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Is More Financial Literacy Always Beneficial? An Investigation through a Mediator

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Abstract: We study the impact of financial literacy on financial risk preference. When financial literacy is measured jointly by actual and self-assessed scores, we find compelling evidence of a valley-shaped relationship between actual financial literacy and risk preference. At a given level of self-assessment, as actual financial literacy increases, the willingness to take risks initially decreases and then rises. Actual financial literacy is modeled to impact risk preference through self-assessed financial literacy, the mediator; this mediation effect is significant. Furthermore, increasing actual financial literacy has a positive (negative) effect in underconfident (overconfident) individuals on several financial behaviors.

Keywords: financial literacy; perception bias; risk preference; mediation effect

JEL Classification: D14; G53

1. Introduction

Financial literacy is the understanding of financial concepts, providing individuals with the skills they need to make informed decisions (Lusardi 2014).[1] Many papers document the robust positive influence of financial literacy on financial decisions and outcomes (Lusardi and Mitchell 2007, 2008; Van Rooij et al. 2011a, 2012; Clark et al. 2017; Bannier and Schwarz 2018; Darriet et al. 2020; Fanta and Mutsonziwa 2021). Studies also report positive roles of financial literacy in helping individuals overcome behavioral bias (Jonsson et al. 2017; Baker et al. 2019). Moreover, financial literacy is found to positively affect individuals' risk taking (e.g., Almenberg and Dreber 2015). Similarly, individuals' risk aversion to investment is found to drop if they are better able to process and understand financial information (e.g., Riley and Chow 1992).

There are two measures of financial literacy: objective (actual) and subjective (self-perceived). Numerous studies (Lusardi and Mitchell 2007; Van Rooij et al. 2011b; Chatterjee et al. 2017) document the evident perception bias that can be evaluated as perceived minus actual financial literacy. Traditionally, the objective financial literacy is the preferred measure (Van Rooij et al. 2011b; Bucher-Koenen and Lusardi 2011; Boisclair et al. 2017; Jonsson et al. 2017). Recent research has begun to employ both measures. Van Rooij et al. (2012) find a pronounced impact from actual financial literacy, but the effect of perceived literacy is less consistent. Chatterjee et al. (2017) find that both measures contribute, but self-perceived financial literacy is more impactful. Bazley et al. (2020) support the positive influence of both actual literacy and self-belief in one's literacy on equity ownership. Besides the mixed results, most cited literature devotes little effort to their effects by cohort.[2] In the cohort of high perceived but low actual financial literacy (i.e., the cohort with positive perception bias, the overconfident), Allgood and Walstad (2016) conclude that the positive and significant effect of actual financial literacy usually found in other cohorts on many

financial decisions turns weak or negligible. This prompts us to explore the interplay of the two measures across cohorts.[3]

Most of the above studies treat the two measures as separate predictors in one regression equation. Our study questions the 'equal exogeneity' of actual and self-assessed financial literacy. Imagine someone improves his or her actual financial knowledge; wouldn't he or she consequently acquire higher self-assessment? Moreover, even people who are unaware of their actual financial knowledge act on their self-perceived literacy to make financial decisions. In such cases, the coefficient estimates in a single-equation regression may provide an inaccurate assessment of the marginal effect of actual financial literacy on financial outcomes, as the coefficient does not account for the change in self-assessed financial literacy.

Therefore, it is natural to conjecture that actual financial literacy (X) affects self-perceived financial literacy (M), which in turn affects risk preference (Y). There are models hypothesizing a chain of relations between the independent variable (X) and the dependent variable (Y) such that X first causes a change in a variable M, which then causes a change in Y. Used in many disciplines, the X → M → Y model is often termed *mediation* in psychology (Baron and Kenny 1986). We thus propose self-perceived financial literacy to be the *mediator*.

Our contribution to financial literacy research is two-fold. First, unlike Allgood and Walstad (2016), who use a single equation approach, we propose an 'endogenous' self-perceived financial literacy, and through a two-equation structure, we investigate the inter-connected roles the two measures play regarding risk preference. We find compelling evidence of a valley-shaped relationship: risk preference first declines and then surges as actual financial literacy increases, underpinning the role of perception bias. In addition, we confirm the endogeneity of self-assessed financial literacy, which mediates between actual financial literacy and risk preference. A bootstrapping method proves the significance of the mediation effect. Another approach by Balasubramnian and Sargent (2020) uses the gap between perceived and actual literacy (which are both classified into high, medium, and low) to center their analysis on a particular cohort labeled 'blind spot', i.e., the cohort of high perceived but low actual literacy. By regressing on the 'blind spot' dummy, perceived literacy, and other covariates, they essentially investigate the effect of actual literacy in the overconfident cohort. Our modeling, in contrast, is flexible enough to account for both overconfident and underconfident groups.

