Is Financial Literacy Dangerous? Financial Literacy, Behavioral Factors, and Financial Choices of Households

Tetsuya Kawamura, Tomoharu Mori, Taizo Motonishi, and Kazuhito Ogawa

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Tetsuya Kawamura[1, 5], Tomoharu Mori[2, 5], Taizo Motonishi[3, 5], and Kazuhito Ogawa[4, 5]

[1]School of Business, Japan University of Economics
[2]College of Comprehensive Psychology, Ritsumeikan University
[3]Faculty of Economics, Kansai University
[4]Faculty of Sociology, Kansai University
[5]Research Institute for Socionetwork Strategies, Kansai University

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Abstract

Using purpose-built original 2018 Japanese survey data, we estimate the financial behaviors and attitudes of households. We find that financial literacy plays an important and consistent role in financial decision-making. This result is contrary to common sense: People with high financial literacy tend to take too many risks, overborrow, and hold naive financial attitudes; that is, financial literacy makes people daring and reckless in some financial ways. Overconfidence in financial ability can be the cause of this behavior. However, financially literate people are good at retirement planning and are indifferent to gambling. Preferences, such as risk and loss aversions and discount factors, also have a role in financial choices.

1 Introduction

Owing to the growing need of people to save for their retirement and the increased opportunities for financial transactions by the development of financial technologies, an increasing number of households face complicated financial decisions. Researchers have investigated the relationship between financial literacy and household decision-making to find better financial education policies for individuals. Financial literacy is related to more stock investment (e.g., van Rooij, Lusardi and Alessie (2011)), low-cost and moderate borrowing (e.g., Lusardi and Tufano (2015)) , and better retirement planing (e.g., Sekita (2011), Clark, Morrill and Allen (2012), van Rooij, Lusardi and Alessie (2012)).

To explain household behaviors, the recent literature focuses also on economic preferences and beliefs. Economists and psychologists have been developing experimental techniques and questionnaire methods to expose individual preferences and beliefs and apply them to a wide range of behaviors (e.g., Dohmen, Falk, Huffman, Sunde, Schupp and Wagner (2011), Falk, Becker, Dohmen, Enke, Huffman and Sunde (2018)). Since financial decisions are risky, ambiguous, and long-terme, they are thought to be strongly related to nonstandard preferences and beliefs besides financial literacy, as well as standard ones.

We investigate the effects of financial literacy and behavioral factors (i.e., preferences and beliefs) on households' financial behaviors and attitudes to obtain policy implications for financial education and consumer protection. Our analyses are based on a purpose-built original Internet survey of 5,848 respondents aged 20-80 years and conducted in March 2018. The survey questionnaire includes financial behaviors and attitudes, knowledge (e.g., financial literacy) and skills (e.g., calculation speed), standard preferences (e.g., risk aversion and discount rate), nonstandard preferences and beliefs (e.g., loss aversion and overconfidence), and demographic factors.

A substantial amount of literature investigates the relationship between financial literacy, behavioral factors, and financial behavior[1]. We build upon the previous literature in four ways. First, we evaluate financial behaviors and attitudes from several viewpoints: speculative investment, risk asset holdings, overborrowing, financial naivety, insufficient retirement planning, and gambling. Second, we collect broad behavioral factors such as overconfidence, present bias, loss aversion, S-shaped probability weighting, and ambiguity aversion, as well as risk aversion and discount rate. These nonstandard preferences and beliefs are important in analyzing the effects of financial literacy because financial literacy education is usually considered a way to prevent irrational financial behaviors and attitudes of households. Third, we used comprehensive and accurate measures of the determinants of financial behaviors and attitudes by using a purpose-built original survey. Financial literacy is measured by 10 financial questions. Calculation speed (a proxy for cognitive ability) and risk aversion are measured by incentivized questions. Fourth, the relationship between financial literacy and financial behavior is not assumed to be constant; i.e., we allow that a little learning and serious learning have different marginal effects.

The regression results show, somewhat surprisingly, that high financial literacy induces

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[1]See Beshears, Choi, Laibson and Madrian (2018), for example.

some inappropriate financial behaviors and attitudes, such as speculative investment, excessive borrowing, and financial naivety. That is, financial literacy makes people daring and reckless in some financial ways. Overconfidence in financial ability can be the cause of this behavior. In contrast, financially literate people are good at retirement planning and are indifferent to gambling.

The significant effects of overconfidence in the financial quiz score show that financial choices are determined by their "perceived" as well as actual financial literacy. Moreover, a higher discount rate is associated with more overborrowing, insufficient retirement planning, and more gambling, whereas it leads to less financial naivety. Other behavioral factors (present bias, risk aversion, loss aversion, S-shaped probability weighting, and ambiguity aversion) generally tend to make people less daring and reckless in some financial ways.

Our results are especially noteworthy because the introduction of financial education into secondary education is under consideration in some countries, including Japan. While financial literacy is believed in the public mind to be effective in preventing households from making inappropriate financial choices, our results show the possibility that financial literacy leads to more inappropriate behaviors and attitudes.

We also show that the determinants of financial behavior are associated with age and gender, which have important implications for financial education. Younger generations are financially illiterate, less financially experienced, less underconfident in financial quiz scores, and patient. Males tend to be more financially literate, less underconfident, and more impatient than females.

The remainder of this paper is organized as follows. Section 2 summarizes the literature related to this research. Section 3 explains the data and empirical methodology. Section 4 reports the estimation results, and Section 5 discusses the results and concludes.

2 Related Literature

Existing research on the relationship between financial literacy and household financial behaviors and attitudes used one of the following two approaches: examining the effects of the levels of financial literacy or examining the effects of the changes in financial literacy. Studies adopting the first approach use financial literacy quiz scores and show that financial literacy plays an important role in financial decisions of households. van Rooij et al. (2011) conclude that people with low financial literacy are less likely to invest in stocks. Lusardi and Tufano (2015) show that people with low financial literacy tend to engage in high-cost borrowing. Sekita (2011) finds that people with high financial literacy are more likely to have a retirement savings plan. Clark et al. (2012) argue that incorrect knowledge of older workers about company and national retirement plans affects their retirement plans. van Rooij et al. (2012) indicate that there is "a strong and positive relationship between financial knowledge and retirement planning." The estimated effects of financial literacy on financial behaviors in these studies are generally favorable for households.

These survey-based studies are important as they use data from respondents from a wider variety of backgrounds compared with experiment-based studies described below. The

proof of causality in the survey-based studies is, however, not definitive because they use observational financial literacy data.

The second approach uses quasi-experimental or experimental techniques to evaluate the causal effect of financial education and finds mixed results. Duflo and Saez (2003) find a significant effect of encouragement to attend a benefits information fair on the enrollment rate of a tax deferred account retirement plan. Using state-level policy changes in the United States, Brown, Grigsby, Van Der Klaauw, Wen and Zafar (2016) argue that economics education leads to more debt and repayment difficulties, whereas mathematics and financial education have the opposite effects. Bruhn, Leão, Legovini, Marchetti and Zia (2016), evaluating high school financial education in Brazil, conclude that while financial education improves savings and budgeting, it also leads to expansive credit use. Skimmyhorn (2016)) shows that the Personal Financial Management Course of the U.S. Army reduces some inappropriate credit card activities in the first year after the course but not in the second year. The estimated effects of financial literacy on financial behavior in these studies are mixed.

Although the advantage of the second approach in identifying causality is apparent, this approach also has its limits in that its data are obtained from people with a specific background or from people in a specific age group. Another limitation of these experimental studies is the degree of financial education intervention. Even a high school curriculum reform analyzed by Bruhn et al. (2016) could be small compared with lifelong financial learning. In contrast, most existing survey-based studies analyze broad general populations and evaluate the effect of larger financial literacy differences compared with experiment-based studies. As we point out in Section 3.4, people's financial literacy improves almost linearly as they age from their 20s to 70s. Considering that financial behavior is relevant especially for the elderly, who generally have larger assets compared with younger generations, it is important to evaluate the effects of large-scale lifelong financial learning.

One of the limitations of existing studies of both approaches is that they do not pay much attention to the stability of the gradient of the relationship between financial literacy and behavior. In existing survey-based studies, a linear relationship is assumed. In an experimental study, it is usually not an easy task to evaluate different degrees of interventions. As Beshears et al. (2018) point out, a possible reason for the mixed results in experimental studies is that what constitutes "financial education" varies according to each study. One dimension of the variability can be the degree of intervention. While Skimmyhorn (2016), for example, evaluates the effect of an eight-hour financial literacy course, Brown et al. (2016) examine the effect of high school curriculum reforms.

In the context of learning-by-doing, Sanchez and Dunning (2018) point out that beginners tend to be overconfident about their performance before they reach an intermediate level. Knecht (2013) argues, in the context of aviation accidents, that although a linear relation is typically assumed between a pilot's total flight hours and aviation accident rate, it is actually a nonlinear relation; that is, fatalities occur most frequently at middle ranges of total flight hours. This is "perhaps because pilots are overconfident" (p. 50). This observation suggests that "a little learning is a dangerous thing." If this also applies to beginners in finance, then the relationship between financial literacy and appropriate financial behavior can be nonlinear; that is, the marginal effect of little learning and that of serious learning can be

different. More financial literacy can lead to more inappropriate behavior because of the possible overconfidence in financial ability.

