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Old Age and the Decline in Financial Literacy

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Abstract. Households age 60 and older bear increasing responsibility for managing retirement portfolios, and they hold the majority of financial assets in the United States. Cognitive aging studies find evidence of a decline in fluid and crystallized intelligence in old age that may impact the ability to manage money effectively. Using a large sample of older respondents, we test whether knowledge of basic concepts essential to effective financial choice declines after age 60. We find a consistent linear decline in financial literacy score after age 60. A nearly identical rate of decline among men, stockowners, older, and college-educated respondents indicates that cohort effects are not driving the results. Confidence in financial decision-making abilities does not decline with age. A separate analysis using data that include measures of cognitive ability suggests that a natural decline in both fluid and crystallized intelligence in old age contributes to falling financial literacy scores.

History: Accepted by Brad Barber, finance.

Keywords: financial literacy • cognitive ability • household finance • aging • retirement

1. Introduction

Households age 60 and over hold 51% of all financial wealth in the United States.¹ Day (2010) predicts that the proportion of U.S. households over the age of 60 will increase as the baby boom cohort and greater longevity contribute to population aging. The transition to defined contribution plans tasks older Americans with greater responsibility for managing their own retirement assets and employing distribution strategies (Butrica et al. 2009). Despite the importance of sound financial decision making among older Americans, little is known about either the magnitude of financial literacy decline in old age or about possible cognitive drivers of decision-making quality.

Our study adds to the existing literature on financial decision making and age, which we review in detail in the next section, by estimating the actual rate of decline in financial knowledge and measuring the decline within subgroups to address possible cohort biases. We also estimate the relation between the decline in fluid and crystallized intelligence and financial literacy scores, and investigate whether age-related financial literacy declines can affect financial decision-making quality. Studies that provide evidence of a decline in investment performance with advanced age (Korniotis and Kumar 2011) and in credit decision making (Agarwal et al. 2009) do not directly estimate the decline in financial literacy that may be driving reduced performance in decision-making ability. These performance studies also do not use data that allow them to accurately control for important demographic characteristics such as gender, race, and education that

may influence observed behavior through differences in mortality rates or cohort differences in human capital investment. We extend the analysis of Lusardi et al. (2014) by using a much larger population of older households that allows subgroup analyses to address cohort and gender biases and more precisely measure the rate of decline. In addition, we provide evidence that older individuals are not aware of the decline in their financial decision-making ability, and that the well-established erosion of cognitive performance in advanced age contributes to the decline in financial literacy.

We use a new financial literacy assessment instrument inserted into the Consumer Finance Monthly (CFM), a nationally representative monthly survey of credit behaviors, and obtain a sample of 3,873 respondents over age 60. The financial literacy score is composed of four questions, each within the topic areas of basic financial concepts, insurance, investments, and credit knowledge. This unique instrument allows us to assess total financial literacy as well as more specific knowledge in financial topic areas. Financial literacy may be lower among older cohorts because of less investing experience in the pre-401(k) era, because women generally outlive men and may have delegated financial decisions to husbands, or because levels of higher education were lower for older cohorts. We estimate performance among domains and focus on insurance knowledge because rates of insurance ownership are higher among older cohorts. Our large sample size allows us to estimate the decline in financial literacy scores among college graduates, stockowners,

men, and cohorts who reached age 60 before the rise in 401(k) popularity.

The survey also includes a self-assessed measure of confidence within each of the four financial literacy domains, and we estimate whether confidence declines with age and whether those with lower financial literacy have lower confidence. To identify possible cohort knowledge biases among topic areas, we estimate whether financial literacy declines with age for each of the 16 questions. The Health and Retirement Study contains measures of both fluid and crystallized intelligence and a special module that contains a series of financial knowledge questions. We use the financial literacy instrument to test whether age-related changes in cognition are associated with a decline in literacy scores.

We find a consistent linear decline in financial literacy scores after age 60 and a monotonic decline in scores among five-year cohorts in the CFM data. Performance on all 16 questions declines significantly with age. The annual rate of decline in financial literacy scores is significant and similar among all subgroup analyses of men, stockowners, those with a college degree, and respondents who were 60 or older by 1992. The magnitude of age-related decline in scores is nearly identical among all four financial topic areas, including insurance. Confidence in one's ability to make financial decisions does not decline in old age and increases significantly for insurance. Age is positively related to financial overconfidence measured as the distance between objective literacy score and subjective financial confidence.

We turn to data from the Health and Retirement Study (HRS) to investigate whether the decline in financial literacy in old age can be traced to the deterioration in fluid and crystallized intelligence. The 2010 HRS contains a module that asks financial literacy questions and a cognition module that includes established measures of fluid and crystallized intelligence. Using data from the HRS, we confirm a decline in lower financial literacy scores in old age and find evidence that the gradual deterioration of fluid and crystallized intelligence contributes to reduce financial literacy.

2. Literature Review

There is evidence that financial decision-making ability declines in old age. Agarwal et al. (2009) show that the quality of credit decisions among borrowers erodes after peaking in the mid-50s. Despite evidence of improved general investment skill with age, investment performance declines significantly after age 70 (Korniotis and Kumar 2011). Decision-making skills closely related to financial literacy such as the reliance on decision rules and resistance to framing decline in old age (de Bruin et al. 2012). Hibbard et al. (2001) find that Medicare beneficiaries are nearly three times

more likely than younger subjects to make errors when interpreting health plan information despite having more experience. Choi et al. (2014) find that lower economic decision-making quality by respondents older than age 65 results in a predicted welfare loss of 5.1 percentage points.

The observed decline in financial decision-making quality may be related to gradual mild cognitive impairment that occurs in old age. Boyle et al. (2012) find that the rate of cognitive decline in a sample of older adults is a significant predictor of incorrect responses to a financial decision-making test and increases susceptibility to financial scams. Older financial decision makers who experience a sharper decline in cognition report an increased difficulty in managing their money (Hsu and Willis 2013). Cognitive ability, and in particular mathematical skills of the primary financial decision maker, is a strong predictor of the ability to avoid depleting net worth in later life (Smith et al. 2010) and in making fewer financial mistakes (Agarwal and Mazumder 2013). Cognitive processing ability and memory scores predict financial literacy and health knowledge scores among the elderly (Bennett et al. 2012).

Horn and Cattell (1967) attribute the declining performance on mathematical or spatial reasoning tasks after young adulthood and improved performance on tasks that require experience and knowledge to the theory of fluid and crystallized intelligence. Large cross-sectional analyses of performance on decision-making tests such as word recall are indeed highest for respondents in their 20s and decline gradually through middle age before falling sharply after age 60, but scores on vocabulary tasks such as the ability to produce a synonym peak late in life and begin to fall after age 60 (Salthouse 2009). Fluid intelligence decline appears to be the result of a general slowing in cognitive processing ability (Bugg et al. 2006) that has been linked to physiological changes such as a decline in frontal lobe volume after age 50 (DeCarli et al. 2005, Rushton and Ankney 2009).

The U.S. Financial Literacy and Education Commission defines financial literacy as "the ability to use knowledge and skills to manage financial resources effectively for lifetime financial security" (Huston 2010, p. 311). Effective management of financial resources requires an understanding of terminology, for example a deductible on an insurance policy or the characteristics of a mutual fund, and the ability to comprehend how a higher deductible lowers an insurance premium or how greater diversification is a benefit of a mutual fund. Studies on information retrieval indicate that the ability to recognize terms may not decline in old age, but there is evidence that interpretation and general problem-solving capability deteriorates. For example,

Salthouse (2010) finds no significant decline in subjects' ability to solve crossword puzzles after age 60. Performance on more complex tasks that require the ability to retrieve information and use that information to solve a problem appears to worsen in old age. The ability to complete everyday tasks, for example to read and interpret instructions on a medicine bottle or interpret a rate chart on a telephone bill, decreases after age 60 (Diehl et al. 1995). De Bruin et al. (2012) find that decreasing scores on fluid cognitive ability tests in old age contribute to the decline in performance on decisions that require both problem solving and accumulated knowledge. The ability to retrieve financial terms may or may not decline with age, but the ability to make an appropriate financial choice is particularly vulnerable to the age-related decline in reasoning skills.

Previous studies suggest a possible decline in financial literacy in old age. Lusardi et al. (2014) identify differences in financial sophistication among older respondents in a subsample of the 2008 Health and Retirement Study. Although the authors focus on how demographics impact knowledge scores, they note that respondents over 75 are less likely to understand basic investment concepts such as stock diversification and the importance of mutual fund fees. Consistent with a loss in fluid intelligence, respondents over 75 also score lower on numeracy questions. Lusardi et al. (2014) does not investigate the rate of decline during old age nor does it investigate whether the decline is related to demographic differences among older cohorts. Descriptive results from van Rooij et al. (2011) show that the proportion of respondents in the highest basic financial literacy quartile peaks in the 41–50 age category and is lowest among those ages 71 and older. The inverted U-shaped relation between age category and literacy is unexpected because rates of stock ownership and net worth are both related to higher financial literacy scores and rise with age. In multivariate analyses, van Rooij et al. (2011) do not segment respondents over the age of 60 and do not find that age is a significant predictor of financial knowledge.

