

# **Cognitive abilities and stock market participation of individual investors during the financial crisis**

## **Abstract**

The paper focuses on the cognitive factors that constrain stock market investments and examines the relationship between cognitive traits and stock ownership. We study this reciprocal relationship in the context of the recent financial crisis which hit Europe during 2008-2009. Numerical skills, verbal fluency, and memory are cognitive function used in this study.

We used data from the Survey of Health Age and Retirement in Europe (SHARE) which provides detailed information about the cognitive skills and portfolio choices of European individual investors aged 50 or older. The data is taken from two similar surveys one between 2006 and 2009 and other during 2010 and 2012.

We investigate the causality behind stock market participation. The empirical model captures the link between stockholding and cognitive abilities and include supplementary variables that influence the stock investment decision of individual investors.

Results show that cognitive abilities are positively associated with stock market participation, even after the financial crisis. Numeracy is found to have the strongest link with stockholding in both periods. The financial crisis exerts a negative effect on the positive link between cognition and investing in stocks. After the financial crisis, cognitive abilities exert a weaker influence on the propensity of individual investors to hold stocks.

The implication of this study is that individual investors refrain from holding due to financial restrictions, rather than psychological factors or personal preferences. Therefore, financial education could increase individual investors' awareness regarding the stock market and, consequently, allow reaping benefits arising from stock investments.

# 1. Introduction

According to the modern portfolio theory (Markowitz, 1952; Samuelson, 1969) the household utility is maximized when the available capital is distributed in different types of wealth. Most common types of assets are: consumption, savings in bank accounts and securities (stocks, bonds, mutual funds, pension accounts, etc.). It is suggested to households to invest in stocks in order to increase their utility as the returns from dividends and price appreciation of the stocks contribute significantly to household wealth.

However, research (Mankiew and Zeldes, 1991; Vissing-Jorgenssen, 2004; Campell, 2006) shows that households do not invest in stocks, even in periods when the market returns are high in comparison to that of other types of securities. Trying to decipher and explain the reasons behind the low stock market participation, many academics study this irrational behavior of individual investors. The main reason found in the existing literature is that investing in stocks is related with fixed expenses which render stockholding expensive. Hence, the majority of the households cannot afford to invest in this class of securities. The expenses that individual investors require to undertake when investing to the market include mainly information and transaction costs (Haliassos and Bertaut, 1995; Calvet et al., 2007; Christelis et al., 2010).

Information and transaction costs in stock market participation are strongly associated with individual cognition and financial education (Andersen and Nielsen, 2010). Cognitive skills, namely mathematical skills, reading comprehension and memory skills of individual investors are channels through which information and transaction costs are related with the stock market participation (Christelis et al., 2010). For example, skilled individual investors need less time to process financial information related to the stock market and, as a result, low skills can have a negative impact on stockholding. In addition, cognitive abilities are linked with investors' behavior towards risk and returns of stocks. Inexperienced and unskillful individual investors tend to be affected by behavioral biases such as holding portfolios that are not diversified (Kimbal and Shumway, 2010). On the other hand, Barber and Odean (2001) find that

overconfidence leads investors to make more transactions and invest in more risky securities than rational investors who are not influenced by behavioral perceptions. This tendency shows a negative impact of cognition to stock market participation.

The broad, and therefore inexhaustible, field of behavioral finance is the main motivation for this study. Its conceptualization is symptomatic of a wide range of financial journals concerned with the investment behavior of individual investors, which, however, remains open to further elaboration. Precisely in response to this inconclusive aspect of behavioral finance, this paper aspires to examine how specific mental characteristics of individual investors influence their portfolio decision during periods of crisis, when the stock market is characterized by high volatility.

In order to test the impact on cognition on investment decisions regarding stocks data from the Survey of Health, Ageing and Retirement in Europe (SHARE) are used. The aim of the SHARE is to record in detail the lives of people aged 50 and above from European countries. The data comes from 2 similar surveys which were conducted in two different periods; Wave 2 survey was conducted in 2006-2007 and wave 4 was conducted in 2010-2012. The two surveys contain information about demographics, health, household income, social activities, and wealth distribution.

