Financial Literacy, Ability, and Stock Market Participation*

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Abstract

We study the role of financial literacy and ability, both cognitive and noncognitive, in explaining stock market participation. We examine a comprehensive set of cognitive and noncognitive measures of ability and a detailed financial-literacy measure using data from the Health and Retirement Study. We find that both financial literacy and a wide range of ability measures have an effect on stock market participation. We decompose the effect of ability into direct and indirect effects that operate via financial literacy. In addition, we address potential endogeneity concerns by exploiting information on genetic variation across individuals.

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1 Introduction

In the U.S., only about half of households participate in the stock market.[1] The observed stock market participation rate is lower than what traditional economic models would suggest.[2] Nor can this rate be fully explained by other factors such as "nonstandard" preferences, or limited wealth to invest in the stock market (*e.g.*, Ang et al., 2005; Cao et al., 2005; and Vissing-Jørgensen, 2004).[3] Others have suggested various abilities, such as cognitive ability, might influence the propensity to participate in the stock market.[4] In addition, in recent years there has been a growing interest in the role of financial literacy in explaining a host of financial outcomes including stock market participation (*e.g.*, Behrman et al., 2012; and Lusardi and Mitchell, 2014). In this paper, using a rich panel dataset from the Health and Retirement Study (HRS),[5] we study the relation between financial literacy and stock market participation, and the direct and indirect mechanisms through which both cognitive and noncognitive abilities affect financial literacy and stock market participation.

In the literature, financial literacy and abilities have often received attention separately,

[1]For example, a recent survey finds that only 53% of households participated in the stock market in 2019 (Federal Reserve Board, September, 2020). The percent of households with "direct holdings" (*i.e.*, "corporate equities not held as part of a managed investment account or mutual fund") is 15.2%. See Gomes et al. (2021, Section 2.3) for a recent survey of the literature on households' limited asset market participation across the world and potential mechanisms underlying this finding.

[2]Without frictions or transaction costs, a standard portfolio-choice model under uncertainty coupled with a standard utility function would imply some allocation to stock at all levels of risk aversion as long as there is a positive equity premium over the risk-free return. See also, for example, the discussion in Haliassos and Bertaut (1995).

[3]The lower-than-predicted level of stock market participation is also intertwined with the well-studied "equity-premium puzzle" (Mehra and Prescott, 1985) - the large additional returns of stocks relative to risk-free bonds. For example, as noted by Curcuru et al. (2010, p. 339): "without the existence of a significant differential between the average return on stocks and that on short-term risk-free bonds (the equity premium), it would be quite easy to account for low stock market participation by appealing to moderate transaction costs or background risk using conventional models."

[4]For example, Grinblatt et al. (2011) examine the role of cognitive ability.

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and there are only a few papers that examine the role of abilities as underlying causes of how financial literacy affects stock market participation. Since the very same ability measures that may affect stock market participation may also affect financial literacy, as Gomes et al. (2021, Section 5) point out, cognition's "influence needs to be separated from [that of] financial literacy." It is important to separate out the effects of financial literacy and cognitive and noncognitive abilities, as the cost effectiveness of potential interventions, such as financial education and default options, would depend on the role that these factors play. Our paper is one of the first to examine the relation between ability, financial literacy, and stock market participation. In this paper, we estimate both the direct effect of ability on stock market participation and the indirect effect of ability on stock market participation as it propagates through financial literacy.

Using the large set of measures in the HRS, we are able to examine a more encompassing measure of financial literacy directly related to financial knowledge, and a wide set of both cognitive and noncognitive measures, while controlling for a host of demographic and financial measures.[6] Though our preferred measure of financial literacy is more comprehensive, it is surveyed only for a small subset of the population. To overcome this limitation and make use of our larger sample, we estimate our models with the efficient GMM imputation method proposed by Abrevaya and Donald (2017).

Several papers have studied the role of cognitive abilities in stock market participation (*e.g.*, Christelis et al., 2010; Kézdi and Willis, 2008; and Grinblatt et al., 2011). Others have focused on the role of noncognitive abilities or social features in explaining stock market participation. For example, Brown et al. (2008) examine the effect of one's community on own likelihood of participation. Guiso et al. (2008) study the role of trust, Hong et al.

[6]We also compare our preferred measure of financial literacy to a less-detailed financial numeracy measure that has been widely used in earlier studies such as Lusardi and Mitchell (2007) and Van Rooij et al. (2011).

(2004) study sociability, and Georgarakos and Pasini (2011) compare the effect of trust and sociability. As such, many papers have either focused on isolated aspects, or factors that are driven by more fundamental factors.[7]

Rather than focus on a small set of measures, our paper uses a comprehensive set of cognitive and noncognitive ability measures.[8] For cognitive ability, we use four measures that cover a wide range of dimensions of cognitive ability. For noncognitive ability measures, we use the Big Five personality traits (*e.g.*, McCrae and Costa, 1987, 1999) to cover a broad set of abilities not fully captured by the cognitive ability measures.[9] We explain the details of our cognitive measures and the Big Five traits in Section 3.

In examining the role of financial literacy while recognizing the importance of controlling for abilities that may be correlated with financial literacy, our paper is in part motivated by the findings of Fernandes et al. (2014) who study several financial outcomes, including stock market participation. They find that the addition of ability measures, focusing mostly on noncognitive ones, reduces the effect of financial literacy on the likelihood of savings and investing. However, Fernandes et al. (2014) do not have at their disposal a panel or a rich set of measures as the ones found in our data, nor do they examine the interaction between the ability measures and financial literacy.

We find that cognitive and noncognitive abilities are underlying factors that explain some of the effect of financial literacy on stock market participation, but that those ability factors do not fully explain the effect of financial literacy on stock market participation. Both ability and financial literacy have a direct explanatory power for stock market partic-

[7]Luik and Steinhardt (2016) and Bucciol and Zarri (2017) look at both cognitive and noncognitive measures, but neither examine the role of financial literacy. Bucciol and Zarri (2017) view their findings regarding the role of noncognitive measures as "complementary" to that of the financial knowledge channel.

[8]We also examine additional measures, such as risk aversion, which have been examined in previous research.

[9]Throughout, our discussion of noncognitive abilities and personality traits treats them as interchangeable. See also discussion in Almlund et al. (2011).

ipation. For example, using our preferred specification, a one-standard-deviation increase in our combined cognitive ability measure directly increases the propensity to participate in the stock market by 6.7 percentage points. Similarly, we find that several measures of noncognitive ability have a statistically significant effect of several percentage points on stock market participation. While we find that both cognitive and noncognitive abilities also have strong effects on financial literacy itself, a one-standard-deviation increase in financial literacy exhibits a statistically significant effect of 2.7 percentage points on the likelihood of stock market participation after controlling for cognitive and noncognitive abilities. Our framework also allows us to measure the relative importance of the indirect effect of ability on stock market participation (via financial literacy) relative to the direct effect. For example, in our preferred specification the indirect effect of the combined cognitive ability measure is 12% of the direct effect.

