Cognitive Ability and Stock Investment among Chinese Middle-aged and Older Population

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Abstract

This study uses the Wave 2 (2013), Wave 3 (2015), and Wave 4 (2018) data released by the Harmonized China Health and Retirement Longitudinal Study (CHARLS) to examine the relationship between cognitive ability and stock investment in the middle-aged and older populations of China. This study evaluates the relationship between the subjective and objective aspects of cognitive ability and the stock ownership and holdings in financial investments over time. We further compare the relationships of subsamples (older adults vs. middle-aged adults). The findings in this study provide implications for policymakers and financial professionals, as well as investors.

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Introduction

Understanding the relationship between cognitive ability and investment decision-making is an important research topic, particularly given the prolonged lifespan and increasingly complex market dynamics faced by households today. Cognitive decline, including difficulty recalling and being challenged by numerical problems, is an inevitable aspect of aging (Harada et al., 2013). Research shows that cognitive ability typically peaks at the age of 30 and gradually diminishes thereafter (USCF, 2022). While a minor cognitive decline may not affect an individual's management of their daily financial matters such as paying bills, it might impede their efficiency in making more complicated financial decisions such as portfolio choices and security selections (Agarwal et al., 2013; Gorlick, 2010; Starnes, 2019), ultimately influencing the quality of life.

There is evidence supporting the positive role of cognitive ability in investment decisions and behaviors in western cultures (e.g., in the United States, Europe, and the United Kingdom). Research shows that individuals with superior cognitive abilities have a higher propensity to invest in stocks, own more diversified portfolios, and achieve better investment performance (Korniotis & Kumar, 2010). Conversely, individuals with weakened cognitive abilities are more likely to hold underperforming portfolios and less wealth. Aging individuals experiencing cognitive declines are particularly susceptible to making problematic investment decisions.

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However, little empirical research has been conducted regarding this relationship, especially within an Asian context (i.e., Chinese middle-aged and older populations). According to data released by the World Health Organization (WHO), China is experiencing one of the most rapid growth rates in aging populations globally. "The population of people over 60 in China is projected to reach 28% by 2040" (WHO, 2022, p. n.a.). Stock investment has become a significant financial instrument for individual investors in China since the establishment of security markets in China in the 1990s (Lu et al., 2020). Today, stocks and mutual funds are considered to be the most risky financial assets owned by Chinese households, excluding real estate (Chen et al., 2020; Gan et al., 2013; Liao et al., 2010).

Given the severe impact that a cognitive decline can exert on financial decision-making, especially among those in the oldest age cohorts, and the important role of stock investment in Chinese households, it behooves researchers, financial advisors, and policymakers to gain a deeper understanding of the association between cognitive ability and stock investment decision-making processes among middle-aged and older adults in China. The findings of this study provide insights and implications for individual investors, financial professionals, and policymakers in China. This study distinguishes itself from prior research in the following aspects. First, it incorporates both subjective and objective measures of cognitive ability, thus providing a more comprehensive perspective. Second, this study is one of the few published studies investigating the relationship between cognitive ability and stock investment among the Chinese middle-aged and older population. Previous studies in this realm have predominantly focused on decision-makers in North America, Europe, and Australia, leaving a gap in understanding regarding the relationship between cognitive ability and stock investment decisions among Chinese middle-aged and older adults. This study addresses this gap in the literature.

Literature Review

Cognitive Ability

Cognitive ability is a multifaceted concept referring to a person's "ability to perform the mental processes required in a variety of tasks" (Mazzonna & Peracchi, 2018, p. 3). Among the subdomains associated with cognitive ability, the mental skills and abilities related to orientation, memory, reasoning, concentration, and the executive function have been closely examined, as reported in the literature (e.g., Christelis et al., 2010; Richards et al., 2004). Another dichotomous categorization of cognitive ability includes crystallized intelligence and fluid intelligence (Li et al., 2015). Researchers have reported finding that people with strong cognitive ability have better memories.

Memory and numeracy are two important components of cognitive ability and have been found to be associated with financial behaviors and decisions. Memory, as an important dimension of cognitive ability, tends to decline with age (e.g., Mazzonna & Peracchi, 2018; Salthouse, 1996). Memory loss, which frequently occurs among older individuals, is highly associated with decreases in financial literacy, capability, and confidence, which in turn, impair financial decision-making (Gamble et al., 2015). Severe memory loss is known to be associated with out-of-pocket medical expenditures, which may influence the overall wealth condition of a household. Some researchers have found that cognitive ability is related to household credit card and home equity loan decisions (Agarwal & Mazumder, 2013), risk preference (Dohmen et al., 2010; Frederick, 2005), along with retirement saving behavior (Banks & Oldfield, 2007). Moreover, numeracy has also been studied as a significant component of cognitive ability. Numeracy is known to be associated with retirement savings and investment portfolio decisions (Banks & Oldfield, 2007); borrowing, savings, and tax decisions (Huhmann & McQuitty, 2009); and wealth accumulation, risk perception, and time preference (Estrada-Mejia et al., 2016).