The empirical results show that cognitive skills do exert a positive impact on stock market participation. People with higher cognitive skills tend to invest more in the stock market. Additionally, this relationship was stronger before the 2008-09 financial crisis. The financial crisis affected in a negative way individual investor's financial decisions. The empirical results are robust after controlling for the size of the sample.

This paper is closely related to the work of Christelis et al. (2010) concerning cognitive skills and portfolio decisions. The aim is to examine and expand their findings and analyze the effect of cognitive abilities on the way individual investors participate in the stock market. The contribution of the study is that this relation is examined under the prism of the recent economic and financial crisis, one of the worst since the Great Depression. Previous studies examine

the effects of cognitive abilities in the stock and portfolio decisions of individuals, but hardly any of them examines the relationship taking in a context of the recent financial crisis. Another contribution of the study is that the effect of each one of the cognitive skills (numerical competence, memory and fluency) to the investment decisions is examined individually.

From a non-academic perspective, the study will contribute to current policies related to investment accounts in Europe. Investment policies in Europe depend on the households portfolio decisions, and this is strongly related with stock market participation. Households can capture market prospects and gain high returns, but when investing significant amounts, or without planning, they might earn lower returns or suffer significant losses in their accounts. Consequently, policies related to individual investors education, knowledge, and consciousness about investing in the stock market rely on the way cognitive abilities influence the financial choices of individuals.

The remainder of this paper is structured as follows. Section 2 exhibits a review of the existing literature on the recent financial crisis, the stock market participation of individual investors and impact of cognitive abilities on portfolio decisions. In section 3, the theoretical framework of the study is presented, along with the hypotheses that are tested. Section 4 introduces the data analysis and explains the methodology which is followed. In Section 5, the empirical findings of the data are presented and discussed. Finally, in section 6 the major points and findings of this study are summarized, drawing a conclusion on the study.

## **2. Literature review**

### **2.1 Optimal portfolio choice theory**

The portfolio choices of individuals have always been an important issue of discussion in the academic literature. In order to be able to understand individual investors' behavior and to examine whether individuals behave rationally in the stock market, however, it is essential to understand the fundamentals behind household portfolio theory.

Among the academic research conducted in order to define which factors influence portfolio choices made by individual investors, a pioneer study related to the portfolio selection was inaugurated by Markowitz in 1952. Markowitz (1952) rejected the hypothesis which was hitherto accepted, namely, that the investor should maximize future anticipated returns. As he proves, that hypothesis does not take into account the advantage of diversification of a portfolio, as compared to a situation where a portfolio is not diversified. Diversification is both real and reasonable; and it is observed that diversified portfolios performed better than non-diversified portfolios. Investors, in other words, are advised to hold a diversified portfolio in order to maximize their utility through returns.

Markovitz (1952) stated that portfolio returns are a balanced combination between expected returns and the variance of those returns. Consequently, an individual investor can achieve the optimal portfolio choice. By choosing from feasible combinations the one which fits in their preferences, individual investors can maximize portfolio returns. Specifically, based on investor's risk preferences -and given desired return- the investor can minimize the variance of the expected return or instead maximize the expected return, given a desired variance. The optimal portfolio choice will be based on investor's preferences about return and risk. This approach includes diversification which minimizes the variance of expected return. Investing in shares of companies which belong in different fields, for example, lowers the variance of the portfolio and renders it less risky than investing in similar companies.

Tobin (1958) contributed in the portfolio theory by analyzing the relationship between liquidity, namely cash, and the interest rates. Tobin (1958) elaborated on the negative relationship between cash and interest rates, reasoning that investing in assets rather than holding cash is more rational for individuals, since it creates more wealth than interest rates. This implies that investors should invest in the assets to benefit from changes in price, instead of holding wealth in saving accounts.

The existing literature that is concerned about portfolio choice and optimal asset allocation supports that households should invest part of their cash in risky assets in order to benefit from the higher expected return. Merton (1969), as a matter of fact, maintained the statement that when an individual faces the problem of choosing the optimal portfolio -given that he/she faces the restriction of their fixed budget in terms of income- he/she should consume one part of his/her income. The remaining part should be invested in a certain amount of risky assets and the rest in safe assets.

