| LTV 90+ | 1.6477 | 0.0079 |
| State Dummies | YES | |
| Number of Observations | 66,278 | |
| Adjusted R-squared | 0.6240 | |

Table 8: 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).

| **Propensity of ever experiencing a "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 | <0.0001 |
| 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 Degree | 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 9: 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.

### 2.2 "Eureka Moments"

Table 9 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)), fraction of education by category in the same zip code, gender, and log(income).[3]. 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 We do not directly observe education levels by borrower; we use ZCTA-level (Zip Code Tabulation Area) census data to compute the fraction of people by zip code in each education category (omitting the category of less than high-school education to avoid collinearity). The only statistically significant category is the fraction of adults with graduate degrees in the zip code, which has a positive effect on the probability of having a Eureka moment. The coefficients on the age spline imply that young adults and older adults are less likely to experience Eureka moments.

### 2.3 Credit Card APRs

Table 10 reports the results of regressing credit card APRs at account origination on a spline with age as its argument and other control variables. As controls, we again use information observed by the

[3] Although we report an OLS regression for ease in interpreting the coefficients, we have also run the regression as a logit and found similar results.

| Credit Card APR | | |
|---|---|---|
| | Coefficient | Std. Error |
| Intercept | 14.1393 | 3.0293 |
| Age $< 30$ | -0.0127 | 0.0065 |
| Age 30-40 | -0.0074 | 0.0045 |
| Age 40-50 | -0.0041 | 0.0045 |
| Age 50-60 | 0.0023 | 0.0059 |
| Age 60-70 | 0.0016 | 0.0183 |
| Age $> 70$ | 0.0016 | 0.0363 |
| Log(Income) | -0.0558 | 0.0801 |
| Log(FICO) | -0.0183 | 0.0015 |
| Total Number of Cards | 0.7715 | 0.7406 |
| Home Equity Balance | 0.0003 | 0.0022 |
| Mortgage Balance | -0.0000 | <0.0001 |
| Number of Observations | 92,278 | |
| Adjusted R-squared | 0.1124 | |

Table 10: 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, home equity debt balance and mortgage balance).

financial institution that may influence pricing. As before, we find that credit scores have 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.[4]

### 2.4 Auto Loans

Table 11 reports the results of regressing the APR paid for auto loans on an age-based spline and control variables. Here, FICO credit risk scores have a statistically and economically significant impact on loan terms–a one percent increase in FICO score reduces auto loan APRs by about 10 basis points. This may be a consequence of bank loan pricing models that take FICO scores as inputs. Higher incomes lower APRs and higher debt-to-income ratios raise them, though the magnitudes of the effects are small. 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, 2007)–though we note that the financial institutions do not directly condition their loans on such variables. We also include loan age and state dummies.

[4] An alternative specification including the total number of cards and total balance on cards yielded nearly identical results. Note that we are not able to include the financial institution's own internal credit score (also known as the behavior score), since that variable cannot be computed by the institution until the borrower's payment behavior is observed, and is thus unavailable at account opening.

| **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 11: 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).

| 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 | <0.0001 |
| Loan Amount | -0.0000 | <0.0001 |
| 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 12: 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.

## 2.5 Mortgages

Table 12 reports results of regressing the mortgage APR on an age-based spline and control variables. As controls, we again use variables observed by 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 30, then negative through age 60 and positive thereafter.

| 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) | $<$0.0001 | $<$0.0001 |
| Log(Total Card Limit) | $<$0.0001 | $<$0.0001 |
| Number of Observations | 11,254 | |
| Adjusted R-squared | 0.0933 | |

Table 13: 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).

### 2.6 Small Business Credit Cards

Table 13 reports the results of regressing the APR for small business credit cards on an age-based spline and control variables. As with individual credit card accounts, we control for the FICO score of the business owner, the total number of cards, card balance, and card limit. We also include dummy variables for the number of years the small business has been operating – we expect APRs to fall for businesses with longer operating histories. All control variables are statistically significant and have the expected sign, though only the dummies for years in business have substantial magnitudes.

### 2.7 Credit Card Fees

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 fees are assessed for use of services.

In the next three sections, we focus on three important types of fees: late fees, over limit fees, and cash advance fees.[5] We describe the fee structure for our dataset below.

[5] 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

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 payments to credit bureaus, adversely affecting consumers' FICO scores.[6] 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 between $30 and $35 – is assessed the first time the borrower exceeds his or her credit limit. Over limit violations generate penalty pricing that is analogous to the penalty pricing that is imposed as a result of late fees.[7]

3. **Cash Advance Fee**: A cash advance fee – which is 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. However, the APR on cash advances is typically greater than the APR on purchases, and is usually 16 percent or more.

Payment of these fees is not generally a mistake. For example, if a card holder is vacationing in Tibet, it may not be optimal to arrange a credit card payment for that month. However, payments of fees are sometimes mistakes, since the fee payment can often be avoided by small and relatively costless changes in behavior. For instance, late fees are sometimes due to memory lapses that could be avoided by putting a reminder in one's calendar.

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

Table 14 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 an age-based spline 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. Now we control for factors that might affect the propensity to pay a fee, which are not necessarily the same as factors 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 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,

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.

[6] The financial institution generally reports such information to credit bureaus and imposes penalty pricing after two months of late payment.

[7] As with the late fee, such penalty pricing is generally imposed after two months of exceeding the credit limit.

| | **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 | <0.0001 | -0.0002 | <0.0001 | -0.0002 | <0.0001 |
| Age 50-60 | -0.0002 | <0.0001 | -0.0002 | <0.0001 | -0.0003 | <0.0001 |
| Age 60-70 | 0.0004 | 0.0002 | 0.0003 | 0.0001 | 0.0004 | <0.0001 |
| Age $> 70$ | 0.0025 | 0.0013 | 0.0003 | 0.0001 | 0.0004 | <0.0001 |
| 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 14: 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, the dollar amount of purchases, and account- and time- fixed effects).