Cognitive Ability and Financial Decisions/Stock Investment

Previous studies have explored the relationship between cognitive ability and the financial decisions and behaviors of individuals and families, as well as other economic outcomes in general. For example, Pak and Babiarz (2018)

investigated the association between cognitive ability and risky asset holding among older American adults. They found that a lower cognitive ability was associated with lower participation in the stock market (i.e., stocks out of total financial net worth and the probability of holding stocks); however, in their study, instrumental variable models did not support a causal inference. Likewise, Mazzonna and Peracchi (2018) noted that an unawareness of cognitive decline may result in negative financial consequences such as incurring financial losses and making poor financial decisions. Further, Fan and Lim (2022) noted that cognitive ability was also significantly associated with financial advice-seeking behavior and advice-source preferences, with older adults who exhibited better cognitive ability (i.e., better memories and numeracy) being less likely to seek financial advice from family members or social networks.

Cognitive abilities, which decline with age, also play an important role in describing the investment decisions of individual investors (Korniotis & Kumar, 2010). Using data from the Health and Retirement Study (HRS), Cheung and Yilmazer (2019) reported that memory issues in older American adults diagnosed with dementia or Alzheimer's disease made them less likely to hold risky assets. They also noted a negative association with the number of risky assets in their investment portfolios and household financial net worth, through the mediator of cognitive ability.

Christelis et al. (2010) used a European survey of older individuals that measured three dimensions of cognitive ability: (a) numeracy (or mathematical skills), (b) verbal fluency, and (c) recall skills. They found that participation in the stock market, either through direct investing in stocks or indirect investing through mutual funds or retirement accounts, was strongly and positively associated with cognitive abilities, after controlling for bequest motives, health status, social interactions, and socioeconomic characteristics. The association was not as strong for bond holding among older adults living in European countries. Christelis et al. argued that cognitive ability is correlated with the ability to process financial data, with those who exhibit higher cognitive ability using lower costs to process complex financial data related to the stock market.

The strong association between cognitive ability and asset allocation choices has been confirmed in other studies. Using the 2006–2008 waves of the HRS, Browning and Finke (2015) observed a significant relationship between retirees' cognitive ability and stock reallocation decisions during recessions. In their study, they focused on fluid cognitive functioning proxied by working memory and the numeracy of respondents, controlling for risk tolerance and sentiment during a recession. They found that those with low cognitive ability were more likely to respond to sentiment effects, and thus were more likely to allocate away from stocks, compared to those with a better working memory and numeracy. Kim et al. (2012) used the 2004 HRS to determine that a strong relationship exists between cognitive ability and stock ownership among older Americans.

Other Factors Relating to Stock Investment

In addition to cognitive ability, the current literature also documents other factors associated with stock investing. Prior research has widely documented the positive role of investors' wealth and income in stock investment decision-making (e.g., Browning & Finke, 2015; Cheung & Yilmazer, 2019; Pak & Babiarz, 2018). Holding one's cognitive score and other controls constant, being married, having a college degree, holding life insurance coverage, and having a higher net worth are known to be positively associated with holding stock among older American adults (Pak & Babiarz, 2018). Similarly, with fluid cognitive ability (i.e., word recall and numeracy) and other factors controlled, Browning and Finke (2015) found that an investor's planning horizon, educational attainment, wealth, and race (being White) were positively associated with stock allocation decisions. Additionally, in a study by Cheung and Yilmazer (2019), it was determined that household net worth and income were positively associated with not only the ownership of risky assets such as stocks but also the proportion of such assets in a household's overall portfolio. In their study, age was negatively associated with the proportion of risky assets after controlling cognitive ability and other

factors. Some research has also determined the role of gender in investment behavior (Holden & Tilahun, 2022), with men being more likely to hold stocks and other risky investment assets.

Conceptual Framework and Hypotheses

According decision theory, "Decision making is one of the basic cognitive processes of human behaviors by which a preferred option or a course of actions is chosen from among a set of alternatives based on certain criteria" (Wang & Ruhe, 2007, p. 11). Within the realm of simple decision-making, which encompasses intuitive and empirical analyses, lies the fundamental concepts of basic and core cognitive processes. Heuristic and rational decision-making strategies can help in real-world decisions (Hastie, 2001; Wang & Ruhe, 2007). The current study focuses on stock investment choices, which, in essence, involves a "repetitive application of the fundamental cognitive process" (Wang & Ruhe, 2007, p. 1). As Frederick (2005) stated, the relationship between cognitive ability and decision-making is too important to be ignored. Decision theory provides a solid theoretical background for examining this relationship.