Higher financial literacy scores have been linked to higher quality financial decisions. Lusardi and Mitchell (2014) review a broad and growing literature that documents the strong independent impact of measured financial literacy on effective financial decision making. For example, Hilgert et al. (2003) find that higher financial literacy scores predict on-time credit repayment, investment diversification, and mortgage refinancing. Lower financial literacy is associated with incurring fees that are 50% higher on credit cards, particularly fees that require a more sophisticated awareness of credit terms (Lusardi and Tufano 2009). A particularly costly financial mistake for older households in a falling interest rate environment is the

failure to refinance a mortgage. Campbell (2006) finds that characteristics associated with financial sophistication predict wealth-maximizing refinancing behavior. More financially literate investors hold better diversified portfolios (von Gaudecker 2015) and are less likely to sell equities after a stock market decline (Bucher-Koenen and Ziegelmeier 2013).

We contribute to this literature with new evidence using a large sample of survey respondents and a new data source (CFM) that provides convincing evidence that financial literacy declines with age, but confidence in decision-making ability does not. Subsample results and extensive controls for demographic characteristics suggest that the observed decline in financial literacy is causally related to aging. Analyses using a secondary data source (HRS) suggest part of the decline in financial literacy can be traced to a general decline in fluid and crystallized intelligence.

3. Methods

3.1. Financial Literacy Assessment

The primary data set we use in our analyses contains a new, comprehensive measure of financial literacy that captures essential financial knowledge in four personal finance topic areas using the nationally representative Consumer Finance Monthly 2012 survey conducted by the Center for Human Resource Research at the Ohio State University.² The Consumer Finance Monthly collects demographic and detailed credit use information through a random digit dialing phone survey in the United States. The survey began in 2005 and contains over 10,000 completed financial literacy assessment instruments.

The objective of the financial literacy instrument used in this study is to measure both financial knowledge and the ability to apply knowledge effectively. A research team initiated development of a financial literacy instrument, tested 89 potential questions, and analyzed responses with the goal of choosing questions that were not biased in terms of age, gender, race and socioeconomic status, had an unambiguous correct response, and correlated well with other high-quality questions. An eight-member panel of national experts in financial literacy and its assessment reviewed the project (including goals, design, model, instrument, scoring, and results) to assess the proposed methods and assessment instrument.

The final instrument of the 16 items selected are the best performing financial literacy questions according to reliability and validity statistics and the recommendations of the expert panel.³ From December 2009 through 2013, the survey was included as a module in the Consumer Finance Monthly survey.

The sample in this study includes financial literacy responses from 3,873 respondents age 60 and older

during this time period. The financial literacy instrument contains 20 items (Appendix A) covering the four content areas of personal finance—basics, investments, credit, and insurance. Analyses show the questions within the instrument show high internal consistency.⁴ Within each of those four personal finance content areas, there are two knowledge questions, two ability questions, and one confidence question. There are 16 questions used to measure the objective financial literacy score and four questions that measure confidence. Basic personal finance concepts include elements such as time value of money, purchasing power, and personal finance accounting. Intertemporal transfers of resources include both borrowing (bringing future resources into the present for consumption through the use of revolving credit and installment loans) and investment (saving present resources for future consumption through the use of savings accounts and investing through stocks, bonds, or mutual funds). Insurance questions include insurance instruments and risk management techniques.

Financial literacy score is estimated as the percent correct out of 16 questions or out of four questions when scores are calculated within each topic area (basics, borrowing, investing, and insurance). Confidence in one's ability to use financial products in each topic area is measured on a scale of 1 to 10 and in total from 4 to 40 for the four topic areas. The average financial literacy score for the full sample in the CFM is 58% (9.3 correct out of 16 questions) and the median score is 62.5% (10 questions correct). The average financial confidence score is 28 out of a possible 40 (an average of 7/10 in each topic area) and the median is 29.

The individual financial literacy questions require an understanding of basic financial products and an ability to apply them appropriately. In this sense, they test both knowledge of financial products that will likely improve with age and experience, and some reasoning skill that may decline in advanced age. For example, an insurance question asks what impact a higher deductible will have on an insurance premium. The question requires an understanding of the financial terms deductible and premium and the ability to think through how a higher insurance deductible will affect the cost of insurance.

3.2. Measuring the Decline in Financial Literacy in Old Age

Our first objective is to test whether financial literacy scores decline among respondents age 60 and older, and to estimate how the rate of decline changes in advanced age. We then test whether respondent characteristics other than age are associated with financial literacy. The greatest challenge to any cross-sectional analysis of knowledge assessment is the possibility of cohort effects that may create estimation biases. We

Table 1. Univariate Relation Between CFM Financial Literacy Score and Age

Financial literacy measure	Annual change (pp)	<i>t</i> -statistic	<i>R</i> ²
Overall financial literacy score (16 questions, %)	−1.53	26.27***	0.96
Overall confidence in literacy	0.11	1.86	0.07
Overconfidence in literacy	1.63	19.88***	0.92
Basic literacy	−1.42	20.86***	0.93
Borrowing literacy	−1.61	22.30***	0.94
Investment literacy	−1.65	21.48***	0.94
Insurance literacy	−1.43	18.75***	0.92
Confidence in managing money	0.06	1.12	0.01
Confidence in credit	0.05	0.99	0.00
Confidence in investing	−0.00	0.05	0.00
Confidence in insurance	0.31	3.91***	0.31

Note. Each row in this table presents the results of a univariate regression of the annual change in mean financial literacy score (percentage points, pp) for each age from 60 to 94 (dependent variable) on age (independent variable).

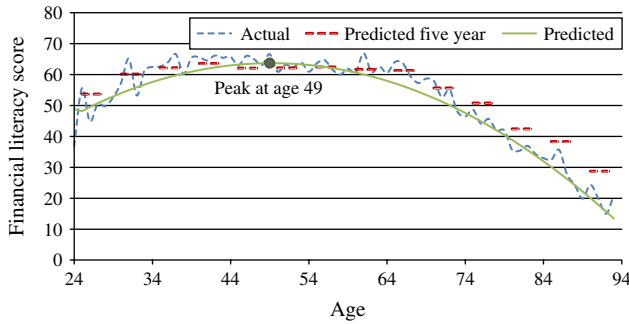
***Indicates significance at the 1% level.

conduct a number of subgroup analyses in order to test whether the hypothesized negative relation between age and financial literacy remains consistent.

We begin by illustrating the change in average financial literacy score for each additional year of age in the CFM. Cross-sectional estimation of the marginal change in average test score for each year of age is common in the cognitive aging literature (Salthouse 2010).⁵ In a random sample, it allows a researcher to first estimate the statistical consistency of the relation between age and financial literacy without the noise that comes from estimating the impact of age on financial literacy among individuals. To create Table 1, we calculate average financial literacy score for each year of age among the 3,873 respondents age 60–94 in the CFM for a total of 35 years. For example, there are 265 respondents age 60 and the average financial literacy score is 61% among 60-year old respondents. We model average score as the dependent variable and age as a single independent variable. We estimate regressions using the average overall 16-question financial literacy score as a dependent variable, the overall four-question confidence score, scores within each of the four-question topic areas (basics, borrowing, investments, and insurance), and confidence within each of the four-question topic areas. Average financial literacy score for all ages is included in Figure 1 (the “actual” line), and Figure 2 shows the average decline in financial literacy and average confidence score by age. Figure 3 shows average score within each topic by age.

Figure 1 shows the average financial literacy scores by age and the score predicted by the multivariate models that specify age as a quadratic variable and as five-year cohorts using the full CFM sample of 8,108

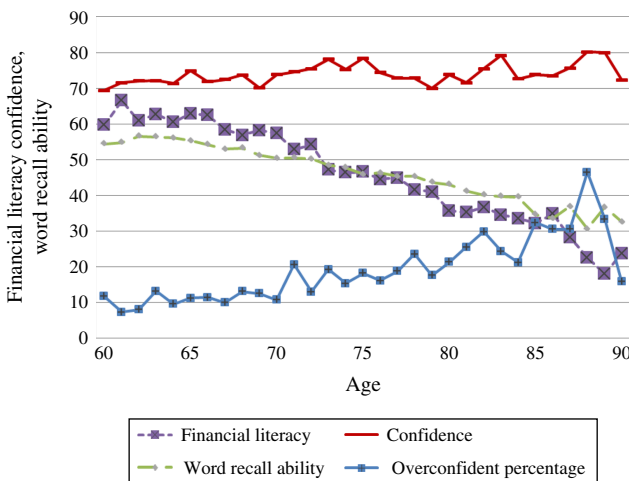
Figure 1. (Color online) Mean and Predicted Financial Literacy Score by Age



Notes. The figure shows mean CFM financial literacy scores for each year of age and predicted financial literacy score using regression estimates when age is specified as age and age squared, and as five-year age groups, in a regression model that controls for household characteristics. All age groups in the CFM sample are included.