Samuelson (1969) analyzed the asset allocation of the portfolio over the lifetime of individual investors and drew similar results with Merton (1969); all investors should have the same tolerant against risk regardless their income and age, and as a result all investors are likely to have the same portfolio construction, holding portfolios with the same risk. Therefore, an individual should maximize his/her lifetime utility by selecting the specific consumption he/she needs and invest the rest wealth in a combination of secure and risky assets. All individuals should hold in their portfolio at least some risky assets, regardless of their risk-aversion preferences. Nevertheless, the amount of risky assets in the portfolio is determined by the tolerance of the individual towards risk. In general, the optimal portfolio supports stock market participation due to high returns from the stocks. Portfolios, in other words, should be diversified, including different types of assets according to risk and returns.

Last but not least, Cocco et al. (2005) study the effect of income risk on the portfolio choice over the lifetime horizon. According to this study, the income from the future retirement of an individual is a replacement for risk-free assets in the portfolio. Putting it differently, this future income increases the total wealth

of investor and, consequently, urges the investor should include a higher amount of stocks in the portfolio.

## **2.2 Cognitive behaviour and portfolio choice**

As mentioned above, individual investors are advised to invest in stocks in order to maximize their utility curve and accumulate wealth. Yet, individual investors do not generally participate directly in the stock market, especially in periods when stocks have historical premiums. (Haliassos and Bertault, 1995). Benartzi and Thaler (1995) define the 'equity market puzzle' as the empirical evidence which make manifest a certain tendency of individual investors to remain puzzling inclined to invest in bonds, even during periods when returns from stocks outperform those from bonds.

Stock market participation is far from universal (Horne et al., 1975; Mankiew and Zeldes, 1991). The stock market participation of households changes significantly from country to country and differences exist in different countries. Christelis et al. (2013) show that before the recent financial crisis, European households used to invest less in stocks and more in houses, than US of similar characteristics.

Although there has been a recent change in the stock market participation, considering that the number of households which invest in stocks is increasing, general figures still remain low (Campbell, 2006). Mankiew and Zeldes (1991) find that approximately 75% of households do not hold stocks and do not participate in the stock market at all, even though the number of participants in the stock market was doubled during 1965 and 1985. This can be referred to as the "equity market puzzle" since the premium from stockholding was 6% higher than the short-term return from investing in bonds. In addition, Cocco et al. (2005) estimate that the loss in household welfare from non-holding stocks -compared to as a percentage of total consumption- comes up to be very important (up to 2% of the total consumption).

The grave challenge academics had to face was to explain the low participation of individual investors in the stock market. Halliasos and Bertaut (1995), Guiso et al. (2003), and Vissing-Jorgensen (2004) provide evidence of positive connection between stock market participation and fixed costs. More specific, some of these studies proved that the participation of individuals in the stock market increasing when wealth, age and literacy are respectively increasing. If participation is expensive, it should be higher when wealth increases, given that more wealthy investors will be able to afford these costs.

The lack of participation of individual investors in the stock market or in the market of other financial assets is mainly caused by the impact of information and transaction costs, as suggested by Haliassos and Bertault (1995). Buying or selling such assets requires information about the nature, the trends and the performance of the market. Individuals generally turn to professionals and exchange knowledge and information with money. In this way, investing in securities becomes more making expensive. In addition, the participation in the market involves transaction fees, relating to the brokerage payments and the difference in buy-sell price of the assets.

Vissing-Jorgensen (2004) conducts a similar study and suggests that individuals who wish to invest in the stock market might bear fixed costs. These costs are related to the buying and selling of the stocks, the fees and commissions given to the brokers, trading costs (bid-ask spreads), and transaction fees. Furthermore, there are other indirect monetary and non-monetary costs as well. These costs refer to time spent by individuals to gain knowledge about the stock market, get accustomed to investment fundamentals and generally access crucial information that could lead to the optimal decision in their portfolio construction.

Mankiew and Zeldes (1991) on the other hand, give different reasons in response to the explanations of the low participation of households in the stock market. Half of the consumers who do not hold assets, they argue, own deposit accounts or other liquid assets of low value. According to the authors, this group of consumers faces significant problems with liquidity, since they cannot save large amount of money in deposit accounts even if they do not invest in stocks.