As noted above, prior studies have highlighted the role of cognitive ability in investment decision-making. In the majority of these studies, a lower cognitive ability was associated with poor financial decisions in general (Mazzonna & Peracchi, 2018), along with less financial net worth (Cheung & Yilmazer, 2019), lower participation in the stock market (Pak & Babiarz, 2018), and a lower probability of holding risky asset portfolios (Cheung & Yilmazer, 2019; Kim et al., 2012). This study extends the literature by focusing on a specific market segment: middle-aged and older adults. This is an important population to evaluate given the negative relationship between age and cognitive ability. In this regard, the Scaffolding Theory of Aging and Cognition (STAC) and its revision (Park & Reuter-Lorenz, 2009; Reuter-Lorenz & Park, 2014) are relevant. The original STAC explains the potential variations in cognitive ability by age from the perspective of biological and neurophysiological factors. The SCAT shows that aging may trigger neural challenges (i.e., structural changes in the brain) and functional deterioration (i.e., maladaptive age-related brain activity, including decreased memory), which may reduce cognitive functioning levels. The revised STAC (STAC-r) expands the understanding of aging and cognitive function to incorporate a life-course perspective, which emphasizes the experience accumulated over a person's life. The STAC-r proposes that two factors have impacts on brain functions: (a) an individual's lifespan and (b) experiences during their life course. Based on this conceptual framework, and the theoretical and empirical literature regarding cognitive ability and stock investment, this study examined the following hypotheses:

H_1: Cognitive ability is positively associated with stock ownership among Chinese middle-aged and older adults.

H_2: Cognitive ability is positively associated with holding stock shares in an investor's portfolio among Chinese middle-aged and older adults.

Methodology

Data

This study used the Wave 2 (2013), Wave 3, (2015), and Wave 4 (2018) datasets, which are the ones most recently released by the Harmonized China Health and Retirement Longitudinal Study (CHARLS), to examine the association between cognitive ability and stock investment among older Chinese people. The CHARLS is a national longitudinal survey conducted by the National School of Development (China Center for Economic Research) at Peking University. The harmonized longitudinal data are a user-friendly version, and are part of the Gateway to Global Aging Data, which compare similar surveys of older populations in different countries. The CHARLS provides a large array of information on the financial situations faced by individuals aged 45 years and older. The CHARLS also provides some information about individuals' expectations and preferences, such as their self-reported health status. Information regarding demographic characteristics such as age, gender, education, and marital status was also collected in this survey. The first wave of the CHARLS was

conducted in 2011. Respondents were followed every two years. The financial variable questions were significantly changed after Wave 1. Thus, in this study, only data from the harmonized Wave 2, Wave 3, and Wave 4 surveys were evaluated. The final sample size used in this study was 36,661 observations.

Variables

Stock ownership and shares. The main dependent variable in this study was stock ownership, which was defined as whether or not a household owned stocks in their portfolio in the form of directly held stocks or stock mutual funds. Stock ownership was used as a dummy variable equal to 1 (otherwise 0) for respondents whose stock amount was positive. Another main dependent variable was stock shares, which was defined as the percentage of the stock amount in financial assets.

Cognitive ability. Following prior studies (e.g., Browning and Finke (2015), who used the HRS dataset; Christelis et al. (2010), who used the SHARE dataset; and Yu et al. (2021), who used the CHARLS dataset), objective cognitive ability was measured using total recall words and math test scores, which are more relevant to financial decisions. In particular, total recall words (ranging from 0 to 20) was measured based on the total amount of words a respondent could immediately recall correctly from a 10-word list, together with the number of words the respondent could recall correctly from a 10-word list after a delay spent answering other survey questions. Respondents were required to complete a math test, which "Asks the individual to subtract 7 from the prior number, beginning with 100 for five trials" (Harmonized CHARLS Documentation, 2021, p. 211). Math scores (ranging from 0 to 5) measured the number of correct subtractions in the serial 7's test across five trials. In addition, subjective cognitive ability was assessed using self-reported doctor's diagnosis of a memory problem (see Fritsch et al., 2014), with 1 indicating a respondent being told they had a memory-related disease and 0 otherwise. Further, self-reported memory was also used to assess subjective cognitive ability, which was measured using a scale ranging from 1 for excellent to 5 for poor (Harmonized CHARLS Documentation, 2021, p. 204).

Control variables. Based on the literature review, the following controlled variables were included in the multivariate tests: income, total financial net worth, homeownership, vehicle ownership, age, gender, marital status, education, self-reported health status, whether a respondent had a dependent child, self-employment, retired, living in an urban region, and having private health insurance coverage. The operationalization of these variables is shown in Table 1.

Models

A descriptive analysis was conducted to show the sample characteristics overall and by subsample. Given that the CHARLS dataset used in this study is a longitudinal dataset, repeated responses about stock investments were collected from the same respondents. Thus, a generalized estimating equations (GEEs) methodology, introduced by Liang and Zeger (1986), was used to determine the relationship between cognitive ability and stock investment over time. A GEE analysis estimates the relationship between changes in an outcome variable of a subject and the covariates while allowing for the possible correlations between repeated measures of the variables over time for the same individuals in longitudinal datasets. Thus, it provides more accurate estimates (Liang & Zeger, 1986; Smith & Smith, 2006). This method has been widely used in previous research using longitudinal datasets (see Filer & Golbe, 2003; Ghisletta & Spini, 2004; Hamza et al., 2021; Klos et al., 2005; Rechner & Dalton, 1991). Based on this method, a logistic regression model was specified as the link function to evaluate the relationship between cognitive ability and stock ownership, and an OLS regression model was specified as the link function to examine the relationship between cognitive ability and stock shares, while considering the within-subject correlation.