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.

## 3 Locating the Peak of Performance

We run the following regression, where $F$ is the outcome associated respectively with each of the 10 studies:

$$F = \alpha + \beta \times Spline(Age)_{Age \notin [40,60]} + \gamma \times Controls + \epsilon \\ + a \times Spline\,(Age)_{Age \in [40,60]} + b \cdot Spline\,(Age)^2_{Age \in [40,60]}\,. \tag{1}$$

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 40 and 60. Hence, for age between 40 and 60, the above formulation is implicitly quadratic in age:

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

The peak of performance is defined as the value that minimizes the above function:

$$Peak = -a/\,(2b)\,. \tag{2}$$

We calculate the asymptotic standard errors on $Peak$ using the delta method, so that the standard error of $Peak$ is the standard error associated with the linear combination:

$$-1/(2b) \cdot (\text{Coefficient on age}) + a/(2b^2) \cdot (\text{Coefficient on age})^2.$$

We next do a formal test for a peak effect. In regression (1), 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).[8] For criterion (ii), a peak in the 40-60 age range can not be rejected for all ten studies.

| Average Debt Levels by Age | | | |
|---|---|---|---|
| | Age | | |
| Product | 25 | 50 | 75 |
| Home Equity Loans | $38,879 | $46,057 | $36,601 |
| Home Equity Lines | $43,477 | $56,891 | $52,031 |
| Balance Transferred | $2,723 | $3,123 | $2,422 |
| Credit Card | $1,426 | $1,778 | $1,203 |
| Auto Loans | $3,782 | $4,031 | $3,554 |
| Mortgage | $40,645 | $47,337 | $41,403 |
| Small Business Credit Card | $1,321 | $1,479 | $1,275 |

Table 15: Average Debt Levels by Age

# 4 Average Debt Levels by Age

# 5 Additional Results on Possible Explanations for the U-Shaped Patterns

## 5.1 Age Effects

The measured age-related decline in analytic performance results from both age effects and cohort effects, but the available panel data implies that the decline is primarily driven by age effects (Salthouse, Schroeder, and Ferrer, 2004).[9] 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, and Agüero-Torres, 1999). There is a growing literature that identifies age-related changes in cognition (see Park and Schwarz, 1999; and Denburg, Tranel, and Bechara 2005).[10]

Specifically, suppose Analytic Capital declines linearly with age, so that Analytic Capital $= \alpha - age/\beta$. Suppose Experiential Capital is accumulated with diminishing returns: Experiential Capital $= \ln(age - \gamma\, age_0)$, where $age_0$ is the actual age at which people start using the product, and $\gamma\, age_0 < age_0$ is the effective age at which people start using the product (so $\gamma < 1$). The effective age is less than the actual age, since consumers get indirect experience (observation and advice) as a result of their interactions with other people who use the product. The additive model – Performance is equal to the sum of Analytic Capital and Experiential Capital – implies that peak performance occurs at $Peak = \beta + \gamma\, age_0$. Hence, peak performance is later when people start using the product later in life.

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

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

[10] Mather and Carstensen (2005) and Carstensen (2006) identify a different type of age-variation in cognitive preferences. Subjects with short time horizons or older ages attend to negative information relatively less than subjects with long time horizons or younger ages.

### 5.2 Selection Effects

The first three columns of data in Table 16 report a cross-tabulation from a 3 by 5 by 3 matrix. We cross an age-group (ages 25-35, 45-55 and 65-75), with a specific type of borrowing (with credit card balances, housing debt, home equity lines of credit, vehicle loans, and home equity loans), with a specific measure of sophistication (education, income, net worth). Each entry is a ratio of the median sophistication measure for a specific borrower group and age group, divided by the median sophistication measure for the corresponding (total) age group. Standard errors calculated through the delta method are in parentheses. Data is from the 2004 Survey of Consumer Finances (SCF).

| Ratio of Median Borrower Characteristics to Whole Group Characteristics By Age Group and Debt Type, 2004 SCF | | | | |
|---|---|---|---|---|
| | | Age Group | | |
| Debt Type | Characteristic | 25-35 | 45-55 | 65-75 |
| Credit Card Balance | Education | **1.00** | 1.00 | **1.00** |
| | | (0.01) | (<0.01) | (0.01) |
| | Income | **1.15** | 1.03 | **1.05** |
| | | (0.03) | (0.02) | (0.06) |
| | Net Worth | **1.14** | 0.91 | 0.58 |
| | | (0.11) | (0.04) | (0.05) |
| Housing Debt | Education | **1.07** | 1.00 | **1.08** |
| | | (0.01) | (0.01) | (0.01) |
| | Income | **1.45** | 1.26 | **1.42** |
| | | (0.04) | (0.03) | (0.05) |
| | Net Worth | **3.39** | 1.53 | 1.08 |
| | | (0.26) | (0.06) | (0.09) |
| Home Equity Lines of Credit | Education | 1.07 | 1.14 | 1.08 |
| | | (0.04) | (0.01) | (0.03) |
| | Income | **1.95** | 1.39 | **1.65** |
| | | (0.10) | (0.04) | (0.12) |
| | Net Worth | **5.48** | 2.45 | 1.99 |
| | | (0.55) | (0.23) | (0.24) |
| Home Equity Loans | Education | 0.86 | 1.00 | **1.33** |
| | | (0.18) | (0.02) | (0.05) |
| | Income | 0.68 | 0.86 | **1.48** |
| | | (0.02) | (0.03) | (0.17) |
| | Net Worth | 0.37 | 1.41 | **1.97** |
| | | (4.51) | (0.23) | (0.12) |
| Vehicle Loans | Education | **1.00** | 1.00 | **1.00** |
| | | (0.01) | (<0.01) | (<0.01) |
| | Income | **1.33** | 1.18 | **1.45** |
| | | (0.03) | (0.02) | (0.07) |
| | Net Worth | **1.54** | 1.11 | 0.78 |
| | | (0.13) | (0.06) | (0.06) |
| *Memo* | *% with Debt* | 81 | 83 | 53 |
| | *Median Debt* | $61,800 | $81,800 | $23,100 |

Table 17: Each entry in this table reports the ratio of the median value of a borrower characteristic within an age group to the median value of the characteristic for all members of that age group. The last two rows report the fraction by age group with debt and the median amount of debt.