This study takes the first approach to evaluate the effects of lifelong financial learning by using a purpose-built original 2018 Japanese survey of the broad general population. The survey includes ten financial literacy questions. This enables us to take varying gradients of the relationship between financial literacy and behavior into account in evaluating the effects of financial literacy. Moreover, although most existing studies analyze only a few types of financial behaviors and attitudes, we investigate six types of financial behaviors, including speculative investment, financial naivety, and gambling, as well as speculative investment, risk asset holdings, and retirement planning.

Considering that financial education is usually aimed at inducing households to make appropriate financial choices, evaluating the effects of nonstandard preferences and beliefs along with financial literacy is important. This study accomplishes this task by taking various behavioral factors into account, which makes this study unique among previous research.

Apart from the studies on the effects of financial literacy, the rest of this section focuses on research on the effects of behavioral factors on financial behaviors. There is a substantial amount of this type of research. This is partly because the recent financial crisis has made economists and policymakers pay attention to financial consumer protection. Shui and Ausubel (2005) find that consumers have a severe self-control problem when they are faced with an introductory offer that presents a lower interest rate with a shorter duration. There is a debate on the consequences of the effect of high-interest consumer credit such as payday loans (e.g., Melzer (2011), Morse (2011)).

Recently, a growing number of studies in various fields have begun to investigate the relationship between economic preferences, psychological biases, and household behaviors using experiments or surveys. For example, Dohmen et al. (2011) and Sutter, Kocher, Glätzle-Rützler and Trautmann (2013) investigate the relationship with a wide range of individual behaviors, including financial ones. Barsky, Juster, Kimball and Shapiro (1997), Anderson and Mellor (2008), and Goldzahl (2017) investigate the relationship in health economics, Burks, Carpenter, Goette and Rustichini (2009) and Fouarge, Kriechel and Dohmen (2014) in labor economics, and Liu (2013) in development economics.

In financial economics and household finance, experiments or surveys are typically used to explain household finance behaviors. Much research focuses on risk preference as the central parameter in financial decisions. For example, Donkers and van Soest (1999) and Dohmen et al. (2011) use subjective measures of risk preference and relate them to financial behaviors. Guiso and Paiella (2008) find that risk aversion, elicited by a direct question of willingness-to-pay for security, is associated with income uncertainty and liquidity constraints.

Time preferences are often mentioned in the context of debt borrowing. Using an incentivized experiment, Meier and Sprenger (2010) find that present biases correlate with credit card debt, and Meier and Sprenger (2012) find that discount factors correlate with creditworthiness and repayment decisions. In association with financial literacy, Meier and Sprenger (2013) show that individuals who have high discount factors are more likely to acquire personal financial information.

Ambiguity aversion is also often mentioned because financial risks often include some

ambiguities. Dimmock, Kouwenberg, Mitchell and Peijnenburg (2016) show that ambiguity aversion elicited by the Elsberg urn experiment is negatively correlated with stock market participation and the fraction of financial assets in stocks. Numerous studies investigate the relationship between overconfidence and financial behaviors (e.g., Biais, Hilton, Pouget and Mazurier (2005), Deaves, Lüders and Luo (2009), Grinblatt and Keloharju (2009), Fellner-Röhling and Krügel (2014), and Kinari (2016)). Most of these studies find results that are consistent with economic theories.

There are methodological debates on the estimation of preferences and beliefs. Economists prefer revealed preferences elicited by incentivized experiments based on induced value theory (Smith (1976, 1982))[2], but they involve physical and monetary costs. It is difficult to elicit preferences and assemble a large and representative sample; however, researchers can now use sophisticated Internet survey or crowd-sourcing methods (e.g., Horton, Rand and Zeckhauser (2011), Arechar, Gächter and Molleman (2018)).

3 Data and Methodology

3.1 Data

This study uses the purpose-built survey data from RISS (the Research Institute for Socionetwork Strategies) of Kansai University. The Institute conducts a series of web-based surveys on an irregular basis. The survey data were collected in March 2018 from a pool of 350 thousand Japanese respondents maintained by MyVoice, a web survey company in Japan. The company informs its registered members about the start of the survey and recruits respondents according to the predetermined proportions of 282 prefecture–age–gender groups (47 prefectures and age groups of 20s, 30s, 40s, 50s, 60s, and 70s and over). The share of each group is determined by the national population share of the prefecture multiplied by the national population share of the age–gender group. The survey questions are tailored by the authors to capture financial behaviors and attitudes, financial literacy, knowledge and skills, preferences, beliefs, and other individual characteristics. The definitions of the variables used in the regressions and corresponding survey questions are summarized in Tables 1, 2, A1 and A2. The summary statistics for the variables used in the regressions are presented in Table 3.

3.2 Empirical variables

3.2.1 Financial behaviors and attitudes

Financial behaviors and attitudes are captured by six variables in Table 1: speculative investment, the share of risk assets, overborrowing, financial naivety, insufficient retirement planning, and gambling. Those variables are aimed at capturing potentially problematic financial behaviors and attitudes of the respondents. The share of risk assets is the share of

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[2]Mata, Frey, Richter, Schupp and Hertwig (2018) argue that stated preferences are more stable than revealed preferences for risk preference.

Table 1: Definitions of Dependent Variables

Variables	Definitions
Speculative Investment	The share of counted responses to questions SI1 and SI2 about speculative investment.
Share of Risk Assets	The share of individual domestic stocks and foreign-currency-denominated assets in the household financial assets.
Overborrowing	Share of counted responses to overborrowing questions OB1-OB6.
Financial Naivety	The share of counted responses to financial naivety questions FN1-FN4.
Insufficient Retirement Planning	Share of counted responses to retirement planning questions RP1-RP10.
Gambling Interest	The share of counted responses to gambling interest questions GI1 and GI2.

See Table A1 for the corresponding survey questions.

individual stocks and foreign-currency-denominated assets obtained from questions on asset shares. Other variables are created from answers to the questions presented in Table A1. The values of these variables are the number of counted answers (specified by square brackets in Table A1) for a corresponding group of questions.

The speculative investment variable captures potentially risky financial behaviors by asking the respondents whether they have experience in trading FX, stocks on margin, futures, options, or Bitcoin. Although these financial instruments are not necessarily speculative if they are used prudently in appropriate occasions, they are basically speculative for most households in that they are leveraged investments for volatile financial assets. The questions used for creating the variable are SI1 and SI2 in Table A1. FX is a form of foreign currency speculation in Japan that allows investors (often called Mrs. Watanabe) to trade at the maximum leverage of 25. In recent years, cryptocurrencies emerged as an alternative to FX as a way of speculative financial trading. A survey conducted by a cryptocurrency exchange shows that only 19 percent of cryptocurrency holders intend to use cryptocurrencies for making payments[3].

The overborrowing variable reflects high-interest or excessive borrowing. The questions used for creating the variable are OB1-OB6 in Table A1. "Revolving payment" (ribo-barai in Japanese) is a combination of revolving credit and a monthly minimum payment. The interest rate for a revolving payment by a credit card is about 15%. Only 20% of the respondents stated that they had ever used revolving payments. Another form of high interest rate borrowing is consumer financing, for which the interest rate is about 18%, which is equal to the legal ceiling on interest rates in Japan. Insufficient funds, credit card renewal refusal, and default reflect excessive borrowing.

The financial naivety variable measures unsophisticated or innocent attitudes of households to potential rip-offs that are hyperbole or unnecessarily complicated. The questions

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[3]The survey was conducted by GMO Coin Inc in 2019 (https://coin.z.com/jp/news/2019/03/1479/, in Japanese)

Table 2: Definitions of Independent Variables

Variables	Definitions
Financial Literacy	Share of correct responses to financial literacy questions FL1-FL10.
Financial Education at University	1: Graduated from economics, business, or commerce department.
Education	0 Junior high school or less, 1 High school, 2 Two-year college, 3 University, 4 Master's degree, 5 Doctor's degree
Financial Experience	The share of counted responses to financial experience questions FE1 and FE2.
Calculation	Natural log of the speed to choose a row or column that adds up to 10 in a 4x4 matrix with a decimal in each cell
Absolute Overconfidence in Financial Quiz Score	Responses to question CFL minus correct responses to ten financial literacy questions.
Discount Rate	One-year discount rate for 10,000 hypothetical yen (about 90 dollars) obtained from the switching point of a price list question
Present Bias	The above discount rate minus the discount rate for the period from one month after to 13 months after
Risk Aversion	Absolute risk aversion obtained from the switching point of a price list of lotteries incentivized by points convertible to gift certificates
Loss Aversion	The marginal loss to gain ratio for a participation in the hypothetical coin flip question LA of gaining some amount of money for heads and losing 10,000 yen (about 90 dollars) for tails
S-Shaped Probability Weighting	The tendency to overweight small probabilities and to underweight large ones calculated from three questions from Tanaka, Camerer and Nguyen (2010) about switching points in price lists of lotteries
Ambiguity Aversion	The dummy variable for the known-ratio urn choice in the ambiguity aversion question AA.
Household Size	Number of persons living together in a household
Household Income	Log income obtained from the income rank question
House Ownership	The dummy variable for owning a house
Population Density	Log population density of municipalities of residence

See Table A2 for the corresponding survey questions.