Table 1. Summary of the Variables Used in the Empirical Model

Variable Name	*Variable Type*	*Measure type*	*Variable description*
Stock ownership	Dependent Variable	Dichotomous	Yes=1, defined as the situation that respondents' stock amount was positive; No=0 [reference]
Stock share	Dependent Variable	Continuous	Defined as the percentage of stock amount in financial assets
Self-reported memory	Independent Variable	5-level Categorical	Scale from 1 for excellent to 5 for poor
Total recall words	Independent Variable	Continuous	varies between 0 and 20
Math test scores	Independent Variable	Continuous	varies between 0 and 5
Doctor diagnosed memory-related disease	Independent Variable	Dichotomous	Yes=1; No=0
Household income	Independent Variable	Continuous	included as log-transformed variable due to its non-normal distribution
Household total financial net worth	Independent Variable	Continuous	included as log-transformed variable due to its non-normal distribution
Homeownership	Independent Variable	Dichotomous	Non-homeowners=0 [reference], homeowner=1);
Vehicle ownership	Independent Variable	Dichotomous	Non-vehicle owners=0 [reference], vehicle owners=1);
Age	Independent Variable	Continuous	
Gender	Independent Variable	2-level Categorical	male [reference], female
Marital status	Independent Variable	2-level Categorical	Not married [reference], married
Education	Independent Variable	3-level Categorical	Less than lower secondary education less [reference], Upper secondary & vocational training, and Tertiary education.
Have a dependent child	Independent Variable	Dichotomous	Yes=1; No=0 [reference]
Self employed	Independent Variable	Dichotomous	Yes=1; No=0 [reference]
Retired	Independent Variable	Dichotomous	Yes=1; No=0 [reference]
Living in the urban region	Independent Variable	Dichotomous	Yes=1; No=0 [reference]
Have private health insurance coverage	Independent Variable	Dichotomous	Yes=1; No=0 [reference]
Self-reported health status	Independent Variable	5-level Categorical	poor [reference], fair, good, very good and excellent

To examine the relationship between cognitive ability and household stock ownership, the following logistic model was estimated:

$$P(Y_{it} = 1|C_{it}, X_{it}) = \frac{\exp(\beta' C_{it} + \gamma' X_{it} + \varepsilon_{it})}{1 + \exp(\beta' C_{it} + \gamma' X_{it} + \varepsilon_{it})}, \quad (1)$$

where Y_{it} is the stock ownership of household i at time t; C_{it} is a vector measuring the cognitive ability of the household's financial respondent, including their self-reported memory, total recall words, math test scores, and doctor diagnosed memory-related disease; and X_{it} captures other control variables related to household stock ownership. All the variables are defined in Table 1.

To study the relationship between cognitive ability and stock shares as a proportion of financial assets, the following OLS model was estimated:

$$Y_{it}^{*} = \beta C_{it} + \gamma X_{it} + \varepsilon_{it}, \varepsilon_{it} \sim N(0, \sigma^2), \quad (2)$$

where Y_{it}^{*} denotes the stock shares, depending on the same cognitive ability variables and other controls as described for model (1).

Results

Descriptive Statistics

The analysis began by examining the descriptive statistics overall and by subsamples of respondents with and without stock investments in the 2018 wave. On average, only 2% of the respondents owned stocks in their portfolios. Stock owners allocated nearly 40% of their financial assets to stocks (37.7%). Across the sample, many respondents reported themselves to have poor (31.8%) or fair (54%) memory. The mean total recall word score was 7.3 out of 20, while the mean math score was 3.6 out of 5. Slightly more than 2% of the respondents reported having been told by their doctor that they had a memory-related disease.

Overall, the mean household income was RMB 37,417, whereas the median household income was RMB 15,500. The mean total household non-housing financial net worth was RMB 17,486. The median total household non-housing financial net worth was RMB 2,000. On average, 56% of respondents were homeowners, and nearly 63% of the respondents reported owning a vehicle. On average, nearly 50% of the respondents were female and over 40% had dependent children (40.4%). A majority of the respondents were married (85.7%) and had less than a lower secondary level of education (88%). Over one-third of the respondents lived in an urban region (37.6%), with few being self-employed (6.3%) or having private health insurance coverage (3.5%). Over half of the respondents reported a good health status (51.9%). Table 2 presents the characteristics of the sample.