Adverse selection will show up as *lower* ratios for younger and older borrowers compared to middle-aged borrowers. In other words, adverse selection is present when the ratios of medians in the first and third columns are *lower* than the ratio of medians in the second column. In contrast, entries in bold *reverse* this pattern; that is, the bold entries are the ones for which sample selection is advantageous and not adverse. Over seventy percent of the ratios for the 25-35-year-olds are greater than the comparable ratios for the 45-55-year-olds, suggesting that selection tends to generates an advantage for younger borrowers relative to middle-aged borrowers.

Likewise, two-thirds of the ratios for the 65-75-year-olds are greater than the comparable ratios for the 45-55-year-olds. Older borrowers consistently display relatively advantageous selection on education and income compared to middle-aged borrowers. Net worth represents an exception to this pattern, implying that older borrowers are adversely selected for net worth compared to middle-aged borrowers. However, there is one exception to this exception. Older borrowers with home equity lines of credit have advantageous selection for net worth, consistent with the findings of Canner, Durkin and Luckett (1998).

The last two rows of the table report, the fraction of borrowers by age group having any debt and the median value of debt (conditional on having any). These rows show that, although the fraction of households having debt and the median level of debt both fall sharply from ages 45-55 to ages 65-75, over half of older households still have debt, and have a substantial amount of it.

The next table reports comparable results for the 1989, 1998, and 2001 SCFs.

| Ratio of Median Borrower Characteristics to Whole Group Characteristics By Age Group and Debt Type | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SCF | 1989 | | | 1998 | | | 2001 | | |
| Debt | | Age Group | | | Age Group | | | Age Group | | |
| Type | Char. | 25-35 | 45-55 | 65-75 | 25-35 | 45-55 | 65-75 | 25-35 | 45-55 | 65-75 |
| | Educ. | 1.00 | 1.08 | 1.00 | 1.08 | 1.00 | 1.00 | 1.08 | 0.93 | 1.00 |
| Credit | | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) | (0.02) | (0.01) | (0.01) | (0.01) |
| Card | Inc. | 1.33 | 1.14 | 0.88 | 1.21 | 1.02 | 0.96 | 1.10 | 0.98 | 1.00 |
| Balance | | (0.04) | (0.03) | (0.06) | (0.03) | (0.02) | (0.01) | (0.30) | (0.27) | (0.05) |
| | Net | 1.69 | 1.08 | 0.56 | 1.53 | 0.91 | 0.61 | 1.06 | 0.77 | 0.59 |
| | Worth | (0.19) | (0.05) | (0.04) | (0.12) | (0.04) | (0.03) | (0.09) | (0.04) | (0.06) |
| | Educ. | 1.00 | 1.08 | 1.00 | 1.08 | 1.00 | 1.08 | 1.08 | 1.00 | 1.08 |
| | | (0.01) | (0.01) | (0.02) | (0.01) | (0.01) | (0.02) | (0.01) | (<0.01) | (0.01) |
| Housing | Inc. | 1.54 | 1.31 | 1.25 | 1.45 | 1.28 | 1.76 | 1.44 | 1.34 | 1.56 |
| Debt | | (0.05) | (0.03) | (0.04) | (0.04) | (0.02) | (0.08) | (0.04) | (0.03) | (0.09) |
| | Net | 4.41 | 1.45 | 0.98 | 2.91 | 1.63 | 1.11 | 3.32 | 1.47 | 1.12 |
| | Worth | (0.39) | (0.06) | (0.14) | (0.21) | (0.07) | (0.07) | (0.26) | (0.06) | (0.12) |
| | Educ. | 1.00 | 1.17 | 1.17 | 1.15 | 1.14 | 1.33 | 1.08 | 1.08 | 1.00 |
| Home | | (0.01) | (0.03) | (0.07) | (0.02) | (0.02) | (0.05) | (0.05) | (0.12) | (0.04) |
| Equity | Inc. | 2.83 | 1.83 | 1.31 | 2.06 | 1.40 | 1.91 | 1.93 | 1.56 | 2.22 |
| Lines | | (0.13) | (0.17) | (0.03) | (0.09) | (0.06) | (0.10) | (0.14) | (0.05) | (0.28) |
| of | Net | 11.10 | 1.84 | 3.68 | 6.09 | 1.66 | 6.35 | 6.59 | 2.06 | 2.15 |
| Credit | Worth | (0.81) | (0.12) | (0.75) | (0.50) | (0.10) | (0.25) | (0.94) | (0.16) | (0.17) |
| | Educ. | 0.92 | 1.00 | 0.92 | 1.23 | 0.93 | 1.00 | 1.23 | 0.93 | 1.33 |
| | | (0.08) | (0.04) | (0.05) | (0.09) | (0.02) | (0.06) | (0.01) | (0.03) | (0.01) |
| Home | Inc. | 1.38 | 1.14 | 1.25 | 2.27 | 1.26 | 1.57 | 1.00 | 1.29 | 0.78 |
| Equity | | (0.05) | (0.15) | (0.17) | (0.34) | (0.04) | (0.30) | (0.10) | (0.35) | (0.40) |
| Loans | Net | 15.40 | 3.22 | 0.54 | 5.85 | 1.76 | 0.84 | 1.83 | 2.65 | 0.79 |
| | Worth | (2.64) | (0.31) | (0.07) | (3.40) | (0.05) | (0.14) | (0.40) | (0.31) | (0.65) |
| | Educ. | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.08 | 1.08 | 1.00 |
| | | (0.01) | (0.01) | (0.02) | (0.01) | (0.01) | (<0.01) | (0.01) | (0.03) | (0.01) |
| Vehicle | Inc. | 1.38 | 1.15 | 1.31 | 1.21 | 1.10 | 1.30 | 1.28 | 1.15 | 1.26 |
| Loans | | (0.04) | (0.03) | (0.04) | (0.03) | (0.03) | (0.09) | (0.03) | (0.03) | (0.08) |
| | Net | 1.98 | 1.02 | 0.64 | 1.50 | 0.95 | 0.76 | 1.60 | 1.02 | 0.83 |
| | Worth | (0.20) | (0.05) | (0.04) | (0.13) | (0.04) | (0.06) | (0.14) | (0.05) | (0.12) |