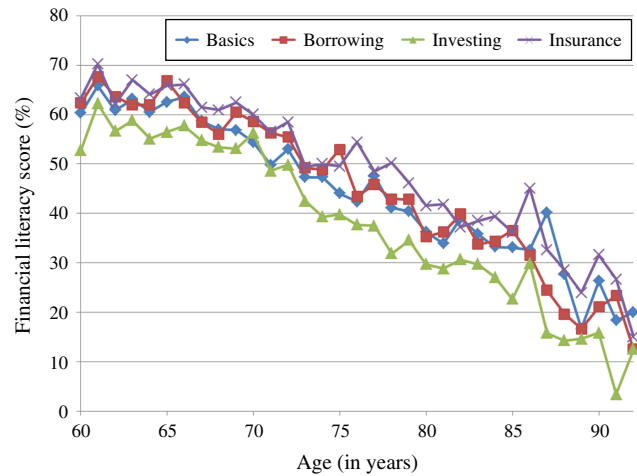
observations between the age of 24 and 94. The mean score for all ages is 58%, or about nine out of 16 questions correct. The relation between age and financial literacy score is concave for both the actual average financial literacy score by age and the predicted score using a quadratic age specification and five-year age categories controlling for other respondent household characteristics. Average financial literacy scores within each year of age increase up to roughly age 50, and the quadratic specification controlling for demographic characteristics peaks at age 49, and five-year cohort model is highest in the age 40–44 group (although it is not statistically different from the 45–49 year old reference group). Within the cohort model, the first cohort

Figure 2. (Color online) Financial Literacy, Financial Confidence, and Cognitive Ability



Notes. The figure shows average financial literacy score, average confidence in financial decision-making ability, and average percentage of overconfident respondents within each age year using the CFM for respondents age 60 or older. Average word recall score within each year of age is drawn from the HRS.

Figure 3. (Color online) Financial Literacy and Topic Area



Note. The figure shows average financial literacy score within each topic area (basics, borrowing, insurance, and investments) by each year of age using the CFM for respondents age 60 or older.

to have scores statistically lower than the 45–49 year old reference group is age 65–69 (3% lower), and predicted financial literacy scores decline at a rate of between five and seven percentage points for each five-year later life cohort. The predicted financial literacy percentage score (when compared to respondents age 45–49) is roughly the same among respondents between age 25 and 29 (7.9% lower) as it is for respondents age 70–74 (8.3% lower), and falls to 35% lower for respondents age 90 or older.

Univariate regression analyses in Table 1 model the yearly change in average financial literacy scores among the 4,152 respondents between the age of 60 and 94. Regression results show that age is a strong and consistent predictor of financial literacy. With each year of age after 60, the average score falls by 1.5 percentage points, and the relation is consistent (R^2 of 0.96). The relation between age and average financial literacy score is consistent among the four decision-making topic areas ranging from a 1.42% decrease each year within basic questions to 1.65% for investment questions. Although financial literacy scores decline with age, confidence in financial decision making does not. Confidence in financial decision-making ability increases slightly with age, but the relation is statistically significant only within the insurance domain.

3.2.1. Controlling for Respondent Characteristics. In the multiple regression analyses, we model financial literacy as a function of demand for financial human capital. The decision to incur the direct and indirect costs of attaining financial knowledge is a function of the time, transaction costs, and the discounted expected utility from making more effective financial decisions in future periods.

Higher education may proxy for a lower cost of information acquisition, a lower rate of time preference, or may involve direct exposure to financial information via business or economics coursework—all of which will increase expected financial literacy. Home ownership may be related to financial literacy both through experience with related financial products (for example, insurance concepts), and by increasing the expected return to learning tax rules. Likewise, stock ownership may involve a fixed information cost that suggests a greater expected benefit from investment in financial human capital (Peress 2004). The use of tax-sheltered accounts requires an initial financial human capital investment and may help explain greater investment knowledge among those who actively saved during the 1980s and 1990s when the use of sheltering instruments expanded in the United States. We use a question that asks respondents whether they have “any money in tax advantaged accounts including IRAs, Keogh plans, variable annuities, or 529 plans” or “money in retirement plans through former employers such as a 401(k) or 403(b).”

Financial wealth will increase the expected future payout from investing time and effort into making more informed financial decisions (Peress 2004). We use the top income and wealth quintile to capture the incentive to invest in financial information among those with the most money to manage. To some extent, homeownership, stock ownership, the ownership of tax sheltered accounts and marital status will also capture financial resource availability. Racial differences in financial literacy may be attributable to differences in financial human capital inherited from parents or to differences in the frequency of financial knowledge transfer in social interactions (Brown et al. 2008). Women may have lower financial literacy if households allocate financial decisions to the spouse with a lower relative cost of financial capital acquisition (Croson and Gneezy 2009). Smith et al. (2010) find that women are less likely to be the primary household financial decision maker in older household cohorts. We also include dummy variables for the year and month of the survey.

To estimate the impact of age on financial literacy among individuals, we model the percent correct on financial literacy topic areas and total score (percent correct of 16 questions) as a function of age and control variables using an ordinary least squares (OLS) regression:

$$FinLit_i = a + bAGE_i + \gamma X + \varepsilon_i, \quad (1)$$

where $FinLit_i$ is the objective financial literacy score (percent correct out of 16 questions) for respondent i and AGE is the respondent's age in years. We include a matrix of control variables (X) that yield a vector of

coefficient estimates (γ). The control variables include education, income, and wealth levels, along with gender, race, marital status, and ownership status of home, tax shelters, and stocks (see Equation (1)).

In Figure 1, we plot the mean financial literacy score by age. In the figure, we also show the predicted financial literacy scores after controlling for demographic characteristics that might vary with age. For example, the predicted five-year age cohort scores are estimated based on the following regression model with control values set to their mean values:

$$\begin{aligned} FinLit_i = & a + bAGE_{25-29}_i + cAGE_{30-34}_i + dAGE_{35-39}_i \\ & + eAGE_{40-44}_i + fAGE_{50-54}_i + gAGE_{55-59}_i \\ & + hAGE_{60-64}_i + jAGE_{65-69}_i + kAGE_{70-74}_i \\ & + lAGE_{75-79}_i + mAGE_{80-84}_i + nAGE_{85-89}_i \\ & + oAGE_{90-94}_i + \gamma X + \varepsilon_i. \end{aligned} \quad (2)$$

We alternatively estimate the regression model with age and age squared as the key independent variables. Figure 1 provides clear evidence that there is a decline in financial literacy in old age.

3.2.2. Addressing Sample Biases. Differences in experiences or incentives to invest in financial knowledge may affect performance on the financial literacy test. To minimize possible biases in older cohorts, we create subsamples that reduce the most significant sources of age-related financial knowledge variation that are unrelated to cognitive decline.

Because rates of educational attainment rose in the United States during the 20th century (Day 2010), younger cohorts may be more likely to have taken an economics or finance course in college. To reduce the potential bias caused by lower educational attainment by older cohorts, we estimate our model only on older respondents who have a college or graduate school education. Men, particularly in older cohorts, may choose to invest in financial knowledge as a result of specialized labor in household production. Because longevity is higher among women than men (63% of respondents in the CFM age 80 or older are women), our results may be biased by a larger proportion of older, less knowledgeable women. To correct for gender-related knowledge differences, we estimate the model among males only. Cohort differences in rates of return on stock investments may drive variation in equity market participation (Malmendier and Nagel 2011). If households over age 60 are less inclined to invest in equities because of their poor performance in the 1970s, this may have influenced the decision to seek out investment information about stocks. To address the bias or reduced preference for risky asset ownership, we estimate the model using households who directly hold stock or mutual fund investments. Finally, because financial literacy is strongly related to stock

market participation (van Rooij et al. 2011), and household stock ownership rates peak among households age 45–54 and rose significantly between 1983 and 1992 in qualified retirement plans (Poterba and Samwick 1995), we estimate our model only for households who were age 60 or older in 1992.

Another potential criticism of estimating the relation between age and financial literacy is the possibility that older households were less likely to be exposed to financial instruments less common in their peak borrowing and saving life cycle years. One exception is insurance products. Cohort ownership rates of life insurance are higher among older households than among the baby boomer cohort (Chen et al. 2003). In addition, insurance products were a common sheltered savings vehicle prior to the 401(k) and IRA era that began in the 1980s. The four financial literacy questions related to household insurance present less potential cohort bias than other topic areas. We estimate OLS regressions on the percent correct (out of four questions) using Equation (1) from within each of the four financial literacy topic areas including insurance, investments, borrowing, and basics in order to detect possible differences in the marginal effect of aging against knowledge in different literacy domains.

