Portfolio Allocations of Older Americans:

The Role of Cognitive Ability and Preference Parameters

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I. Introduction

The low rate of stock market participation has been a longstanding puzzle in the financial literature (Haliassos and Bertaut, 1995). Among the different factors found to partially explain the puzzle, the possibility that low cognitive ability prevents some individuals from participating in the stock market is potentially concerning from a retirement planning perspective.[1] Over long time periods, the stock market tends to yield higher returns than alternative saving vehicles requiring a lower degree of investor sophistication, such checking or saving accounts. If individuals with low cognitive ability are deterred from investing in stocks, they will forego those higher returns. As the return difference is compounded over many years, heterogeneity in cognitive ability will translate into substantial differences in retirement wealth, even across individuals with similar saving rates.

Avoiding stocks and the risk they involve is, of course, not necessarily suboptimal, and may simply be driven by risk preferences. Other things equal, less-risk tolerant individuals will favor safer assets. There exists ample evidence that individuals' willingness to take risks increases systematically with cognitive ability (Frederick, 2005, Dohmen et al., 2010, Benjamin et al., 2013). This raises the question of whether cognitive ability is an independent driver of financial decisions (the "barrier to entry" hypothesis) or mostly acts as a proxy for risk attitudes (the "omitted variable" hypothesis).

[1] Several dimensions of cognitive ability have been found to be associated with stock market participation in Christelis et al. (2010), Grinblatt et al. (2011), and Van Rooij et al. (2011), among others.

This paper aims to resolve the role of cognition in household portfolio choices and distinguish it from that of risk preferences, an issue that has important policy implications. For example, if cognitive ability is linked to fixed participation costs implying that those with low cognition are prevented from accessing complex financial products, then policies such as financial literacy programs or retirement plan default options that automatically allocate some share of wealth into equities can be welfare enhancing. If, instead, the portfolio choices of those with poor cognition are driven by intrinsically different attitudes toward risk, the aforementioned policies could be ineffective or, at worst, reduce welfare.

Using a sample of individuals over the age of 50 from the Health and Retirement Study (HRS), we first show that high cognitive ability is a strong predictor of stock ownership and, to a lesser extent, bond ownership. Conversely, it is negatively correlated with the share of financial wealth held in bank deposits, the least risky but also the least complex saving vehicle. These associations persist after controlling for variables known to predict financial decisions and which may be correlated with cognitive ability, including risk preferences. The results cannot be interpreted as a rejection of the "omitted variable" hypothesis, however, given that the measure of risk aversion available in the HRS is coarse and subject to substantial measurement error, and thus unlikely to fully capture heterogeneity in risk attitudes (Kimball et al., 2008).

Next, we focus on life insurance ownership, a financial outcome whose association with cognitive ability has not, to our knowledge, been previously studied. This part of the analysis constitutes the main contribution of the paper, as it provides the basis for a falsification test. The attractiveness of life insurance should increase with risk aversion. At the same time, life insurance contracts typically entail a significant degree of complexity, discouraging ownership among less skilled investors. Hence, if cognitive barriers increase the fixed cost of investing in complex assets,

we would expect cognitive ability to be negatively associated with life insurance ownership. The opposite would be true if cognitive ability was simply acting as a proxy for higher risk tolerance. We find that cognitive ability is negatively associated with life insurance ownership, a result supporting the "barrier to entry" hypothesis.

Finally, we show that the association between cognitive ability and portfolio choice largely disappears when the estimation is carried out by fixed-effects. The absence of changes in portfolio composition following cognitive declines at old ages suggests that cognitive barriers act as a one-off cost that individuals pay when they first familiarize themselves with a particular financial product. Previous research has documented the presence of one-off entry costs partly driving low participation rates in the stock market (Vissing-Jørgensen, 2002). Our findings indicate that such costs operate, to some extent, through cognitive barriers.

This study substantiates previous evidence that higher cognitive ability lowers the cost of accessing sophisticated financial products, thereby increasing household holdings of more complex assets, such as stocks, which often result in higher returns to investment over time. Thus, policy interventions aimed at facilitating access to the stock and bond markets through educational campaigns and default pension plan options can be effective in improving retirement security. Since cognitive barriers act mainly as a one-off entry cost, and household portfolios exhibit substantial inertia over time, these policies should optimally target young investors in order to take advantage of compounded returns over a long time span.