Table 18: Each entry in this table reports the ratio of the median value of a borrower characteristic within an age group to the median value of the characteristic for all members of that age group.

### 5.2.1 Incorporating Sample Selection Information into the Regressions of APR and Fees on Age

We use these ratios to construct three indicator variables for changing financial sophistication of the pool of borrowers. For each type of borrowing in Table 16, define $R_i^{educ}$, $R_i^{inc}$, and $R_i^{netw}$ to be the ratio of borrower to non-borrower characteristics corresponding to borrower $i$'s age group for education, income, and net worth, respectively. For example, a 33-year-old home equity line of credit borrower would have $R_i^{educ} = 1.07$, $R_i^{inc} = 1.95$, and $R_i^{netw} = 5.48$. Then define $Z_i^{educ} = R_i^{educ}/R_{45-55}^{educ}$, $Z_i^{inc} = R_i^{inc}/R_{45-55}^{inc}$, and $Z_i^{netw} = R_i^{netw}/R_{45-55}^{netw}$. The $Z$ variables normalize each of the $R$ variables by the peer-group ratio of 45-55-year-olds. Thus, for a 33-year-old home equity line of credit borrower, $Z_i^{educ} = 1.07/1.14 = 0.94$, $Z_i^{inc} = 1.95/1.39 = 1.40$, and $Z_i^{netw} = 5.48/2.45 = 2.24$.

The $Z$ variables are intended to capture potential deterioration in the borrower pool by age, using borrowers age 45-55 as a baseline. If for a borrower a $Z$ variable is greater than one, that means, at that borrower's age and for that characteristic, borrowers generally have better characteristics relative to non-borrowers than is the case for 45-55-year-olds. The converse is true if $Z < 1$.

Since we have more than one indicator of deterioration in the borrower pool, and all indicators are potentially noisy, we assume that each $Z$ variable depends on both an unobserved (or latent) measure of borrower pool deterioration $D$ and the set of $Controls$ included in equation **??**, and augment the latter with $D$. Thus, the full system of equations is:

$$
\begin{aligned}
F &= \alpha + \beta \times Spline(Age) + \gamma \times Controls + \theta \times D + \epsilon \\
Z^{educ} &= \lambda^{educ} \times Controls + \delta^{educ} \times D + \nu^{educ} \\
Z^{inc} &= \lambda^{inc} \times Controls + \delta^{inc} \times D + \nu^{inc} \\
Z^{netw} &= \lambda^{netw} \times Controls + \delta^{netw} \times D + \nu^{netw},
\end{aligned}
$$

where the error terms are assumed to be uncorrelated with each other. If sample selection is driving the results, we would expect the coefficient $\beta$ on $Spline(Age)$ in the first equation to be zero and the coefficient $\theta$ on the unobserved pool deterioration variable $D$ to be negative.

Note that an alternative way to proceed would be to directly put one of the $Z$ variables into the first equation instead of $D$ and use the other two $Z$ variables as instruments (as discussed in Wooldridge 2007 and Griliches 1977). That approach, although consistent, is not efficient and has the disadvantage of requiring one to choose which variable goes into the regression and which to serve as instruments–in this case, three possibilities. The latent variable approach described above is both consistent and efficient and represents the optimal combination of instrumental variable estimates.

We estimate the latent variable model for all four types of borrowing for which we have SCF data–home equity loans, home equity lines of credit, credit cards, and auto loans– via maximum likelihood, using the SAS TCALIS procedure. For brevity, we present the results just for home equity loans; results for other types of lending are qualitatively similar. Estimates for the main equation are presented in Table 19.

Note that the estimate for the coefficient on $D$ is negative and statistically insignificant. Moreover, the point estimate is not large enough to explain the large differences in APRs that we observe for younger and older borrowers. This analysis does not support the idea that deterioration in the pool of borrowers by age is an important driver of the U-shape patterns we see.

| **Home Equity Loan APR** | | |
|---|---|---|
| | Coefficient | Std. Error |
| Intercept | 7.5822 | 0.1236 |
| Log(FICO Score) | -0.0017 | 0.0006 |
| Loan Purpose–Home Improvement | 0.0148 | 0.0116 |
| Loan Purpose–Rate Refinance | -0.0068 | 0.0100 |
| No First Mortgage | -0.1680 | 0.0090 |
| Log(Months at Address) | 0.0019 | 0.0037 |
| Second Home | 0.3188 | 0.0221 |
| Condominium | 0.3633 | 0.0149 |
| Log(Income) | -0.0605 | 0.0066 |
| Debt/Income | 0.0033 | 0.0002 |
| Log(Years on the Job) | -0.0211 | 0.0038 |
| Self Employed | 0.0088 | 0.0149 |
| Home Maker | -0.0315 | 0.0362 |
| Retired | 0.0315 | 0.0210 |
| Age $< 30$ | -0.0461 | 0.0073 |
| Age 30-40 | -0.0280 | 0.0039 |
| Age 40-50 | -0.0111 | 0.0041 |
| Age 50-60 | 0.0087 | 0.0033 |
| Age 60-70 | 0.0160 | 0.0066 |
| Age $> 70$ | 0.0207 | 0.0087 |
| LTV 80-90 | 0.5453 | 0.0094 |
| LTV 90+ | 1.4697 | 0.0108 |
| Log(House Value) | 0.0009 | 0.0002 |
| Log(Loan Amount) | 0.0176 | 0.0057 |
| $D$ | -0.2121 | 0.2644 |
| State Dummies | YES | |
| Number of Observations | 16,683 | |

Table 19: 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), 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), and a latent variable D for deterioration of the pool of borrowers.

