

# **Heterogeneous Relationship between Financial Literacy and Fund Investment Behaviors: Evidence from South Korea during the Financial Crisis**

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The importance of financial knowledge on efficient investment behaviors is well known. However, few studies have examined the relationship between financial literacy and investment behaviors under different economic situations. Using the 2007–2016 Fund Investors Survey from South Korea, we investigate the heterogeneous effects of financial literacy on individual investment decisions during and after the 2008 financial crisis. While differentiating objective and subjective financial knowledge, we find that only subjective knowledge is positively related to participation in financial markets and negatively related to fund exit decisions during the financial crisis (2007–2008). However, in the post-crisis period (2009–2016), both subjective and objective financial knowledge affect fund investment behaviors. We further examine these results through a knowledge calibration mechanism. We present suggestive evidence that the effect of subjective knowledge during the financial crisis is not driven by overconfident investors whose subjective knowledge level deviates from objective knowledge but by the group whose subjective and objective knowledge are highly calibrated.

*Keywords:* Financial Crisis, Financial literacy, Knowledge calibration, Objective knowledge, Subjective knowledge

*JEL Classification:* D12, D91, E22, G11

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## I. Introduction

Financial decision-making is crucial to the effective management of households' wealth. Researchers have found that financial knowledge<sup>1</sup> is an effective measure to predict the quality of an individual's financial behaviors. Those who are financially literate are known to be more sensitive to financial costs (*i.e.*, interest, credit card debt) and to make better investment decisions (Behrman *et al.* 2012; Lusardi and Mitchell 2007; Lusardi and Mitchell 2014; Robb and Babiarz 2016; van Rooij *et al.* 2011a; van Rooij *et al.* 2012).

However, there is not enough evidence to determine whether the effect of financial knowledge on financial decision-making behavior is consistent under different economic situations. Investors have been repeatedly exposed to vulnerable market situations such as financial crises. Shocks in financial markets such as the 1997 Asian Financial Crisis, 2008 Financial Crisis, and 2020 Stock Market Crash came unexpectedly and caused panic selling of retail investors. The price of financial assets plummeted due to panic-selling behaviors, which intensified the sentiment of market fear and often led to a vicious circle. Thus, it is important to examine whether financial knowledge still helps investors make a better decision when the market is under crisis.

The Korean mutual fund market had grown at an astonishing rate just before the 2008 financial crisis. Fundraising in South Korea hit a record high of KRW 321 trillion (about 344 billion dollars) in 2007<sup>2</sup>, which is a 26.5% increase compared to 2006. After the 2008 financial crisis, however, the stock market index in Korea fell by approximately

<sup>1</sup> Throughout this paper, we use the terms "financial literacy" and "financial knowledge" interchangeably.

<sup>2</sup> The exchange rate used for December 2007 is US\$ 1 = KRW 932.

50% from its peak, and the value of financial products as well as the rate of investment return substantially decreased, which caused severe losses for individual investors (Kim and Rhee 2009; Park and Lee 2009). Our sample based on the 10-year repeated cross-sectional surveys (2007–2016) allows us to examine the potential heterogeneity of financial knowledge effect because it covers the boom-to-bust (2007–2008) and back-to-normal (2009–2016) situations.

While examining the different economic situations, we also dissect financial literacy into objective and subjective knowledge. We use two measures on financial knowledge about mutual fund products: objective knowledge measured by a test score and subjective knowledge measured by self-reported answers. Objective financial knowledge is known to affect financial behaviors directly. People with higher objective financial knowledge are known to reduce searching costs when choosing one among different investment options (Hastings and Tejada-Ashton 2008; Lusardi and Tufano 2015). They also choose suitable investment products, and these processes are beneficial to accumulate their wealth (Calvet *et al.* 2007; Lusardi and Mitchell 2014). By contrast, subjective financial knowledge is deeply related to psychological motivation during financial decision-making. Individuals are pressured to take responsibility for their actions when making new investment decisions and doubt their knowledge. Self-esteem, a general self-perception, raises confidence on their level of subjective financial knowledge. People with a higher level of subjective financial knowledge are known to do more active financial behaviors (Carlson *et al.* 2008; Chung and Park 2019; Tang and Baker 2016).

Using these measures of objective and subjective financial knowledge, we address the following questions. How did objective and subjective fund knowledge affect investment behavior during the financial crisis? Is there a heterogeneous effect of financial knowledge under different economic circumstances? As financial knowledge is endogenous, finding a causal relationship between financial knowledge and investment behaviors is empirically challenging due to various confounding factors. For the financial crisis period data (2007–2008), we control individual heterogeneity by including individual fixed effects. For the post-crisis period data (2009–2016), we group individuals into so-called “pseudo-cohorts” classified by gender, age, educational level, and region. These cohorts of similar individuals are generated on the same criteria in each wave of the repeated cross-section survey data, and then we apply

the pseudo-panel technique to control the time-invariant differences between the pseudo-cohorts (Deaton 1985).

We find evidence that during the financial crisis period (2007–2008), only subjective fund knowledge is positively related to participation in fund investment and negatively related to fund exit decision, whereas objective fund knowledge does not show any association. However, during the post-crisis period (2009–2016), both objective and subjective fund knowledge are related to extensive and intensive margins of mutual fund investment behaviors.