II. Data and Sample Selection

We use HRS data for the decade 2002-2012, for which homogeneous cognition and numeracy measures are available. We restrict our sample to household financial respondents (those most knowledgeable about household finances) age 51-79. The key dependent variables in our analysis

are financial assets held outside of retirement accounts and insurance holdings. We separate financial assets into three categories that differ in terms of expected return/risk and complexity. The first category ("stocks") includes stocks and mutual funds, the most risky and complex assets. Assets in the second category (bonds, certificates of deposit, government saving bonds and Treasury Bills, referred to as "bonds") display lower risk and lower return than stocks, and typically also require a lower degree of financial sophistication. Finally, assets in the third category ("bank deposits", which includes checking, savings and money market accounts) are the least risky and complex. For the first two categories we consider an indicator of ownership as the dependent variable. Because 87% of households have bank deposits, we use the share of bank deposits on financial wealth as outcome variable.[2] To run the falsification test, we use an indicator for whether the individual holds a life insurance policy---a relatively complex financial product which, other things equal, should be more appealing to risk-averse individuals---as the dependent variable.

We construct two measures of cognitive ability, one capturing episodic memory and fluid intelligence ("cognition") and another one measuring numerical ability ("numeracy"). The cognition variable has 5 categories corresponding to the quantiles of an index summing the scores of the immediate and delayed word recall tests (respondents are read a list of 10 words and asked to recall them in no particular order immediately and after 5 minutes) and the Serial 7's test (serial 7 subtraction from 100 up to five times). The numeracy variable takes the value 1 if individuals answer correctly at least 2 questions out of the 3 included in the HRS numeracy battery.[3] In the HRS, respondents' risk attitudes are elicited using questions about hypothetical lifetime income

[2] We focus on stock and bond ownership to be able to compare out results to previous literature. Using the shares of stocks and bonds on financial wealth as dependent variables yields qualitatively similar results.
[3] These questions are asked in alternate waves. When missing, we impute the numeracy score with that of wave *t-1*.

gambles and measured on a 4-point scale (1 for least risk averse and 4 for most risk averse).[4] These questions were not asked to all respondents in all waves and were dropped from the questionnaire in 2008. We use individual-specific average risk aversion across waves and treat risk aversion as a constant individual trait.

All our regressions include controls for gender, race, age, marital status, education, work status, self-reported health, total household income and wealth, as well as wave indicators. To better capture individual-specific characteristics that may inform financial decisions, we add to the set of controls an educational attainment polygenic score, which measures genetic contributions to variation in years of schooling and has been shown to be strongly correlated with financial outcomes in the HRS (Barth et al., 2017). This score is available for 12,270 HRS respondents, who were genotyped between 2006 and 2010.

Our analytic sample has 26,527 observations referring to 6,408 individuals, 70% of whom are observed for at least 4 waves out of 6. In the sample, 31% of individuals have stocks, 26% have bonds, and 87% have bank deposits. The fraction of life insurance holders is 70%. The standardized cognition index ranges from -3.18 to 2.6, with a standard deviation of 0.92. Fifty percent of the sample are classified as having high numeracy skills. Approximately 8% of respondents are in the least risk-averse group, and 58% are in the most risk-averse group. Summary statistics of all the variables used in the analysis are provided in the online Appendix.

III. Results

Table 1 shows results of OLS regressions. The first column replicates previous findings on the positive association between cognitive ability and stockholding in the cross-section. Specifically, the probability of owning stocks increases monotonically with cognitive ability. Individuals in the

[4] A risk measure based on a 6-point scale has been elicited starting from the 2000 wave. The results of our analysis are qualitatively similar when we use this measure, although sample size is reduced because of missing risk measure.

highest cognition quintile are 5.3 percentage points more likely to own stocks than those in the lowest quintile. Meanwhile, a high numeracy score increases stockholding by 2 percentage points. These associations are conditional on a rich set of demographics, education, polygenic score of educational attainment, household income and wealth.