In our robustness check we find that additional controls and proxies for factors that have been suggested as important in the literature, such as risk aversion, do not eliminate the effect of financial literacy, while at times reducing the point estimate of the financial-literacy effect. In addition, we address the potential endogeneity of both observed ability and education measures by exploiting unique data on genetic variation.[10] We use Polygenic Scores (PGS) that were designed to predict cognitive ability and education as a plausibly-exogenous source of variation.[11] To the best of our knowledge, our paper is the first to use PGS to aid in the study of the effects of financial literacy on stock market participation.

Our finding that both financial literacy and a broad set of abilities influence the propensity to participate in the stock market is consistent with these factors lowering the indirect cost of participation. The perceived indirect costs might stem from an individual's view

[10]See, for example, the discussion of the use of genetic information in economics (Beauchamp et al., 2011) and in studying financial decision making (Cesarini et al., 2010).

[11]For example, the HRS's Polygenic Scores are used by Barth et al. (2020) to study wealth inequality, Shin et al. (2019) to study savings decisions, and by Sias et al. (2020) to study stock market participation.

that the stock market is complex and asset trading requires expert knowledge. Financial knowledge and ability (both cognitive and noncognitive) can help one lower the perceived indirect costs. If, in fact, financial literacy and abilities affect indirect costs of participation, one would expect them to also lower the indirect cost of investment in other financial instruments or participation in voluntary retirement accounts. To examine this hypothesis, we study whether ability and financial literacy have similar effects on the propensity to participate in the bond market and *voluntary* retirement plans. We find that financial literacy and the same set of abilities play an important role for the propensity to own bonds or participate in voluntary retirement plans.

Our paper makes several important contributions: Examining both direct and indirect (via financial literacy) channels that affect stock market participation; examining a comprehensive set of cognitive and noncognitive abilities rather than focusing on a narrow set of measures; addressing potential threats to validity using underlying genetic variation; providing evidence that ability and financial literacy lower the indirect cost of utilizing other financial instruments; and the statistically-efficient estimation of the effect of our preferred measure of financial literacy overcoming the fact that it is available only in a small sample.

Our results allow us to assess the benefit to programs that target financial literacy, such as financial education for high school or college students.[12] For example, if one were to raise the average number of correctly-answered financial-literacy questions by two questions (out of a total of eight questions), all else equal, stock market participation rates would increase by about 3.2 percentage points. To obtain a similar increase, one would need to raise the composite cognitive score by 0.43 of a standard deviation, which would likely require larger

[12]In a recent story, the Wall Street Journal (Koh, November 11, 2020) discussed Steven Levitt's proposal to "[c]ondense three years of high-school math ... to two years. Then, devote the freed up time to more relevant learning, such as data science or financial literacy."

public investment.[13]

Over one's life cycle, avoidance of the stock market or delayed entry has historically led to a large negative effect on one's wealth accumulation. As such, an increase in stock market participation rates, especially among less affluent households, could dampen the effects of income shocks such as those due to retirement or changes in health.[14]

The remaining sections are structured as follows: Section 2 explains our empirical model and estimation strategy. In Section 3, we explain the data and the variables used in our analysis. Section 4 explains the main empirical results. Section 5 provides robustness checks, and Section 6 concludes.

2 Empirical Framework

The main outcome of interest in our paper is stock market participation, which we define as a binary variable equal to one if a household holds stock, stock mutual funds, or has a retirement account (*e.g.*, IRA or Keogh plan) investing in a stock mutual fund.[15] Our empirical analysis focuses on the role of financial literacy in explaining stock market participation, where stock market participation depends also on individual demographics (*e.g.*, age and marital status), household financials (*e.g.*, income and wealth excluding stocks and bonds), ability (both cognitive and noncognitive), *etc.*

[13]For example, Figlio and Loeb (2011, p. 412) survey a host of educational interventions, and report: "effect sizes of up to 0.34 standard deviations for NCLB [No Child Left Behind Act]. Most of the other estimated effects range from no effect to up to 0.20 standard deviations."

[14]Gallup (Norman, May 4, 2018) reports that the two-year average percent of those under 35 years old holding stocks has dramatically decreased from 52% in 2006-2007 to 37% in 2017-2018.

[15]We examine alternative market participation measures in Section 5 such as holding stock not through a retirement plan.

Formally, we consider the following linear probability model:

$$(\textit{Stock Market Participation})_i = \beta_0 + \beta_1(\textit{Financial Literacy})_i + \boldsymbol{\beta_2'}(\textit{Ability})_i + \boldsymbol{\beta_3'}\mathbf{X_i} + \varepsilon_i, \quad (1)$$

where *Stock Market Participation* is a binary variable equal to one if a household participates in the stock market, *Financial Literacy* is a financial knowledge measure ranging from zero to eight, *Ability* is a vector of cognitive and noncognitive ability measures, and $\mathbf{X_i}$ includes controls for individual and household characteristics. When estimating our model we cluster standard errors at the cohort-region-urbanicity level.[16]

There are several challenges that we address next. First, factors that influence stock market participation, such as the ability measures in eq. (1) may also be influencing financial literacy. For example, consider the effect of Conscientiousness, which we use as one of the noncognitive ability measures. Conscientiousness may have a direct effect on stock market participation as shown in eq. (1) because, for example, those with a higher level of Conscientiousness are more likely to devise a long-term investment strategy or follow through on their investment plan.[17] But Conscientiousness may also have an indirect effect on stock market participation because Conscientiousness has a positive effect on financial literacy, and financial literacy, in turn, increases the likelihood of stock market participation.[18] Second, our preferred financial knowledge measure is only surveyed for a small part

[16]We use nine census regions, birth cohorts (*e.g.*, "Early Baby Boomer" (born 1948-53), "Baby Boomer" (born 1954-59), *etc.*), and three levels of urbanization (large (population over 1 million); medium (population of 250,000-1 million); and small metro or rural area). The standard errors are of similar magnitude when we instead use heteroskedasticity-robust standard errors.

[17]For example, Almlund et al. (2011) describe Conscientiousness as being related to facets such as "order (organized)," "self-discipline," and "deliberation." All of these facets are likely to contribute to one's likelihood of participating in the stock market.

[18]Conscientiousness has been found to be important for academic performance, even after controlling for cognitive ability. See, for example, the review of studies in Chamorro-Premuzic and Furnham (2008). Similar underlying factors could explain a higher likelihood of acquiring financial literacy.

of the sample, which significantly reduces our estimation efficiency. Third, measures such as financial literacy and education, may be subject to an endogeneity bias.