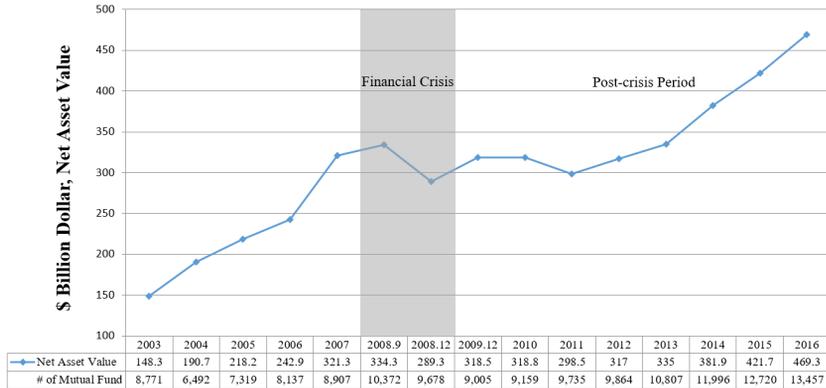
We further examine these results through a knowledge calibration mechanism. Previous research on knowledge calibration shows that miscalibration between objective and subjective knowledge can increase judgment errors and biased decision-making (Alba and Hutchinson 2000; Pillai and Hofacker 2007). Overconfident people whose subjective knowledge is higher than objective knowledge level are likely to make suboptimal decisions (Barber and Odean 1999; Pillai and Goldsmith 2006). However, we present suggestive evidence that the effect of subjective knowledge during the financial crisis is not driven by overconfident investors whose subjective knowledge level deviates from their objective knowledge but by the group whose subjective and objective knowledge are highly calibrated.

This study is organized as follows. Section 2 reviews the previous literature on financial knowledge and its effect on financial behaviors and summarizes the history of the mutual fund market in South Korea. Section 3 presents the data and empirical strategy. Section 4 reports the regression results. Section 5 concludes the study.

## **II. Background and Literature**

### *A. The Korean fund market*

In the 2000s, the Korean mutual fund market grew at an astonishing rate. The net asset value increased by 21.7% annually from 2003 to the end of 2007, and the number of mutual funds exceeded 10,000 for the first time in 2008 (Figure 1). The domestic stock market boom accompanied the rapid growth of the mutual fund market in Korea. Along with the growth of global stock markets, the Korean Composite Stock Price Index (KOSPI) broke the 2,000-point level for the first time in its history, and Korean mutual funds earned high returns from the



**FIGURE 1**  
KOREA MUTUAL FUND MARKET

strong market situation.

The Korean government tried to support the mutual fund market by implementing investor-friendly policies. For example, the Korean government temporarily introduced tax exemption for foreign stock trading from the middle of 2007 to the end of 2009. This policy made foreign mutual funds more popular than before. Financial authorities also tried to improve the investment climate by promoting the online mutual fund market and revising financial terms and regulations. Some experts raised concerns about insufficient investor protection that could cause investors to suffer damage, but financial authorities kept the policies to encourage mutual fund investment. As a result, Korean mutual fund market set a record high of 334.3 billion dollars in September 2008, just before the financial crisis. Individual investors also maintained an optimistic outlook for the mutual fund market as well as the global economy. Individual investors accounted for 59% of the net asset value at the end of 2007. This is an increase of 10% points from the end of 2006.

The crisis began in September 2008. KOSPI had fallen by 50% from its peak. The value of financial products and the rate of return plummeted. The Korean government accelerated the implementation of restructuring, and the National Assembly approved the government’s supplementary budget. The Bank of Korea lowered interest rates and supplied liquidity for market stability (Kim and Rhee 2009; Park and Lee 2009). Nevertheless, some investors were skeptical about the

effectiveness of these policies. The volatility of stock and currency markets recorded the highest since the 1997 Asian financial crisis. Individual investors who experienced financial losses complained about incomplete sales, and the number of disputes increased. Korea Financial Supervisory Service reported that the number of grievance mediation increased by 510% year-on-year in 2008.

### *B. Financial knowledge and behaviors*

When macroeconomic situations were unstable, like during the 2008 financial crisis, many factors can affect individual investment behaviors, and financial knowledge has been emphasized as a critical determinant of financial well-being. For example, financially sophisticated households are less likely to report negative income shock (Klapper *et al.* 2013) and default on their obligations (Gerardi *et al.* 2010). They also recover their losses faster than the financially illiterate after the crisis (Buscher-Koenen and Ziegelmeier 2014).

This financial literacy can be explained by two constructs: objective and subjective financial knowledge. Objective financial knowledge is one criterion to measure individual ability to understand, analyze, and choose when making complex decision-making (Lusardi and Mitchell 2014). Researchers have shown that individuals with high objective financial knowledge are likely to have an account (Noor *et al.* 2020), participate in financial markets, and prefer to invest in financial products with lower fees (Christelis *et al.* 2010; Lusardi and Tufano 2015). They are able to balance the riskiness and profitability of investment products, thus holding profitable assets with lower risk (Chu *et al.* 2017; Stango and Zinman 2009). Objective financial knowledge is also positively associated with long-term planning for retirement and household asset accumulation (Behrman *et al.* 2012; Bucher-Koenen and Lusardi 2011; Lusardi *et al.* 2017; van Rooij *et al.* 2012).

Conversely, a low level of objective knowledge may lead to a suboptimal financial decision, such as incurring the high cost of borrowing or paying higher fees. (Hastings and Mitchell 2020; Lusardi and Tufano 2015). People with lower objective financial knowledge are vulnerable when choosing multiple options (Hibbert *et al.* 2012). They are more likely to make a mistake and choose the investment product that is unsuitable for their wealth budget (Robb 2011). The accumulation of those poor decisions with bias may cause a higher risk

of default (Gerardi *et al.* 2010). They also have difficulties in assessing information-intensive assets; thus, they choose stable assets (saving account, bond) over risky assets (stock or mutual fund) (Bucher-Koenen and Ziegelmeier 2014; Hibbert *et al.* 2012).

Previous literature found that gender, age, education level, cognitive ability, and counselling experience are associated with objective knowledge. Researchers have suggested that women are less financially sophisticated than men, and they are likely to be at risk of making sub-optimal decisions (Bucher-Koenen and Lusardi 2011; Van Rooij *et al.* 2011b). According to Almenberg and Dreber (2015), women tend to participate in the stock market less than men do, and their average financial literacy is low. The age profile of objective knowledge shows a hump-shaped pattern, peaking in the age 50s. Many studies have shown that both the young (under 30) and old (over 60) are more likely to make financial mistakes (Bucher-Koenen and Lusardi 2011; Lusardi *et al.* 2010; Stolper and Walter 2017).