As a result, the ability to hold stocks is wrenched because of the shortage of liquid wealth. However, liquid restrictions are not the only aspect that attends to and explains why people do not participate in the stock market. For instance, individuals who have significant amounts of liquid investments, still hold a small number of stocks. The explanation for wealthy non-stockholders might be more complicated. Some possible explanations can be traced to the costs related to the information about the stocks, prices and the market conditions or other non-economic reasons.

Another important finding of Mankiew and Zeldes (1991) is that labor income is positively correlated with stock ownership. The higher the income, the larger the number of households which own stock is. The results are robust even between individuals with similar standards of education. Furthermore, the authors suggest that another factor possible related with to the low stock market participation is financial education. As the education of the decision-maker in the household increases, the possibility to invest in stocks increases as well, even between household with the same amount of income. The results are robust even between individuals with same standards of education. It can be assumed that income and education can be thought as two of the crucial factors that affect individual investor's stock market participation. High income households are able to pay the high information cost related to stock holding and the fixed cost of stock market participation is usually less for individuals who have higher education (information access and evaluation is less expensive).

In an attempt to explain the behavior of individual investors, there are many studies which try to relate non-stock ownership with financial education and other psychological factors. Vissing-Jorgensen (2003) being a prominent example, examines if wealth exerts a positive influence on rational behavior of investors. The results show that as household wealth increases, 'irrationality' and behavioral biases in stock investing decrease. These findings imply that information cost and transaction costs are a possible explanation of why many individuals do not hold stock. Vissing-Jorgensen (2003), for example, states that an annual fee of \$55 is a reason that prevents half of the non-participants from investing in the stock market. Consequently, participation and transaction

costs are not likely to explain why wealthy investors shy away stocks. The possible reasons might be psychology or other behavioral biases.

According to Christelis et al. (2010), cognitive abilities can exert substantial influence on individuals' decisions to acquire stock or other financial assets in many different ways. The study points out that there are three ways through which cognitive skills might influence portfolio decisions. Firstly, individuals who are skillful usually face low cost for collecting and analyzing information related to the financial market. Secondly, cognitive abilities are strongly connected with individual preferences, such as risk preference, which affects individual's tendency to accept financial risk. And lastly, investors with the low intellectual skills might misjudge the accuracy of the financial data they own.

Individuals who manage portfolios and make decisions need to put time and effort in order to be familiar with the fundamental concepts of transaction cost, asset returns and volatility (Christelis et al., 2010). Therefore, the cost of gaining and processing information represents a considerable obstacle of stock market participation for individuals.

Poor cognitive skills are expected to increase costs of accessing financial information (Christelis et al., 2010). Campbell (2006) suggest that costs of gaining information related to the stock market results from psychological factors which make stock participation impossible for certain investors. Korniotis and Kumar (2007) also highlight that the awareness of having inadequate abilities can result in high cost of investing in stocks.

Moreover, stockholding and financial decisions are informed through the relation between cognition and the utility function. Bernartzi and Thaler (1995) mention myopic loss-aversion as a possible reason for individuals' low participation in the financial markets. Myopic loss-aversion is a result of a frivolous cross-section; or rather short term evaluation combines the term myopic loss-aversion. People tend to prefer avoiding losses than acquiring gains (loss aversion) and more risky assets are more attractive in the long term rather than in the short term. Benjamin et al. (2006) find that higher intellectual abilities are related with more risk tolerance and less risk aversion. On the other

hand, lower cognitive abilities are related with higher risk aversion and lower participation in the stock market.

Spaniol and Bayen (2005) suggest that cognitive impairment is associated with a low capability of using information, and go on to support that memory, as well, influences the ability of understanding probabilities and to identify the relevant information. The above is symptomatic of the overconfidence associated with low intellectual abilities (Barber and Odean, 2001). Investors who are characterized by overconfidence do not fully understand the real risk of holding a stock and, as a result, are more likely to hold stocks.

Let bear in mind that this study is related to existing literature about financial education and portfolio construction. Lusardi and Mitchel (2006), show that retirement plans are positively related with financial education. Graham et al. (2005) find that investors who believe they have a good perceptive about financial products construct more profitable portfolios.