To address the first two concerns, in conjunction with eq. (1), our model incorporates a second equation:

$$(\textit{Financial Literacy})_i = \gamma_0 + \boldsymbol{\gamma_1'}(\textit{Ability})_i + \boldsymbol{\gamma_2'}\mathbf{X_i} + \eta_i. \tag{2}$$

Thus, our model allows for both a direct effect and an indirect effect, via financial literacy, on stock market participation.[19] We are able to measure the relative importance of the two channels (direct and indirect) and examine the underlying mechanisms. For each ability measure we can estimate the share of the overall effect that is due to the direct or indirect effect. To estimate the model in eqs. (1) and (2), and address the sparsity of the financial literacy measure, we implement the efficient GMM imputation framework derived by Abrevaya and Donald (2017).[20]

To reduce the threat to validity due to endogeneity, we take several steps. First, we exploit the panel structure of our data, and use a two-year lag for our financial control variables.[21] Second, like several other papers in the literature that study stock market participation (*e.g.*, Grinblatt et al., 2011; and Hong et al., 2004) we control for wealth. We exclude stocks, bonds, and retirement assets from wealth, and lag the measure by two years.[22] As an example of a concern regarding our financial measures that requires

[19]See, for example, the discussion in Imai et al. (2010).

[20]As explained by Abrevaya and Donald (2017, p. 662), "[our] GMM estimate is more efficient than the complete data method, the dummy variable method, or the linear imputation methods" and that unlike other methods, it does not suffer from "'cure that is worse than the disease.'" Abrevaya and Donald (2017, p. 658) further explain that their model consists of "a regression equation and a linear projection of the possibly missing covariate on the other covariates ... a set of moment conditions for the observed data [,] and an optimally weighted GMM estimator[.]"

[21]This is primarily focused on concerns regarding these financial controls, and would not address the endogeneity of financial literacy which we directly address below.

[22]However, our results are robust to not including wealth as a control.

us to lag our measures, stock market participation may affect household income (*e.g.*, via prompting household members to retire or work part-time) and/or household wealth (*e.g.*, households may invest back in their business or in real estate rather than the stock market). Next, to address any concerns regarding the endogeneity of measures such as educational attainment, we take advantage of the unique richness of our data and use PGS as a source of exogenous variation. The PGS, which we further discuss in Section 3, is based on genetic characteristics which are arguably more exogenous in nature. Finally, we examine an instrumental variable for financial literacy suggested in Fernandes et al. (2014).

3 Data

Our paper uses data from the Health and Retirement Study (2012). The HRS is a biennial longitudinal survey of a nationally representative sample of the population over age 50. The data from the HRS contain detailed information on demographics, health, and economic and financial variables. The HRS also contains a rich set of measures of cognitive and noncognitive abilities. We focus on households in the 2012 wave as our main sample because it is the last survey year that has all of the necessary data.[23] To reduce concerns of endogeneity, for our financial control variables, we use the households' 2010 financial information. The HRS contains both individual and household-level data. For couples, we use the demographics and financial literacy and ability measures of the individual designated as the "financial respondent." The financial measures are measured at the household level.[24]

[23]However, our results are very similar when we examine stock market participation during 2012 and 2014 instead of stock market participation only in 2012 – though this requires that we use 4-year rather than 2-year lags for some of our explanatory variables.

[24]We therefore assume that the person designated as the financial respondent is the decision maker of the household when it comes to stock market participation. We also estimated our models including non-financial respondents and found that the effect of financial literacy was larger and the statistical significance of several of our ability measures increased likely due to the larger sample size and additionally-available

Our main sample consists of 6,777 households. Table 1 summarizes the variables used in our regression analyses. We define a household to be participating in the stock market if the household owns any stocks or stock mutual funds including through voluntary retirement accounts. In our sample, 34% of the households participate in the stock market. Among all households, 46% are couples. In couple households, in 61% of cases the financial respondent is a male. The majority of single households (76%) are female, 22% of the financial respondents have a college education or more, 75% of the households own a home, and the average total household income, to include wages, government transfers, *etc.*, is $50,154.

Our preferred financial literacy measure is based on an additional module in the 2008 and 2010 HRS surveys. Using the survey questions in Lusardi et al. (2009), we measure the number of correct answers to eight questions about investments and finance.[25] Our financial literacy measure is designed to capture accumulated financial knowledge of risk and diversification, financial markets, and facts about financial products. The average number of correct answers is 4.67. The measure has the advantage of covering a wider-than-usual range of topics related to financial literacy, but it is only administrated to about 10% of households in our sample. We address this limitation using two approaches: an imputation implemented via GMM, and using an alternative, coarser measure of financial literacy that is available for the entire sample.

For our cognitive ability measures, we use four commonly-used measures: Number Se-

observations with non-missing financial literacy information.

[25]The eight questions are: (1) You should put all your money into the safest investment you can find and accept whatever return it pays; (2) An employee of a company with publicly traded stock should have a lot of his or her retirement savings in the company's stock; (3) It is best to avoid owning stocks of foreign companies; (4) Even older retired people should hold some stocks; (5) You should invest most of your money in a few good stocks that you select rather than in lots of stocks or in mutual funds; (6) If the interest rate falls, bond prices will rise; (7) If one is smart, it is easy to pick individual company stocks that will have better than average returns; and (8) There is no way to avoid people taking advantage of you, if you invest in the stock market.

ries, Numeracy, Retrieval Fluency, and the HRS's Total Cognition Score (which is defined as the sum of the short-term memory, long-term memory, and mental status scores).[26] We standardize the measures to have a mean of zero and a standard deviation of one. The Number Series score is designed to measure fluid intelligence.[27] The Numeracy measure is designed to capture the ability to perform simple calculations such as subtraction and division.[28] Retrieval Fluency measures the ability to access long-term stored information/knowledge.[29] The HRS Total Cognition Score measures episodic memory (both short- and long-term word recall) and mental status.[30]

Our noncognitive ability measures are based on the widely-used Big Five personality traits: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism.[31] John et al. (2008, p. 120) describe Openness as "the breadth, depth, originality, and complexity of an individual's mental and experiential life"; Conscientiousness as "socially prescribed impulse control"; Agreeableness as "prosocial communal orientation toward others"; Extraversion as "an energetic approach toward the social and material world"; and Neuroticism as the contrast between "emotional stability and even-temperedness with negative emotionality, such as feeling anxious, nervous, sad, and tense." Although there is

[26]See Fisher et al. (2013) for a description of the measures.

[27]Horn (1970, p. 462) explains that fluid intelligence is the "ability to perceive complex relations, educe complex correlates, form concepts, develop aids, reason, abstract, and maintain span of immediate apprehension in solving novel problems in which advanced elements of the collective intelligence of the culture were not required for solution."

[28]For example, this measure was used to proxy for financial literacy in Lusardi and Mitchell (2007), and Van Rooij et al. (2011). In Section 5.3, we examine the additional explanatory power of our preferred measure of financial literacy in addition to using numeracy.