Although objective financial knowledge is based on an individual's thought accuracy, subjective financial knowledge is measured by individual self-assessment of financial knowledge: how much do they think they know about the financial market and financial products. Neymotin (2010) provided a theoretical background with a simple model that higher level of self-esteem helps financial planning as it reduces the psychic cost of accepting information. Individuals with high subjective knowledge are likely to be confident in understanding complex information and making effective decisions (Alba and Hutchinson 2000; Park *et al.* 1988). They think they can examine the profitability and riskiness of financial products and decide quickly (Hadar *et al.* 2013).

In a similar viewpoint, previous studies noted the strong link between self-esteem and knowledge: knowledge affects performance through self-belief in their knowledge. If individuals are confident of their knowledge, then they tend to plan successful scenarios, prepare to confront potential risks and threats, and finally show better outcomes (Baumeister *et al.* 2003; Di Paula and Campbell 2002). Researchers suggest that people with high self-esteem are more likely to achieve their financial goals and engage in a higher level of financial behavior (Tang and Baker 2016). By contrast, people with low self-esteem are likely to hesitate to do risky behavior because they are sensitive to losing or failing (Sommer and Baumeister 2002; Wood and Bandura 1989). Hence, researchers have argued that subjective financial

knowledge is more important in terms of predicting financial decision-making behaviors than objective financial knowledge (Robb and Woodyard 2011; Xiao *et al.* 2011).<sup>3</sup>

Addressing the importance of two similar, but different concepts of knowledge, researchers raised the need for an integrated perspective on them. Knowledge calibration framework is the outcome of the consideration. Although the definition and construct of knowledge calibration in the previous literature vary by researcher, the consensus is that the difference between objective and subjective knowledge should be considered. When we analyze the heterogeneous effect of subjective knowledge by the level of objective knowledge, we follow a  $2 \times 2$  calibration matrix approach suggested by Pillai and Goldsmith (2007). According to the approach, people's knowledge status can be divided into four groups: 1) highly calibrated group with high levels of both objective and subjective knowledge, 2) overconfident group with high subjective knowledge and low objective knowledge, 3) underconfident group with high objective knowledge and low subjective knowledge, and 4) low calibrated group with low levels of both objective and subjective knowledge. Researchers can choose the threshold for defining the level of knowledge: Lee *et al.* (2017) defined four groups on the basis of sample means and found heterogeneous attitudes on mutual fund investment across investors in Korea.

Knowledge miscalibration (overconfident or underconfident group) is known to cause restricted rationality and suboptimal decision-making, thus leading to consumer vulnerability and damage (Alba and Hutchinson 2000; Pillai and Hofacker 2007). Studies have shown that people with overconfidence (high subjective knowledge but low objective knowledge) depend too much on their memory or experience rather than public information (Goetzmann and Peles 1997). They are more likely to be interested in unreliable financial information such as past earnings, temporary performance, and personal experience (Alba and Hutchinson 2000; Daniel *et al.*, 1998; Pillai and Goldsmith 2006). According to Gervais and Odean (2001), individual investors tend to assess their investment skills better than their actual ability when

<sup>3</sup> Xiao *et al.* (2011) found that both objective and subjective financial knowledge can cause individuals to reduce risky credit behavior, but the impact of subjective financial knowledge is more significant than that of objective financial knowledge.

they earn high returns. This belief may translate into action (Griffin *et al.* 2007), where people become overconfident and aggressive in their investment (Dhaoui and Bacha 2017). Overconfident investors are likely to end up making irrational investment decisions and behavior, such as excessive trading (Odean 1999). This phenomenon is known as a pattern of “overreaction,” where people act by giving too much meaning to their dramatic experience (De Bondt and Thaler 1985). Another study suggests that investors tend to rate the stock market more positively during the bull market, and this consensus among people promotes confidence in themselves (Nofsinger 2005).

Considering the mechanism, overconfidence and accompanying behavior would be weakened if enhancing factors are deleted. Meier and De Mello (2020) reported that investors’ overconfidence decreases sharply if an unexpected event occurs (*e.g.*, an asset crash resulting from unexpected bad news). Moreover, cases have been reported wherein reduced overconfidence shifts to a stagnant approach to investing. Nofsinger (2005) found that investors who tend to overreact during the market boom become risk-averse when market conditions turn pessimistic.

Despite a burgeoning literature on the impact of financial knowledge, how these effects are examined must be considered. Empirically, assessing the causality between financial knowledge and financial behaviors is challenging, because financial knowledge is potentially endogenous. To overcome this endogeneity issue, much of the literature takes advantage of the following approaches: 1) finding exogenous (instrument) variables (Klapper *et al.* 2013; Bucher-Koenen and Lusardi 2011); 2) employing experimental approaches (Hastings and Mitchell 2020; Hastings and Tejada-Ashton 2008); or 3) collecting longitudinal (panel) data (Calvet *et al.* 2007). Although employing an instrumental variable is an effective way to address the endogeneity from the reverse causality, a valid instrument that affects financial literacy but not investment behavior is difficult to find. Given that our research hypothesis—heterogeneous effect of financial knowledge under different economic situations—needs to cover multiple years, both during and after the financial crisis, we believe that a panel data approach is the only available option to consider, despite its limitations on causal interpretation.

### III. Data and Empirical Strategy

#### A. Data

We constructed data sets from the 2007–2016 Fund Investors Survey (FIS, hereafter) administered annually by the Korea Financial Investors Protection Foundation.<sup>4</sup> FIS is a representative survey of mutual fund investors who are 20–64 years old in South Korea. The data include demographic information, socio-economic status, financial literacy, and mutual fund investment information. The survey was designed to collect individual investors' specific investment propensities such as preferred investment strategy, level of satisfaction concerning financial products, financial education experience, and whether or not they received financial counselling.