In addition to these studies, Christelis et al. (2010), on their part, find evidence that cognitive abilities are positively correlated with stockholding. In other words, higher intellectual skills increase participation in the stock market. In addition, health negatively affects stock holding; as the health condition of a person worsens, the risk and expenditures related to health increases and, therefore, limits the household wealth. The results also show that more educated investors are more financially aware and tend to deal with reduced cost of stock market participation.

Moreover, household wealth is positively correlated with stock market participation. This means that transaction costs act as barriers in stockholding for poor individuals who cannot afford such costs (Christelis et al., 2010). The results of the study for bondholding verify a positive relation between cognitive abilities and investment in bonds, this relation, however, being less strong. Bonds are less risky than stocks, because they yield lower returns to investors and, hence, are less affected by cognitive skills. Therefore the association between cognition and stockholding seems to be related with information barriers.

Christelis et al. (2010) suggest that information constraints can explain the relation between cognitive skills and portfolio choices. Cognitive abilities might lower the stock market participation cost, and are related with risk patience and the skill to analyze financial information, which tends to increase stockholding.

Andersen and Nielsen (2010) conduct a pioneering survey to examine whether the fixed cost of stock market participation is the possible explanation why many individuals do not hold stock. They approach their subject-matter by monitoring whether individuals enter in the market after receiving a significant amount of money unexpectedly, as a bequest from a close relative who died suddenly. They found that only 35% of the individuals, who didn't hold stock, were tempted to enter in the stock market after they received an unexpected amount of money. This means that approximately the two thirds of the investors who do not hold stocks, continue to not participate in the stock market in the long term, even if they can afford it economically. Thus, the low tendency to invest in stocks might be related not with household wealth, but rather with other factors such personal preferences.

Another interesting result from this study yields is that the same behavior is followed by individuals who have high financial education and broad understanding of stock market rules. It can be critically discussed, according to this analysis, that fixed costs cannot be seen as a barrier to stockholding as previously thought and suggested by existing literature. Andersen and Nielsen (2010) argue that the reasons why people refrain from investing in stocks might be assigned to cognitive, behavioral and psychological parameters. However, individuals with high education and financial knowledge are more likely to invest in stocks after receiving an unexpected gain than those who have low education and financial knowledge. Non-participants prefer to hold cash and bonds and they do not reap the benefits of stocks.

Christelis et al. (2010) find that individuals who have low education and a merely fundamental financial knowledge bear high participation costs in the stock market. This implies that individuals with high cognitive abilities and education incur lower cost than those who are not familiar with financial markets and have low cognitive skills.

van Rooij et al. (2011) state that many households have little knowledge and information over the stock market and, as a result, are reluctant to invest in stocks. On the other hand, stock market participation increases sharply when financial education is increasing, suggesting a positive relation between financial knowledge and investment in stock market.

Lusardi and Mitchell (2011) highlight another aspect of financial education. They mention that schooling has a positive impact on people's understanding of the fundamental economic concepts. People who ignore the fundamentals of finance are not likely to prepare a saving plan for retirement. This seems to be yet another evidence of a possible link between financial literacy and economic behavior. If individuals possess financial knowledge they are expected to behave rationally.

In a similar study for Dutch households, van Rooij et al. (2012) examine the relation between retirement planning and financial education. In general, Dutch individuals are not well prepared and seem to be reluctant to proceed on plans for their retirement. This means that in a case where individuals experience unpredictable shocks in their income (e.g. unemployment, health problems), might face significant difficulties to manage their running expenses, and such behavior is irrational. Results show that fundamental financial knowledge and education are not linked with planning for retirement, while deep knowledge and education about financial and economics influences retirement planning.

Calvet et al. (2007) argue that individual who has poor financial education might come to realize their lack of knowledge and skills, hence, avoid investing in risky markets to prevent mistakes, such as investing less than the optimal. In addition, individuals who participate to the market are more motivated to gain knowledge related to the market and, as a result, are highly educated in comparison with those who do not participate in the stock market.

However, information costs and cognitive skills are not the only factors that affecting stock ownership. Christelis et al. (2013) comparing household data from US and European households, find evidence that difference in investor preferences and choices stem from differences in economic conditions between countries. Stock ownership is positively correlated with the size of the equity

market, the percentage of GDP consumed on technology and communication, and the access of the Internet. Consequently, there are some other factors that can exert a significant effect on stock market participation of households as well which are not related with their cognition or financial education.