Table 2. Demographic Profile: Cognitive Ability and Stock Ownership—Wave 4

Variables	*All*	*Non-Stockowners (98.0%)*	**Stockowners** *(2.0%)*
Cognitive Ability			
Self-reported memory			
Excellent*	0.8	0.7	1.5
Very good**	5.3	5.3	7.8
Good***	8.2	8.0	17.1
Fair***	54.0	53.8	60.4
Poor***	31.8	32.2	13.2
Total recall words***	Mean: 7.3 Median: 7	Mean: 7.2 Median: 7.0	Mean: 10.5 Median: 11.0
Math test scores***	Mean: 3.6 Median: 4	Mean: 3.6 Median: 4	Mean: 4.4 Median: 5.0
Doctor diagnosed memory-related disease	2.3	2.3	2.5
Financial situations			
Household income***	Mean: 37,416.9 Median: 15,500.0	Mean: 35,576.6 Median: 14,600.0	Mean: 138,375.3 Median: 87,000.0
Household total financial wealth***	Mean: 17,485.6 Median: 2,000.0	Mean: 9,364.9 Median: 2,000.0	Mean: 439,474.9 Median: 157,265.1
Homeowners***	56.0	55.7	70.9
Vehicle owners**	62.7	62.6	68.0
Demographics			
Age***	Mean: 59.3 Median: 59.0	Mean: 59.4 Median: 59.0	Mean: 56.5 Median: 55.0
Female	47.8	47.8	49.0
Married***	85.7	88.9	43.5
Educ: Less than lower secondary education***	88.0	9.8	37.7
Educ: Upper secondary & vocational training***	10.3	1.4	18.8
Educ: Tertiary education***	1.7	15.3	84.7
Having a dependent child	40.4	40.4	40.7

Table 2 Continued

Self-employed	6.3	6.3	6.1
Retired***	33.1	32.7	53.1
Living in the urban region***	37.6	36.6	89.5
Having private health insurance coverage***	3.5	3.2	16.7
Health expectation: excellent	11.4	11.4	10.9
Health expectation: very good***	13.1	12.9	25.3
Health expectation: good	51.9	51.8	55.4
Health expectation: fair***	18.4	18.6	6.9
Health expectation: poor***	5.2	5.3	1.5

Note: Weighted mean values are reported for household income (in Chinese yuan), household total non-housing final wealth (in Chinese yuan), total recall words, math test scores, and age. For other variables, weighted mean percentages are reported. Percentages may not sum to 100% due to rounding. A chi-square test was employed for categorical independent variables while T-test was used for continuous independent variables.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

It was noted that more stock owners reported having good, very good, or excellent memory, while more non-stock owners reported having poor or fair memory. Among stock owners, the mean total recall words and math scores were 10.5 and 4.4, respectively, while these measures were 7.2 and 3.6 for non-stock owners, respectively. For stock owners, the mean household income was RMB 138,375, whereas the mean total household non-housing financial net worth was RMB 439,475. For non-stock owners, the mean household income was RMB 35,577. The mean total household non-housing financial net worth was RMB 9,365. More stock owners were homeowners (70.9% vs. 55.7%) and vehicle owners (68.0% vs. 62.6%). The proportion of stock owners (84.7%) with a tertiary level of education was significantly higher than that among non-stock owners (5.3%). Additionally, more stock owners considered their health status to be very good (25.3%), while more non-stock owners reported their health status as only poor or fair (18.6% for fair and 5.3% for poor).

Multivariate Analyses

The results listed in Table 3 provides confirmation of the first hypothesis: Cognitive ability was positively associated with stock ownership. Specifically, respondents with better objective cognitive ability were more likely to own stocks. The results showed that respondents who recalled more total words (at a $p < 10\%$ significance level) and had a higher score on the math test showed an increased probability of owning stocks (odds ratio = 1.034 and 1.147, respectively). The results showed a significant positive relationship between doctor-diagnosed memory problems and stock ownership, which indicates that those who reported being diagnosed with memory problems were more likely to invest in stocks. However, the results did not find a significant relationship between self-reported memory status and stock ownership.

Consistent with much of the prior literature (e.g., Cheung & Yilmazer, 2019), wealth and income were found to be positively associated with stock ownership. It was also noted that homeowners had a nearly 50% higher propensity to invest in stocks, compared to non-homeowners. Having private health insurance coverage was also found to be a significantly positive contributor to a respondent's degree of stock ownership. In addition, findings confirmed the results from prior studies (e.g., Browning & Finke, 2015) that those with higher education levels had a higher probability of investing in stocks. For example, respondents in this study with upper secondary and vocational training were approximately 2.8 times as likely to invest in stocks, compared to respondents with less than a lower secondary level of education. Further, their self-reported health status in general bore a positive relation to the propensity to invest in stocks. For example, compared to respondents who claimed to be in poor health, those who reported having excellent health were 1.6 times more likely to own stocks in their portfolios. Findings also showed that respondents who were married, lived in cities, and were retirees were more likely to own stocks (odds ratio = 1.147, 6.675, and 2.417, respectively).