Table 3: Summary Statistics

	count	mean	sd	min	max
Speculative Investment	5848	0.07	0.19	0	1
Share of Risk Assets	5848	0.12	0.23	0	1
Overborrowing	5848	0.10	0.18	0	1
Financial Naivety	5848	0.31	0.14	0	1
Insufficient Retirement Planning	5848	0.78	0.21	0	1
Gambling Interest	5848	0.68	0.40	0	1
Financial Literacy	5848	0.54	0.28	0	1
Financial Education University	5848	0.06	0.24	0	1
Education	5845	2.12	1.07	0	5
Financial Experience	5848	0.06	0.17	0	1
Calculation Time (Seconds)	5847	172	160	1	2477
Absolute Overconfidence in Financial Quiz Score	5848	-0.10	0.22	-1	1
Discount Rate	5848	0.13	0.11	0.00	0.30
Present Bias	5848	0.00	0.06	-0.30	0.30
Risk Aversion	5051	0.40	0.82	-0.95	1.37
Loss Aversion	5848	6.30	7.33	0.1	20
S-Shaped Probability Weighting	5848	0.39	0.24	-0.45	0.95
Ambiguity Aversion	5848	0.81	0.39	0	1
Male	5848	0.50	0.50	0	1
Married	5848	0.62	0.49	0	1
Household Size	5848	2.77	1.28	1	7
Household Income (Ten Thousand Yen)	5766	566	378	150	2000
House Ownership	5848	0.72	0.45	0	1
Population Density (Thousand per Square Kilometer)	5843	3.87	4.69	0.00	22.38
Observations	5848				

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used for creating the variable are FN1-FN4 in Table A1. Question FN1 captures the indifference to financial fees. A 0.2% monthly fee is about a 2.4% yearly fee, which is almost equal to the average ROA of 2–3% for companies in the Nikkei 225 in the 2010s. Question FN2 captures the respondents' indifference to the complexities of insurance policies. Kunreuther, Pauly and McMorrow (2013) present return-of-premium life insurance policies as an example of complex types of coverage, which is often regarded by financial advisors as questionable. This is because the combination of insurance and savings makes it complicated and difficult for the insurance policy to attain competitive pricing. Kunreuther et al. (2013) also argue that the popularity of insurance policies with gaps in coverage is another example of anomalies in the insurance market. Some policies cover only minor damage but not catastrophic damage. Considering the costs incurred by the insurer and the effect of adverse selection, buying insurance against small damages is generally not reasonable. Question FN3 captures the respondents' preference for these unnecessary and possibly overpriced insurance policies. Question FN4 test the respondents' tendency to be attracted by too-good-to-be-true investment opportunities. Although an investment with a guaranteed principal and a high rate of return is fraudulent advertising in financial markets, 11% of the respondents stated that they are attracted to those opportunities.

Retirement planning behavior is measured by the scores of the 10 retirement planning questions, RP1-RP10, in Table A1. Under the universal public pension system, all Japanese aged 20 years or over receive yearly letters about their estimated future annuity. RP1 in Table A1 asks whether the respondents always scan these letters. RP7 asks about the planning behavior for their retirement, with 13% of the respondents stating that they have created their own financial plan for their retirement.

The gambling interest variable measures attitudes against public lotteries and legal gambling by using GI1 and GI2 in Table A1. In Japan, gambling is generally forbidden except for state-controlled or decriminalized gaming. GI1 in Table A1 asks about interest in public lotteries. GI2 is about public gambling and pachinko, a Japanese pinball game. Yearly sales of public lotteries, public gambling, and pachinko in Japan were 0.16%, 1.0%, and 3.6% of GDP in 2018, respectively.

3.2.2 Knowledge and skills

Financial literacy, financial education at university, school education, financial experience, and calculation ability variables presented in Table 2 are included in our financial behavior regression as knowledge and skills variables. Financial literacy is measured by the score of a financial quiz that consists of the 10 financial questions presented in Table A2. The questions in Table A2 ask about interest calculation (FL1), compound interest calculation (FL2), inflation (FL3), bond price (FL4), mortgage (FL5), diversified investment (FL6), foreign exchange rate (FL7), liquidity (FL8), insurance (FL9), and risk-return tradeoff (FL10). FL2, FL3, and FL6 correspond to the "big three" questions by Lusardi and Mitchell (2011), with the following modifications. In FL2, the amount of money is modified to make the problem reasonably difficult, and it is presented in Japanese yen terms. In FL6, we replaced "mutual fund" in the big three questions with its explanation, "splitting an investment between a

number of companies" considering the low recognition of mutual funds in Japan.

Financial experience is measured by questions FE1–FE6 in Table A2, which capture financial work and study of the respondents. The questions are presented in Table A2.

Calculation ability is measured by the speed with which the correct answer is given to the five questions of choosing a row or column that adds up to 10 from a 4x4 decimal matrix. This question is incentivized in that the respondents obtain more bonus points when they answer quickly (see Section 3.3 for details).

3.2.3 Preferences and beliefs

Preference and belief variables include overconfidence, discount rate, present bias, risk aversion, loss aversion, S-shaped probability weighting, and ambiguity aversion, as presented in Table 2. Overconfidence in the financial quiz score is measured by the absolute overconfidence, i.e., the difference between the score of the financial quiz and the respondent's expectation of the score measured by question CFL in Table A2[4]. As is shown in Table 3, the average Japanese household is underconfident by about 10%. Please note that the overconfidence variable captures only overconfidence in the financial quiz score. It is possible, however, that a person with a good financial quiz score and no financial quiz score overconfidence (i.e., the person's financial quiz score is equal to the person's expectation) engages in inappropriate financial behavior because of overconfidence in financial ability, like the effect of total flight hours on aviation accident rate (Knecht (2013)). This kind of overconfidence is captured not by the overconfidence variable of the financial quiz but by the financial quiz score variable explained in Section 3.2.1.

The discount rate is a one-year discount rate for 10,000 hypothetical yen (about 90 dollars) obtained from the switching point of a multiple price list question. Present bias is the one-year discount rate minus the discount rate for the period of one month after to one year and one month after. Risk aversion is the absolute risk aversion obtained from the switching point of a multiple price list of lotteries. They are incentivized by reward points that are convertible to gift certificates (see Section 3.3 for details).

Loss aversion is measured by question LA in Table A2 and is the marginal loss to gain ratio for participation in the hypothetical coin flip of gaining some amount of money for heads and losing 10,000 yen (about 90 dollars) for tails. S-shaped probability weighting is the tendency to overweight small probabilities and to underweight larger ones calculated from the answers to the three hypothetical lotteries from Tanaka et al. (2010). Ambiguity aversion is measured by question AA in Table A2 and is the dummy variable for the known-ratio urn in the hypothetical Ellsberg urn choice.

3.2.4 Other individual characteristics

Other individual variables include age, gender, marital status, household size, household income, house ownership, and population density. Population density is that of the respon-

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[4]Relative overconfidence is defined as the difference between the respondent's expectations and actual above-average score.

dent's residential municipality. The estimated coefficients for these variables, except for age and gender, are omitted from the regression results tables.

3.3   Incentive payment

In our survey, the participants earn reward points consisting of the questionnaire participation fee of 90 points and the bonus points. Reward points can be exchanged for universal gift certificates, book cards, PeX points, Amazon gift certificates, WebMoney, App Store money, or iTunes codes[5].

The questions for risk aversion and the calculation task are incentivized in the bonus points. In the questions for risk aversion, the participants are asked to select one lottery from two possible lotteries (safe lottery and risky lottery) in 10 cases (cases 1–10) in the same manner as in Holt and Laury (2002). In case $X \in \{1, 2, \ldots, 10\}$, the participants earn 40 points ($10 \times X\%$) or 32 points ($100 - 10 \times X\%$) in the safe lottery, and they earn 75 points ($10 \times X\%$) or 2 points ($100 - 10 \times X\%$) in the risky lottery. One of the cases is randomly chosen, and the result in the chosen lottery is added to the bonus points.

In the calculation task, the participants are asked to complete five tasks in 300 seconds. The remaining time is reduced by 60 seconds for each incorrect answer. After the completion of the tasks, the remaining seconds $\times 0.1$ points are added to the participants' bonus points.

3.4   Econometric framework

We estimate the effects of financial literacy, preferences, and beliefs on financial behaviors and attitudes using the following regression model:

$$Y_i = K_i\beta_0 + P_i\beta_1 + X_i\gamma + \alpha + \epsilon_i, \tag{1}$$

where Y_i is a vector of the financial behaviors and attitudes of respondent i; K_i is a vector of the knowledge and skills, including financial literacy; P_i is a vector of preference and belief variables; X_i is a vector of other individual characteristics; α denotes the constant term; and ϵ_i is an error term. All the dependent and independent variables are standardized. OLS is used in Tables 6-8 to estimate Equation (1). In Table 9, ordered probit models are used for regressions with discrete dependent variables.

The effect of the financial literacy variable is the focus of our regression model. This variable, however, could be endogenous, especially when the dependent variables are speculative investment, share of risk assets, and overborrowing. This is because these financial behaviors may increase the respondents' financial literacy as a result of more financial experience. To deal with this potential endogeneity problem, we employ two instrumental variables: parents' financial work experience and parents' stock trade experience. The IV regression results are presented in Tables A3 and A4.