[29]As explained by Fisher et al. (2013, p. 19): "Retrieval Fluency measures an aspect of long-term retrieval: fluency of retrieval from stored knowledge. [...] The measure consisted of a single item in which respondents were asked to name as many animals as they could within a 60-second time limit."

[30]Mental status is measured by testing backwards counting from 20 and 86, naming today's date, serial 7's (sequential subtracting 7 from 100), naming an object to match a description, and naming the current President and Vice President.

[31]The Big Five traits are calculated form the answers to the question "Please indicate how well each of the following DESCRIBES YOU" for 26 adjectives. The answers are scored from 1 ("not at all") to 4 ("a lot"), and the scores are averaged over the adjective items corresponding to each of the five traits.

evidence that the Big Five are rather stable over time, to reduce the concerns of endogeneity, for each sample member we use the most recent Big Five personality traits measured in the panel prior to the year in which stock market participation is measured. We standardize each of the Big Five measures to have a mean of zero and a standard deviation of one for ease of interpretation of the regression coefficients.

We also use genomic data to address endogeneity concerns for education and cognitive ability. The HRS genotyped survey respondents in 2006-2012 and calculated various PGSs for predicting cognition, behaviors, longevity, and other health outcomes (Ware et al., 2018). The PGS for a specific outcome of interest is calculated as the weighted sum of numerous indicators that mark genomic variations across people in some relevant genetic loci for that outcome. The weights and the loci are chosen to maximize the predictive power of an outcome. We use three measures computed by the HRS: the General Cognition PGS, the Attention Deficit Hyperactivity Disorder (ADHD) PGS, and the Education PGS.

4 Results

4.1 The Effect of Financial Literacy and Ability on Stock Market Participation

We begin by examining the propensity to participate in the stock market using a linear probability model, but our results are qualitatively and quantitatively the same using a logit specification. Table 2 presents the regression results for the likelihood of stock market participation in 2012 for our main sample of 6,777 households. Each column in Table 2 is based on GMM results implementing Abrevaya and Donald (2017) allowing each variable to have both a direct effect on stock market participation, and indirect effect via financial literacy. For example, cognitive and noncognitive abilities are allowed to affect

stock market participation directly as well as affect financial literacy, which may in turn affect stock market participation.

All columns control for the household's financial characteristics such as wealth quartiles (excluding stock, bond assets, and retirement accounts), home ownership, household income, and out-of-pocket medical expenses. The household financial measures are lagged two years to reduce the concern of endogeneity. All columns also control for the household's financial respondent's characteristics, such as birth cohort, race, gender, employment status, and marital status.[32] We report the coefficients for the direct effect in Panel A of Table 2, and the coefficients for the effect on financial literacy in Panel B. The indirect effect is the product of the effect on financial literacy (Panel B) and the effect of financial literacy on stock market participation (Panel A).

The first column includes only household financials and demographics with no controls for ability. For succinctness, we only report the coefficients for income, wealth quartiles, and gender. The effect of income is statistically significant at the 1%-level throughout Table 2. Similarly, the effect of household wealth is positive and statistically significant at the 1%-level.[33] We find that the effect of a male financial respondent is statistically significant, though the magnitude of the effect decreases as we add additional controls, and similar to Van Rooij et al. (2011), this effect is no longer statistically significant once an instrumental-variable specification is used in Table 3.

The coefficient on financial literacy suggests that, all else equal, correctly answering one additional financial literacy question increases the likelihood of stock market participation by 3.3 percentage points, and the result is statistically significant at the 1%-level. The

[32]In addition, we control for household size (whether two or more), and census region and metro-type (population over 1 million; population of 250,000-1 million; and small metro or rural area) fixed effects.

[33]We follow several papers in the literature that use household wealth as a control when examining stock market participation (*e.g.*, Grinblatt et al., 2011; and Hong et al., 2004). We exclude stocks, bonds, and retirement account holding from our wealth measure. We find similar results when not including wealth as a control. We use wealth quartiles, but find similar results when using a continuous measure of wealth.

magnitude of the result is in line with, for example, Van Rooij et al. (2011) who examine the effect of a financial literacy measure on stock market participation in the Netherlands, though our effect is less than half of the effect they report once we include a full set of cognitive and noncognitive ability measures.

In column 2, we add measures for noncognitive ability, using the Big Five personality traits. The effect of financial literacy remains statistically significant at the 1%-level. Focusing on Conscientiousness as an example, we find that the effect of Conscientiousness is statistically significant at the 1%-level both directly, affecting the likelihood of stock market participation, and indirectly, affecting the likelihood of financial literacy, which in turn affects stock market participation. We find that, all else equal, an increase of one standard deviation in Conscientiousness would increase stock market participation by 1.8 percentage points. Furthermore, we decompose this effect, and find that 75% of it is due to the direct effect.

Throughout Table 2, we find that Agreeableness and Neuroticism have a direct, negative, and statistically significant effect on stock market participation. Higher levels of Agreeableness may lead savers to prefer less volatile alternatives. Higher levels of Neuroticism may reduce the likelihood that an investor either enters or stays in the market in the long run.[34] For financial literacy, consistent with findings in the literature on the role of Openness in learning and knowledge acquisition, we find that Openness has a positive effect and Extraversion has a negative effect, both statistically significant at the 1% to 10%-level.[35]

[34]The effect of both Agreeableness and Neuroticism may be due to a correlation with risk aversion. For example, Borghans et al. (2009, p. 655) find that "[p]eople who are less agreeable, less neurotic [...] are less risk averse." In addition, Borghans et al. (2009) summarize findings that show that after Conscientiousness, Neuroticism is the second most important trait of the Big Five related to risk aversion.

[35]For example, Almlund et al. (2011) report a positive correlation with Openness and a negative correlation with Extraversion for a host of education measures such as years of education, course grades, and standardized achievement test scores.

We next add measures for cognitive ability in column 3. The effect of financial literacy on stock market participation remains positive and statistically significant at the 1%-level. The point estimate of financial literacy when controlling for ability (both cognitive and noncognitive) is 40% smaller (comparing columns 1 and 3), consistent with ability being an important factor for stock market participation. The effect of financial literacy absent the inclusion of ability factors is therefore likely to be capturing ability effects on stock market participation in addition to the effect of financial knowledge.

Among the multiple dimensions of cognitive abilities, we find that the Fluid Intelligence, Numeracy, and Total Cognition scores have a statistically significant, direct effect on stock market participation at the 1%-level. For example, a one-standard-deviation increase in Fluid Intelligence increases the direct propensity to participate in the stock market by 3.6 percentage points, which represents 84% of the total of the direct and indirect effects. Therefore, we find that Fluid Intelligence operates mainly via the direct effect. In contrast, the Retrieval Fluency score does not have a direct statistically significant effect, but does have a statistically significant effect on financial literacy at the 1%-level. As such, the results suggest that the effect of Retrieval Fluency on stock market participation operates mainly through financial literacy rather than directly.