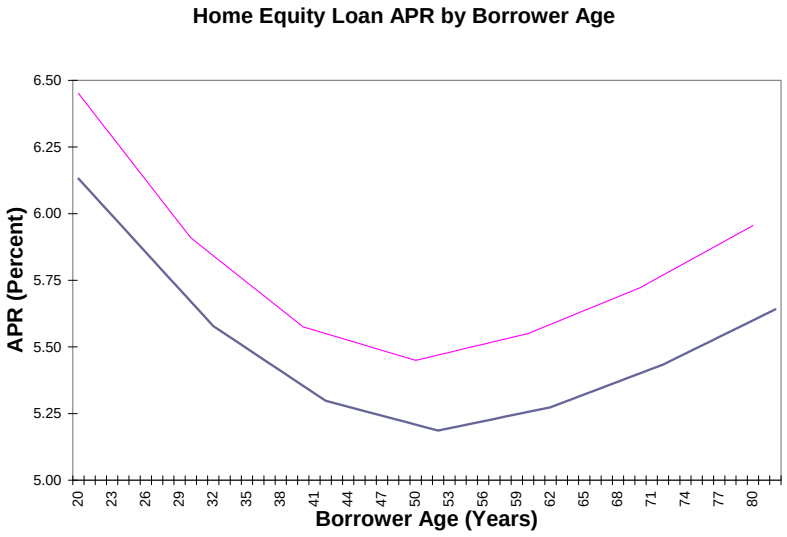


Figure 1: This figure plots fitted values of two regression of home equity loan APRs on a spline for age, with other controls. The darker line plots estimates for a four-equation model with a latent variable for deterioration in the pool of borrowers, as described in the text. The lighter line plots estimates without that latent variable.

Figure 1 plots the new fitted values for the age spline along with the old fitted values for the age splines. Both sets of fitted values display nearly the same pattern–which was to be expected, since the SCF ratios generally showed that the pools of relatively young and old borrowers generally had better levels of education, income, and net worth relative to their peers than the pool of middle-aged borrowers.

Taken as a whole, these results suggest that borrowers are generally better-educated, have higher income, and are wealthier than non-borrowers; older borrowers have higher levels of education and income, but lower net worth levels, relative to their peers than do middle-aged borrowers; and younger borrowers have higher education, income, and net worth levels relative to their peers than do middle-aged borrowers These results do not offer support to the idea that differential adverse selection in the borrowing pool by age is responsible for the U-shapes by age that we see; indeed, many of the results appear to go in the opposite direction.

### 5.2.2 Comparing Characteristics by Race

Another potential explanation for the U-shape patterns in APRs and fees is that they may reflect a combination of discrimination and a U-shape in the fraction of borrowers by racial group. If banks charge higher rates to African Americans, and larger fractions of younger borrowers and older borrowers are African American, we would expect to see rates for younger and older borrowers to be higher than middle-aged borrowers.

Table 20 uses SCF data to compute the racial composition of borrowers by borrowing category and

| Racial Composition of Borrowers, by Borrowing Category and Age Group (SCF) | | | | | |
|---|---|---|---|---|---|
| | Age Group | White | African American | Hispanic | Other |
| Credit Card | 25-35 | 66.6 | 17.3 | 12.6 | 3.6 |
| | 45-55 | 72.9 | 12.8 | 8.2 | 6.1 |
| | 65-75 | 81.8 | 12.8 | 4.7 | 0.8 |
| Home Equity Line of Credit | 25-35 | 93.8 | 0 | 3.1 | 3.1 |
| | 45-55 | 92.2 | 2.1 | 2.1 | 3.6 |
| | 65-75 | 88.6 | 6.8 | 4.6 | 0 |
| Home Equity Loan | 25-35 | 66.7 | 0 | 33.3 | 0 |
| | 45-55 | 90.5 | 4.8 | 4.8 | 0 |
| | 65-75 | 100 | 0 | 0 | 0 |
| Vehicle Loan | 25-35 | 71.8 | 15.4 | 9.0 | 3.8 |
| | 45-55 | 78.7 | 9.7 | 6.4 | 5.3 |
| | 65-75 | 88.2 | 7.0 | 4.8 | 0 |

Table 20: Each entry gives the fraction of borrowers within the given age group and borrowing category by race.

age group. In no case does the fraction of non-white borrowers show a U-shape by age. Moreover, the changes that we do observe are relatively small in magnitude.[11]

### 5.2.3 Comparing Older Adults to Younger Adults in Our Sample

As an alternative approach to evaluating the importance of selection effects, we ask whether the older adults in our sample have comparable socio-economic characteristics to the other adults in our sample. Figure 2 shows that credit-worthiness (FICO) scores on home equity loans and lines show a U-shape by age distribution. In other words, older and younger borrowers in our sample, are less risky than middle-aged borrowers in our sample. Figure 3 shows that LTV ratios decline substantially with age, indicating that older borrowers in our sample are devoting a relatively smaller fraction of their assets to servicing home equity loans and lines. Likewise, Appendix Table A9 shows that debt levels rise from age 25 to 50 and then decline to age 75.[12] Finally below, we report that default rates are *lower* for older borrowers in our sample relative to younger borrowers. These analyses suggest that the older borrowers in our sample compare favorably (in terms of risk characteristics) to the other borrowers in our sample.