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[5]The list of the gifts exchangeable for points is shown at http://www.myvoice.co.jp/voice/about/point.html

Our hypothesis about the effect of financial literacy is that it has both positive and negative effects on financial behaviors and attitudes. Even if we assume, as commonly believed, that more financial literacy induces appropriate financial behaviors and attitudes, the direction of the effect on the share of risk assets is undecided because the optimal risk asset share is usually neither 0 nor 100 percent. Moreover, as we saw in Section 2, more financial literacy can lead to inappropriate financial behaviors and attitudes because of the possible overconfidence in financial ability. If this is true, the directions of the effect of financial literacy are undecided for all the six variables of financial behaviors and attitudes.

Our hypothesis about the effect of discount rate and present bias is that they have negative effects on speculative investment and risk asset holdings and that they have positive effects on overborrowing and insufficient retirement planning. As for the effect of risk aversion, loss aversion, and ambiguity aversion, our hypothesis is that they have negative effects on all financial behaviors and attitudes. This is because these factors work to contain the risk-taking that is needed for more financial activities (or inactivity for retirement planning).

Table 4 shows the correlation matrix for the knowledge and skills variables and preference and belief variables. Financial literacy is positively correlated with other knowledge and skills variables, risk aversion, and ambiguity aversion, and is negatively correlated with overconfidence in the financial quiz score and discount rate.

Table 4: Correlation Matrix for Independent Variables

	Fin. Lit.	Fin. Edu.	Edu.	Fin. Exp.	Calc.	A. Oconf.	Discount	Pr. Bias	Risk Av.	Loss Av.	S Prob. W.	Am. Av.
Fin. Lit.	1.00											
Fin. Edu.	0.12***	1.00										
Edu.	0.18***	0.19***	1.00									
Fin. Exp.	0.12***	0.11***	0.00	1.00								
Calc.	0.15***	0.07***	0.12***	0.02	1.00							
A. Oconf.	-0.44***	0.00	0.01	0.01	0.01	1.00						
Discount	-0.06***	-0.01	-0.08***	-0.02	-0.01	-0.01	1.00					
Pr. Bias	0.00	0.01	-0.02	0.00	0.01	0.02	0.29***	1.00				
Risk Av.	0.23***	0.02	0.04**	0.01	0.06***	-0.10***	0.03*	0.02	1.00			
Loss Av.	0.00	0.01	0.04**	-0.03*	0.01	0.01	0.05***	0.02	0.13***	1.00		
S Prob. W.	0.02	-0.02	-0.05***	0.01	0.01	-0.02	0.03*	0.02	0.07***	0.02	1.00	
Am. Av.	0.17***	0.03*	0.02	0.00	0.04***	-0.08***	0.02	0.01	0.18***	0.02	0.03*	1.00

To further clarify the relationship among those variables, financial literacy is regressed on other explanatory variables. The result in Table 5 indicates that financial literacy is closely correlated with other knowledge and skills variables, preference and belief variables, and other individual characteristics. The estimated coefficients are basically consistent with the estimated correlations presented in Table 4. High financial literacy is attained by those who are more financially experienced, fast in calculation, educated, underconfident in financial literacy, patient, risk-averse, with S-shaped probability weighting, ambiguity averse, and old. The estimated effect of discount rate is consistent with Meier and Sprenger (2013), who show that individuals who choose to acquire financial literacy discount the future less. People in their 70s and over have the highest financial quiz score compared with people in other age groups after controlling for other factors listed in the table.

Table 5: Financial Literacy Regression

	Fin. Literacy
Fin. Edu. Univ.	0.046***
	(0.010)
Education	0.119***
	(0.012)
Fin. Experience	0.082***
	(0.011)
Calculation	0.130***
	(0.012)
A. Overconf. FL	-0.409***
	(0.010)
Discount Rate	-0.057***
	(0.012)
Present Bias	0.023*
	(0.012)
Risk Aversion	0.165***
	(0.011)
Loss Aversion	-0.010
	(0.012)
S Prob. W.	0.023**
	(0.011)
Ambiguity Aver.	0.086***
	(0.012)
30s	0.016
	(0.016)
40s	0.093***
	(0.017)
50s	0.100***
	(0.017)
60s	0.198***
	(0.018)
70 and over	0.218***
	(0.018)
Male	0.148***
	(0.012)
R-Squared	0.391
N	4968

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Omitted variables: marital status, household size,

household income, home ownership,

population density, and a constant term.

4 Results

4.1 Knowledge and skills

Table 6 shows the OLS estimates of Equation (1). The coefficients for several independent variables (marital status, household size, household income, house ownership, and population density) are dropped from the table. Columns (1) and (2) show the results for speculative investment and the share of risk assets. Financial literacy has positive and significant effects in both regressions. The result shows that those with high financial literacy are highly active in the financial markets. The result for speculative investment is a warning sign that financially literate people are financially too active. The result for the share of risk assets is consistent with van Rooij et al. (2011).

The regression results in columns (3) and (4) show the effects of overborrowing and financial naivety. They suggest a somewhat bleak picture of financially literate respondents. Overborrowing implies that the respondent has borrowed money at a very high-interest rate or has had difficulty in debt repayment. The positive coefficient for financial literacy implies that financially literate respondents tend to have the experience of being too deep in debt. Financial naivety reflects inadvertent attitudes, which seems to contradict with high financial literacy. The regression result, however, shows that respondents with high financial literacy tend to engage in more naive behavior in the financial markets. Combining the results in columns (1)-(4), we can summarize that people with higher financial literacy are "daring and reckless"; i.e., they take risks, overborrow, and behave in a more financially naive manner. Overconfidence in financial ability can be the cause of this behavior.

In contrast to the above regression results, the results in columns (5) and (6) show that high financial literacy leads to preparedness for retirement and a distaste for gambling. These results are consistent with the conventional view that inappropriate financial behaviors and attitudes are negatively correlated with financial literacy. One may notice that the financial literacy variable has the opposite sign in the speculative investment regression, and the gambling regression. The respondents do not seem to see gambling as a form of speculative investment and the financially literate people are discreet about gambling.

Financial education at university does not seem to have a significant impact on financial behaviors and attitudes, in contrast to its significant effect on financial literacy, as presented in Table 5. General education contributes to containing overborrowing and no-retirement-planning, while at the same time it induces taking more risks. The effect on overborrowing is opposite to that of financial literacy, suggesting that what is important for preventing overborrowing is not financial literacy but general education.

The effects of financial experience are similar to those of financial literacy, except for the insignificant effect on financial naivety. Calculation ability has no significant impact.

We also estimate parsimonious regression equations, focusing on the role of the financial literacy variable, to check the effects of the high correlation between financial literacy and other independent variables presented in Table 4. In Table 7, all knowledge, skills, preference, and belief variables other than financial literacy are dropped from Equation (1). In Table 8, only knowledge and skill variables other than financial literacy are dropped. The estimated

Table 6: Financial Behavior OLS

	(1) Specul.	(2) Risk Asset	(3) O. Borrow	(4) F. Naive	(5) I. Ret. P.	(6) Gamble
Fin. Literacy	0.234***	0.137***	0.112***	0.148***	-0.318***	-0.165***
	(0.018)	(0.018)	(0.017)	(0.016)	(0.016)	(0.017)
Fin. Edu. Univ.	-0.018	0.017	0.003	0.005	-0.021	-0.005
	(0.016)	(0.016)	(0.014)	(0.016)	(0.015)	(0.014)
Education	-0.009	0.085***	-0.095***	-0.008	-0.030**	-0.026*
	(0.016)	(0.016)	(0.015)	(0.016)	(0.014)	(0.015)
Fin. Experience	0.062***	0.057***	0.038**	0.013	-0.073***	0.027*
	(0.018)	(0.016)	(0.015)	(0.016)	(0.014)	(0.014)
Calculation	-0.010	-0.015	-0.003	-0.024*	0.006	0.001
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)
A. Overconf. FL	0.102***	0.097***	0.016	0.039**	-0.116***	-0.021
	(0.016)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)
Discount Rate	0.026*	-0.029*	0.125***	-0.050***	0.103***	0.044***
	(0.015)	(0.015)	(0.016)	(0.014)	(0.013)	(0.015)
Present Bias	-0.029**	0.003	-0.024	0.006	-0.025*	-0.003
	(0.014)	(0.019)	(0.017)	(0.015)	(0.013)	(0.013)
Risk Aversion	-0.034**	-0.071***	-0.028*	0.018	-0.031**	-0.116***
	(0.014)	(0.015)	(0.015)	(0.014)	(0.013)	(0.014)
Loss Aversion	-0.041***	-0.029**	-0.038***	-0.037***	0.016	-0.050***
	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.014)
S Prob. W.	0.022	-0.030**	0.018	0.018	-0.000	-0.010
	(0.014)	(0.014)	(0.014)	(0.015)	(0.013)	(0.014)
Ambiguity Aver.	0.009	-0.041***	0.013	0.027*	-0.021*	-0.062***
	(0.014)	(0.015)	(0.013)	(0.014)	(0.012)	(0.013)
30s	0.027	-0.049**	0.017	0.003	-0.038***	-0.003
	(0.022)	(0.019)	(0.018)	(0.018)	(0.014)	(0.017)
40s	-0.049**	-0.035	0.097***	0.010	-0.055***	-0.001
	(0.022)	(0.022)	(0.021)	(0.019)	(0.017)	(0.019)
50s	-0.073***	-0.052**	0.095***	0.017	-0.121***	-0.071***
	(0.022)	(0.021)	(0.021)	(0.019)	(0.017)	(0.020)
60s	-0.099***	-0.020	0.034	0.053**	-0.250***	-0.112***
	(0.024)	(0.023)	(0.022)	(0.023)	(0.020)	(0.022)
70 and over	-0.114***	0.024	-0.006	0.091***	-0.199***	-0.137***
	(0.025)	(0.024)	(0.022)	(0.024)	(0.020)	(0.022)
Male	0.121***	0.082***	0.068***	-0.003	0.031**	0.110***
	(0.015)	(0.014)	(0.014)	(0.015)	(0.013)	(0.014)
R-Squared	0.082	0.082	0.074	0.035	0.230	0.100
N	4968	4968	4968	4968	4968	4968

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Omitted variables: marital status, household size, household income, home ownership,
population density, and a constant term.

coefficients for the financial literacy variable are similar in Tables 6, 7, and 8. Despite the correlations between the explanatory variables, the estimated coefficients for the financial literacy variable are robust to the changes in the regression specifications.