The survey has been originally surveyed as repeated cross-sectional data. However, 954 respondents out of the 2,530 who responded in 2008 had also been interviewed in 2007. Thus, we were able to construct a panel data of two years and compare the differences between the early stage and the period right after the financial crisis. Since 2009, the FIS has surveyed about 2,500 people each year, and the sample size of our pooled data from 2009 to 2016 is 20,429. To examine the impact of mutual fund knowledge on investment behaviors while controlling for individual heterogeneity, we construct pseudo panel data using eight years (from 2009 to 2016) of the cross-section for the extended analysis.<sup>5</sup> In the pseudo panel data, each cohort was constructed by the same gender (male or female), the same age (20–60 years), and the same education level (high school, two-year college, four-year university, or graduate school).<sup>6</sup>

We measured two types of mutual fund knowledge: objective

<sup>4</sup> The dataset for replication is publicly available at the Mendeley Data (Chung and Kim, 2022). Korea Financial Consumers Protection Foundation has been implementing FIS since 2007, and the 2007 dataset is the earliest data we can utilize.

<sup>5</sup> Deaton (1985) proposed the idea of estimating a model using a cohort. The fundamental assumption is that individuals in a cohort share common characteristics on average.

<sup>6</sup> We have 328 cohort bins (gender [2] \* age [41] \* education [4]) in total. Among them, four cohort bins do not include any respondents, and we finally end up with 324 cohorts.

**TABLE 1**  
MUTUAL FUND KNOWLEDGE TEST

Panel A. Objective Fund Knowledge Test

No.	Question
1	A mutual fund is not a principal-protected investment.
2	Mutual funds can be categorized by asset class such as stock-type, bond-type, and multi-type.
3	A mutual fund invests only in the stock market.
4	Mutual fund price varies depending on the transaction time.
5	You can withdraw money as soon as you redeem your mutual fund.
6	Every mutual fund is priced at the same net asset value.
7	When the periodic payment plan of a mutual fund is over, no additional returns will be generated.
8	Any profits generated from mutual funds are taxed except tax-exempt mutual funds.
9	Mutual funds subscribed to a bank are protected on the basis of the Depositor Protection Act.
10	If you redeem your mutual fund, then you will always be charged a redemption fee.

Panel B. Subjective Fund Knowledge Test

No.	Term	No.	Term
1	Net asset value	8	Types of mutual fund
2	Redemption fee	9	Annual report
3	Sales commission	10	Mark to market
4	Asset management company	11	Loads and fees for fund
5	Rate of return	12	Tax on mutual fund investment
6	Redemption price	13	Investment prospectus
7	Redemption period		

Notes: For each question in the objective fund knowledge test, respondents can choose between 1 = “Correct,” 2 = “Wrong,” or 3 = “I don’t know.” “Objective Fund knowledge” is the correct answer rate out of 10 questions with an equal weight. “Subjective Fund knowledge” is measured by averaging the responses of 13 questions with an equal weight. In 2007–2008, subjective fund knowledge is defined as the rate of reporting “3 = I know” or “4 = I know well” on the 4-point Likert scale (1 = “I have no knowledge,” 2 = “I have little knowledge,” 3 = “I know,” and 4 = “I know well”). In 2009–2016, subjective knowledge is defined as the rate of reporting “3 = I know well” on the 3-point Likert scale (1 = “I have no knowledge,” 2 = “I just heard of it,” 3 = “I know well”). The average scores of objective and subjective fund knowledge per survey year are reported in Tables A1 and A2, respectively.

knowledge scored from the set of mutual fund test questions (objective fund knowledge hereafter) and a self-assessed level of knowledge on mutual fund terminologies (subjective fund knowledge hereafter). Panel A of Table 1 presents 10 questions for objective fund knowledge, and Panel B reports 13 topics for testing subjective fund knowledge. If we were able to measure both objective and subjective fund knowledge with the same questionnaires, then compare one measure to the other would be ideal. However, we use two different sets of questionnaires to construct objective and subjective fund knowledge, which is one of the limitations in measurement. Given the dataset we have, we believe it is still relevant to measure objective knowledge on the basis of the questionnaires with correct answers and to measure subjective knowledge by asking respondents whether they think they know the fund-related concepts (Alba and Hutchinson, 2000). Compared with the previous studies on financial literacy which utilized only three to five questions mostly about interest rate, inflation, and discounts (Bucher-Koenen and Ziegelmeyer 2014; Gerardi *et al.* 2010; Klapper *et al.* 2013), the FIS comprehensively asked 23 questions in total on “mutual fund-specific” financial knowledge.

Panel A of Table 2 shows descriptive statistics of the full sample. The average age of respondents is 42.9, and female constitutes half of the sample. Moreover, 79.8% of respondents hold a college or higher education diploma, and 89% reported they were actively working. Their monthly income of USD 5,790 is higher than the average monthly income (USD 3,460) of Korean households. Respondents correctly answered about 60% of objective fund knowledge questions and responded that they know well about 35% of the concepts and terminologies on mutual fund investment.<sup>7</sup> Furthermore, 44% responded they have at least one mutual fund, and 18% of them reported that they earn profit from mutual fund investment. Only 15% of them have ever experienced financial counselling, and 11% have participated in an investment education course.