Second, not only are we the first to detect the positive (negative) effect of actual financial literacy in the underconfident (overconfident) cohort on risk preference (thereafter termed 'dual effects' of actual financial literacy or 'duality'), but we also find these dual effects on other financial decisions. Traces of these dual effects have emerged in Allgood and Walstad (2016). Similarly, Anderson et al. (2017) find that precautionary savings and retirement planning decisions are driven by self-perceived financial literacy as opposed to actual financial literacy, particularly among the low-literacy respondents. We further document that the effect of actual financial literacy could be significantly negative on numerous financial behaviors (e.g., credit cards, college savings, emergency funds).[4] This duality is more substantial than what prior studies suggest.

In summary, our findings are: (1) the dual effects of actual financial literacy on risk preference related to the over- and underconfident cohorts; (2) the significant mediation effect within the total effect of actual financial literacy on risk preference; and (3) the extension of dual effects of actual financial literacy to other financial behaviors.

2. Materials

The National Financial Capability Study (NFCS) surveyed U.S. households in four waves (2009, 2012, 2015, and 2018), with 25,000 respondents participating in each.[5] We provide summary statistics for the key variables in Table 1.

Table 1. Summary statistics of key variables.

Variables	Obs.	Mean	Std. Dev.	Min	5%	10%	25%	50%	75%	Max
Actual financial literacy	93,227	3.117	1.404	0	0	1	2	3	4	5 (or 6)
Self-assessed financial literacy	93,227	5.157	1.25	1	3	4	5	5	6	7
Risk preference	93,227	4.781	2.635	1						10
College savings	34,681	0.377	0.485	0						1
Credit cards	72,936	0.542	0.498	0						1
Emergency funds	90,433	0.442	0.497	0						1

Note: This table presents summary statistics of key variables and percentile distribution of actual and self-assessed financial literacy.

The three core variables are actual financial literacy, self-perceived financial literacy, and risk preference. Actual financial literacy (Actual FL) is measured by the scores on five multiple-choice questions (2009 and 2012) and later by scores on six questions (2015 and 2018). The scores range from 0–5 (2009 and 2012) or 0–6 (2015 and 2018) in integers. The four-wave sample can be used for the original five questions, whereas the two-wave (2015, 2018) sample can be used for the six questions. We refer to them as the two datasets. Participants report (on a 7-point scale) self-perception of financial literacy (Self-Perceived FL) for all four years. Risk preference (on a 10-point scale) is based on self-assessment of willingness to take risks in financial investments.

Financial planning decisions are binary variables based on Yes or No answers to questions or statements: (1) In the past 12 months, I always paid my credit cards in full. (2) Are you setting aside some money for your children's college education? (3) Have you set aside emergency or rainy-day funds that would cover your expenses in case of sickness, job loss, economic downturn, or other emergency? Controls are mainly demographic variables, such as age, gender, ethnicity, education, income, and employment, all of which take either binary or ordinal categorical values.[6]

A complete description of all the variables used in our study is presented in Appendix A.

3. Methods and Results

Figure 1 illustrates the triangular mechanism (i.e., the mediation model) through which Actual FL (X) influences Risk Preference (Y) with the mediator Self-Perceived FL (M) (Hayes 2013). We propose a two-equation model (1) and (2) in which Self-Perceived FL (M) is now an endogenous variable predicted by Actual FL (X). The model accounts for the direct effect (γ_2), the mediation effect ($\beta_2 * \gamma_1$), and the total effect ($\gamma_2 + \beta_2 * \gamma_1$) of X on Y.