Table 1: Cross-sectional relationship between cognitive ability and portfolio allocation

	Stocks (ownership)	Bonds (ownership)	Bank Deposits (share)	Life insurance (ownership)
Cognition				
2	0.008	0.015*	-0.016*	0.028**
	(0.008)	(0.008)	(0.008)	(0.011)
3	0.021**	0.027***	-0.026***	0.045***
	(0.009)	(0.009)	(0.009)	(0.012)
4	0.028***	0.037***	-0.025***	0.048***
	(0.010)	(0.010)	(0.009)	(0.013)
5 (highest)	0.053***	0.033***	-0.035***	0.050***
	(0.011)	(0.011)	(0.010)	(0.013)
Numeracy				
1 (highest)	0.020***	0.000	-0.011*	0.009
	(0.008)	(0.008)	(0.007)	(0.009)
Risk Aversion				
2	-0.031*	0.002	0.021	0.043*
	(0.019)	(0.018)	(0.017)	(0.022)
3	-0.054***	-0.003	0.032**	0.049**
	(0.017)	(0.016)	(0.015)	(0.021)
4 (highest)	-0.038**	0.017	0.016	0.052***
	(0.016)	(0.015)	(0.014)	(0.020)
Observations	26,527	26,527	23,633	26,527

Notes: Regressions include controls for gender, race, age, marital status, work status, health, education, polygenic score for educational attainment, income and wealth quartiles, and wave indicators. The complete set of estimated coefficients is reported in Table 2A in the online appendix. The regression for the bank deposits share excludes households with zero financial wealth. Standard errors clustered at the individual level are in parentheses; significance level denoted as *** p<0.01, ** p<0.05, * p<0.1.

The next two columns expand the analysis to other types of financial assets that have previously received less attention than stocks, despite playing an important role in household portfolios, namely bonds and bank deposits. The probability of owning bonds is positively and significantly associated with cognition, although slightly less strongly than that of owning stocks. Individuals in the highest cognition quintile are 3.3 percentage points more likely than those in the

lowest quantile to hold bonds in their portfolio. Numeracy does not correlate with bond ownership. Finally, the share of wealth held in bank deposits is negatively associated with cognitive ability. Individuals with the highest cognition hold a 3.5-percentage-points lower share of their financial wealth in bank accounts than those with the lowest cognition. A high numeracy score is associated with a 1.1 percentage-point lower share of financial wealth kept in bank deposits.

Risk aversion is found to have an independent effect only on stock ownership. In this case, there is no clear gradient across risk-aversion categories but, other things equal, the least risk averse individuals are more likely to own stocks than individuals in any other category. Comparing these results to those obtained when risk aversion is excluded from the set of regressors (Table 2A in the Appendix) shows that controlling for risk attitudes has virtually no effect on the estimated correlation between cognition and portfolio choices, thereby offering no support for the "omitted variable" hypothesis that the effect of cognition on portfolio decisions is, to a large extent, moderated by risk attitudes. A legitimate concern, however, is that the risk aversion measure elicited by the HRS is too coarse to capture much variation in individual preferences---as stated previously, 58% of individuals fall in the most risk averse category---and is notoriously affected by substantial measurement error (Kimball et al., 2008). Because the ranking of financial assets based on riskiness is the same as the ranking based on complexity (stocks being the most risky and complex; bank deposits the least risky and sophisticated), if low cognition is linked to high risk aversion and a good measure of risk preferences is not available, the possibility remains that omitted risk attitudes drive the observed correlation between cognition and portfolio choice.

To shed further light on the extent to which cognition acts as a proxy for risk attitudes, in the last column of Table 1 we analyze life insurance policy holding. Other things equal, more risk averse individuals should be more likely to buy life insurance. Meanwhile, the complexity of life

insurance contracts and policy structures should discourage ownership among individuals with low cognitive ability. Thus, if cognition is acting as a proxy for low risk aversion we would expect it to be negatively associated with life insurance ownership. Instead, if low cognition increases the perceived cost of purchasing complex financial products, the association should be positive. The results reveal that, as expected, life insurance holding increases monotonically with risk aversion. Most importantly for our purposes, the probability of holding a life insurance policy is monotonically and positively associated with cognition too. Individuals in the highest cognition quintile are 5 percentage points more likely to be covered by life insurance than those in the lowest quintile. Numeracy is also positively associated with life insurance holding although its coefficient is not precisely estimated. Thus, cognitive ability has an effect on life insurance holding that is not mediated by risk aversion, a result supporting the hypothesis that low levels of cognition act as a barrier to entry into the markets of relatively complex financial products.