<sup>7</sup> In 2007–2008, subjective fund knowledge is defined as the rate of reporting “3 = I know” or “4 = I know well” on the 4-point Likert scale (1 = “I have no knowledge,” 2 = “I have little knowledge,” 3 = “I know,” and 4 = “I know well”). In 2009–2016, the knowledge is defined as the rate of reporting “3 = I know well” on the 3-point Likert scale (1 = “I have no knowledge,” 2 = “I just heard of it,” 3 = “I know well”)

**TABLE 2**  
DESCRIPTIVE STATISTICS

Variable	Mean	Std. Dev.	Min.	Max.
A. Full sample (2007–2016 Respondents, N=21,769)				
Age	42.93	10.33	24	64
Female (=1)	0.50	0.50	0	1
< High school (=1)	0.20	0.40	0	1
Some college (=1)	0.12	0.33	0	1
Undergraduate (=1)	0.56	0.50	0	1
Graduate (=1)	0.11	0.31	0	1
Objective fund knowledge (full mark=1)	0.60	0.25	0	1
Subjective fund knowledge (full mark=1)	0.35	0.31	0	1
Real estate assets (unit: USD 1K)	260	481	0	21,459
Monthly income (unit: USD 1K)	5.79	7.38	0	354
Wageworker	0.69	0.46	0	1
Self-employed	0.21	0.41	0	1
Participates in mutual fund market (=1)	0.44	0.50	0	1
Number of mutual funds	1.64	2.84	0	67
Value of mutual funds invested (unit: USD 1K)	18.57	70	0	3,502
Mutual fund investment to financial asset ratio	0.14	0.27	0	1
Earned profit from mutual fund investment (=1)	0.18	0.38	0	1
Experience in financial counselling (=1)	0.15	0.36	0	1
Experience in investment education (=1)	0.11	0.31	0	1
B. 2007 Mutual Fund Investor (N=581 out of 954)				
Number of mutual funds	3.22	2.52	1	17
Value of mutual funds invested (unit: USD 1K)	45.74	117.86	0.1	1,288
Mutual fund inv. to financial asset ratio	0.36	0.26	0	0.996
“I am satisfied with my mutual fund investment” (=1)	0.86	0.34	0	1
“I am planning to invest more than before” (=1)	0.37	0.48	0	1
C. 2008 Mutual Fund Investor (N=569 out of 954)				
Number of mutual funds	2.76	7.70	1	20
Value of mutual funds invested (unit: USD 1K)	16.01	32.94	0.1	451
Mutual fund to financial asset ratio	0.26	0.24	0	1
“I am satisfied with my mutual fund investment” (=1)	0.25	0.43	0	1
“I am planning to invest more than before” (=1)	0.04	0.19	0	1
“I redeemed my loss recently” (=1)	0.27	0.44	0	1

Notes: “Objective fund knowledge” is the correct answer rate out of 10 questions with an equal weight. “Subjective fund knowledge” is measured by averaging the responses of 13 questions with an equal weight, in which we coded each response as 1 if the respondent indicated “I know” or “I know well” and 0 otherwise. Panel B shows the summary statistics restricted to individuals who invested in mutual fund as of November 2007, and Panel C shows the summary statistics restricted to individuals who invested in mutual fund as of December 2008. The exchange rate applied here is US\$ 1 = KRW 932 (as of December 2007).

Panels B and C of Table 2 describe the stark differences between before and after the financial crisis. The average number of mutual funds decreased from 3.22 to 2.76, whereas the value of the mutual funds invested plummeted from USD 45,740 to USD 16,010. Accordingly, the satisfaction level with mutual fund investment dropped from 86% in 2007 to 25% in 2008. Although 37% of the respondents in 2007 answered that they will invest more in mutual funds, which reflects their optimism in the future, only 4% of the respondents in 2008 considered further investment in mutual funds after the financial crisis.

### *B. Empirical strategy*

We have a (pseudo) panel data estimation strategy to examine the relationship between financial knowledge and investment behaviors under different economic situations. We conduct individual (cohort) fixed-effects estimation (equation 1) to figure out whether objective and subjective fund knowledge are associated with fund investment behaviors after controlling for individual (cohort) heterogeneity.

$$Y_{it} = \beta_0 + \beta_1 OFK_{it} + \beta_2 SFK_{it} + \beta_3 X_{it} + \alpha_i + \gamma_t + \varepsilon_{it} \quad (1)$$

$y_{it}$  is an outcome variable of individual  $i$  at time  $t$ . For example, entry and exit in mutual fund market, number of mutual funds, the value of the entire mutual funds invested, fund investment to financial asset ratio, and the gain in profits from fund investment are used as dependent variables of interest.  $OFK_{it}$  and  $SFK_{it}$  are standardized objective and subjective financial knowledge, respectively. In order to compare the effect sizes between the objective and subjective financial knowledge, we standardize both financial knowledge scores for each survey year by subtracting the mean value and dividing by the standard deviation. Our main interest is in the sign and magnitude of the coefficients  $\beta_1$  and  $\beta_2$ , which measure the change in outcome variables as objective and subjective fund knowledge, increase by a one standard deviation.  $\alpha_i$  is the individual (cohort) fixed effects for the 2007–2008 (2009–2016) sample. We also include year fixed effects,  $\gamma_t$ . After controlling for the time-invariant individual (cohort) heterogeneity and common year-by-year time trends, we further control for the individual time-varying characteristics such as age, age squared, real

estate assets, income, employment status (wageworker, self-employed, or unemployed), experience in mutual fund counselling, and experience in investment education.<sup>8</sup>

#### **IV. Results and Discussion**

We first estimate the effect of fund knowledge on the extensive margin of mutual fund investment behavior in Table 3. During the financial crisis period (2007–2008), a one standard deviation increase of subjective fund knowledge is associated with 3.6% points (5.9%) increase in fund market investment. However, objective fund knowledge does not have any explanatory power on fund investment behavior in terms of coefficient size (close to zero) and statistical significance.

This pattern does not hold during the post-crisis period (2009–2016), as shown in Columns 3–4 of Table 3. Both objective and subjective knowledge are strong predictors for the fund market participation. A one standard deviation increase in objective and subjective fund knowledge are associated with 8.9% points (21.8%) and 6.0% points (14.7%) increase in the probability of investing in mutual fund, respectively. In the post-crisis period, the coefficient size of objective fund knowledge increases more than 12 times larger than that of financial crisis period, which shows the stark contrast of the effect of objective fund knowledge in different economic situations.