$$M_i = \alpha_1 + \gamma_1 X_i + \theta_1 C_i + \varepsilon_{1i} \tag{1}$$

$$Y_i = \alpha_2 + \beta_2 M_i + \gamma_2 X_i + \theta_2 C_i + \varepsilon_{2i} \tag{2}$$
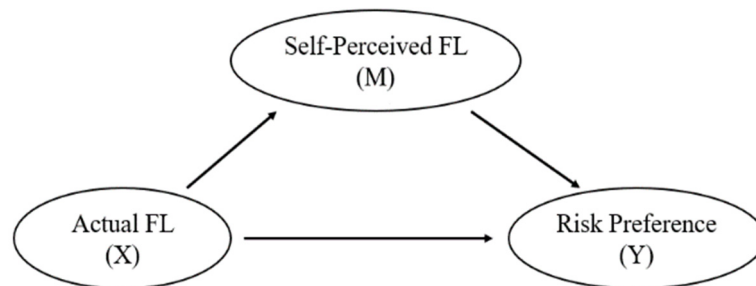

Figure 1. X-M-Y triangle relationship.

Equation (1) regresses M_i on X_i, while controlling for demographic variables and year dummies (C_i). Equation (2) regresses Y_i on M_i and X_i, along with control variables (C_i).

3.1. Mediation Effect

Self-assessed financial literacy (7-point scale) and actual financial literacy (5-question scale or 6-question scale) are not directly comparable because of their different scales, but the relative positions of respondents within the distribution of self-assessed literacy and actual literacy do provide information. For instance, an individual with a medium score on actual literacy rating himself/herself a medium score on self-assessed literacy would be considered accurate in self-perception. The percentile distribution in Table 1 shows that a medium individual in actual literacy scores 3 out of 5 questions, while a medium individual in self-assessed literacy rates himself/herself 5 out of 7. The lowest 5% in actual literacy scores 0 out of 5 questions, while the lowest 5% in self-assessment still rate themselves as high as 3 out of 7. As the distribution of actual and self-assessed literacy in Table 1 shows that at almost any percentile the perceived literacy is higher than actual literacy by at least 2 points, we define as the overconfident cohort the subset for which self-assessed FL – actual FL > 2 and as the underconfident cohort the subset for which self-assessed FL – actual FL < 1.[7]

Table 2 presents Equation (1) estimation results. Columns 2 and 4 reveal that among the underconfident, actual financial literacy along with control variables substantially explain the variation in perceived literacy (0.72 and 0.74 R^2), and less so (columns 1 and 3) among the overconfident (0.37 and 0.36 R^2). The disparity between the under- and the overconfident becomes overwhelming in the regression results of Equation (2), reported in Table 3. Actual financial literacy has a positive influence on risk preference among the underconfident (columns 3 and 6) but a negative influence among the overconfident (columns 2 and 5), holding self-perceived literacy constant. Table 3 also reports a consistently positive effect of perceived literacy on risk preference.[8] Our findings from both Equations (1) and (2) are robust to the two datasets.

Table 2. Determinants of self-perceived financial literacy (regression results for Equation (1)).

	1	2	3	4
Actual FL (X_i)	0.470 *** (0.004)	0.943 *** (0.006)	0.460 *** (0.006)	0.886 *** (0.006)
Constant (α_1)	4.626 *** (0.027)	−0.628 *** (0.042)	4.782 *** (0.043)	−0.588 *** (0.062)
Sample size	37,091	15,369	18,658	10,771
Adj R-sq	0.371	0.724	0.359	0.741

Note: Each column shows regression results from a subsample: (1) 4-wave (2009, 2012, 2015, and 2018) overconfident; (2) 4-wave underconfident; (3) 2-wave (2015 and 2018) overconfident; (4) 2-wave underconfident. Demographic and year controls are not shown here but are included in Supplementary Materials. Standard errors in parentheses. *** $p < 1\%$.

Table 3. Factors that determine risk preference (regression results for Equation (2)).

	1	2	3	4	5	6
Actual FL (X_i)	0.075 *** (0.006)	−0.168 *** (0.014)	0.150 *** (0.033)	0.056 *** (0.007)	−0.121 *** (0.020)	0.143 *** (0.033)
Self-assessed FL (M_i)	0.461 *** (0.006)	0.676 *** (0.016)	0.337 *** (0.027)	0.527 *** (0.009)	0.738 *** (0.023)	0.391 *** (0.030)
Constant (α_2)	1.934 *** (0.059)	1.128 *** (0.112)	2.251 *** (0.143)	2.461 *** (0.092)	1.661 *** (0.172)	2.588 *** (0.199)
Sample size	93,227	37,091	15,369	47,091	18,658	10,771
Adj R-sq	0.229	0.256	0.185	0.245	0.286	0.219

Note: Each column shows estimation results from a subsample: (1) 4-wave (2009, 2012, 2015, and 2018) whole sample; (2) 4-wave overconfident; (3) 4-wave underconfident; (4) 2-wave (2015 and 2018) whole sample; (5) 2-wave overconfident; (6) 2-wave underconfident. Standard errors in parentheses. *** $p < 1\%$.