We also find that average income for home equity loan borrowers rises from $76,000 for those aged less than 30, and about the same to those between 30 and 40 to a peak of $88,500 for those between 40 and 50, and then declines to about $69,000 for those between 60 and 70 and $62,000 for those over 70. These relative income levels are consistent with the pattern of earnings measured in studies of representative populations of US households (e.g. Gourinchas and Parker, 2002).

[11] For a five percentage point change in sample composition to explain a 75 basis point increase, for example, discrimination would have to increase borrowing costs by about $\frac{75}{0.05} = 1500$ basis points.

[12] In comparing the debt levels with those from survey data, one should bear in mind that these data, from the lender, may be higher than those reported by individuals. Gross and Souleles (2002a, 2002b) document the under-reporting of credit card debt by individuals.

All in all, the characteristics that we observe do not point to strong negative selection effects for the older adults in our sample. This is probably due to the fact that our sample only includes *prime* borrowers, and is thus truncated in a way that reduces some selection effects that might otherwise arise. In our sample average FICO score levels are much higher than those for the population as a whole; default rates are lower; and income levels are higher.

Figure 4 shows the results of re-estimating the regressions for home equity loans and lines of credit, now dropping data on all borrowers over the age of 60. There is less reason to believe that the pool of borrowers below 60 are subject to sample selection problems. The results still show a U-shape, albeit somewhat less pronounced.[13]

In principle, an additional way to attempt to determine how selection effects affect our results would be to compare debt levels in our data to those in the SCF. However, this approach has two difficulties which make comparisons difficult. First, our data only captures borrowing from one financial institution. This is important for some categories, such as credit cards, in which consumers may borrow from several different institutions. This effect suggests that our data should understate the total amount of borrowing. Second, Gross and Souleles (2002) and Zinman (2007) have documented that the SCF and other self-reported surveys tend to greatly understate their amount of debt (by a factor of three or more). This effect suggests that our data should overstate the total amount of borrowing. In practice, the first effect appears to dominate: for example, in the 2001 SCF, average credit card debt holdings, conditional on having debt, by 70-79-year-olds is $3,471, while for our sample for 75-year olds the comparable number is $1,203. Thus while our data show relatively little debt holding by the relatively old, conditional on having debt, those figures may be a consequence of having access to data from only one financial institution.

### 5.3 Cohort Effects

Figures 5 and 6 plot the residual effects of age on home equity line and loan APR for female and male borrowers, respectively. Both show a U-shaped pattern by age, with no substantive difference between the two groups.. Figures 7 and 8 replicate the plots of the fitted values of the effects of age on APR for this earlier dataset. Both plots show the same U-shape, with the minimum in the early 50s (like our results using *later* cross-sections). If our findings were driven by cohort effects, the U-shape should not reproduce itself in cross-sections from different years.

### 5.4 Default Risk

The figure below plots the effects of borrower age on default frequency, after controlling for other observable characteristics.

[13] This graph also reinforces the arguments above that potential higher riskiness of borrowers above age 60 is likely not responsible for the results.

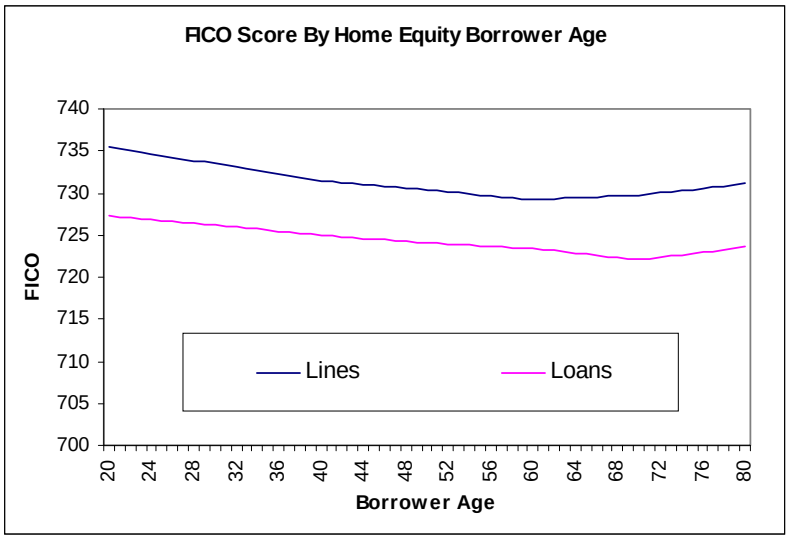


Figure 2: This figure plots the FICO (credit-worthiness) scores of home equity loan and line of credit borrowers by age. A high FICO score means a high credit-worthiness.

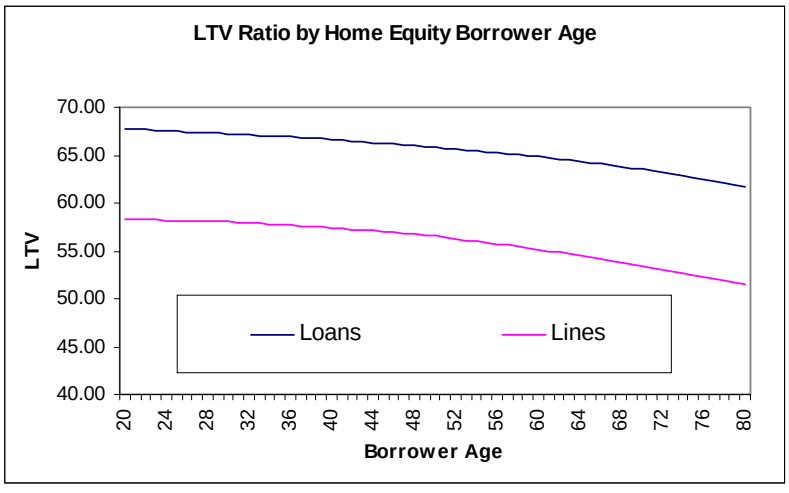


Figure 3: This figure plots the loan-to-value (LTV) ratio of home equity loan and line of credit borrowers by borrower age.