	(1)	(2)	(3)	(4)	(5)	(6)
	Specul.	Risk Asset	O. Borrow	F. Naive	I. Ret. P.	Gamble
Fin. Literacy	0.170***	0.074***	0.076***	0.145***	-0.289***	-0.202***
	(0.013)	(0.014)	(0.013)	(0.011)	(0.012)	(0.013)
30s	0.028	-0.060***	0.030*	0.005	-0.037***	0.000
	(0.021)	(0.019)	(0.017)	(0.016)	(0.014)	(0.017)
40s	-0.044**	-0.068***	0.114***	0.007	-0.057***	0.004
	(0.021)	(0.021)	(0.020)	(0.018)	(0.016)	(0.018)
50s	-0.069***	-0.076***	0.119***	0.021	-0.114***	-0.055***
	(0.021)	(0.020)	(0.020)	(0.018)	(0.017)	(0.018)
60s	-0.086***	-0.048**	0.076***	0.040*	-0.235***	-0.096***
	(0.022)	(0.022)	(0.021)	(0.021)	(0.018)	(0.020)
70 and over	-0.090***	-0.005	0.038*	0.078***	-0.188***	-0.104***
	(0.022)	(0.022)	(0.021)	(0.021)	(0.018)	(0.021)
Male	0.123***	0.120***	0.060***	-0.006	0.018	0.118***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.013)
R-Squared	0.066	0.054	0.045	0.030	0.195	0.075
N	5761	5761	5761	5761	5761	5761

Table 7: Financial Behavior OLS

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Omitted variables: marital status, household size, household income, home ownership, population density, and a constant term.

Table 9 shows ordered probit regression results for the discrete dependent variables. The regression results are not substantially different from those in Table 6. Tables A3 and A4 show IV regression results, which correspond to Tables 6 and 9, respectively. These tables show that the estimated effects of financial literacy are robust to changes in the estimation method.

4.2 The literacy–behavior gradient

The regression results in Section 4.1 show that higher financial literacy is associated with some inappropriate financial behaviors and attitudes. A possible objection to this result is that the effects of financial literacy on financial behaviors and attitudes are not always negative, like the effect of total flight hours on aviation accident rate (Knecht (2013)). It is possible, for example, that the estimated effects apply only to people with a low to moderate level of financial literacy; i.e., the effects could reverse for people with more than a certain level of financial literacy, and financial experts are supposed to use their financial literacy properly. To further explore the relationship between the financial literacy variable and the financial behaviors and attitudes variable, we employ partitioned regression. First, both variables are regressed on other independent variables in Equation (1). Then, quadratic fit lines for residualized variables are plotted. Figure 1 shows the fitted lines along with binned

Table 8: Financial Behavior OLS

	(1) Specul.	(2) Risk Asset	(3) O. Borrow	(4) F. Naive	(5) I. Ret. P.	(6) Gamble
Fin. Literacy	0.237***	0.159***	0.099***	0.143***	-0.334***	-0.166***
	(0.018)	(0.018)	(0.017)	(0.015)	(0.016)	(0.017)
A. Overconf. FL	0.103***	0.106***	0.012	0.037**	-0.124***	-0.021
	(0.016)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)
Discount Rate	0.026*	-0.036**	0.131***	-0.050***	0.107***	0.045***
	(0.015)	(0.015)	(0.016)	(0.014)	(0.014)	(0.015)
Present Bias	-0.028**	0.004	-0.023	0.006	-0.026*	-0.003
	(0.014)	(0.019)	(0.017)	(0.015)	(0.013)	(0.013)
Risk Aversion	-0.034**	-0.071***	-0.029**	0.017	-0.030**	-0.116***
	(0.014)	(0.015)	(0.015)	(0.014)	(0.013)	(0.014)
Loss Aversion	-0.043***	-0.027*	-0.042***	-0.037***	0.016	-0.052***
	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.014)
S Prob. W.	0.023	-0.034**	0.022	0.018	0.001	-0.008
	(0.014)	(0.014)	(0.014)	(0.015)	(0.013)	(0.014)
Ambiguity Aver.	0.007	-0.041***	0.010	0.026*	-0.020*	-0.063***
	(0.014)	(0.015)	(0.014)	(0.014)	(0.012)	(0.013)
30s	0.027	-0.050**	0.017	0.003	-0.037**	-0.003
	(0.022)	(0.020)	(0.018)	(0.018)	(0.015)	(0.017)
40s	-0.045**	-0.039*	0.105***	0.012	-0.054***	0.002
	(0.022)	(0.022)	(0.021)	(0.019)	(0.017)	(0.019)
50s	-0.069***	-0.060***	0.106***	0.020	-0.119***	-0.067***
	(0.022)	(0.021)	(0.021)	(0.019)	(0.017)	(0.020)
60s	-0.093***	-0.026	0.047**	0.057**	-0.251***	-0.108***
	(0.024)	(0.023)	(0.022)	(0.023)	(0.020)	(0.022)
70 and over	-0.107***	0.009	0.014	0.096***	-0.194***	-0.131***
	(0.024)	(0.024)	(0.022)	(0.023)	(0.019)	(0.022)
Male	0.111***	0.092***	0.049***	-0.006	0.030**	0.104***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)
R-Squared	0.078	0.072	0.065	0.034	0.223	0.098
N	4970	4970	4970	4970	4970	4970

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Omitted variables: marital status, household size, household income, home ownership,

population density, and a constant term.

18

Table 9: Financial Behavior Ordered Probit

	(1) Specul.	(2) O. Borrow	(3) F. Naive	(4) I. Ret. P.	(5) Gamble
Fin. Literacy	0.427***	0.144***	0.195***	-0.426***	-0.225***
	(0.035)	(0.023)	(0.023)	(0.021)	(0.023)
Fin. Edu. Univ.	-0.026	0.020	0.005	-0.027*	-0.009
	(0.022)	(0.017)	(0.021)	(0.016)	(0.017)
Education	-0.009	-0.109***	-0.011	-0.037**	-0.030
	(0.026)	(0.019)	(0.021)	(0.017)	(0.019)
Fin. Experience	0.086***	0.043**	0.015	-0.084***	0.032*
	(0.022)	(0.018)	(0.020)	(0.014)	(0.018)
Calculation	-0.023	-0.009	-0.033*	0.007	0.002
	(0.025)	(0.018)	(0.019)	(0.015)	(0.018)
A. Overconf. FL	0.164***	0.023	0.048**	-0.138***	-0.024
	(0.027)	(0.019)	(0.022)	(0.018)	(0.020)
Discount Rate	0.042	0.138***	-0.051***	0.123***	0.052***
	(0.026)	(0.019)	(0.020)	(0.017)	(0.019)
Present Bias	-0.062**	-0.042**	0.001	-0.031*	-0.003
	(0.028)	(0.020)	(0.020)	(0.017)	(0.018)
Risk Aversion	-0.064**	-0.033*	0.023	-0.036**	-0.149***
	(0.025)	(0.018)	(0.020)	(0.016)	(0.018)
Loss Aversion	-0.070***	-0.047***	-0.051***	0.029*	-0.062***
	(0.025)	(0.018)	(0.018)	(0.016)	(0.017)
S Prob. W.	0.046*	0.033*	0.023	0.005	-0.008
	(0.024)	(0.017)	(0.020)	(0.015)	(0.017)
Ambiguity Aver.	0.015	0.018	0.045**	-0.026*	-0.090***
	(0.026)	(0.018)	(0.020)	(0.015)	(0.018)
30s	0.043	0.013	0.003	-0.064***	-0.001
	(0.033)	(0.024)	(0.025)	(0.021)	(0.024)
40s	-0.070*	0.114***	0.020	-0.089***	-0.004
	(0.036)	(0.026)	(0.027)	(0.023)	(0.026)
50s	-0.111***	0.117***	0.031	-0.175***	-0.094***
	(0.037)	(0.026)	(0.027)	(0.023)	(0.025)
60s	-0.152***	0.050*	0.070**	-0.312***	-0.141***
	(0.040)	(0.028)	(0.031)	(0.024)	(0.027)
70 and over	-0.178***	-0.023	0.113***	-0.264***	-0.172***
	(0.042)	(0.030)	(0.031)	(0.025)	(0.028)
Male	0.207***	0.067***	-0.020	0.069***	0.142***
	(0.027)	(0.018)	(0.019)	(0.016)	(0.018)
R-Squared	0.104	0.032	0.023	0.076	0.055
N	4968	4968	4968	4968	4968

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Omitted variables: marital status, household size, household income, home ownership, population density, and a constant term.

scatterplots, which are the average values of the residualized financial literacy variable and the financial behaviors and attitudes variable in 10 equal-sized bins.