We estimate 16 separate logistic regressions using Equation (1) on each financial literacy question to determine whether the results are driven by a subset of questions that may be age or cohort biased. We calculate the standardized beta coefficient of each variable in the regression model, which provides a measure of the relative independent strength of each variable as a predictor of correct response to the individual questions. This provides additional information about the strength of the age effect by showing the relative importance of age among other control variables.

3.3. Financial Confidence

The financial literacy assessment instrument includes four questions that ask the respondents to assess how confident they are at making financial decisions within each of the topic areas. It is possible that older subjects are not aware of declines in their financial decision-making ability and may or may not remain confident of their financial capabilities. Understanding whether actual ability and age are related to higher confidence is important in understanding whether seniors are potentially vulnerable to decision-making mistakes from overestimating their decision-making ability. To better understand an overconfidence in one's abilities, we investigate the characteristics that predict a high level of confidence among respondents with a low level of knowledge.

We measure confidence in financial ability through a question asking respondents to rate on a scale of 1 to 10 how confident they are in making decisions within

each of the four financial literacy topic areas. We use an OLS model to estimate predictors of confidence in each topic area, and the summed total of all four topic areas, as a function of age, financial literacy within that topic area (or total financial literacy score), and household characteristics and time dummy variables (X):

$$\text{Confidence}_i = a + b\text{FinScore}_i + c\text{AGE}_i + \gamma X + \varepsilon_i, \quad (3)$$

where Confidence_i is either confidence in a specific topic area (basics, borrowing, investment, insurance) or total confidence (percentage total of all four topic areas) for respondent i (see Equation (3)). Confidence in each topic area is respondent assessed on a scale of 0 (no confidence) to 10 (highest confidence). FinScore_i is the specific topic area objective score (percent correct out of four questions) or the total score (FinLit) for respondent i . Coefficient estimates indicate the marginal effect of age on financial confidence controlling for actual ability. The sample size decreases slightly to 3,403 because of some missing responses among those who completed the financial literacy test.

We consider respondents whose confidence score is an average of at least 8 for all four topic areas (or a total score of at least 80%), and whose objective financial literacy score is in the lowest quartile, to be overconfident. Because slightly higher confidence may improve financial outcomes for those with adequate financial literacy, we choose to specify overconfidence as very low financial literacy and very high confidence. We select a logistic model (see Equation (4)) of overconfidence as a function of age (AGE), and interaction of age and financial literacy ($\text{AGE} \times \text{FinLit}$), and the same matrix of control variables (X):

$$\begin{aligned} \text{Overconfidence}_i \\ = a + b\text{AGE}_i + c\text{AGE}_i \times \text{FinLit}_i + \gamma X + \varepsilon_i. \end{aligned} \quad (4)$$

3.4. Cognitive Aging and Financial Literacy Decline

The CFM does not include cognition variables that would allow us to estimate the extent to which gradual decline in fluid and crystallized intelligence may contribute to falling financial literacy scores. The 2010 HRS contains a module that asks financial literacy questions to a subsample of respondents. The HRS also asks respondents to answer questions in a cognition module that includes established measures of fluid and crystallized intelligence. Through the use of cognition measures, we are able to test whether lower financial literacy scores are related to cognitive aging.

Financial literacy questions are drawn from an HRS module of questions that assess respondent "financial sophistication and investment decision making."⁶ The HRS module includes questions that measure financial literacy and other concepts related to financial

awareness. We select the questions from the module that measure financial literacy. These include the original three questions from Lusardi and Mitchell (2007) and four additional questions that have a specific answer (“buying a single company stock usually provides a safer return than a stock mutual fund”), and we avoid questions with no specific correct response (“are you considering investing in the stock market for the next year?”). The financial literacy instrument is an additive metric that includes one question on interest compounding and one on inflation (each of these may be related to numeracy), whether a single stock is safer than a mutual fund, whether stocks historically provide higher returns than bonds or savings accounts, whether an employee should have a lot of their retirement savings in employer stock, whether foreign stocks should be avoided, and whether bond values are inversely related to interest rates.

The correlation between age and the HRS financial literacy score is -0.15 , and the average score appears to follow a linear decline with age.⁷ Using the percent correct from an additive score of seven financial literacy-related questions as the dependent variable, we model financial literacy using OLS as a function of age and cognitive function while controlling for a matrix of household characteristics (X) for respondents age 60 and older (see Equation (8)). We estimate models that specify age as a linear variable and as five-year cohorts using age 60–64 as the reference category (see Equation (5)):

$$\begin{aligned} \text{HRS-Score} = & a + b\text{AGE}_i + c\text{AGE}_i + c\text{Recall}_i \\ & + d\text{Vocab}_i + \gamma X + \varepsilon_i, \end{aligned} \quad (5)$$

where HRS-Score_i is the percent correct out of seven financial literacy-related questions from the HRS for respondent i and AGE is the respondent’s age in years (or age category using five-year intervals). We calculate fluid intelligence using a combination of immediate and delayed word recall scores, a reliable measure available in the HRS (McArdle et al. 2007).⁸ Recall_i is the number of nouns (out of 10) recalled by respondent i . Vocab_i is a vocabulary measure adapted from the WAIS-R crystallized intelligence test that asks respondents to define each of five words (such as plagiarize or perimeter). Responses are scored between 0 (wrong) and 2 (perfectly correct) for a total score of between 0 and 10. The correlation between vocabulary and word recall measures is 0.31, and the correlation between financial literacy and vocabulary is 0.29 and 0.25 with word recall. We perform analyses using a sample of 1,109 respondents who answered the financial literacy module for the analyses without the cognition variables and a total of 887 respondents who completed both the cognition and financial literacy questions.

4. Results

4.1. Financial Literacy Decline in Old Age

Figure 2 shows the similar rate of decline in average financial literacy score in the CFM and in average word recall ability by age in the HRS. Although episodic memory and financial literacy score decline at roughly the same rate after age 60, confidence in financial decision-making ability remains relatively unchanged with age. The percentage of overconfident respondents with high self-assessed ability and low objective literacy scores increases from about 10% in the 60s to higher than 30% among respondents over 85. Figure 3 illustrates the consistent decline in financial literacy score with age among all four topic areas.

Sample characteristics in Table 2 indicate consistently lower financial literacy scores in all topic areas among respondents age 70–79 (49%) and 80+ (32%) than among respondents age 60–69 (62%). Older respondents have lower average financial literacy scores in all topic areas including insurance. Scores are much higher among respondents with a college (61%) and graduate (66%) degree than among respondents with a high school (39%) or below high school (25%) education. Scores are higher among whites, men, homeowners, those who are married, and stock owners, and increase monotonically with wealth and income quintile. Greater financial resource availability is associated with higher financial literacy scores. Older households are slightly more confident in their financial decision-making abilities (Table 3). Because average financial literacy score declines with age, it is not surprising that a higher percentage of respondents age 80 or above (19.3%) are overconfident than respondents age 70–80 (10.4%) and age 60–69 (4.7%). Financial confidence is only slightly higher among more educated respondents, but a much higher percentage of respondents with a high school or below high school education are overconfident.

Table 4 presents regression results that estimate the financial literacy score of individuals with and without control variables among respondents 60 years and older in the CFM.⁹ Unlike Table 1, the regression model predicts individual financial literacy score for each of the 3,873 respondents as a function of the respondent’s age (rather than average financial literacy score for all respondents that have the same age in Table 1). Because financial literacy will vary among respondents of the same age with different demographics and life experience, the unexplained variance between age and financial literacy is higher (R^2 is 0.17 versus 0.96 when estimating aggregate average change in financial literacy by age) but still statistically significant. Each year of age is associated with a 1.36 percentage point decline in the total financial literacy score. When age is sorted into five-year groups, respondents age 70–74 have significantly lower financial literacy scores than