If we hold the self-assessment level fixed and consider four individuals, two overconfident and two underconfident, then among the two overconfident (underconfident), the one with higher actual financial literacy is less (more) willing to take risks. The inferred decline and rise in the individual's risk preference exhibits a valley-shaped relationship, which is

also observed at the aggregate levels (see Figure 2).[9] Holding self-perception constant, the more overconfident appear to be more risk-loving.
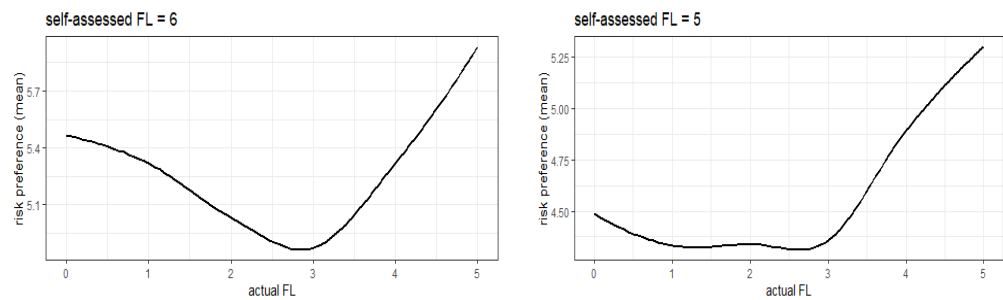

Figure 2. Plots of mean risk preference against actual financial literacy at given self-assessed literacy.

This valley-shaped relationship is the direct effect of actual financial literacy on risk preference. The combination of heightened self-assessment resulting from enhanced actual knowledge captured in Equation (1) and the elevated risk preference fueled by heightened self-assessment captured in Equation (2) funnels the indirect (mediation) effect. The two-equation model (1) and (2) represents the total effect in accordance with Figure 1's triangle relationship.[10]

The dual effects of actual financial literacy on risk preference among the over- and underconfident is evident. Nevertheless, additional control variables can be included to check for robustness. Several additional control variables available in the NFCS dataset and commonly used in the literature include a categorical variable that classifies living arrangements (living as the only adult/with spouse/in parents' home/with friends or roommates), a dummy variable on health insurance (Covered or Not), and a dummy variable on retirement benefits (Have or Not through an employer). Tables S3 and S4 in Supplementary Materials present estimation results when these additional control variables are added. From the highly similar outputs, the disparity between the under- and the overconfident and the dual effects of actual financial literacy are shown to remain robust.

A formal test of the mediation effect is to test the significance of the product of the two coefficients, $\gamma_1 * \beta_2$.[11] Table 4 summarizes the results of several tests. Based on 5000 bootstrap replicates, the mediation effect is significant. For instance, the 95% confidence interval of the mediation effect for the underconfident is (0.341, 0.351), accounting for about 71% of the total effect of actual financial literacy on risk preference.[12]

Table 4. Test of mediation effect.

Type of Method	# of Replicates	95% Confidence Interval
Bootstrap	5000	0.341 to 0.351
Sobel (1982)	NA	0.293 to 0.399
Goodman (1960)	NA	0.293 to 0.399

Note: The sample size of each bootstrap replicate equals that in Tables 2 and 3. Sobel's test is derived using the delta method based on a first order Taylor approximation. Goodman (1960) is based on the unbiased variance of the product of two normal variables.

3.2. Dual Effects of Financial Literacy

Our study is the first to document the dual effects of actual financial literacy on risk preference among the over- and underconfident. This duality is also present with respect to other financial behaviors.

Table 5 presents the output of logistic regressions of binary financial behaviors on financial literacy and controls. Three financial behaviors, (1) credit cards, (2) college savings, and (3) emergency funds, are measured as binary variables that equal 1 if the respondents reply Yes to the following statements or questions (Appendix A): (1) In the past 12 months, I always paid my credit cards in full. (2) Are you setting aside some money for your children's

college education? (3) Have you set aside emergency or rainy-day funds that would cover your expenses in case of sickness, job loss, economic downturn, or other emergency?