Table 3. Multivariate analysis—Cognitive Ability, Stock Ownership, and Stock Shares

	Stockownership		Stock Share	
	Coef	**Odds Ratio**	**Coef**	**St. Err.**
Independent variables				
Cognition				
Self-reported memory (ref: poor)				
Excellent	-0.189	0.828	0.002	0.007
Very good	0.042	1.043	-0.001	0.002
Good	0.082	1.085	0.002	0.003
Fair	0.135	1.144	0.000	0.001
Total recall words	0.034*	1.034	0.000	0.000
Math scores	0.137***	1.147	0.001	0.000
Having doctor diagnosed memory-related disease (ref: No)	0.726*	2.067	0.003	0.004
Financial situations				
Household income (log)	3.157**	23.491	0.007	0.005
Household total financial wealth (log)	13.836***	$1.021*10^6$	0.003*	0.002
Homeownership (ref: non-owner)	0.375*	1.455	0.003**	0.001
Vehicle ownership (ref: non-owner)	-0.004	0.996	-0.001	0.002
Demographics				
Age	0.0329	1.033	0.001*	0.001
Age^2	-0.0004	1.000	0.000*	0.000
Female	-0.103	0.902	-0.002	0.001
Married	1.257***	3.516	0.005**	0.002
Educ: (ref: less than lower secondary education)				
Upper secondary & vocational training	1.019***	2.770	0.017***	0.003
Tertiary education	1.842***	6.307	0.077***	0.013
Having a dependent child	-0.098	0.907	0.001	0.001
Self-employed (ref: no)	-0.070	0.932	-0.001	0.002
Retired (ref: no)	0.883***	2.417	0.009	0.002
Living in an urban region	1.898***	6.675	0.010***	0.001
Having private health insurance coverage	0.939***	2.558	0.021***	0.006
Self-reported health status: (ref: poor)				
Excellent	0.955*	2.598	0.005	0.003
Very good	1.200**	3.321	0.008**	0.003
Good	0.841*	2.318	0.003	0.002
Fair	0.175	1.191	0.000	0.002
Intercept	-278.835		-0.196*	0.081
			0.000	

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

The results listed in Table 3 also highlight that those with greater math acumen (i.e., having a higher score on the math test) held more stocks in their financial portfolios ($p < 0.08$). To be specific, for every one point increase in the math score earned by a respondent, the weight of the stock holdings in their portfolios increased by 0.1%. Additionally, the results provide evidence that older adults with a greater financial net worth held more shares of stock in their portfolios (at $p < 0.10$). Further, it was noted that homeowners invested 0.3% more in stocks in their portfolios than non-homeowners. Respondents with private medical insurance coverage were found to have 2.1% more shares of stock than those who did not.

The results also highlight the roles played by other personal characteristics in describing the weight of stocks held in financial portfolios. For example, a one-year increase in age was found to be related to a 0.12% increase in the weight of stock holdings, but with a decreasing rate. Further, compared to those who had less than a lower secondary level of education, those who reported having upper secondary and vocational training were found to invest 1.7% more of their portfolio in stocks, whereas those who reported having a tertiary level of education were shown to invest 7.7% more in stocks.

Subsample Results

Previous research has suggested that people are more likely to reduce their stock holdings in alignment with declines in cognitive ability. Following Christelis et al. (2010), we split the sample in this study by age based on whether a respondent was younger (age 45–59, middle-aged adults) or older adults (age 60 and older), which is the normal retirement age for most people in China. Age 60 is also the acceptable cut-off used to define older adults (Han et al., 2020). An analysis of the subsamples allowed for an assessment of potential differences in cognitive ability and their relationship to stock ownership between middle-aged and older adults. The results listed in Table 4 illustrate how the math score measure was a significant positive factor related to stock ownership among older investors. Those with doctor-diagnosed memory problems were more likely to also hold stocks. This finding contradicts what some have reported in the literature. It was found that middle-aged investors who could recall more total words had a higher probability of owning stocks and were shown to own more stocks in their portfolios.

A comparison of respondents' personal characteristics related to stock investment provided some interesting insights. For example, in the older adult subsample, those with an excellent health status were found to be almost three times as likely to own stocks, compared with those who reported being in poor health. Married older investors were observed to have a higher probability of investing in stocks (odds = 3.767), while living with dependents was found to contribute negatively to stock ownership (odds = 0.555). These factors were not significant in the middle-aged subsample group. Interestingly, homeownership was positively associated with stock ownership in the middle-aged subsample, which provides some evidence that homeownership is an important wealth indicator (Beracha et al., 2017) among middle-aged investors. It was also found that middle-aged investors with private health insurance coverage had a higher propensity to invest in stocks, as well as a higher weight of stock shares in their portfolios. This might be explained by the cushion effect and resilience provided by private health insurance coverage (Jain & Garg, 2022).

An analysis of data from the subsamples also provides some insight regarding the shares of stock investment in financial assets over time. First, it was noted that health status was a vital factor related to stock share ownership among the older-adults subsample. Those who reported having a very good health status reported having 1.1% more weight of stocks in their portfolios compared to the those in poor health. Additionally, consistent with the association between homeownership and stock ownership, for the middle-aged-adults subsample, compared to non-homeowners, homeowners were found to have 0.49% more weight in stocks in their portfolios.