Table 2. CFM Sample Financial Literacy Scores and Variable Frequency/Mean

	Financial literacy objective scores (0–100)					Frequency or mean	N
	Total score %/(SD)	Basics %/(SD)	Borrowing %/(SD)	Investment %/(SD)	Insurance %/(SD)		
<i>Sample</i>	52 (28)	52 (33)	54 (33)	47 (36)	57 (34)		4,152
<i>Age</i>							
Age 60–69	62 (26)	62 (31)	63 (30)	57 (34)	65 (31)	51.1%	2,122
Age 70–79	49 (28)	48 (33)	51 (32)	43 (36)	54 (34)	31.0%	1,287
Age 80 or above	32 (24)	34 (29)	33 (29)	25 (29)	37 (32)	17.9%	743
<i>Education</i>							
<High school	25 (20)	22 (25)	30 (28)	16 (22)	31 (30)	4.9%	204
High school	39 (26)	38 (30)	42 (32)	31 (32)	44 (33)	23.8%	984
Some college	51 (26)	51 (32)	54 (32)	44 (34)	55 (32)	25.9%	1,073
College	61 (26)	62 (31)	61 (31)	58 (34)	64 (31)	24.5%	1,013
Graduate	66 (26)	67 (30)	64 (30)	62 (34)	69 (31)	20.9%	865
<i>Race</i>							
White	54 (28)	54 (33)	55 (32)	48 (36)	58 (33)	88.6%	3,679
Nonwhite	42 (27)	40 (31)	47 (33)	35 (33)	47 (34)	11.4%	473
<i>Gender</i>							
Male	58 (28)	58 (33)	59 (32)	54 (36)	61 (33)	43.3%	1,799
Female	48 (28)	48 (33)	50 (32)	41 (34)	53 (34)	56.7%	2,353
<i>Homeownership</i>							
Homeowner	54 (28)	54 (33)	55 (32)	49 (36)	58 (33)	90.2%	3,739
Not homeowner	38 (28)	40 (33)	40 (32)	30 (32)	43 (33)	9.8%	407
<i>Marital status</i>							
Married	59 (27)	59 (32)	60 (32)	54 (35)	62 (33)	54.6%	2,264
Unmarried	45 (28)	44 (32)	47 (32)	38 (34)	50 (34)	45.4%	1,884
<i>Tax sheltered status</i>							
Tax sheltered acct.	64 (26)	66 (30)	63 (31)	62 (34)	67 (30)	30.1%	1,180
No tax sheltered	48 (28)	48 (33)	51 (32)	41 (35)	53 (34)	69.9%	2,737
<i>Stock ownership</i>							
Stock/MF owner	64 (25)	64 (31)	63 (30)	61 (33)	67 (31)	43.1%	1,684
No stock/MF	45 (28)	45 (32)	48 (32)	37 (34)	50 (33)	56.9%	2,225
<i>Income Level</i>							
Lowest income	39 (27)	37 (31)	42 (32)	32 (33)	46 (33)	\$7,953	670
Quintile 2 income	46 (27)	46 (32)	48 (32)	37 (34)	51 (33)	18,881	670
Quintile 3 income	57 (25)	55 (31)	59 (29)	51 (34)	61 (31)	33,756	670
Quintile 4 income	62 (24)	64 (30)	63 (29)	56 (33)	65 (31)	59,427	670
Highest income	69 (22)	70 (27)	69 (28)	66 (32)	72 (27)	165,598	670
<i>Wealth level</i>							
Lowest net worth	37 (27)	37 (32)	40 (33)	30 (32)	42 (34)	(\$11,418)	822
Quintile 2 net worth	44 (27)	43 (32)	48 (32)	34 (33)	50 (33)	104,917	823
Quintile 3 net worth	53 (27)	54 (33)	55 (32)	47 (35)	57 (33)	250,351	823
Quintile 4 net worth	60 (25)	61 (29)	60 (30)	56 (33)	64 (31)	459,537	823
Highest net worth	68 (24)	68 (29)	67 (29)	67 (32)	71 (29)	1,797,815	823

Notes. Each panel in this table presents the total financial literacy score and topic area financial literacy scores for each variable, along with the sample frequency or mean for each variable attribute. The sample excludes respondents who are younger than age 60.

respondents age 60–64. The predicted financial literacy score falls by between 6 and 9 percentage points with each older cohort group. Respondents age 90 or older score 41.7 percentage points lower on average than respondents age 60–64. The age effect declines slightly to 1.02 percentage points per year when control variables are included in the model, but the effect is no less consistent.¹⁰ The model with control variables explains 37% of the variation in observed financial literacy. Coefficients in the multivariate model also decline slightly in magnitude but remain significant when age

is measured in five-year groups and the R^2 is identical to the linear age model.

4.1.1. Addressing Sample Biases. Regressions in Table 5 model financial literacy scores using the linear age variable within subsamples in order to correct for possible biases in experience or motivation to acquire financial knowledge. Among households with a college education, the magnitude of the decline in financial literacy score is slightly higher than in the full sample (1.10 percentage points per year). The annual decline in financial literacy is similar in a sample of

Table 3. CFM Sample Financial Confidence Score and Overconfidence Status

Financial confidence scores (0–100) and overconfidence status			
	Confidence score %/(SD)	Overconfidence %	N
<i>Sample</i>	73 (19)	9.7	3,655
<i>Age</i>			
Age 60–69	72 (19)	5.7	1,985
Age 70–79	75 (19)	10.4	1,115
Age 80 or above	74 (21)	19.3	555
<i>Education</i>			
<High school	69 (25)	16.2	134
High school	73 (21)	16.6	827
Some college	72 (20)	8.7	962
College	75 (17)	6.5	927
Graduate	74 (18)	4.9	795
<i>Race</i>			
White	73 (19)	9.0	3,247
Nonwhite	70 (23)	14.2	408
<i>Gender</i>			
Male	74 (19)	7.2	1,659
Female	73 (19)	11.5	1,996
<i>Homeownership</i>			
Homeowner	74 (19)	9.4	3,333
Not homeowner	66 (22)	11.9	316
<i>Marital status</i>			
Married	74 (18)	7.4	2,087
Unmarried	72 (21)	12.2	1,564
<i>Tax sheltered status</i>			
Tax sheltered acct.	76 (16)	3.8	1,117
No tax sheltered	72 (20)	11.1	2,354
<i>Stock ownership</i>			
Stock/MF owner	77 (16)	5.0	1,607
No stock/MF	72 (20)	10.7	1,862
<i>Income level</i>			
Lowest income	69 (23)	13.1	539
Quintile 2 income	70 (22)	13.7	573
Quintile 3 income	71 (19)	7.8	618
Quintile 4 income	74 (17)	5.2	630
Highest income	76 (17)	2.9	639
<i>Wealth level</i>			
Lowest net worth	65 (23)	11.5	636
Quintile 2 net worth	69 (21)	11.7	697
Quintile 3 net worth	73 (18)	8.4	729
Quintile 4 net worth	75 (17)	5.9	777
Highest net worth	79 (15)	4.4	788

Note. Each panel in this table presents the financial confidence score and the percentage that are overconfident for each variable attribute.

men (0.96 percentage points per year) compared to a full sample of male and female respondents. Among stock or mutual fund owners, the annual decline in financial literacy is 0.98 percentage points and also statistically significant. Among the cohort of respondents who were age 60 or older in 1992, the magnitude of decline with age is 1.37 percentage points per year. The estimated linear decline in financial literacy is similar among subgroups.

Table 4. CFM Regressions for Financial Literacy Scores and Age

	Linear age	Age dummies	Linear age	Age dummies
Age	–1.36*** (0.05)		–1.02*** (0.05)	
Age 65–69		–1.62 (1.14)		–1.41 (1.01)
Age 70–74		–9.85*** (1.22)		–5.98*** (1.10)
Age 75–79		–17.36*** (1.33)		–11.8*** (1.22)
Age 80–84		–26.66*** (1.44)		–19.95*** (1.31)
Age 85–89		–32.55*** (1.87)		–25.41*** (1.71)
Age 90+		–41.72*** (3.26)		–32.15*** (3.14)
<High school			–10.09*** (1.79)	–10.23*** (1.79)
Some college			7.92*** (1.03)	8.13*** (1.03)
College			13.85*** (1.08)	14.11*** (1.08)
Graduate			16.83*** (1.14)	16.93*** (1.14)
High income			2.38* (1.20)	2.72** (1.19)
High wealth			5.47*** (0.99)	5.08*** (0.99)
White			8.82*** (1.15)	8.86*** (1.15)
Male			4.35*** (0.76)	4.28*** (0.76)
Homeowner			4.37*** (1.26)	4.08*** (1.26)
Married			3.96*** (0.80)	3.76*** (0.80)
Tax sheltered			5.42*** (0.87)	5.32*** (0.87)
Stock/MF			5.43*** (0.84)	5.77*** (0.84)
Sample size	4,152	4,152	3,898	3,898
Adjusted R ²	0.17	0.17	0.37	0.37

Notes. The first column presents the results of a univariate regression financial literacy score (% correct out of 16 questions—dependent variable) on continuous age (independent variable). The second column presents the same regression using five-year age categories. The third (age continuous) and fourth (age categorical) columns present multivariate regressions that include a matrix of control variables. All analyses exclude respondents younger than age 60.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Financial literacy regression results for individual topic areas in Table 6 show the marginal impact of age on predicted score within the four areas of financial literacy knowledge. The annual decline in financial literacy scores is consistent among all four topic areas,