Next, we run fixed-effects regressions, which rely on variation in cognition and numeracy over time to identify the effect of these variables on financial outcomes.[5] In these regressions, time-invariant heterogeneity in risk attitudes is captured by the fixed effect.

The results from this analysis, presented in Table 2, are strikingly different from those of the OLS regressions in Table 1. Even though the sign of the correlations between asset ownership and cognitive ability remains largely unchanged, the magnitude of these correlations is now substantially smaller, and cognition is no longer significantly associated with portfolio choices. Numeracy is negatively and significantly associated with the share of wealth kept in bank deposits, but has no significant association with any other outcome. The results shed light on the channel

[5] The within variation is approximately 0.65 times as large as the between variation for both variables. In fixed-effects regressions, one more year of age is associated with a 0.04 standard deviation decrease in cognition score and a 0.01 decrease in numeracy score. These are sizeable declines, implying that, for the average individual, cognition and numeracy scores decline by 0.95 and 0.25 standard deviations, respectively, from the mid 50's to the mid 70's.

through which cognition determines financial choices. Specifically, there is limited support for the possibility that cognition acts as a per-period transaction cost of accessing complex financial products (associated, for example, to actively managing such products). If this were the case, the process of cognitive decline at old ages would tilt household portfolios toward less complex financial assets over time. Given the sign of the coefficients, we cannot rule out the presence of some changes in portfolio allocation resulting from cognitive decline. However, the magnitude of the coefficients indicates that, if present, this effect is rather small. Instead, the effect of cognition is mostly absorbed by the fixed effects, consistent with cognition representing a one-off entry cost paid by individuals the first time they familiarize themselves with specific financial products and basic financial literacy concepts. The presence of one-off transaction costs in stock market participation has been documented in previous research (Vissing-Jørgensen, 2002). Our results indicate that such one-off costs operate, to some extent, through cognitive barriers.

Table 2: Cognitive ability and portfolio allocation, fixed effects regressions

	Stocks (ownership)	**Bonds (ownership)**	**Bank Deposits (share)**	**Life Insurance (ownership)**
Cognition				
2	0.002	-0.003	-0.006	-0.002
	(0.007)	(0.008)	(0.008)	(0.008)
3	0.013	0.009	-0.016*	0.004
	(0.008)	(0.009)	(0.009)	(0.008)
4	0.003	0.007	-0.008	0.001
	(0.009)	(0.010)	(0.009)	(0.009)
5 (highest)	0.014	0.002	-0.007	0.008
	(0.009)	(0.010)	(0.010)	(0.010)
Numeracy				
1 (highest)	0.005	-0.008	-0.013*	0.002
	(0.007)	(0.008)	(0.007)	(0.007)
Observations	26,527	26,257	23,633	26,257

Notes: Regressions include controls for age, marital status, work status, health, income and wealth quartiles, and wave indicators. The complete set of estimated coefficients is reported in Table 3A in the online appendix. The regression for the bank deposits share excludes households with zero financial wealth. Standard errors are in parentheses; significance level denoted as *** p<0.01, ** p<0.05, * p<0.1.

IV. Conclusions

Our results have important policy implications. They confirm that low cognition can deter individuals from investing in the types of assets that are likely to yield higher returns over long time periods, thereby adversely affecting retirement wealth accumulation. Most importantly, this effect does not stem from low levels of risk tolerance among individuals with low cognitive ability. On this basis, programs aimed at increasing cognition or at exposing individuals to complex financial products through retirement plan defaults are advisable. Moreover, the fact that cognitive barriers act as a one-off entry cost, together with the high degree of inertia in household portfolio composition, suggests that policies targeted at young investors may remain effective as individuals approach retirement age.

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