The effects of the Big Five personality traits on stock market participation and financial literacy remain significant after including the cognitive ability measures. For example, the direct effect of Conscientiousness is 0.9 percentage points, which is about 75% of the total effect on stock market participation. This result supports that the variations in both cognitive and noncognitive abilities are important in stock market participation directly and indirectly through financial literacy. Specifically, Conscientiousness seems to influence stock market participation directly and indirectly through financial literacy whereas Openness works on stock market participation mainly through financial literacy.

Our results are consistent with findings in the literature in that the effects of cognitive ability on stock market participation are economically and statistically significant. Furthermore, the effects are not limited to a certain aspect of cognitive ability, but rather we find that various dimensions of cognitive ability are important, suggesting that researchers should not focus on a single and narrow measure of cognitive ability. Because the various cognitive ability measures are important, and for tractability purposes and ease of comparison, we combine the four cognitive ability measures (Fluid Intelligence, Numeracy, Total Cognition, and Retrieval Fluency scores) into a single measure in columns 4 and 5 by using the average of the standardized four cognitive ability measures.

The unidimensional cognitive ability measure is statistically significant at the 1%-level, both in its direct effect on stock market participation, and its effect on financial literacy. In column 4, the direct effect of the single, combined cognitive measure is 9.6 percentage points, representing 88% of the total of the direct and indirect effects. The financial literacy effect remains statistically significant at the 1%-level. The effects of financial literacy and the Big Five personality traits in column 4 remain very similar to those in column 3. The results suggest that both the cognitive and noncognitive ability measures have independent explanatory power. This is consistent with findings in the literature that cognitive and noncognitive abilities span independently the space of explanatory measures.[36]

Financial literacy and more general measures of educational attainment that are traditionally controlled for could potentially be proxying for each other (or for a third common variable). We therefore examine their effects separately in column 4 by first focusing on the role of financial literacy excluding education.[37] In the last column, we add the financial

[36]For example, Almlund et al. (2011) review a host of studies that find that noncognitive abilities have explanatory power after controlling for cognitive measures (and other demographics) for various outcomes related to educational attainment.

[37]For example, both Hong et al. (2004) and Georgarakos and Pasini (2011) use years of education as control and find a positive and statistically significant effect on stock-market participation. Christiansen et al. (2008) find that more specialized education (an economics degree) has a larger effect on stock-market

respondent's years of education.[38] Schooling has been shown to be positively correlated with many outcomes beyond the labor market. Education could be a proxy for general knowledge, financial experience, or other skills that would not be captured by our cognitive and noncognitive ability measures.[39] The effect of education is statistically significant at the 1%-level, both on the likelihood of stock market participation and on financial literacy. The direct effect of a one-year increase in education is 1.6 percentage points, representing 90% of the total of the direct and indirect effects. The effect of financial literacy on stock market participation remains statistically significant, though the point estimate is a little smaller, possibly due to the correlation between education level and financial literacy.

4.2 Addressing Endogeneity

In this section, we further address the potential endogeneity of the ability, education, and financial literacy measures. Our measures of education and cognitive ability capture a broad set of abilities and knowledge, and are therefore less likely to suffer from an omitted variable bias.[40] But one may still be concerned that our measures of cognitive ability and education are correlated with the unobservable propensity to participate in the stock market.[41]

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participation relative to other majors. Arguably, financial literacy is an even more specialized form of knowledge.

[38] Our results are similar when we control for categories of educational attainment (*e.g.*, college, some college, high-school, *etc.*).

[39] For example, Oreopoulos and Salvanes (2011) survey the literature on various types of returns to schooling, and discuss how schooling can help decision-making skills, encourage patience and long-term thinking, promote trust and civic participation, as well as teach students how to manage money.

[40] Christiansen et al. (2008) examine the role of a more specialized education and find the effect on stock market participation to be much larger amongst those with an economics degree. For example, Fernandes et al. (2014) are only able to control for Numeracy as cognitive ability.

[41] Many studies use education as a control, but most do not address the potential endogeneity of education. Christiansen et al. (2008) use the availability of a nearby university as an instrumental variable. For example, Van Rooij et al. (2012) use economics education as an instrument for their financial literacy measure, and are therefore assuming that education is exogenous.

A similar concern exists for our financial literacy measure. Though the effect of financial literacy on stock market participation that we report in Table 2 is after allowing financial literacy to be affected by ability, demographics, and household financials, there may be a remaining concern of endogeneity of financial literacy – for example, because those interested in stock market participation may be more inclined to increase their financial literacy.[42]

In Table 3, we address these potential threats to validity. We make use of two types of instruments, the first is "Need for Cognition," which has previously been suggested as an instrument for financial literacy by Fernandes et al. (2014). Second, we rely on Polygenic Scores (PGS) related to cognitive ability and education. In using PGS, our exclusion restriction assumes that the genetic markers and the weights used to construct the scores are uncorrelated with the unobserved propensity to participate in the stock market.[43]

In columns 1 and 2 of Table 3, we address the potential endogeneity of the education and cognitive ability measures by relying on the (assumed) exogeneity of the PGS measures. In the first column, we replace years of education with an education PGS.[44] The effect of financial literacy remains statistically significant at the 1%-level. The education PGS has a positive and statistically significant effect on stock market participation.[45]

In column 2, to address the potential endogeneity of our cognitive ability measures

[42]See also the discussion regarding the endogeneity of financial literacy in Kotlikoff and Bernheim (2001) and Van Rooij et al. (2012).

[43]Though an individual's genome is fixed to a large degree, this of course does not imply it can necessarily serve as a valid instrumental variable. We acknowledge the challenges associated with this assumption of exogeneity and our use of PGS as an instrument (see, for example, Conley, 2009). However, we argue that it provides an alternative exclusion restriction which is arguably as plausible as those considered previously in the literature, such as the finances of siblings and parents (Alessie et al., 2011).

[44]We use the HRS's "PGS_EDU3_SSGAC18" measure. We additionally control for the HRS-computed PGS principal component factors, as recommended by Ware et al. (2018).

[45]The PGS measures we use are unavailable for approximately a quarter of our sample. However, we find that our results in Table 2 are qualitatively the same if we condition on the sample for which the PGS measure is available.

in addition to replacing the education measure as in column 1, we replace our combined average cognitive ability measure with the General Cognition PGS and ADHD PGS. The first polygenic score was constructed to be correlated with cognitive performance, and the second was constructed to have a predictive power for ADHD. Both measures are correlated with our measure of cognitive ability as both are likely proxies for performance on cognitive tests.