Table 5. CFM Subsample Regressions of Financial Literacy and Age

	College	Males	Stock/MF owners	Older cohort
Age	-1.1*** (0.06)	-0.96*** (0.07)	-0.98*** (0.08)	-1.37*** (0.22)
<High school		-11.19*** (3.25)	-6.79 (4.89)	-5.53 (3.39)
Some college		8.52** (1.72)	7.54*** (1.81)	5.00** (2.12)
College		15.95*** (1.73)	11.89*** (1.77)	11.04*** (2.31)
Graduate		17.22*** (1.75)	15.37*** (1.78)	12.7*** (2.54)
High income	3.53** (1.34)	2.25 (1.68)	2.64 (1.62)	4.29 (4.13)
High wealth	5.3*** (1.09)	4.84*** (1.35)	5.35*** (1.27)	0.77 (2.43)
White	8.75*** (1.42)	8.36*** (1.75)	6.82*** (1.89)	5.47** (2.56)
Male	5.4*** (0.9)		4.15*** (1.15)	6.76*** (1.72)
Homeowner	4.67*** (1.67)	6.84** (2.21)	1.16 (2.82)	-1.14 (2.25)
Married	4.37*** (0.97)	6.53*** (1.26)	3.59*** (1.26)	2.44 (1.79)
Tax sheltered	6.04*** (0.98)	6.16*** (1.27)	4.04*** (1.16)	9.26*** (1.97)
Stock/MF	5.25*** (0.98)	4.08*** (1.26)		7.36*** (1.93)
Sample size	2,803	1,702	1,654	800
Adjusted R ²	0.27	0.34	0.23	0.26

Notes. Each column of this table presents the results of a multivariate regression of financial literacy (dependent variable) on age (independent variable) and control variables. The sample is censored by those with a college degree (first column), males only (second column), stockowners (third column), and the older cohort of respondents who were 60 years of age or older in 1992 (fourth column). All analyses exclude respondents younger than age 60.

*** and ** indicate significance at the 1% and 5% levels, respectively.

and the magnitude of the effect is comparable (ranging from a 0.94 percentage point decline per year for basics to a 1.10 percentage point decline in borrowing knowledge).¹¹ All results are statistically significant. Insurance knowledge, which would increase with age if results are driven by cohort financial instrument familiarity effects, declines with age at roughly the same rate (0.96 per year) as basic financial knowledge. The consistency of the age decline among financial literacy topic areas can also be seen when we model the correct response to individual questions. Table 7 shows that the likelihood of providing a correct response to each financial literacy question declines significantly with age. Of the 12 control variables (including important human capital-related characteristics such as education, income race, gender), age is the

Table 6. CFM Regressions of Financial Literacy Topic Areas and Age

	Basics	Borrowing	Investment	Insurance
Age	-0.94*** (0.06)	-1.1*** (0.06)	-1.06*** (0.06)	-0.96*** (0.06)
<High school	-11.87*** (2.23)	-9.76*** (2.27)	-9.95*** (2.36)	-8.8*** (2.37)
Some college	8.55*** (1.28)	7.07*** (1.31)	8.17*** (1.36)	7.88*** (1.37)
College	15.9*** (1.34)	10.79*** (1.37)	15.72*** (1.42)	12.99*** (1.43)
Graduate	18.78*** (1.42)	13.27*** (1.45)	19.08*** (1.5)	16.18*** (1.51)
High income	2.76* (1.53)	1.55 (1.49)	3.16** (1.46)	2.05 (1.41)
High wealth	4.56*** (1.23)	3.94*** (1.28)	8.44*** (1.29)	4.94*** (1.31)
White	11.2*** (1.42)	6.47*** (1.46)	9.99*** (1.51)	7.61*** (1.52)
Male	4.28*** (0.94)	3.95*** (0.96)	6.23*** (0.99)	2.96*** (1.00)
Homeowner	1.1 (1.57)	6.17*** (1.6)	4.82*** (1.66)	5.4*** (1.67)
Married	4.62*** (0.99)	4.11*** (1.01)	3.65*** (1.05)	3.47*** (1.05)
Tax sheltered	6.81*** (1.08)	3.32*** (1.1)	7.29*** (1.14)	4.25*** (1.15)
Stock/MF	5.89*** (1.03)	3.15*** (1.05)	7.82*** (1.1)	4.87*** (1.11)
Sample size	3,898	3,898	3,898	3,898
Adjusted R ²	0.29	0.23	0.32	0.22

Notes. Each column of this table presents the results of a multivariate regression of individual financial literacy topic areas (dependent variables) on age (dependent variable) and control variables. The first column dependent variable is the four questions on financial literacy basic topics, the second column dependent variable is the four questions on borrowing, the third column dependent variable is the four financial literacy questions on investing, and the fourth column dependent variable is the four insurance-related financial literacy questions. All analyses exclude respondents younger than age 60.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

strongest independent predictor of providing the correct answer for 11 of the 16 financial literacy questions. Of the remaining questions, age is the second and third strongest predictor. Interestingly, the weakest age effect is for a question that asks about appropriate mortgage types for a first-time home buyer. The strongest age effect occurs for the questions on the deductibility of interest and the use of money market accounts.

4.2. Financial Confidence

Table 8 shows multivariate analyses of confidence in managing money, managing credit and debt, using investment products, and using insurance, as well as overconfidence measured as the difference between self-assessed and actual financial literacy. Confidence

Table 7. CFM Logistic Regression Age Coefficients for Individual Financial Literacy Items

Financial literacy question	Age pt. estimate	St. beta	Max-rescaled R^2
Net worth is equal to	-5.2%***	0.23 ^c	0.26
If your assets increase by \$5,000 and your liabilities decrease by \$3,000, your net worth would	-5.0%***	0.2 ^a	0.18
Which bank account is likely to pay the highest interest rate on money saved?	-6.2%***	0.28 ^a	0.18
Savings accounts and money market accounts are most appropriate for	-7.0%***	0.32 ^a	0.20
To reduce the total finance costs paid over the life of an auto loan, you should choose a loan with the	-5.7%***	0.26 ^c	0.28
If you always pay the full balance on your credit card, which of the following is least important?	-6.4%***	0.29 ^a	0.21
On which type of loan is interest never tax deductible?	-7.0%***	0.32 ^a	0.25
Which type of mortgage would allow a first-time home buyer to qualify for the highest loan amount?	-2.9%***	0.13 ^c	0.15
The benefit of owning investments that are diversified is that it	-6.0%***	0.27 ^a	0.19
A young investor willing to take moderate risk for above-average growth would be most interested in	-4.2%***	0.19 ^a	0.19
The main advantage of a 401(k) plan is that it	-4.3%***	0.20 ^a	0.12
To ensure that some of your retirement savings will not be subject to income tax upon withdrawal, you would contribute to	-3.8%***	0.17 ^a	0.11
If you have an insurance policy with a higher deductible, the premiums will be	-3.9%***	0.17 ^b	0.17
Which of the following types of insurance is most important for single workers without children?	-5.4%***	0.24 ^a	0.22
Which policy provides the most coverage at the lowest cost for a young family?	-4.7%***	0.21 ^a	0.12
Which household would typically have the greatest life insurance need?	-3.9%***	0.17 ^b	0.11

Notes. This table presents the age coefficients (only) from 16 logistic regressions of each individual financial literacy item (dependent variable) on age (independent variable) and household control variables (education, income, wealth levels, race, gender, marital status, and ownership of home, tax sheltered account, and stocks). All analyses exclude respondents younger than age 60. Responses to the financial literacy questions are in Appendix A.

***Indicates significance at the 0.01 level.

^{a,b,c}Indicates age ranks first, second, and third, respectively, of explaining variation in answering question correctly.

in overall financial decision-making ability increases with age, and also within all topic areas. More financially literate respondents are also more confident for each topic area except insurance. Respondents who are less knowledgeable about insurance are not less confident about their insurance knowledge. Older respondents are more likely to be confident about their ability to make insurance and investment decisions.

The likelihood of being overconfident with one's financial knowledge increases with age. Each year of age after 60 increases the likelihood of having high confidence and low financial literacy scores by 7%. Higher levels of education are associated with a much lower likelihood of overconfidence, as are being male and white.

The only variable that consistently predicts confidence in all four areas is homeownership. Although age is related to increased financial confidence, the multivariate models explain little variation in financial confidence and the marginal effect of age is weak compared to other variables (the effect of an additional 20 years of age is roughly equal to homeownership in predicting total confidence).

4.3. Financial Literacy Decline and Cognitive Aging

Table 9 shows results using data from the HRS that include measures of respondent fluid and crystal-

lized intelligence as well as a different measure of financial literacy. Coefficients represent the percentage change in financial literacy score out of seven questions included in the HRS (Appendix B).

The HRS financial literacy questions show a consistent, but slightly weaker, decline in financial literacy among respondents 60 and older. The linear age specification is negative and statistically significant, and the five-year age group coefficients are negative and monotonic but only reach the level of a statistically significant difference from age 60–64 by the 75–79 age group. Similar to the model using CFM data, controlling for household characteristics slightly reduces the linear age effect. The magnitude of financial literacy decline is similar among five-year age groups who have reached at least age 80 after controlling for demographics.