The panels in Figure 1 show no signs of a strong nonlinearity that leads to the reversal of the literacy-behavior gradient. We see some signs of flattening of the gradient in the financial naivety panel at high financial literacy levels, which indicate that although financial literacy almost always leads to financial naivety, adding financial literacy is more dangerous for novice learners than for serious ones. The insufficient retirement planning panel indicates that the gradient is almost constant. This implies that more financial literacy is effective in inducing people to prepare for their retirement even for those with the highest level of financial literacy.

4.3   Preferences and beliefs

We examine the effects of preferences and beliefs based on Table 6. Overconfidence about financial literacy leads to speculative investment, more risky asset holdings, and naive attitudes but also to preparedness for old age. These results are similar to the effect of financial literacy shown in Section 4.1 and suggest that individual behaviors are determined not only by actual literacy but also by "perceived" literacy.

The coefficients for the discount rate have the expected positive sign for overborrowing and insufficient retirement planning. The negative sign in financial naivety regression indicates that impatience suppresses naive financial behavior. This may reflect that financially naive behaviors involve some forms of investment. The sign in gambling regression is positive, which may indicate that impatient people are vulnerable to get-rich-quick schemes.

Other behavioral factors generally tend to make people less daring and reckless in some financial ways. Risk aversion has the expected negative signs for speculative investment, risk asset holdings, insufficient retirement planning, and gambling. Loss aversion has the expected negative signs in speculative investment, risk asset holdings, and gambling. It also has negative signs in overborrowing and financial naivety. S-shaped probability weighting has a negative sign in risk asset holdings, whereas it does not affect gambling. Ambiguity aversion has the expected negative signs for risk asset holdings and gambling. The effect on risk asset holdings is consistent with Dimmock et al. (2016), who show that ambiguity aversion is negatively correlated with stock market participation and the fraction of financial assets in stocks.

4.4   Age and gender

This subsection explores the relationship between age, gender, and the determinants of financial behaviors and attitudes to determine the implications for financial education. The results are presented in Figure 2. The age variable is grouped into 12 equal-sized bins. Quadratic fit lines for the combinations of variables are plotted along with binned scatterplots.

The upper-left panel shows that people become more financially literate almost linearly as they age and that males are more financially literate than females[6]. This age effect is

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[6]The linear age effect is consistent with Sanchez and Dunning (2018), who analyze a nationally represen-
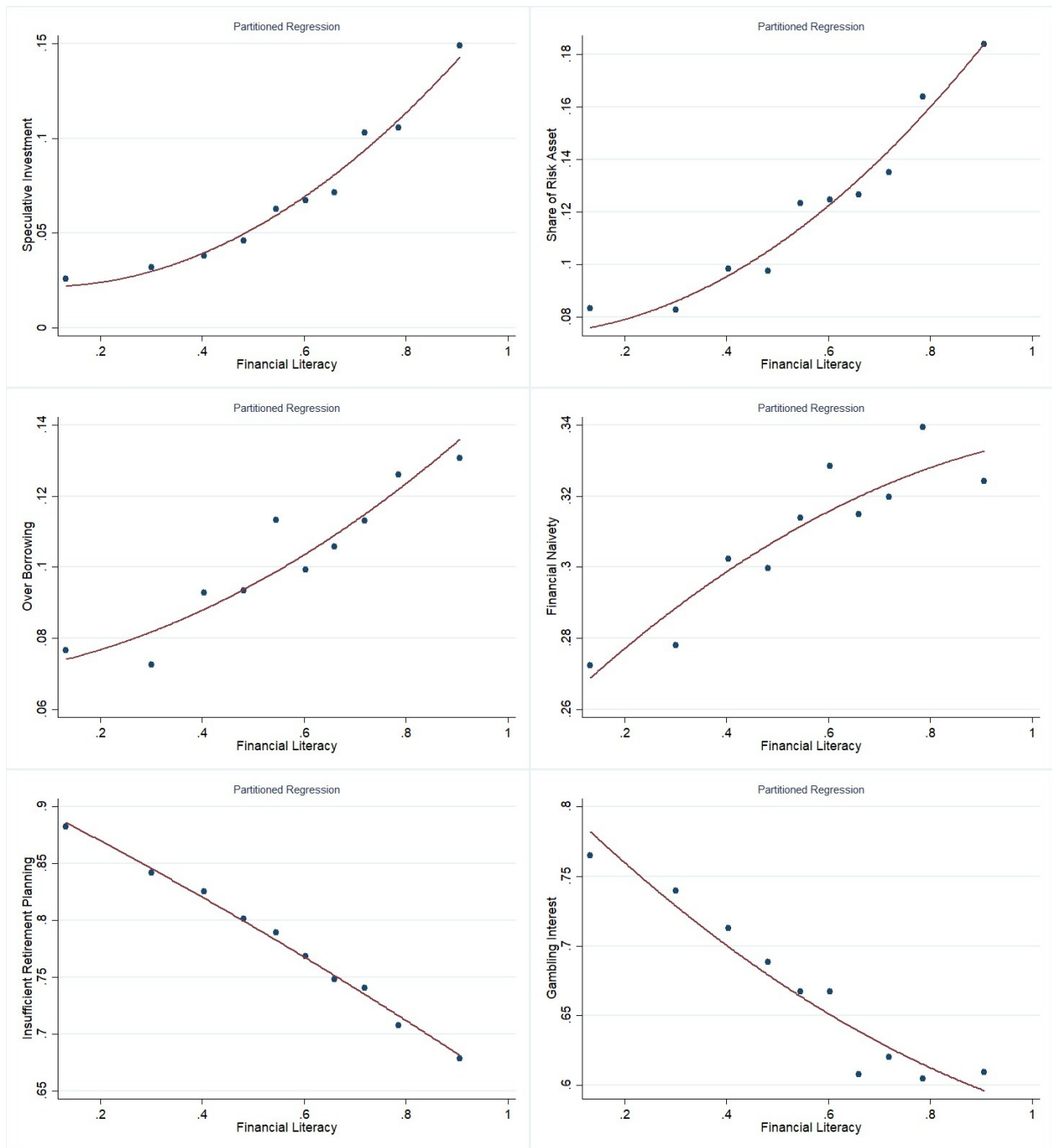
Figure 1: Effects of Financial Literacy on Financial Behavior: Partitioned Regression
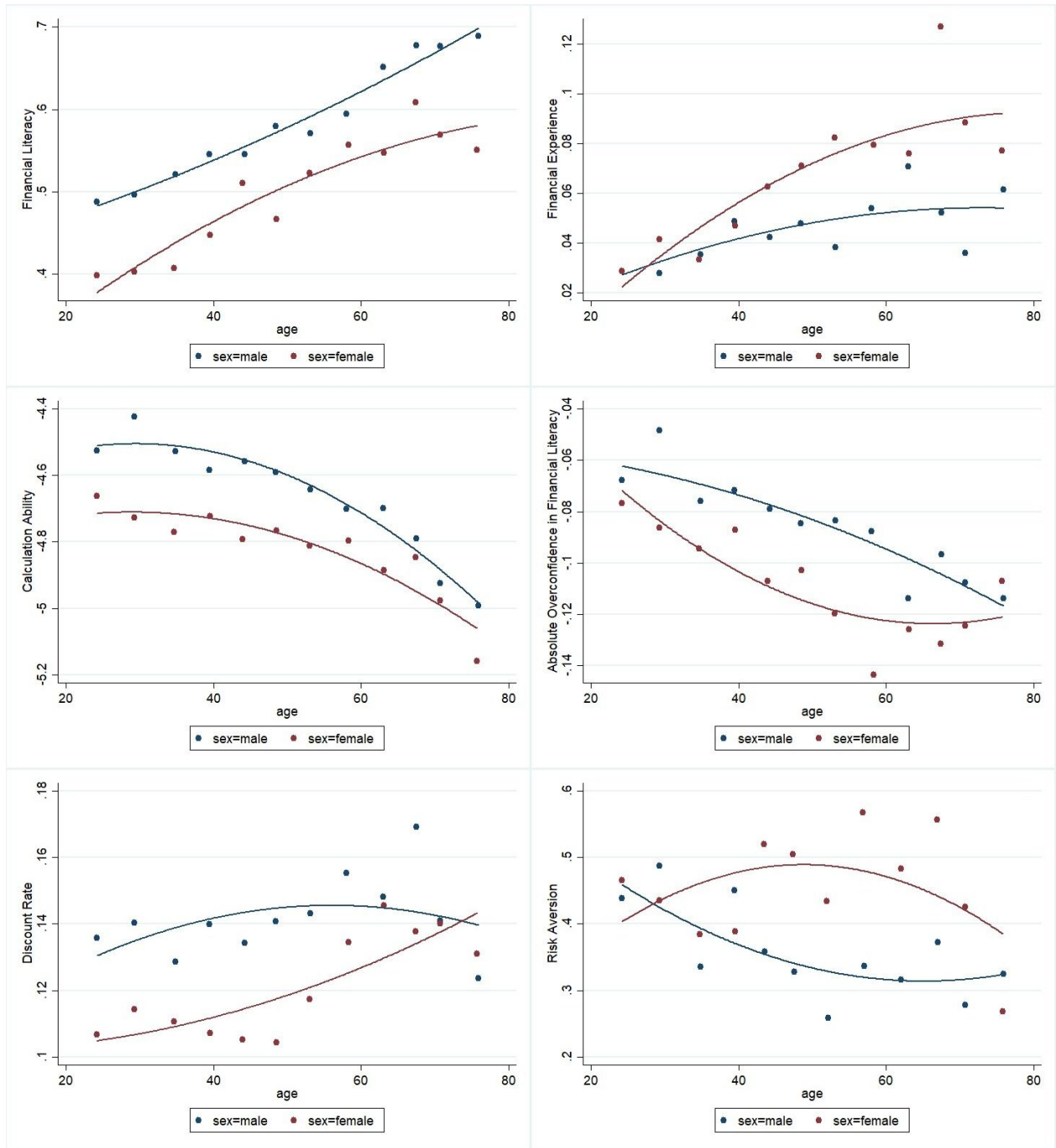
Figure 2: Age, Gender and the Determinants of Financial Behaviors and Attitudes: OLS