Table 4. Multivariate Analysis—Subsamples—Cognitive Ability, Stock Ownership, and Stock Shares

	Older Adults, Aged 60 and Older				Middle-aged Adults, Aged 45 to 59			
	Stock Ownership		Stock Shares		Stock Ownership		Stock Shares	
	Coef	Odds Ratio	Coef	St. Err.	Coef	Odds Ratio	Coef	St. Err.
Independent variables								
Cognition								
Self-reported memory (ref: poor)								
Excellent	-1.064	0.345	0.000	0.008	-0.017	0.983	0.001	0.010
Very good	0.045	1.046	-0.003	0.004	-0.028	0.973	0.001	0.004
Good	0.465	1.592	0.007	0.004	-0.329	0.720	-0.002	0.003
Fair	0.193	1.213	0.003	0.002	0.032	1.032	-0.002	0.002
Total recall words	0.005	1.005	0.000	0.000	0.055*	1.057	0.0004*	0.000
Math scores	0.211**	1.235	0.001	0.000	0.055	1.056	0.000	0.001
Having doctor diagnosed memory-related disease (ref: No)	0.664*	1.942	0.002	0.004	0.638	1.892	-0.003	0.002
Financial situations								
Household income (log)	2.484***	11.987	0.098	0.078	5.275**	195.430	0.003	0.003
Household total financial wealth (log)	22.012***	$3.629*10^9$	0.058	0.070	9.512**	$1.352*10^4$	0.002	0.001
Homeownership (ref: non-owner)	0.019	1.019	0.000	0.002	0.789***	2.202	0.005***	0.001
Vehicle ownership (ref: non-owner)	0.207	1.230	0.001	0.002	-0.115	0.891	-0.003	0.002
Demographics								
Age	0.205	1.228	0.004	0.003	-0.118	0.889	-0.001	0.002
Age^2	-0.002	0.998	0.000	0.000	0.001	1.001	0.000	0.000
Female	-0.045	0.956	-0.002	0.002	-0.181	0.835	-0.002	0.002
Married	1.326**	3.767	0.004*	0.002	0.901	2.462	0.004	0.003
Educ: (ref: less than lower secondary education)								
Upper secondary & vocational training	0.632*	1.881	0.014**	0.005	1.349***	3.853	0.015***	0.003
Tertiary education	0.893*	2.443	0.062**	0.021	2.617***	13.690	0.091***	0.018

Table 4 (Continued)

	Stock Ownership		Stock Shares		Stock Ownership		Stock Shares	
	Coef.	Odds Ratio	Coef.	St. Err.	Coef.	Odds Ratio	Coef.	St. Err.
Having a dependent child	-0.590*	0.555	-0.005***	0.002	0.285	1.330	0.005**	0.002
Self-employed (ref: no)	-0.749	0.473	-0.007***	0.002	-0.058	0.943	0.001	0.003
Retired (ref: no)	1.449***	4.257	0.008***	0.002	0.555	1.742	0.009***	0.003
Living in an urban region	2.202***	9.042	0.008***	0.002	1.641***	5.159	0.009***	0.002
Having private health insurance coverage	0.582	1.789	0.026	0.015	1.021***	2.775	0.018**	0.006
Self-reported health status: (ref: poor)								
Excellent	1.073*	2.924	0.006	0.004	0.888	2.430	0.004	0.004
Very good	1.334**	3.796	0.011*	0.005	1.012	2.751	0.005	0.004
Good	0.843	2.324	0.004	0.003	0.859	2.361	0.002	0.004
Fair	0.511	1.667	0.003	0.003	-0.498	0.608	-0.004	0.004
Intercept	-407.271	0.000	-2.476	1.559	-236.063	0.000	-0.070	0.058

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Discussion and Implications

This study was designed to investigate the relationship between cognitive ability and stock investment using a longitudinal dataset of middle-aged and older Chinese households. Overall, the findings confirm the positive role of cognitive ability in the context of stock investment decisions. Specifically, this study contributes to the existing literature by examining multiple dimensions of cognitive ability among Chinese middle-aged and older investors. The study confirms H_1, as evidenced by identifying the positive roles of math skills and word recall ability in stock ownership. Furthermore, it highlights that math skill holds greater significance and magnitude compared to word recall ability in describing stock investment decisions. We did not find any significant results to support H_2 in the full sample. However, a positive relationship between word recall ability and stock shares in the portfolios of the middle-aged adults subsample was observed, partially supporting H_2.

The results from this study can be used to assist policymakers and financial service institutions to depict a profile of middle-aged and older stock investors in China. They share some similar personal characteristics, including being wealthy, younger (age 45–59), married, and well-educated. Compared to non-stock owners, stock investors live in urban regions and report relatively better health status. This information is crucial for financial institutions in identifying target clients. It is also useful for professionals who work with middle-aged and older clients in China. As the results from this study show, engaging clients in ways that uncover aspects of numeracy and cognitive decline can help a financial service professional provide relevant advice with appropriate strategies. For example, the results indicate that individuals with better math skills are more likely to invest in stocks and increase the stock holdings of their portfolios. Since these types of clients understand math better, it is reasonable to argue that they are more comfortable using data when making financial decisions. The use of charts, graphs, and other visual aids might appeal to these types of clients.