Both measures of crystallized and fluid intelligence are statistically significant and the coefficients are identical as predictors of higher financial literacy scores. Once cognitive ability is controlled for, the age coefficient remains statistically significant but the magnitude of the annual decline falls by 41%. When age is specified using five-year age groups, none of the age groups is statistically significant after we control for word recall and vocabulary ability. Again, we find that fluid and crystallized intelligence predict financial literacy scores by a similar magnitude.

Table 8. CFM Financial Confidence Regressions on Age

	Total confidence	Managing money	Managing credit	Using investments	Using insurance	Overconfident
Age	0.03*** (0.00)	0.01*** (0)	0.02*** (0)	0.04*** (0.01)	0.04*** (0.01)	1.07***
Objective score (by area)	0.006*** (0.001)	0.003** (0.001)	0.003** (0.001)	0.009*** (0.002)	0.001 (0.002)	
<High school	-0.16 (0.18)	0.06 (0.16)	-0.33** (0.17)	-0.14 (0.27)	-0.24 (0.26)	1.48
Some college	-0.11 (0.09)	-0.08 (0.09)	-0.14 (0.09)	0.03 (0.14)	-0.18 (0.14)	0.59***
College	-0.06 (0.10)	-0.09 (0.1)	-0.05 (0.1)	0.2 (0.15)	-0.13 (0.15)	0.45***
Graduate	-0.27*** (0.10)	-0.27*** (0.1)	-0.22** (0.1)	-0.12 (0.16)	-0.32** (0.16)	0.35***
High income	0.21** (0.09)	0.12 (0.09)	0.14 (0.09)	0.27* (0.14)	0.21 (0.14)	0.69
High wealth	0.35*** (0.09)	0.26*** (0.09)	0.42*** (0.09)	0.64*** (0.14)	0.18 (0.13)	0.79
White	0.17* (0.10)	0.16 (0.1)	0.38*** (0.1)	0.02 (0.16)	0.13 (0.16)	0.68**
Male	-0.03 (0.07)	-0.13** (0.07)	-0.15** (0.07)	0.28*** (0.1)	-0.13 (0.1)	0.73**
Homeowner	0.47*** (0.12)	0.19* (0.11)	0.36*** (0.12)	0.9*** (0.18)	0.36** (0.17)	1.3
Married	-0.02 (0.07)	-0.02 (0.07)	-0.02 (0.07)	-0.03 (0.11)	0.06 (0.11)	0.9
Tax sheltered	0.31*** (0.07)	-0.03 (0.08)	0.2*** (0.08)	0.87*** (0.12)	0.2* (0.12)	0.94
Stock/MF	0.38*** (0.07)	0.16** (0.07)	0.33*** (0.07)	0.63*** (0.11)	0.29** (0.11)	0.93
Sample size	3,455	3,849	3,815	3,590	3,657	3,455
Adjusted R ²	0.07	0.01	0.04	0.10	0.01	0.16

Notes. Each column in this table presents multivariate regression results of financial confidence on age and household control variables. The first column dependent variable is total confidence that combines all of the four confidence items. The second through fifth columns use each of the four confidence items individually as the dependent variable (respondent-reported confidence in managing money, managing credit, using investment products, and using insurance products, respectively). The last column presents the logistic regression results (log odds ratios, thus standard errors are omitted) of overconfidence (yes/no) as the dependent variable on age (independent variable) along with the matrix of control variables. All analyses exclude respondents younger than age 60.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

5. Conclusion

Using a new financial literacy instrument and a large, nationally representative sample, this study is the first to measure the rate of decline in financial literacy in advanced age. We find a consistent linear decline in average financial literacy score of about one percentage point per year among respondents over age 60. This linear decline in age remains after we estimate individual financial literacy scores controlling for respondent characteristics. The large sample allows us to perform a number of subgroup analyses in order to reduce the impact of information and experience-related biases that may exist among older cohorts. We find that the decline in financial literacy score in old age is consistent among stockholders, males, college graduates, and among those who reached retirement age before the growth of 401(k)s.

The decline in financial literacy is quite robust. The likelihood of correctly answering each of the 16 individual questions used in the literacy instrument decreases significantly with each year of age. The decline in financial literacy is present across all four financial topic areas (basics, borrowing, investing, and insurance), but decision-making confidence in each topic does not fall with age. This decline in financial literacy coupled with no decrease in confidence results in an increased likelihood that respondents score high on confidence and low on financial literacy in advanced age.

Our results add to the literature on observed declines in financial performance with advanced age by providing evidence consistent with the decline in financial literacy being caused by a general deterioration in cognition. For example, Korniotis and Kumar (2011)

Table 9. HRS Regressions of Financial Literacy Scores, Age, and Cognitive Ability

	<i>Linear age</i>	<i>Age dummies</i>	<i>Linear age</i>	<i>Age dummies</i>	<i>Linear age</i>	<i>Cohort age</i>
<i>Age</i>	−0.41*** (0.08)		−0.35*** (0.08)		−0.24** (0.1)	
<i>Age 65–69</i>		−1.33 (−0.65)		−0.01 (0)		3.12 (0.91)
<i>Age 70–74</i>		−3.23* (−1.69)		−2.03 (−1.16)		1 (0.3)
<i>Age 75–79</i>		−4.96** (−2.39)		−3.49* (−1.83)		0.13 (0.04)
<i>Age 80–84</i>		−6.58** (−2.53)		−7.29*** (−3.09)		−2.68 (−0.72)
<i>Age 85–89</i>		−10.43*** (−3.57)		−8.72*** (−3.27)		−2.81 (−0.7)
<i>Age 90+</i>		−13.8*** (−3.28)		−7.45* (−1.94)		−2.07 (−0.42)
<i>Word recall</i>					0.13*** (0.04)	0.13*** (2.78)
<i>Vocabulary ability</i>					0.13*** (0.04)	0.13*** (0.04)
<i><High school</i>			−8.59*** (1.72)	−8.62*** (−5)	−6.36*** (1.93)	−6.48*** (−3.34)
<i>Some college</i>			2.6* (1.56)	2.82* (1.79)	0.88 (1.79)	0.97 (0.54)
<i>College</i>			10.52*** (1.69)	10.98*** (6.42)	7.4*** (2.01)	7.7*** (3.8)
<i>High income</i>			0.81 (1.67)	0.91 (0.54)	0.85 (2.01)	0.73 (0.36)
<i>High wealth</i>			0.27 (1.74)	0.07 (0.04)	0.95 (1.99)	0.8 (0.4)
<i>White</i>			3.75** (1.59)	3.57** (2.24)	1.44 (1.86)	0.89 (0.47)
<i>Male</i>			5.74*** (1.22)	5.71*** (4.66)	7.21*** (1.42)	7.32*** (5.11)
<i>Homeowner</i>			3.91** (1.59)	3.74** (2.34)	3.1* (1.8)	2.92 (1.62)
<i>Married</i>			−0.12 (1.4)	−0.02 (−0.02)	−0.22 (1.6)	−0.18 (−0.11)
<i>Tax sheltered</i>			6.42*** (1.39)	6.46*** (4.63)	5.69*** (1.58)	5.76*** (3.62)
<i>Stock/MF</i>			3.25** (1.53)	3.14** (2.04)	3.46** (1.71)	3.46** (2.01)
<i>Sample size</i>	1,109	1,109	1,108	1,108	887	887
<i>Adjusted R²</i>	0.02	0.02	0.23	0.23	0.23	0.22

Notes. The first column presents the results of a simple univariate regression financial literacy score (% correct out of seven HRS financial literacy-related questions—dependent variable) on continuous age (independent variable). The second column presents the same regression using age categories. The third (age continuous) and fourth (age categorical) columns present multivariate regressions that include cognitive ability measures (word recall and vocabulary ability) as control variables.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

show a decrease in investment performance that mirrors observed declines in cognitive ability by age. Our study shows that the decline in performance may be attributed directly to an age-related decrease in financial knowledge and the ability to apply knowledge correctly to financial decision making. We are also able to better control for possible confounding effects closely related to financial knowledge by using

household-level control variables such as education, homeownership, and race. For example, the proportion of individuals with a college degree declines among older cohorts, which could explain lower observed financial literacy and investment performance. However, we find that college-educated respondents over age 60 experience a decline in financial literacy with age that is similar in magnitude to the full sample.

Multivariate analyses of financial literacy within four topic areas provide the most convincing evidence that our results are not driven by cohort effects. Life insurance ownership rates are higher among older age cohorts (Chen et al. 2003), so older Americans are more likely to have encountered information related to life insurance concepts. Three of the four insurance questions test knowledge and application of life insurance concepts (the fourth tests knowledge of insurance deductibles). The magnitude of annual decline in scores on insurance knowledge (0.96%) is nearly identical to the decline in basic financial literacy (0.94% per year) and similar to the annual decline in investment literacy (1.02%). We also find a similar annual decline among stockowners (0.98%), evidence that cohort effects related to differences in equity market participation are not driving the decline in financial literacy.