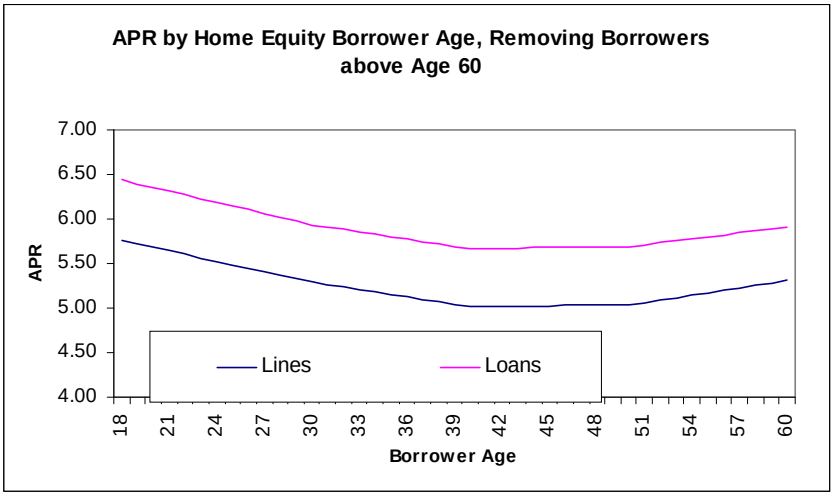


Figure 4: This figure plots the residual effect of age on home equity loan and line APRs, after controlling for other observable characteristics, such as log(income) and credit-worthiness. Observations on borrowers over age 60 have been dropped.

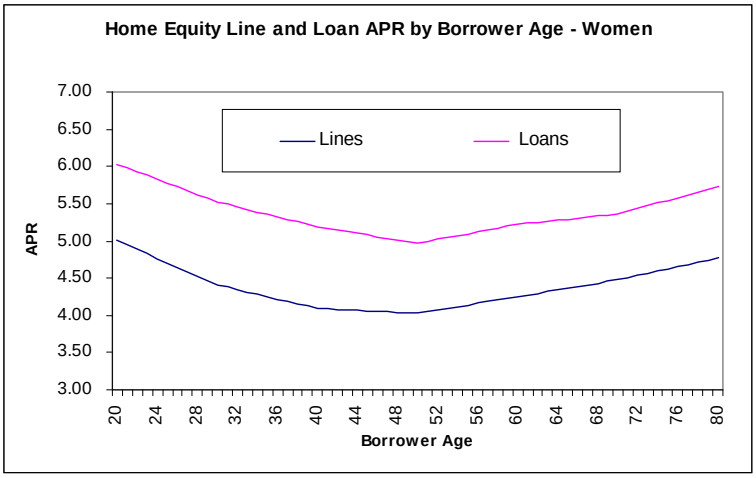


Figure 5: This figure plots the residual effect of age on home equity loan and line APRs for women, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

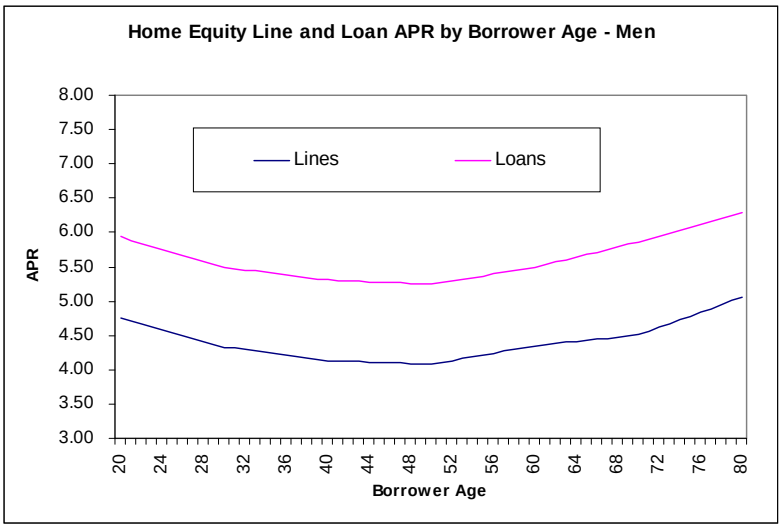


Figure 6: This figure plots the residual effect of age on home equity loan and line APRs for men, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

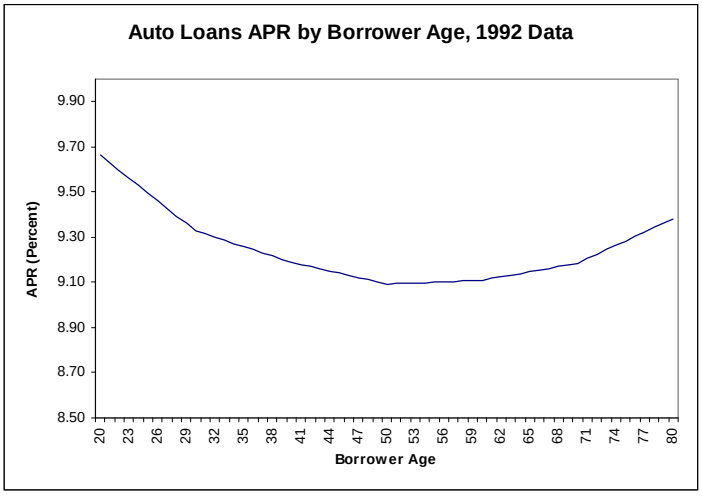


Figure 7: Auto loan APR by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness. Data is from 1992.