One interesting finding is that many control variables, such as assets, income, investment counselling/education experience, and employment type do not have any association with fund investment behavior during the financial crisis but after the crisis. They become statistically significant to explain the fund market participation, which is consistent with the pattern of objective fund knowledge seen during and after the

<sup>8</sup> Although we control for time-invariant differences between individuals or cohorts through panel data analysis, we cannot completely rule out reverse causality and other time-varying confounding factors. For example, investors who purchase mutual fund products may learn more about the fund's details, which may affect the objective and subjective financial knowledge scores. Employing an instrumental variable that is correlated with financial literacy but not directly affecting the mutual fund investment behaviors could be a more convincing approach. However, a valid instrument is difficult to find in the FIS questionnaire. Thus, we need to take caution in interpreting our results as causality.

financial crisis.

In Table 4, we further examine the relationship between objective/

**TABLE 3**  
FUND MARKET PARTICIPATION

Dependent Variable	Currently participating in fund investment (=1)			
	Financial Crisis Period (2007–2008)		Post-crisis Period (2009–2016)	
Sample:	(1)	(2)	(3)	(4)
Objective Fund Knowledge	0.005 (0.017)	0.006 (0.017)	0.090*** (0.016)	0.089*** (0.015)
Subjective Fund Knowledge	0.035*** (0.012)	0.036*** (0.012)	0.071*** (0.018)	0.060*** (0.018)
Age		-0.284*** (0.082)		-0.024* (0.012)
Age Squared		0.003*** (0.001)		-0.000 (0.000)
Real Estate Assets (log)		0.008 (0.007)		0.008* (0.005)
Income (log)		0.020 (0.013)		0.031 (0.022)
Mutual Fund Counselling (=1)		0.094 (0.071)		0.075* (0.044)
Investment Education (=1)		0.026 (0.060)		0.142*** (0.050)
Wageworker (=1)		-0.057 (0.051)		0.049 (0.040)
Self-employed (=1)		-0.026 (0.044)		0.011 (0.049)
R-squared	0.011	0.031	0.181	0.204
Mean of Dependent Variable	0.603		0.408	
Observations	1,908		19,861	
Number of Individuals (Cohorts)	954		324	

Notes: Both objective and subjective mutual fund knowledge are normalized per survey year. The dependent variable (currently participating in fund investment) and control variables (“Mutual Fund Counselling,” “Investment Education,” “Wageworker,” and “Self-employed”) are dummy variables. All regressions include individual (cohort) fixed effects and year fixed effects. Robust standard errors are clustered at cohort level. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**TABLE 4**  
INTENSIVE MARGINS OF FUND INVESTMENT

Dependent Variable:	Number of funds		Value of mutual funds invested (log)		Fund investment to financial asset ratio		Gained profits from fund investment (=1)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Financial Crisis Period (2007–2008)								
Objective Fund Knowledge	0.131 (0.091)	0.152* (0.091)	0.107 (0.181)	0.138 (0.181)	0.012 (0.015)	0.011 (0.015)	0.021** (0.011)	0.021** (0.010)
Subjective Fund Knowledge	0.236*** (0.074)	0.247*** (0.073)	0.344** (0.171)	0.367** (0.169)	0.021* (0.011)	0.022** (0.011)	0.016 (0.012)	0.017 (0.011)
Control Variables	N	Y	N	Y	N	Y	N	Y
R-squared	0.058	0.072	0.047	0.070	0.094	0.107	0.082	0.100
Mean of Dependent Variable	2.474		5.636		0.262		0.035	
Observations	1,390		1,390		1,390		1,390	
Number of Individuals	695		695		695		695	
Panel B. Post-crisis Period (2009–2016)								
Objective Fund Knowledge	0.214 (0.146)	0.248* (0.133)	0.321* (0.171)	0.319* (0.169)	0.025** (0.012)	0.026** (0.012)	0.047** (0.020)	0.047** (0.020)
Subjective Fund Knowledge	0.492*** (0.127)	0.378*** (0.118)	0.496*** (0.155)	0.445*** (0.156)	0.019 (0.012)	0.017 (0.012)	0.048** (0.021)	0.044** (0.021)
Control Variables	N	Y	N	Y	N	Y	N	Y
R-squared	0.086	0.141	0.159	0.178	0.121	0.141	0.155	0.162
Mean of Dependent Variable	1.929		6.289		0.157		0.211	
Observations	8,418		8,418		8,418		8,418	
Number of Cohorts	318		318		318		318	

Notes: Both objective and subjective fund knowledge are standardized per survey year. Basic controls include age, age squared, real-estate assets (log), income (log), mutual fund counselling experience, investment education experience, and two occupation dummy variables (wageworker and self-employed). All regressions include individual (cohort) fixed effects and year fixed effects. Robust standard errors are clustered at cohort level. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1

subjective fund knowledge and the intensive margins of fund investment behaviors (conditional on fund investment) such as number and value of funds invested, fund investment to financial asset ratio, and profit gain. During the financial crisis period (Panel A), a one standard deviation increase in subjective financial knowledge is associated with 0.247 (10%) increase in the number of funds invested in, and 36.7% increase in the total value of funds invested, whereas objective financial knowledge does not have statistically significant association with the intensive

margins of fund investment. Consistent with the results reported in Table 3, we reconfirm in Table 4 that fund investment behavior (intensive margins) is related to only subjective financial knowledge, not objective financial knowledge during the financial crisis period. Panel B suggests that both objective and subjective financial knowledge can be predictors to all the intensive margin outcomes reported in Table 4, whereas the effect sizes (coefficients) of subjective financial knowledge are mostly larger than those of objective financial knowledge.