in contrast to the negative age effect on calculation ability shown in the middle-left panel. Note that people in their late 60s and 70s have the highest financial quiz score. This result is consistent with the financial literacy regression results in Table 5. The high financial literacy of elderly males requires attention because high financial literacy can be a cause of some inappropriate financial behaviors and attitudes, as described in Sections 4.1 and 4.2. Ironically, what protects young people from inappropriate financial behaviors, such as speculative investment, overborrowing, and financial naivety, is their low financial literacy. Financial experience, which has similar effects to those of financial literacy, is also increasing with age, and it is higher for females than for males.

As for the preference and belief variables, the middle-right panel shows that people (who are generally underconfident) become more underconfident in financial literacy as they age and that females are more underconfident than males. Combining the result with the regression results in Section 4.1 suggests that the risk of young males could be their weak underconfidence.

The bottom-left panel in Figure 2 shows that the discount rate tends to increase as people age until they reach an age of around 70 years and it is higher for males than for females. Considering the results in Section 4.1, elderly males must be cautious about impatience, which can lead to overborrowing, insufficient retirement planning, and gambling, whereas young females must be vigilant about patience, which can lead to making naive financial decisions. The bottom-right panel in Figure 2 shows that males are less risk-averse than females.

In the context of financial fraud, *Financial Fraud and Fraud Susceptibility in the United States* (2013) points out that "older Americans are particularly vulnerable" (p. 3) and that "males are more willing to take on investment risk than females" (p. 6). Although elderly males are underconfident about their financial literacy, their high financial literacy, and low risk aversion could be the causes of financial fraud vulnerability and excessive risk-taking.

5 Discussion and Conclusion

We have estimated the effects of financial literacy and behavioral factors on the financial behavior and attitudes of Japanese households and found that high financial literacy induces more speculative investment, risk asset holdings, overborrowing, and financial naivety; i.e., financial literacy makes people more daring and reckless financially. Moreover, there is no clear threshold above which the effects of additional financial literacy are reversed. This is in contrast to the analysis of aviation accidents analyzed by KnechtKnecht (2013), who shows that fatalities occur most frequently at middle ranges of total flight hours. It comes as a surprise that more financial literacy at any level does not prevent overborrowing and financial naivety, which can hardly be seen as sensible financial behaviors. This result can be interpreted as an indication that overconfidence in financial ability is created by financial literacy even at its highest level.

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tative sample of American adults

Holding more risk assets, which is not always inappropriate, can be disastrous for consumers when these assets are combined with speculative investment, overborrowing, and financial naivety. All these four types of financial behaviors and attitudes can be induced, rather than prevented, by more financial literacy.

Lusardi and Tufano (2015) conclude that "individuals with lower levels of debt literacy tend to transact in high-cost manners, incurring higher fees and using high-cost borrowing." (p. 332). This statement seems to be at odds with the regression results of this study, which show that financial literacy is associated with high-cost borrowing or delinquency. Although further investigation is needed, this contradiction could ariase partly because their measures of literacy (debt literacy) and borrowing behavior are different from ours.

Financial literacy is, however, instrumental in making households more prepared for retirement. This result is consistent with Lusardi and Mitchell (2011) who conclude that financially literate people are more likely to plan. Financial literacy also serves to restrain gambling, an important result with the current spread of decriminalized gambling, such as pachinko, and Internet gambling, such as "gacha" (lottery for items in video games), in Japan.

These results about the effects of financial literacy have major implications for financial education. They indicate that financial literacy can help you or hurt you. In financial education, it is important to stress the dangers of overconfidence in financial ability along with the importance of financial literacy. In other words, the aim of financial education should be not only about teaching financial economics but also about ensuring consumer protection through teaching dangers inherent in financial literacy.

As Charlie Munger, the co-chair of Berkshire Hathaway, once said, "There must be some wisdom in the folk saying: It's the strong swimmers who drown." This mindset is consistent with our results showing that financial literacy leads people to engage in daring and reckless financial behaviors and attitudes. This is especially noteworthy because financial literacy education is considered to be a key tool for policymakers to protect ordinary people, including innocent young and affluent elderly people, from speculation or rip-off.

It may be hard to believe that financial literacy continues to instigate inappropriate financial behaviors and attitudes even at its highest level. One possible reason for the estimated constant unfavorable effect is the level of our financial literacy questions. Because the questions are designed to capture the financial literacy of the general population, the level of these questions is quite rudimentary in light of the knowledge of professional financiers. Evaluation of more sophisticated investor behaviors using an intermediate level financial quiz could lead to different conclusions. Still, it is possible that people with the highest levels of financial literacy are not good at making financial decisions, as is illustrated, for example, by the collapse of Long-Term Capital Management in 2000.

While this study demonstrates that financial literacy can lead to inappropriate financial behaviors and attitudes, several issues warrant further research. First, our main results are not derived from rigorous causal inference. Instrumental variable estimation is not a perfect solution. Existing studies that use a strict causal inference framework focus mostly on the effects of small changes in financial literacy in a specific group of people. Future research should explore the causal effect of larger financial literacy changes on financial behaviors

using data from the general population. Second, our measure of financial behaviors and attitudes is based on the answers to our survey questions. Analyses based on data from actual financial transactions are required. Third, the way to teach finance without incurring overconfidence has practical usefulness. Overcoming the trade-off between financial literacy and consumer protection is of great importance for financial education. Fourth, we need analysis based on teenage survey respondents. Our results show that age is an important determinant of financial behaviors and attitudes. Therefore, it is highly likely that teenagers behave differently from people aged 20 or above. Moreover, teenagers have current financial problems, such as student loans or online gambling, as well as financial worries about their future. Analysis of current financial behaviors of teenagers is therefore also required.

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A Appendix

Table A1: Survey Questions: Dependent Variables

Categories		Questions
Speculative Investment	SI1	You have experience dealing in the foreign exchange (FX) market, trading stocks on margin, or trading futures or options. [Y]
	SI2	You have experience trading cryptocurrencies such as Bitcoin. [Y]
Overborrowing	OB1	You have used revolving credit through a credit card. [Y]
	OB2	You have borrowed money through consumer financing. [Y]
	OB3	You have been denied a withdrawal from your bank account because of insufficient funds. [Y]
	OB4	You have been refused a credit card or credit card renewal. [Y]
	OB5	You have been stuck paying down debt. [Y]
	OB6	You have borrowed money from a loan shark. [Y]
Financial naivety	FN1	You feel attracted to arrangements in which trusted financial experts manage your finances for a 0.2% monthly fee. [Y]
	FN2	You feel attracted to life insurance and casualty insurance policies that have no cash value at maturity. [N]
	FN3	You feel attracted to casualty insurance that offers compensation even for small damages. [Y]
	FN4	You feel attracted to investments described as having a guaranteed principal and a high rate of return. [Y]
Insufficient Retirement planning	RP1	You always scan the contents of letters about your public pension. [N]
	RP2	You have checked your estimated pension benefits. (For those already receiving such benefits, you checked your benefits before you began receiving them.) [N]
	RP3	You always know how many assets you have. [N]
	RP4	You always know how many liabilities you have. [N]
	RP5	You understand your yearly income and expenditures (savings accounts, etc.). [N]
	RP6	You generally know the value of your estimated severance package. [N]
	RP7	You have created your own financial plan for your retirement. [N]
	RP8	You have asked an expert to create a financial plan for your retirement. [N]
	RP9	You have a financial plan that allows you not to worry about running out of funds, even if you live 10 years longer than the average lifespan. [N]
	RP10	You are proactive about collecting information on financial planning for your retirement from books, magazines, television, the Internet, etc. [N]
Gambling interest	GI1	You have no interest in any kind of lottery (Jumbo Lottery, LOTO, Numbers, etc.). [N]
	GI2	You have no interest in pachinko, horse racing, cycle racing, boat racing, or auto races. [N]