In column 2, the effect of financial literacy on stock market participation remains positive and statistically significant at the 1%-level. Moreover, all three PGSs have a statistically significant direct effect on the likelihood of stock market participation at least at the 5%-level, and of the expected signs. The effects of the noncognitive ability measures are similar, with the direct effects of Agreeableness and Extraversion statistically significant at the 5%-level, though the effect of Conscientiousness is smaller and no longer statistically significant across the specifications of Table 3.

The last column of Table 3 presents our results of using an instrumental variable approach for addressing the potential endogeneity of financial literacy by adding one additional exclusion restriction and using Need for Cognition as an instrument. We follow Fernandes et al. (2014) in using Need for Cognition as an instrument for financial literacy. We implement an instrumental variable approach by incorporating Need for Cognition as an exclusion restriction within the GMM framework of Abrevaya and Donald (2017) that was used in Table 2.[46] As such, we assume that it is uncorrelated with the unobservable propensity to participate in the stock market. In addition to instrumenting financial literacy, as in the previous column, we replace education and cognitive ability with our PGS measures.[47] The coefficient on financial literacy remains statistically significant at the 1%-level, and of similar magnitude.[48]

[46]This is akin to implementing a two-stage-least-squares using GMM.

[47]Because our main interest is the effect of financial literacy, to increase the efficiency of our estimates, we followed a "hybrid" approach where we used an instrumental variable for financial literacy, but replaced the other two variables of potential concern (education and cognitive ability) with PGS measure as exogenous proxies for those variables.

[48]In the "first stage," the effect of Need for Cognition on financial literacy is statistically significant at the 1%-level and the first-stage F-statistic is 12.44.

5 Robustness of the Results to Incorporating Other Factors and Examining Alternative Participation Measures

5.1 Additional Measures Affecting Stock Market Participation

Our specifications in Tables 2 and 3 control for a multitude of demographic, financial and ability measures. We examine the robustness of our finding regarding the effect of financial literacy on stock market participation to the inclusion of additional measures that have been suggested in the literature as explaining stock market participation. We find that the effect of financial literacy remains positive and statistically significant after controlling for sociability, degree of optimism, risk aversion, and individuals' perception of the control they have over their lives.

In Table 4 column 1, we add a measure for Internal Locus of Control,[49] which Rotter (1966) describes as "the degree to which the individual perceives that the reward follows from, or is contingent upon, his own behavior or attributes[.]" This measure has been suggested as an important factor in explaining labor market outcomes and human capital investment (Cobb-Clark, 2015; and Coleman and DeLeire, 2003), and financial choices (Cobb-Clark et al., 2016; and Salamanca et al., 2020). The measure has a direct, positive (as predicted) and statistically significant effect on stock market participation at the 5%-level. The effect of financial literacy remains positive and statistically significant at the 1%-level.

In column 2, we examine the role of sociability. We add a binary proxy for sociability using whether one contacts friends once or more a week, similar to the measure used by Hong et al. (2004). The effect of our sociability indicator on stock market participation is found to be positive (as predicted) and statistically significant at the 1%-level. As in column 1, the effect of financial literacy on stock market participation remains statistically

[49] We operationalize Internal Locus of Control with the Perceived Mastery measure available in the HRS.

significant at the 1%-level. Whereas Internal Locus of Control and sociability have a statistically significant direct effect on stock market participation, their effect on financial literacy is not statistically significant.

In column 3, we examine the role of optimism, which was found to have a positive effect on stock market participation (*e.g.*, Puri and Robinson, 2007).[50] The effect is positive and statistically significant at the 1%-level both for the direct effect on stock market participation and the effect on financial literacy. Last, columns 4 and 5 examine the role of risk aversion. In column 4, we use the risk aversion measure imputed from the "preference model" of Barsky et al. (1997) and Kimball et al. (2008). Column 5 uses instead a categorical risk aversion measure based on the "income gamble" questions where people are asked to choose between pairs of jobs with guaranteed or uncertain incomes. In both cases, the direct effect of risk aversion on stock market participation is negative, as expected, and statistically significant at the 5%-level. Taken together, the results of Table 4 demonstrate that the effect of financial literacy on stock market participation remains similar in magnitude, and statistically significant at the 1%-level even accounting for various additional factors that have been examined in the literature.

5.2 Alternative Participation Measures

As we explained in Section 2, our preferred measure for stock market participation as the dependent variable is an indicator equal to one if a household invests in stocks or stock mutual funds via a taxable account or through a retirement account. However, financial literacy (and cognitive and noncognitive abilities) may influence the propensity

[50]We derive the optimism measure by averaging the scores (scale ranging 1-6) of the following six questions (questions (4)-(6) are reverse-coded): (1) I'm always optimistic about my future. (2) In uncertain times, I usually expect the best. (3) Overall, I expect more good things to happen to me than bad. (4) If something can go wrong for me it will. (5) I hardly ever expect things to go my way. (6) I rarely count on good things happening to me. See, *e.g.*, the discussion in Scheier et al. (1994) on the measurement of expectancies of one's future.

to participate in capital markets beyond the stock market. For example, financial literacy would reduce the indirect cost of participation in the bond market as people with financial knowledge may realize the importance of portfolio diversification and feel more confident of buying complex financial instruments.

In Table 5, we examine the robustness of our findings by studying the role of financial literacy and abilities on the propensity to hold various financial instruments using alternatives to our dependent variable. Throughout Table 5 we use the same specification as that in Table 3 column 2, using PGSs as exogenous proxies for ability and education. In columns 1-3, we replace the dependent variable with the binary outcomes of: 1) participation in the stock market via taxable nonretirement accounts; 2) participation in the bond market; 3) and participation in the stock or bond market, respectively. Finally, in column 4 we examine whether financial literacy affects the propensity to participate in voluntary retirement plans.

The effect of financial literacy is positive and statistically significant at least at the 5% level for each of the alternative definitions of the dependent variables in Table 5. This suggests that financial literacy is not exclusively important for stock market participation, but rather for any participation decision that may involve what is often referred to as an "indirect participation cost" (*e.g.*, Grinblatt et al., 2011). Indirect costs are those that go beyond direct costs (examples of direct costs include brokerage fees and trading commissions). However, the fact that the effect of financial literacy on participation in the bond market is a third of the effect on participation in the stock market (compare columns 1 and 2), suggests that financial literacy has an incremental effect on stock market participation beyond the effect on bond market participation. As such, the results are consistent with financial literacy operating via two types of mechanisms. First, financial literacy may lower the indirect costs of participation in financial markets (for example,

setup and entry costs may be similar for stocks and bonds). Second, increased levels of financial literacy allow more households to participate in the stock market and take advantage of the equity premium.[51]

5.3 Comparing Numeracy and Financial Literacy

The rich dataset at our disposal allows us to disentangle the effects of financial literacy and the effect of an ability measure closely related to financial literacy. We next examine the role of numeracy and our preferred measure of financial literacy in explaining stock market participation. In settings where only numeracy measures are available, numeracy has been a natural choice as a proxy for financial literacy.[52] Therefore, we include numeracy as a separate ability measure.[53]

To measure the separate effects of numeracy and financial literacy measures, we use two different specifications. First, we use observed education and the combined cognitive ability measure redefined without numeracy. Second, we use PGSs for education and cognitive ability measures other than numeracy. Our results from both specifications show that when numeracy is included separately from our other cognitive ability measures, it has a direct positive and statistically significant effect on stock market participation at the 1%-level. However, the effect of financial literacy remains statistically significant at the 5%-level, and of similar magnitude.[54] As such, the results suggest that there is additional

[51]For example, financial literacy may contribute to households' awareness of the equity premium, or it is possible that stocks have additional indirect costs relative to bonds. Our data do not allow us to ascertain the types of bonds held by households (and their associated level of risk and length to maturity).