Table 5. Logistic estimation of financial planning decisions.

	College-over-4wave	College-under-4wave	Credit Card-over-2wave	Credit Card-under-2wave	Emergency-over-4wave	Emergency-under-4wave
Actual FL	−0.119 *** (0.022)	0.077 ** (0.034)	−0.129 *** (0.020)	0.173 *** (0.040)	−0.017 (0.013)	0.113 *** (0.040)
Self-assessed FL	0.296 *** (0.025)	0.160 *** (0.028)	0.463 *** (0.024)	0.217 *** (0.035)	0.403 *** (0.015)	0.402 *** (0.033)
Sample size	14,661	13,541	13,792	9452	35,712	14,975
Pseudo R-sq	0.198	0.173	0.108	0.114	0.201	0.226

Note: Each column regresses a decision for a subsample: (1) college fund decision, 4-wave, and overconfident cohort; (2) college fund decision, 4-wave, and underconfident cohort; (3) credit card decision, 2-wave, and overconfident cohort; (4) credit card decision, 2-wave, and underconfident cohort; (5) emergency fund decision, 4-wave, and overconfident cohort; (6) emergency fund decision, 4-wave, and underconfident cohort. Standard errors in parentheses. ** $p < 5\%$; *** $p < 1\%$.

Table 5 results support the insignificant effect reported by Allgood and Walstad (2016) but also reveal the negative effect on various financial behaviors for the overconfident cohort. We document the uniformly positive contributions of actual financial literacy on three financial decisions in the underconfident cohort. However, for people of high self-assessment, the contributions turn significantly negative on credit cards and college savings, and insignificant on emergency funds. This is evidence of the pervasiveness of the dual effects.

4. Discussion

We have demonstrated the importance of modeling individuals' self-perception as a mediator. The mediation effect is significant. Furthermore, increasing actual financial literacy has a positive (negative) effect in underconfident (overconfident) individuals on several financial behaviors. These dual effects should be considered in policymaking.

We start by examining the impact of financial literacy on financial risk preference. In addition to finding support for the positive effect of financial literacy established in previous studies (Lusardi and Mitchell 2007, 2008; Van Rooij et al. 2011a, 2012; Almenberg and Dreber 2015; Bannier and Schwarz 2018; Darriet et al. 2020; Fanta and Mutsonziwa 2021), we discover and identify the negative effect of actual financial literacy among the overconfident cohort. These opposite effects of actual financial literacy in over- and underconfident individuals we call dual effects of actual financial literacy. This duality is hinted at in some previous studies (Allgood and Walstad 2016; Anderson et al. 2017), but we show that it is more substantial than earlier studies admit. Previous studies often investigate the undivided population for the effects of the two measures of financial literacy: actual and self-perceived (Van Rooij et al. 2012; Chatterjee et al. 2017). In contrast, our study clearly differentiates the two cohorts and their effects.

Modeling self-perceived financial literacy as a mediator between actual financial literacy and risk preference is a new approach, whereas most previous studies treat the two measures as equally exogenous predictors in one regression equation. Through the mediation model, we have shown that the mediation effect accounts for a significant portion of the total effect of actual financial literacy on risk preference.

In practice, the dual effects of actual financial literacy will have implications for policy interventions. Policymakers should distinguish between underconfident and overconfident cohorts and subsequently treat the two groups separately, as they trigger different risk preference dynamics based on actual financial literacy. To do so, classifying individuals into underconfident and overconfident cohorts requires effectively measuring self-estimation of financial knowledge. For example, it might be optimal for policymakers to further encourage increases in actual financial literacy of the underconfident individuals, as this will result in sounder credit card behaviors. However, encouraging an increase in actual financial literacy of the overconfident individuals might not be optimal, as it leads to

undesired results. Similarly, but more broadly, the dual effects, for instance on credit card behavior, will have implications for risk management as well. Credit card companies that appraise clients' creditworthiness and likelihood of paying card debt in full should also archive client profiles in two pools: the over- and underconfident.

Appendix A

Table A1. Description of data variables.