Table A2: Survey Questions: Independent Variables

Categories		Questions
Financial literacy questions	FL1	You have a normal savings account with 10,000 yen and an interest rate of 2% per year. If you do nothing to change the balance, how much money will be in the account after one year? [1. 10200 yen] 2. I am not sure.
	FL2	You have a normal savings account with 10,000 yen and an interest rate of 2% per year. If you do nothing to change the balance, how much money will be in the account after five years? [1.More than 11,000 yen] 2. Exactly 11,000 yen. 3. Less than 11,000 yen. 4. I am not sure.
	FL3	Your savings account has an interest rate of 1% per year, and the rate of inflation (the rate at which the cost of living increases) is 2% per year. After one year, which of the following will you be able to buy with the money in the account? 1. More than you can now. 2. The same as you can now. [3. Less than you can now.] 4. I am not sure.
	FL4	When interest rates increase, what happens to bond prices? 1. They increase. 2. They do not change. [3. They decrease.] 4. There is no relationship between the interest rate and the cost of bonds. 5. I am not sure.
	FL5	When taking out a mortgage, the monthly payment is greater for a 15-year loan than for a 30-year loan, but there is less total interest paid during the repayment period. Is this statement correct or incorrect? [1. Correct] 2. Incorrect 3. I am not sure.
	FL6	When investing, splitting an investment between a number of companies is a safer way to obtain returns than investing everything in a single company. Is this statement correct or incorrect? [1. Correct] 2. Incorrect 3. I am not sure.
	FL7	When the value of the yen increases relative to other currencies, what happens to the yen-denominated value of financial assets held in foreign currency? 1. The value increases. 2. The value does not change. [3. The value decreases.] 4. I am not sure.
	FL8	When financial assets are sold quickly, they tend to be sold at lower prices. Between real estate and government bonds, which experiences a greater decrease in price when sold in this manner? [1. Real estate experiences a greater decrease.] 2. The decrease is the same. 3. Government bonds experiences a greater decrease. 4. I am not sure.
	FL9	There is no particular need to hold insurance policies for events that have a very low chance of occurring. Is this statement correct or incorrect? 1. Correct [2. Incorrect] 3. I am not sure.
	FL10	Investments that are expected to have high returns tend to also have considerable risks. Is this statement correct or incorrect? [1. Correct] 2. Incorrect 3. I am not sure.
Financial experience questions	FE1	Experience in jobs related to financial matters, such as banks, brokerages, insurance, real estate, etc. [Y]
	FE2	Experience handling finances for a company [Y]
Confidence in financial literacy: absolute	CFL	FL1 to FL10 have dealt with financial literacy. How many of these questions do you think you were able to answer correctly? I was able to correctly answer (please select) questions.
Loss aversion question	LA	There is a gambling game in which a coin is flipped and you receive a certain sum of money if heads appear; however, you must pay 10,000 yen if tails appear. Assuming heads would appear, how much money would you have to receive to participate in this game? Please select the lower limit and assume that there are no legal problems with playing this game.
Ambiguity aversion question	AA	There are two urns, A and B, and each holds 100 balls. The balls are either red or white. In Urn A, there are 50 red and 50 white balls, but the ratio of red to white balls in Urn B is unknown. You must select one urn and draw one ball out of that urn. If you draw a red ball, you will receive 10,000 yen. If you draw a white ball, you will receive nothing. Which urn do you choose?

Table A3: Financial Behavior IV

	(1)	(2)	(3)	(4)	(5)	(6)
	Specul.	Risk Asset	O. Borrow	F. Naive	I. Ret. P.	Gamble
Fin. Literacy	0.871***	1.807***	0.315**	0.529***	-0.942***	-0.535***
	(0.164)	(0.220)	(0.128)	(0.153)	(0.148)	(0.137)
Fin. Edu. Univ.	-0.047**	-0.060**	-0.006	-0.012	0.008	0.012
	(0.019)	(0.026)	(0.015)	(0.018)	(0.018)	(0.016)
Education	-0.085***	-0.114***	-0.119***	-0.054**	0.044*	0.018
	(0.026)	(0.037)	(0.021)	(0.024)	(0.023)	(0.022)
Fin. Experience	0.010	-0.081***	0.022	-0.019	-0.021	0.057***
	(0.024)	(0.030)	(0.019)	(0.022)	(0.019)	(0.018)
Calculation	-0.092***	-0.232***	-0.029	-0.074***	0.087***	0.049**
	(0.026)	(0.038)	(0.023)	(0.025)	(0.024)	(0.023)
A. Overconf. FL	0.362***	0.781***	0.099*	0.195***	-0.372***	-0.172***
	(0.069)	(0.092)	(0.054)	(0.065)	(0.062)	(0.057)
Discount Rate	0.063***	0.067**	0.137***	-0.028*	0.068***	0.022
	(0.019)	(0.028)	(0.017)	(0.017)	(0.017)	(0.017)
Present Bias	-0.044***	-0.035	-0.028*	-0.003	-0.011	0.005
	(0.017)	(0.030)	(0.017)	(0.016)	(0.015)	(0.014)
Risk Aversion	-0.139***	-0.347***	-0.062**	-0.045	0.072**	-0.055**
	(0.031)	(0.043)	(0.025)	(0.029)	(0.028)	(0.027)
Loss Aversion	-0.035**	-0.011	-0.036***	-0.033**	0.010	-0.054***
	(0.015)	(0.025)	(0.013)	(0.014)	(0.015)	(0.015)
S Prob. W.	0.007	-0.068***	0.013	0.009	0.014	-0.001
	(0.016)	(0.023)	(0.014)	(0.016)	(0.015)	(0.015)
Ambiguity Aver.	-0.046**	-0.184***	-0.004	-0.006	0.032*	-0.030*
	(0.021)	(0.031)	(0.017)	(0.019)	(0.019)	(0.018)
30s	0.016	-0.076**	0.013	-0.004	-0.027	0.003
	(0.024)	(0.034)	(0.018)	(0.019)	(0.018)	(0.019)
40s	-0.108***	-0.191***	0.078***	-0.025	0.003	0.034
	(0.029)	(0.041)	(0.025)	(0.025)	(0.024)	(0.024)
50s	-0.137***	-0.219***	0.074***	-0.021	-0.059**	-0.034
	(0.029)	(0.042)	(0.025)	(0.026)	(0.025)	(0.025)
60s	-0.225***	-0.350***	-0.006	-0.023	-0.127***	-0.039
	(0.041)	(0.058)	(0.035)	(0.039)	(0.037)	(0.035)
70 and over	-0.253***	-0.341***	-0.051	0.007	-0.063	-0.057
	(0.045)	(0.061)	(0.037)	(0.042)	(0.039)	(0.038)
Male	0.027	-0.165***	0.038	-0.060**	0.123***	0.165***
	(0.029)	(0.041)	(0.023)	(0.028)	(0.026)	(0.025)
N	4968	4968	4968	4968	4968	4968

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Omitted variables: marital status, household size, household income, home ownership,

population density, and a constant term.

Table A4: Financial Behavior IV Ordered Probit

	(1) Specul.	(2) O. Borrow	(3) F. Naive	(4) I. Ret. P.	(5) Gamble
Fin. Literacy	1.104***	0.534***	0.618***	-0.992***	-0.621***
	(0.094)	(0.140)	(0.151)	(0.092)	(0.133)
Fin. Edu. Univ.	-0.056***	0.001	-0.016	0.005	0.010
	(0.020)	(0.018)	(0.022)	(0.017)	(0.018)
Education	-0.098***	-0.152***	-0.062**	0.041*	0.021
	(0.027)	(0.023)	(0.027)	(0.022)	(0.026)
Fin. Experience	0.007	0.008	-0.021	-0.023	0.064***
	(0.026)	(0.022)	(0.024)	(0.019)	(0.020)
Calculation	-0.117***	-0.060**	-0.087***	0.086***	0.055**
	(0.026)	(0.026)	(0.027)	(0.021)	(0.025)
A. Overconf. FL	0.442***	0.184***	0.223***	-0.374***	-0.190***
	(0.044)	(0.061)	(0.066)	(0.042)	(0.059)
Discount Rate	0.079***	0.154***	-0.023	0.073***	0.025
	(0.023)	(0.019)	(0.022)	(0.020)	(0.022)
Present Bias	-0.069***	-0.049***	-0.009	-0.013	0.007
	(0.025)	(0.019)	(0.020)	(0.016)	(0.018)
Risk Aversion	-0.177***	-0.097***	-0.051	0.071***	-0.074**
	(0.027)	(0.029)	(0.033)	(0.025)	(0.034)
Loss Aversion	-0.048**	-0.041**	-0.043**	0.019	-0.063***
	(0.023)	(0.018)	(0.018)	(0.016)	(0.017)
S Prob. W.	0.021	0.022	0.012	0.018	0.001
	(0.022)	(0.018)	(0.020)	(0.015)	(0.017)
Ambiguity Aver.	-0.053**	-0.017	0.006	0.030	-0.050**
	(0.026)	(0.021)	(0.025)	(0.018)	(0.023)
30s	0.024	0.006	-0.004	-0.046**	0.006
	(0.029)	(0.024)	(0.024)	(0.021)	(0.024)
40s	-0.126***	0.072**	-0.022	-0.020	0.034
	(0.032)	(0.031)	(0.031)	(0.027)	(0.029)
50s	-0.165***	0.072**	-0.015	-0.092***	-0.048
	(0.033)	(0.032)	(0.032)	(0.029)	(0.030)
60s	-0.273***	-0.030	-0.019	-0.152***	-0.053
	(0.037)	(0.041)	(0.045)	(0.043)	(0.043)
70 and over	-0.306***	-0.108**	0.012	-0.098**	-0.074
	(0.039)	(0.042)	(0.050)	(0.044)	(0.046)
Male	0.057	0.005	-0.083***	0.151***	0.195***
	(0.039)	(0.029)	(0.030)	(0.020)	(0.024)
N	4968	4968	4968	4968	4968

Robust standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Omitted variables: marital status, household size, household income, home ownership, population density, and a constant term.