The results on Table 3 and Table 4 show consistent evidence that objective fund knowledge is related to neither the extensive margin (fund market participation) nor the intensive margins (number of funds, value of funds invested, fund investment ratio, and profit gain) of mutual fund investment during the financial crisis period (2007–2008). However, it does not mean that objective fund knowledge plays no role in fund investment behavior during a crisis because the effects of subjective knowledge could be different given the level of objective knowledge. In order to check this possibility, we split sample into two groups (high objective fund knowledge group and low objective fund knowledge group) according to the median (50th percentile) of each fund knowledge and investigate whether the effects of subjective fund knowledge during the financial crisis period are heterogeneous by objective knowledge level.

Table 5 shows interesting results: a one standard deviation increase in subjective fund knowledge during the financial crisis is significantly related to 7.0% points (9.8%) increase in the probability of participating in mutual fund market only if the level of objective fund knowledge is high enough (above the median). However, this pattern does not hold for those whose objective fund knowledge is low (below the median). This finding may imply that the significant association between subjective fund knowledge and fund investment behavior during the crisis is driven not by the overconfident group (whose subjective knowledge is high but objective knowledge is low) but by the highly calibrated group (whose subjective and objective knowledge are both high). Therefore, the level of objective knowledge can be considered a prerequisite for realizing the effect of subjective financial knowledge during the economic crisis.

We reaffirm that subjective fund knowledge is significantly related to the intensive margins of fund investment behavior during the financial crisis. Panel A of Table 6 reports that for investors whose

**TABLE 5**  
 MARKET PARTICIPATION DURING THE CRISIS: SUBGROUP ANALYSIS

Dependent Variable:	Currently participating in fund investment (=1)			
	High Obj. Knowledge Group (Top 50%)		Low Obj. Knowledge Group (Bottom 50%)	
Sample:	(1)	(2)	(3)	(4)
Objective Fund knowledge	0.054 (0.037)	0.071* (0.037)	-0.007 (0.019)	-0.012 (0.019)
Subjective Fund knowledge	0.072*** (0.018)	0.070*** (0.019)	0.013 (0.016)	0.015 (0.016)
Age		-0.367*** (0.106)		-0.219* (0.116)
Age Squared		0.005*** (0.001)		0.002* (0.001)
Real Estate Assets (log)		-0.003 (0.007)		0.018* (0.010)
Income (log)		0.032 (0.023)		0.015 (0.016)
Mutual Fund Counselling (=1)		0.092 (0.084)		0.159 (0.134)
Investment Education (=1)		-0.051 (0.080)		0.118 (0.096)
Wageworker (=1)		-0.026 (0.092)		-0.070 (0.068)
Self-employed (=1)		-0.024 (0.067)		-0.026 (0.059)
Individual Fixed Effect	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
R-squared	0.041	0.077	0.003	0.029
Mean of Dependent Variable	0.717		0.496	
Observations	920		988	
Number of Individuals	460		494	

Notes: Both objective and subjective mutual fund knowledge are standardized per survey year. The dependent variable (currently participating in fund investment) and control variables (“Mutual Fund Counselling,” “Investment Education,” “Wageworker,” and “Self-employed”) are dummy variables. All regressions include individual (cohort) fixed effects and year fixed effects. Robust standard errors are clustered at cohort level. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1.

**TABLE 6**  
INTENSIVE MARGINS OF INVESTMENT DURING THE CRISIS: SUBSAMPLE ANALYSIS

Dependent Variable	Number of funds		Value of funds invested (log)		Fund investment to financial asset ratio		Gained profits from fund investment (=1)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. High Objective Knowledge Group (Top 50%)								
Objective Fund knowledge	0.321* (0.168)	0.404** (0.168)	-0.091 (0.293)	0.055 (0.294)	0.004 (0.024)	0.007 (0.024)	0.029 (0.020)	0.027 (0.021)
Subjective Fund knowledge	0.408*** (0.129)	0.411*** (0.125)	0.704*** (0.215)	0.737*** (0.212)	0.045*** (0.017)	0.047*** (0.017)	0.030* (0.017)	0.030* (0.017)
Control Variables	N	Y	N	Y	N	Y	N	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.082	0.099	0.088	0.124	0.136	0.153	0.079	0.091
Mean of Dependent Variable	2.871		5.950		0.284		0.026	
Observations	770		770		770		770	
Number of individuals	385		385		385		385	
Panel B. Low Objective Knowledge Group (Bottom 50%)								
Objective Fund knowledge	0.068 (0.103)	0.079 (0.104)	0.196 (0.224)	0.199 (0.228)	0.015 (0.018)	0.012 (0.018)	0.018 (0.013)	0.018 (0.013)
Subjective Fund knowledge	0.119 (0.083)	0.129 (0.083)	0.094 (0.245)	0.091 (0.241)	0.005 (0.015)	0.005 (0.015)	0.009 (0.014)	0.010 (0.013)
Control Variables	N	Y	N	Y	N	Y	N	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.044	0.071	0.027	0.052	0.061	0.094	0.101	0.131
Mean of Dependent Variable	1.980		5.245		0.234		0.047	
Observations	620		620		620		620	
Number of Individuals	310		310		310		310	

Notes: Both objective and subjective fund knowledge are standardized per survey year. Basic controls include age, age squared, real-estate assets (log), income (log), mutual fund counselling experience, investment education experience, and two occupation dummy variables (wage worker and self-employed). All regressions include individual (cohort) fixed effects and year fixed effects. Robust standard errors are clustered at cohort level.  
\*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1

objective fund knowledge is higher than the median, a one standard deviation increase in subjective financial knowledge is associated with 0.411 (14.3%) increase in the number of funds invested in, 4.7% points (16.5%) increase in fund investment to financial asset ratio, and 3% points (115%) increase in the probability of gaining profit from fund

investment. By contrast, as shown in Panel B of Table 6, objective financial knowledge does not have a statistically significant association with the intensive margins of fund investment behaviors for those whose objective fund knowledge is below the median.