Credit card	Binary, Yes = 1, 'In the past 12 months, I always paid my credit cards in full'.
Emergency funds	Binary, Yes = 1, 'Have you set aside emergency or rainy day funds that would cover your expenses in case of sickness, job loss, economic downturn, or other emergency?'
College savings	Binary, Yes = 1, 'Are you setting aside some money for your children's college education?'
Actual financial literacy	Number of financial literacy questions answered correctly: 0—5 (2009, 2012, 2015, and 2018) or 0—6 (2015 and 2018). Questions (https://www.usfinancialcapability.org/downloads/NFCS_2018_State_by_State_Qre.pdf, accessed on 1 February 2021): M6) Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? M7) Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? M8) If interest rates rise, what will typically happen to bond prices? M9) A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage, but the total interest paid over the life of the loan will be less M10) Buying a single company's stock usually provides a safer return than a stock mutual fund. M31) Suppose you owe $1000 on a loan and the interest rate you are charged is 20% per year compounded annually. If you didn't pay anything off, at this interest rate, how many years would it take for the amount you owe to double? (New question in 2015 and 2018)

Table A1. *Cont.*

Self-assessed financial literacy	Respondents' assessment of their overall financial knowledge, on a scale from 1 to 7, where 1 means very low and 7 means very high. Question (https://www.usfinancialcapability.org/downloads/NFCS_2018 _State_by_State_Qre.pdf, accessed on 1 February 2021): M4) On a scale from 1 to 7, where 1 means very low and 7 means very high, how would you assess your overall financial knowledge?
Risk preference	Response to question 'When thinking of your financial investments, how willing are you to take risks?' on a 10-point scale, where 1 means "not at all willing" and 10 means "very willing".
Gender	1. Male; 0. Female
Age	1. 18–24; 2. 25–34; 3. 35–44; 4. 45–54; 5. 55–64; 6. 65+
Ethnicity	1. White; 0. Non-white
Marital status	1. Married; 0. Single, Separated, Divorced, or Widowed/Widower
Children	Number of financially dependent children respondents have
Education	1. Did not complete high school; 2. High school graduate; 3. Some college; 4. College graduate; 5. Post graduate
Income	1. less than USD $15,000; 2. $15,000–$24,999; 3. $25,000–$34,999; 4. $35,000–$49,999; 5. $50,000–$74,999; 6. $75,000–$99,999; 7. $100,000–$149,999; 8. $150,000 or more
Employment	1. Employed; 0. Unemployed
Home	=1 if respondents reporting they or their spouse/partner currently own their home
Disabled	=1 if respondents describing current employment or work status as permanently sick, disabled, or unable to work

Notes

[1] https://www.apec.org/publications/2014/11/apec-guidebook-on-financial-and-economic-literacy-in-basic-education, accessed on 1 December 2022.

[2] Among the exceptions are Allgood and Walstad (2016) and Balasubramnian and Sargent (2020).

[3] Cupák et al. (2018), Bannier and Neubert (2016), and Almenberg and Dreber (2015) are among the recent attempts to explain gender differences in financial literacy, financial risk preference, and investment participation. However, the gender angle is not explored in this work and is left to future research.

[4] In contrast, many papers (e.g., Van Rooij et al. 2011a; Darriet et al. 2020) identify only the positive effect on various financial results (e.g., lessened money illusion, better retirement planning).

[5] https://www.usfinancialcapability.org/downloads.php, accessed on 1 February 2021.

[6] The inclusion of ethnicity as a demographic control is consistent with the literature (Lusardi and Mitchell 2007; Allgood and Walstad 2016; Balasubramnian and Sargent 2020).

[7] This is still a coarse classification based on the distribution of about 100,000 respondents into only 7 (and fewer) discrete score points.

[8] See Supplementary Materails for the full outputs of Tables S1 and S2 that report all details of controls.

[9] Figure 2 plots the sample means of risk preference for each cohort of actual financial literacy 0 to 5, holding perceived financial literacy at either 5 or 6 (respectively, the 25th and 75th percentiles as Table 1 reports). Regardless of actual financial literacy measured in 5 or 6 questions, the valley-shaped patterns are persistent.

[10]   To assess collinearity, we compute the variance inflation factor (VIF) from Equation (1). The resulting VIFs (1.3 to 3.8) indicate no major collinearity in the model.

[11]   The test is needed even if each of the two coefficients is significant on its own.

[12]   Based on the estimation in Tables 2 and 3, $\beta_2 = 0.39$, $\gamma_1 = 0.886$, $\gamma_2 = 0.14$, the mediation effect as a percentage of total effect is $0.886 \times 0.39 \div (0.886 \times 0.39 + 0.14) = 71.17\%$.

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