Empirical evidence from cross-sectional studies of cognitive aging shows a steady linear decline in tests of fluid intelligence and a more modest decline in problem solving that involves both processing ability and information retrieval. Financial literacy questions in the HRS assess numerical ability (for example the estimation of compound interest over time), as well as problem-solving skills (such as whether an employee should own employer stock). Within this smaller sample, we find a similar linear decline in financial literacy score in old age. The HRS also includes measures of fluid and crystallized intelligence, allowing us to estimate the impact of cognition on financial literacy scores. These results indicate that nearly half of the relation between aging and the decline in financial literacy is correlated with declines in word recall (a measure of fluid intelligence) and vocabulary (a measure of crystallized intelligence). Although we are not able to tease out the origins of the decline in financial literacy, these results point to an interesting direction for future research. Our results suggest that, unlike the ability to solve a crossword puzzle (Salthouse 2010), which does not materially degrade with age, financial literacy might require both the ability to recall terms and solve problems. Fluid intelligence measured through word retrieval and crystallized intelligence measured through a vocabulary test have an equal impact on predicted financial literacy scores in the HRS.

A decline in financial skills may not lead to poor financial outcomes if individuals recognize and anticipate the decline. For example, recognition of diminished investment skills may increase demand for annuitization or the delegation of important financial decisions to a trusted advisor. However, our study finds that, in aggregate and within all financial decision-making domains, advanced age increases overconfidence in financial decision-making abilities. The largest marginal effects are within the investment

and insurance topic areas. The less educated, non-whites, and females are more likely to be financially overconfident in the old age sample.

Our results show that it is not so much the imbalance between confidence and knowledge that is causing poor financial decisions, but the low financial literacy itself. Many appear to be unaware of the gradual change in cognitive abilities in old age. For example, older drivers generally do not perceive a decline in their driving skills despite a predictable deterioration in sensory ability with advanced age (Holland and Rabbitt 1992). Those who took an objective test that provided evidence of a decline, however, modified their driving behavior to reduce the likelihood of getting into an accident. It is possible that increased awareness of the natural decline in cognitive abilities essential to making effective financial decisions will lead to greater demand for more passive financial instruments such as annuities or passive investment vehicles that automatically rebalance. It may also increase demand for professional services such as financial planning, accounting, and legal assistance that substitute for one's own decision-making ability. The simultaneous decline in financial literacy and increase in decision-making confidence with advanced age also has implications for national retirement policy. Programs (such as Social Security) that automatically annuitize retirement income and do not require a retiree to manage withdrawal and investment, may improve social welfare (Diamond 2004).

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Appendix A. Financial Literacy Assessment Test (FLAT) Items from the CFM Survey

Basics Items:

1. Net worth is equal to
 1. Total assets
 2. Total assets plus liabilities
 3. *Total assets minus liabilities*
2. If your assets increase by \$5,000 and your liabilities decrease by \$3,000, your net worth would
 1. Increase by \$2,000
 2. *Increase by \$8,000*
 3. Increase by \$3,000
3. Which bank account is likely to pay the highest interest rate on money saved?
 1. Savings account
 2. Six month CD or certificate of deposit
 3. *Three year CD*
4. Savings accounts and money market accounts are most appropriate for

1. Long-term investments like retirement
2. *Emergency funds and short-term goals*
3. Earning a high rate of return

Borrowing Items:

5. To reduce the total finance costs paid over the life of an auto loan, you should choose a loan with the
 1. Lowest monthly payment
 2. Longest repayment term
 3. *Shortest repayment*
6. If you always pay the full balance on your credit card, which of the following is least important?
 1. *Annual interest rate*
 2. Annual fees
 3. Line of credit
7. On which type of loan is interest never tax deductible?
 1. A home equity loan
 2. An adjustable rate mortgage
 3. *A personal vehicle loan*
8. Which type of mortgage would allow a first-time home buyer to qualify for the highest loan amount?
 1. Fixed-rate mortgage
 2. *Adjustable-rate mortgage*
 3. Reverse mortgage

Investing Items:

9. The benefit of owning investments that are diversified is that it
 1. *Reduces risk*
 2. Increases return
 3. Reduces tax liability
10. A young investor willing to take moderate risk for above-average growth would be most interested in
 1. Treasury bills
 2. Money market mutual funds
 3. *Balanced stock funds*
11. The main advantage of a 401(k) plan is that it
 1. Provides a high rate of return with little risk
 2. *Allows you to shelter retirement savings from taxation*
 3. Provides a well-diversified mix of investment assets
12. To ensure that some of your retirement savings will not be subject to income tax upon withdrawal, you would contribute to
 1. A Traditional IRA or Individual Retirement Account
 2. *A Roth IRA*
 3. A 401(k) plan

Insurance Items:

13. If you have an insurance policy with a higher deductible, the premiums will be
 1. Higher
 2. *Lower*
 3. The same
14. Which of the following types of insurance is most important for single workers without children?
 1. Life insurance
 2. *Disability income insurance*
 3. Dental insurance
15. Which policy provides the most coverage at the lowest cost for a young family?

1. *Renewable term life*
2. Whole life
3. Universal life

16. Which household would typically have the greatest life insurance needs?

1. A middle-class retired couple
2. A middle-aged working couple with children in college
3. *A single-earner family with two young children in preschool*

Confidence Items:

For the following four questions, record a number from 0 (LOWEST confidence) to 10 (HIGHEST confidence):

LOWEST CONFIDENCE

HIGHEST CONFIDENCE

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

1. How confident are you with managing money? —
2. How confident are you with managing credit and debt? —
3. How confident are you with using investment products? —
4. How confident are you with using insurance products? —

Appendix B. Financial Literacy-Related Items from the HRS Survey**Question 1.**

First, suppose you had \$100 in a savings account and the interest rate was 2% per year. After five years, how much do you think you would have in the account if you left the money to grow—more than \$102, exactly \$102, or less than \$102?

1. *More than \$102*
2. Exactly \$102
3. Less than \$102

Question 2.

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, would you be able to buy more than today, exactly the same as today, or less than today with the money in this account?

1. More than today
2. Exactly the same as today
3. *Less than today*

Question 3.

Do you think that the following statement is true or false: buying a single company stock usually provides a safer return than a stock mutual fund?

- 1 True
- 5 *False*

Question 4.

Which asset do you think historically has paid the highest returns over a long time period, say 20 years or more—savings accounts, bonds, or stocks?

1. Saving accounts
2. Bonds
3. *Stocks*

Question 5.

An employee of a company with publicly traded stock should have a lot of his or her retirement savings in the company's stock.

1. True
5. False

Question 6.

It is best to avoid owning stocks of foreign companies.

1. True
5. False

Question 7.

If the interest rate falls, bond prices will rise.

1. True
5. False

Endnotes

¹Calculated from the 2008 Survey of Consumer Finances (Federal Reserve Board, Washington, DC).

²<https://www.chrr.ohio-state.edu/content/surveys/cfm/cfm.html> (last accessed December 20, 2015).

³The complete financial literacy assessment instrument can be found at <https://sites.google.com/site/pfinttu/flat>.

⁴Construct validity estimates for our financial literacy assessment instrument are higher than for previous financial literacy instruments, and the sample size is more than twice as large as any previous literacy module (Hung et al. 2009).

⁵Although there is some debate about the use of cross-sectional data to identify age-related decline in task ability, Salhouse (2009) illustrates how longitudinal estimate biases caused by subject learning create significant problems in panel data. Even questions that measure spatial orientation and word recall show increased ability in subsequent panel surveys among young and old respondents, whereas cross-sectional data show a consistent decline (Salhouse 2009). The best method of estimating age-related task decline is to carefully reduce potential cohort effects through empirical models that control for differences among age groups that may be related to task ability.

⁶<http://hrsonline.isr.umich.edu/index.php?p=showmod> (last accessed December 20, 2015).

⁷Regressions using a nonlinear functional form provide no evidence that the rate of decline in financial literacy changes in advanced age.

⁸McArdle et al. (2007) subject the cognition variables in the HRS to a factor analysis and find that the single vocabulary score is likely “the only indicator of crystallized intelligence” (p. 542) and that the two word recall variables load to a single factor that may be conceptualized as fluid intelligence.

⁹A quadratic age specification yields an insignificant age-squared coefficient that is near zero indicating no inflection point of age on financial literacy in the older sample.

¹⁰To address the possibility of reverse causality in the financial control variables, we also run the multivariate analysis without high wealth, homeownership, stock ownership, and sheltered tax savings and find that the linear age parameter estimate rises to -1.11 and remains statistically significant at $p < 0.01$.

¹¹We also perform a series of ordered logitics on the topic area score and find that the relation between age and financial literacy scores within each topic is negative and statistically significant.

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