Additionally, this study shows that objective cognitive ability contributes positively to stock investment decisions. However, this study did not find evidence supporting the role of subjective

self-reported memory problems in stock investment decisions. Moreover, a positive relationship between self-reported doctor-diagnosed memory problems and stock ownership was noted. These findings create educational opportunities for financial institutions, financial service professionals, and educators. On the one hand, the findings indicate the usefulness of objective measures of cognitive ability. Financial service professionals should rely more on objective measures of cognitive ability when collecting information about a client's situation. On the other hand, reflecting on an increased probability of stock investment for those who reported being told by doctors that they had memory-related problems might indicate a point of caution when providing advice and education. Those with memory loss may not understand the risk and return characteristics of stocks, and thus could make allocation decisions that put them at risk of financial loss and distress. It is possible that some cognitively impaired individuals make decisions based on the fear of losing future opportunities rather than basing decisions on a comprehensive analytical investment strategy. It is also possible that because of the Chinese culture's emphasis on wealth accumulation, these investors, despite receiving medical advice regarding memory issues, might actively pursue investment avenues such as stocks to augment their wealth and ensure future provisions. Conversely, Chinese cultural norms often regard cognition decline as a natural aspect of aging, which leads to insufficient attention being given to this concern (Dai et al., 2013; Han et al., 2020). This might cause investors to disregard medical recommendations and advice about memory loss. This possibility creates opportunities for financial institutions, working with policymakers, to design investment programs that help older individuals make more informed investing decisions that align with long-term financial goals. For example, financial institutions and policymakers could work together to develop heuristic tools to help clients overcome cognitive biases during the investment decision-making process (Otuteye & Siddiquee, 2015).

Further, the multivariate analyses showed how different factors can be associated with stock investment decisions across subsamples of older (i.e., 60 years of age and older) and younger investors (i.e., aged 45 to 59 years) in China. For the younger subgroup, total word recall skill was found to be a significant contributor to stock investment decisions, while doctor-diagnosed reported memory problems and math scores were two significant factors related to stock ownership for those in the older subgroup. Financial institutions and educators may want to apply these findings when developing assessments and strategic interventions. Rather than relying on one common assessment tool across client populations, findings from this study suggest the need for a more nuanced approach, where different aspects of cognitive ability for older and younger subgroups can be used for better outcomes.

As mentioned earlier, a positive relationship between doctor-diagnosed memory problems and an increased possibility of stock investment raises the need for further investigation. This is particularly important for the older subgroup because of their shorter investment horizon and potential need to rely on financial assets to maintain their retirement life quality, as well as an increased possibility of potentially diminishing cognitive ability. Although findings from this study cannot be used to indicate a causal pathway from cognitive decline to increased probability of stock ownership, these results do nonetheless suggest that it is essential to build a structured financial planning process to ensure that a client's requests are handled appropriately (Starnes, 2019).

This study also showed that unique factors such as being married, living with dependent children, and exhibiting general good or better health status provide significant insights into the stock investment decisions of investors in the older subgroup. Findings also highlight the positive role of homeownership in stock investment among the younger subgroup. It is possible that owning a home provides the capacity to take on more financial risk. It is also possible that homeownership provides a pathway to portfolio diversification. It is therefore important for financial service professionals to endeavor to familiarize themselves with a client's overall

health status and patterns of asset ownership, given the significance of these findings.

Finally, this study adds to the current literature by showing important associations between various characteristics of Chinese middle-aged and older investors and their preferences for holding stocks in their portfolios. For example, consistent with prior research, investors with higher educational achievements were found to be more likely to hold stocks in their portfolios. This confirms the significance of literacy programs, including those at the general education level, in prompting increased participation in the stock market. We also found that people living in urban regions had a higher propensity for owning stocks. This provides policymakers with valuable insight into the disparities regarding access to stock market resources or a comprehension of stock investments in rural regions of China.

Although this study used a longitudinal dataset to examine the relationship between cognition and stock investment, it was limited to incorporating only three waves of data because of dataset constraints. Consequently, caution is warranted in interpreting the results as causal inferences because of the potential endogeneity of the measured cognitive ability. Furthermore, the findings were constrained by the lack of detailed information regarding cognitive ability within the dataset. Notably, the reliance on the respondents' self-reported memory-related disease diagnoses introduced uncertainty regarding accuracy, and crucial details such as disease types, severity, treatment, and outcomes remained undisclosed. Moving forward, future research directions could entail revisiting this topic with expanded data collection efforts. This would allow for a more comprehensive examination of the role of cognitive ability in portfolio choice across a broader time span and through more sophisticated analytical approaches.

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