[52]For example, Christelis et al. (2010) examine the effect of numeracy, but do not have any measures of financial literacy.

[53]In our data, numeracy and financial literacy have a correlation of 29.2%.

[54]In the first specification, the effect of the numeracy measure is 3.3 percentage points and statistically significant at the 1% level. The financial literacy measure still has a statistically significant effect of 1.8 percentage points at the 5% level. In the second specification, the effects of numeracy and financial literacy measures are 4.4 and 5.2 percentage points, respectively, and both effects are statistically significant at the 1% level.

explanatory power in our preferred measure of financial literacy, perhaps evidencing that in-depth financial knowledge plays a role that goes beyond the ability to perform numerical tasks.

6 Conclusion

Controlling for a rich set of demographics and financial variables, we find that financial literacy, cognitive abilities, and noncognitive abilities all have an effect on the likelihood that a household participates in the stock market. We further find that financial literacy and various ability measures, as well as demographics and financial variables have not only a direct effect on stock market participation, but also an indirect effect on stock market participation as they operate via financial literacy. For example, we find that several cognitive measures (Fluid Intelligence, Numeracy, and Total Cognition), noncognitive measures (Conscientiousness, Agreeableness, and Neuroticism), and financial literacy have a direct, statistically significant effect on stock market participation. As such, our findings demonstrate the importance of controlling for a sufficiently-wide array of ability measures when examining the role of financial literacy.

Our findings also suggest that as additional controls for ability and other measures examined in the literature are included (such as risk aversion), the effect of financial literacy does decrease, though it remains statistically significant. This is consistent with the conjecture of Fernandes et al. (2014) that large financial literacy effects that have been found by some in the literature may be due to failing to control for a sufficient number of factors.

In addition, the availability of a more detailed, direct measure of financial literacy allows us to compare this measure to a coarser numeracy-based measure that has been widely-used in the literature. The numeracy-based financial literacy measure is arguably

more of a proxy for cognitive ability than a measure of financial knowledge. We find that when used in tandem, both our preferred knowledge-based measure of financial literacy and the ability-based proxy of financial literacy have a statistically significant effect on stock market participation. As such, when available, the measures should not be used interchangeably, but rather together.

Commonly-discussed interventions for increasing stock market participation rates are financial education and classes in the area of financial literacy.[55] Our results allow for a comparison between the returns on such an investment and an investment in ability in terms of increasing stock market participation.[56] Our findings also shed light on the relative importance of various measures of ability and demographics on the level of financial literacy.

Given the importance of stock market participation over one's life cycle for wealth accumulation, our results suggest that investments in financial literacy could have large benefits for households. As such, we think an important area for future research is to examine the cost-effectiveness of efforts to increase financial knowledge, as well as to compare those to other possible interventions such as setting the default in employer-sponsored retirement plans to investing a certain percent in the stock market with an opt-out option.

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[55]For example, Fernandes et al. (2014) examine 90 intervention effects ("manipulated financial literacy"). See the list of articles in the authors' Web Appendix A, Tables WA1 and WA2, available online at `https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2333898`.

[56]However, we note that investment in ability (both cognitive and noncognitive) is likely not very cost-effective beyond early childhood, and that investments in ability have returns in domains beyond stock market participation or financial outcomes.

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Table 1 - Summary Statistics

Variables	Mean	Standard Deviation
Household-level variables		
Stock market participation[1]	34.01%	47.38%
Total household income[2]	$50,154	$64,423
Total wealth excluding stocks, bonds, and retirement accounts[2]	$276,698	$656,962
Own home[2]	73.51%	44.13%
Married	42.50%	49.44%
Financial-respondent-level variables		
White	79.19%	40.59%
Male	40.68%	49.13%
Years of education	12.78	2.92
Financial literacy (0-8)[3]	4.67	1.66
Cognitive ability measures		
Number Series *W*-score (390-584)	499	39
Numeracy score (0-3)	1.17	0.88
Retrieval Fluency score (0-90)	15.38	6.75
Total Cognition score (0-35)	21.98	4.63
Personality traits (1–4)		
Openness	2.93	0.56
Conscientiousness	3.37	0.48
Extraversion	3.21	0.55
Agreeableness	3.53	0.47
Neuroticism	1.99	0.61
Number of households	6,777	

Notes: Range of scores in parentheses. [1] Holding stocks or stock mutual funds. [2] Measure lagged by two years in the regressions. [3] Number of correct answers (available for 563 observations; see paper for details).

Table 2 - Direct and Indirect Effects on Stock Market Participation

Panel A - Direct effect

	Dependent variable: stock market participation				
Explanatory variables	(1)	(2)	(3)	(4)	(5)
Financial literacy	0.033***	0.027***	0.020***	0.019**	0.016**
	(0.009)	(0.008)	(0.007)	(0.008)	(0.008)
Male financial respondent	0.027***	0.025***	0.017**	0.019**	0.024***
	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)
Household income†	0.027***	0.023***	0.016***	0.019***	0.017***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Wealth quartile (2nd)†	0.131***	0.137***	0.132***	0.129***	0.124***
	(0.014)	(0.013)	(0.012)	(0.013)	(0.013)
Wealth quartile (3rd)†	0.293***	0.291***	0.283***	0.271***	0.260***
	(0.017)	(0.016)	(0.014)	(0.016)	(0.016)
Wealth quartile (Top)†	0.452***	0.459***	0.436***	0.435***	0.416***
	(0.019)	(0.018)	(0.017)	(0.018)	(0.018)
Openness		0.006	-0.003	-0.004	-0.009*
		(0.006)	(0.005)	(0.005)	(0.005)
Conscientiousness		0.014***	0.009*	0.012**	0.011**
		(0.005)	(0.005)	(0.005)	(0.005)
Extraversion		-0.001	0.010**	0.006	0.008*
		(0.005)	(0.004)	(0.005)	(0.004)
Agreeableness		-0.030***	-0.028***	-0.029***	-0.029***
		(0.005)	(0.005)	(0.005)	(0.005)
Neuroticism		-0.017***	-0.010***	-0.009**	-0.008**
		(0.004)	(0.004)	(0.004)	(0.004)
Number Series score			0.036***		
			(0.005)		
Numeracy score			0.034***		
			(0.005)		
Retrieval Fluency score			-0.003		
			(0.006)		
Total Cognition score			0.024***		
			(0.005)		
Combined cognitive score				0.096***	0.067***
				(0.008)	(0.008)
Years of education					0.016***
					(0.002)
Observations (households)	6,777	6,777	6,777	6,777	6,777