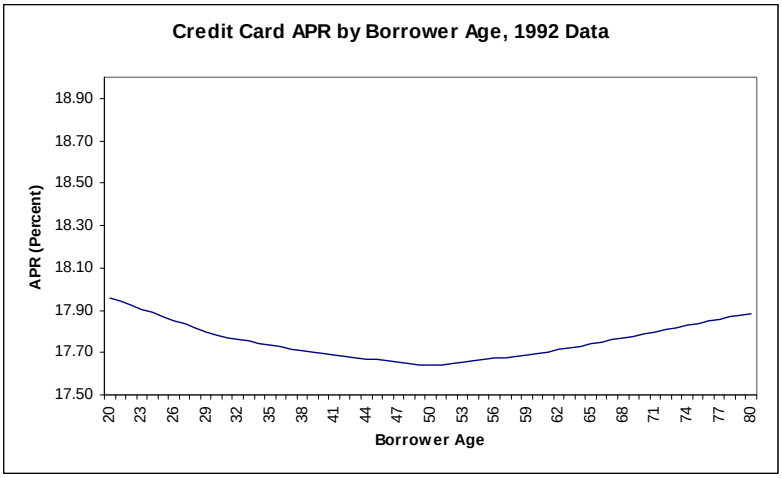


Figure 8: Credit card APR by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness. Data is from 1992.

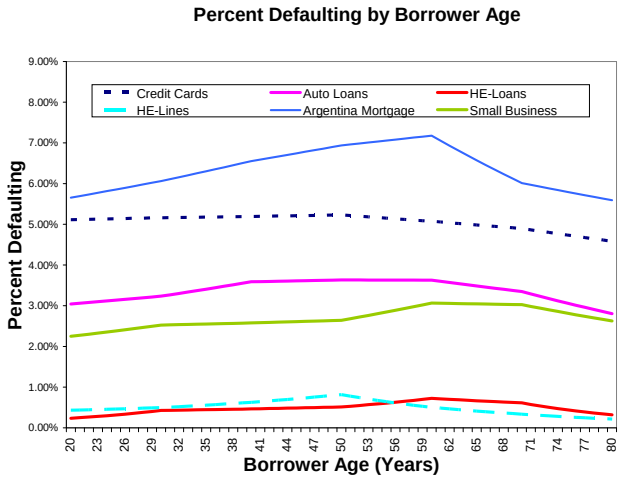


Figure 9: Default frequency by borrower age. The figure plots the residual effect of age, after controlling for other observable characteristics, such as log(income) and credit-worthiness.

### 5.5 Opportunity Cost

The tables below provide results from two special questions in the 2007 Survey of Consumer Finances (SCF). The first question asks about shopping intensity for decisions about borrowing money or obtaining credit. At younger ages, the vast majority of respondents report doing a moderate or a great deal amount of shopping about borrowing decisions. Through age group 45-54, roughly 15 percent report doing almost no shopping. That latter percentage then increases rapidly, to 20 percent for 55-64-year-olds, 30 percent for 65-74-year-olds, and about 45 percent for those 75 and older. It appears that older adults are not using whatever extra time that they may have by virture of being retired to more intensively shop for borrowing decisions.

**Table 21: Shopping Intensity for Borrowing Decisions**

| | Intensity of Shopping (% reporting) | | |
|---|---|---|---|
| Age | A Great Deal | Moderate | Almost None |
| Less than 35 | 24 | 61 | 15 |
| 35-44 | 28 | 58 | 13 |
| 45-54 | 25 | 60 | 15 |
| 55-64 | 27 | 53 | 21 |
| 65-74 | 24 | 46 | 30 |
| 75 or More | 15 | 39 | 46 |

The second question asks about sources of information used in making borrowing decisions. We again report results by age group in the table below.[14] Respondents were asked to check all sources that applied; hence totals do not sum to 100. The data seem to show two types of patterns by age. Some sources of information show an inverse U-shape in usage by age–for example, both the relatively young and the relatively old use financial planners, financial professionals, magazines, and newspapers less than the middle-aged. Other sources of information show a decline by age; for example, about 60 percent of borrowers younger than 65 use friends at work for information, while about 30 percent of 65-74-year-olds and borrowers aged 75 or more use this source of information. Overall, borrowers age 65-74 and 75 and above appear to use fewer sources of all types of information than do borrowers at younger ages. Also note that although the fraction of respondents reporting they do not borrow rises substantial for borrowers at 65-74 and 75 and older, over 70 percent of respondents in the latter category are still borrowing (consistent with some of the results reported above).

[14] Definitions: "Financial Planner" is a lawyer, accountant, or financial planner; "Financial Professional" is a banker, broker, real estate broker, builder, dealer, or insurance agent; "Friend at Work" refers to friends or material from work or business contacts; "Internet" refers to internet or online services; "Magazine or Newspaper" refers to magazines, newspapers, or books; "Mail" refers to material in the mail, TV, radio, or other advertisements, or telemarkets; "Call Around" means the borrower reporting calling around for information; and "Self" means the respondent reported relying on themselves, shopping around, or doing other personal research.

| Table 22: Sources of Information Used for Borrowing Decisions | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Information Source (% reporting) | | | | | | | | |
| Age | Fin. Planner | Fin. Prof. | Friend at Work | Internet | Mag. or News. | Mail | Call Around | Self | Don't Borrow |
| Less than 35 | 17 | 33 | 61 | 53 | 17 | 38 | 36 | 4 | 5 |
| 35-44 | 19 | 39 | 51 | 49 | 20 | 40 | 40 | 5 | 6 |
| 45-54 | 20 | 41 | 46 | 43 | 24 | 40 | 36 | 7 | 6 |
| 55-64 | 23 | 45 | 40 | 34 | 24 | 40 | 34 | 6 | 8 |
| 65-74 | 20 | 42 | 31 | 19 | 18 | 29 | 30 | 7 | 17 |
| 75 or More | 17 | 38 | 31 | 4 | 13 | 16 | 15 | 2 | 28 |