## V. Conclusion

Our results highlight that the association between objective/subjective fund knowledge and fund investment behaviors are heterogeneous under different economic circumstances. During the financial crisis period (2007–2008), only subjective fund knowledge is significantly related to the extensive and intensive margins of fund investment, whereas both objective and subjective fund knowledge have strong associations with fund investment behaviors during the post-crisis period (2009–2016).

This finding implies that the role of financial literacy can be systematically different given economic circumstances. In the previous literature, objective financial literacy has been considered a strong predictor of positive financial behavior (Behrman *et al.* 2012; Lusardi and Mitchell 2007; Lusardi and Mitchell 2014; van Rooij *et al.* 2011a; van Rooij *et al.* 2012), but we find that this positive association became insignificant and disappeared during the financial crisis when the market uncertainty and volatility were at the peak.

By contrast, subjective fund knowledge measured in this study consistently shows strong association with fund investment behaviors both during the financial crisis and the post-crisis periods. This study is in line with the literature which emphasizes the role of subjective financial knowledge or financial self-efficacy (Hadar *et al.* 2013). Our results emphasize that the impact of subjective knowledge during the financial crisis is not attributed to overconfidence but is most visible among a highly calibrated group that has high objective and subjective knowledge. When facing a crisis, overconfident investors tend to refrain from market participation or additional investment. Such behavior is consistent with the previous studies that overconfidence is largely affected by the market situation, and it decreases rapidly when people experience a shock against their beliefs (Meier and De Mello 2020; Nofsinger 2005). As our study shows that the importance of objective knowledge as a prerequisite for the possible impact of subjective knowledge becomes even more salient during the financial crisis, we

suggest that more effective counselling and educational programs for financial consumers are needed to enhance financial knowledge. Especially, the literature on how to improve subjective (or self-assessed) knowledge about financial products is scant, and further research is needed.

Although this study takes advantage of the comprehensive measures on objective and subjective fund knowledge as well as of the 10-year representative sample of fund investors in South Korea, we acknowledge that we are limited when interpreting our results as causal effects of fund knowledge on fund investment behaviors. If FIS (which is a repeated cross-sectional survey) in Korea can be administered as a longitudinal survey in the future, then a causal interpretation of the relationship between financial knowledge and financial behaviors would improve.

Moreover, the measures on financial knowledge we used in this study capture very specific financial knowledge related to mutual fund products. While understanding the similarities and differences between product-specific financial knowledge and more general financial knowledge, further research needs to test whether our results are generalizable across different types of financial knowledge measures.

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Appendix

**TABLE A1**  
CORRECTION RATE OF OBJECTIVE FUND KNOWLEDGE

Question Number	Year									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.803	0.850	0.772	0.719	0.821	0.735	0.736	0.726	0.608	0.712
2	0.911	0.904	0.817	0.763	0.834	0.783	0.735	0.753	0.630	0.683
3	0.909	0.874	0.789	0.747	0.819	0.788	0.722	0.749	0.678	0.690
4	0.588	0.570	0.579	0.509	0.527	0.531	0.472	0.489	0.440	0.429
5	0.795	0.850	0.740	0.717	0.770	0.751	0.676	0.698	0.646	0.609
6	0.843	0.795	0.728	0.674	0.719	0.695	0.652	0.674	0.615	0.583
7	0.649	0.563	0.569	0.542	0.563	0.530	0.499	0.456	0.508	0.504
8	0.803	0.743	0.747	0.666	0.691	0.703	0.570	0.601	0.581	0.544
9	0.666	0.720	0.607	0.578	0.615	0.606	0.567	0.510	0.527	0.513
10	0.355	0.310	0.291	0.301	0.296	0.270	0.292	0.211	0.273	0.267

Notes: For each question in the objective fund knowledge test, respondents can choose between 1 = "Correct," 2 = "Wrong," or 3 = "I don't know."

**TABLE A2**  
MEASURING SUBJECTIVE FUND KNOWLEDGE

Question Number	Year									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.666	0.563	0.400	0.364	0.382	0.440	0.356	0.379	0.364	0.363
2	0.656	0.737	0.665	0.621	0.559	0.340	0.438	0.405	0.290	0.409
3	0.617	0.662	0.611	0.510	0.485	0.328	0.394	0.384	0.271	0.378
4	0.657	0.719	0.593	0.581	0.634	0.325	0.403	0.384	0.276	0.346
5	0.676	0.798	0.777	0.730	0.780	0.411	0.449	0.481	0.318	0.396
6	0.655	0.651	0.509	0.458	0.552	0.266	0.336	0.335	0.221	0.306
7	0.693	0.642	0.408	0.396	0.435	0.325	0.341	0.332	0.251	0.303
8	0.681	0.681	0.512	0.457	0.418	0.285	0.312	0.338	0.225	0.290
9	0.618	0.538	0.516	0.453	0.477	0.295	0.289	0.290	0.238	0.260
10	0.469	0.291	0.151	0.131	0.109	0.093	0.109	0.097	0.111	0.121
11	0.565	0.372	0.254	0.262	0.192	0.194	0.233	0.218	0.180	0.244
12	0.567	0.334	0.241	0.204	0.162	0.168	0.128	0.115	0.151	0.143
13	0.617	0.501	0.455	0.465	0.422	0.279	0.233	0.254	0.236	0.225

Notes: In 2007–2008, subjective fund knowledge is defined as the rate of reporting "3 = I know" or "4 = I know well" on the 4-point Likert scale (1 = "I have no knowledge," 2 = "I have little knowledge," 3 = "I know," and 4 = "I know well"). In 2009–2016, the knowledge is defined as the rate of reporting "3 = I know well" on the 3-point Likert scale (1 = "I have no knowledge," 2 = "I just heard of it," 3 = "I know well").

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