Notes: † denotes measure lagged by 2 years. *, **, *** denote statistical significance at the 10, 5, and 1-percent level, respectively. Panels A and B are jointly estimated using GMM. Standard errors, in parentheses, are clustered by birth cohort × census region × metro type. Metro types are defined as: large (population over 1 million); medium (population of 250,000-1 million); and small metro or rural area. Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism are standardized to have a mean of zero and a variance of one. All specifications control for birth cohort ("Early Baby Boomer" (born 1948-53), "Baby Boomer" (born 1954-59),*etc.*), race, gender, marital status, employment status, household size (whether two or more), home ownership, out-of-pocket medical expenditure, and region and metro-type fixed effects. The sample includes households in 2012 (income, wealth, home ownership, and medical expenditure are lagged).

Table 2 - Direct and Indirect Effects on Stock Market Participation (cont.)

Panel B - Indirect effect

	Dependent variable: financial literacy				
Explanatory variables	(1)	(2)	(3)	(4)	(5)
Male financial respondent	0.141	0.105	0.131	0.074	0.039
	(0.119)	(0.110)	(0.108)	(0.106)	(0.108)
Household income†	0.183***	0.177***	0.095*	0.117**	0.078
	(0.066)	(0.065)	(0.054)	(0.059)	(0.052)
Wealth quartile (2nd)†	-0.017	0.018	-0.162	-0.138	-0.180
	(0.164)	(0.163)	(0.166)	(0.171)	(0.175)
Wealth quartile (3rd)†	0.030	0.104	-0.229	-0.153	-0.237
	(0.186)	(0.182)	(0.175)	(0.181)	(0.187)
Wealth quartile (Top)†	0.416**	0.425**	0.126	0.158	0.028
	(0.190)	(0.186)	(0.182)	(0.185)	(0.193)
Openness		0.252***	0.173***	0.178***	0.126*
		(0.066)	(0.061)	(0.063)	(0.065)
Conscientiousness		0.140***	0.167***	0.158***	0.176***
		(0.051)	(0.043)	(0.043)	(0.042)
Extraversion		-0.238***	-0.121*	-0.126*	-0.128**
		(0.068)	(0.063)	(0.065)	(0.062)
Agreeableness		0.010	-0.003	-0.008	-0.017
		(0.060)	(0.051)	(0.052)	(0.052)
Neuroticism		0.083	0.146***	0.142***	0.156***
		(0.055)	(0.055)	(0.055)	(0.054)
Number Series score			0.367***		
			(0.063)		
Numeracy score			0.064		
			(0.049)		
Retrieval Fluency score			0.228***		
			(0.057)		
Total Cognition score			0.069		
			(0.067)		
Combined cognitive score				0.713***	0.506***
				(0.077)	(0.080)
Years of education					0.105***
					(0.021)
Observations (households)	6,777	6,777	6,777	6,777	6,777

Notes: See notes to Panel A.

Table 3 - Addressing the Potential Endogeneity of Education, Cognitive Measures, and Financial Literacy

	Dependent variable: stock market participation		
Explanatory variables	(1)	(2)	(3)
Financial literacy	0.043***	0.060***	0.046***
	(0.009)	(0.009)	(0.016)
Combined cognitive measure	0.087***		
	(0.009)		
Polygenic score (PGS) [1]			
Education PGS	0.038***	0.051***	0.039***
	(0.005)	(0.006)	(0.005)
General Cognition PGS		0.014**	0.003
		(0.006)	(0.006)
Attention deficit hyperactivity disorder PGS		-0.029***	-0.020***
		(0.005)	(0.005)
Instrumental variable (IV) for financial literacy	No	No	Need for Cognition
F-statistic for excluded IV			12.44
Observations (households)	5,083	5,083	4,633

Notes: [1] We use the HRS's PGS_EDU3_SSGAC18, PGS_GENCOG_CHRG15, and PGS_ADHD_PGC17, respectively.

, * denote statistical significance at the 5, and 1-percent level, respectively. Estimated using GMM. Standard errors, in parentheses, are clustered by birth cohort × census region × metro type (large, medium, and small/rural). See Table 2 and notes to Table 2 for list of controls.

Table 4 - Additional Explanatory Measures

Explanatory variables	(1)	(2)	(3)	(4)	(5)
Panel A - Dependent variable: stock market participation (direct effect)					
Financial literacy	0.059***	0.061***	0.060***	0.056***	0.060***
	(0.009)	(0.009)	(0.010)	(0.008)	(0.008)
Internal Locus of Control	0.017**				
	(0.008)				
Sociability (contact friends at least once a week)		0.085***			
		(0.020)			
Optimism (positive expectations for one's future)			0.015***		
			(0.004)		
Risk aversion (based on Barsky *et al.* 's "preference model")				-0.008***	
				(0.002)	
Risk aversion (based on "income gamble" question)					-0.013**
					(0.006)
Panel B - Dependent variable: financial literacy (indirect effect)					
Internal Locus of Control	-0.058				
	(0.086)				
Sociability (contact friends at least once a week)		0.239			
		(0.189)			
Optimism (positive expectations for one's future)			0.128***		
			(0.036)		
Risk aversion (based on Barsky *et al.* 's "preference model")				0.004	
				(0.023)	
Risk aversion (based on "income gamble" question)					-0.002
					(0.054)
Observations (households)	5,076	4,928	5,073	5,083	5,083

Notes: **, *** denote statistical significance at the 5, and 1-percent level, respectively. Estimated using GMM. Standard errors, in parentheses, are clustered by birth cohort × census region × metro type (large, medium, and small/rural). See Table 2 and notes to Table 2 for list of controls.

Table 5 - Alternative Participation Measures

	Dependent variable:			
Explanatory variable	**Stock Market Participation (taxable account)** (1)	**Bond Market Participation** (2)	**Stock or Bond Market Participation** (3)	**Participation in Voluntary Retirement Plan** (4)
Financial literacy	0.030***	0.010**	0.020**	0.035***
	(0.009)	(0.004)	(0.009)	(0.012)
Observations (households)	5,083	5,083	5,083	5,083

Notes: **, *** denote statistical significance at the 5 and 1-percent level, respectively. Estimated using GMM. Standard errors, in parentheses, are clustered by birth cohort × census region × metro type (large, medium, and small/rural). See Table 2 and notes to Table 2 for list of controls.