To summarize, a great range of academic studies project the fixed costs of stock market as the possible reason of why people refrain from holding stocks. Some of the studies mentioned above try to relate these fixed costs and the information asymmetry and education about finance. The link is still not very clear since other factors such as psychological or personal can be related with the low stockownership levels of households. Further research needs to be done in order to clarify to what extent is this link credible.

### **2.3 Effects of global financial crisis on banking systems and corporations**

The current study focuses on the analysis of the financial crisis and the way individual investors behave in such an environment. Having discussed the literature about what is the expected rational behavior of individual investors and how they actually come to behave in the market, the focus is placed on how the financial crisis, along with similar shocks, has affected their investment decisions.

Before commencing with the microeconomic analysis, a macroeconomic analysis will be given. A brief discussion will be presented about the context, causes and consequences of the financial crisis in the market as a whole.

In 2007, the US financial market entered in a severe recession which, not long after, propagated around the world, causing the Global Financial Crisis. The effects of the crisis were deep both for companies and the individuals.

The crisis spread an unexpected shock for companies worldwide. Hellwig (2009), Ivashina and Scharfstein (2010) state that borrowers defaulted on their subprime mortgage payments on banks, thus leaving the banks suffer from liquidity constraints. Banks faced serious liquidity restrictions that even the

interbank lending market proved incapable to provide solution to their liquidity problems (Iyer et al., 2013).

Chava and Purnanandam (2011) suggest a twofold defect: neither were the banks unable to meet borrowers' demand, nor could firms successfully raise new capital from bank loans. They go on to highlight how substantial losses and drops in liquidity harmed the equity capital of many banks, hence negatively affected their ability to provide loans in the financial market.

The reduction of liquidity for some banks was transmitted directly to their customers through a change in lending policy, and more specifically, a shortage in credit supply (Iyer et al., 2013). Evidence from this same study shows that upon the crisis's proliferation, there was a sharp decline in interbank borrowing, followed by a reduction in credit to corporations. Interestingly enough, Ivashina and Scharfstein (2010) find that the issuance of new loans from banks to large companies almost halved during the peak of the crisis in late 2008. In addition to these findings, Iyer et al. (2013) show that it was the small companies and new established companies that suffered the most from the illiquidity of the banks by reducing their loan demands. These results were felt even more severely for firms who relied mainly to bank loans for meeting their consumption and investing policies before the crisis, and as follows had no alternative options to raise capital.

The banks that were most profoundly affected by the financial crisis decreased the quantity of their loans and raised the interest rates their customers had to pay in order for the loans to get issued (Chava and Purnanandam, 2011). For example, Campello et al. (2011) premise on evidence to suggest that in the US, banks raised commission fees on credit lines by approximately 15% during the financial crisis. Therefore, firms were facing multifaceted financial constraints to enter in the capital market; they were struggling with the decreased credit given by banks and the increased cost of capital due to the higher interest rates from borrowing (Chava and Purnandam, 2011).

In addition to this, Campello et al. (2011) highlight that during the period of 2008-2009 firms around the world experienced a huge credit shock. Firms were struggling to finance their activities and turned to internal financing or tried to

exploit their line of credit from banks. Profitable firms relied mainly in their profits and cash to draw funds for their investment activities. For this reason, it can be implied that this firms traded-off the increased cost of borrowing and preferred to harm their profitability. On the other hand, firms which were unprofitable used lines of credit to draw funds, even if the cost was increased.

Firms which relied mainly on external capital sources to fund their operations were forced to cut their expenses (Campello et al., 2010). Their financial plan for the following years included substantial cuts in wage, investments and expenditures related to Research and Development. As firms invested less in comparison with the years previous to the financial crisis, their growth declined, thus damaging their performance.

Chava and Purnanandam (2011) find evidence that the limited ability of banks to provide funds was negatively related to firms' performance. During the crisis, the share price of firms, which relied mostly on raising capital from bank loans, exhibited a sharp decline. In addition, this group of companies suffered from profitability decline and restrictions of capital investments due to lack of adequate capital to finance them. With restrictions to borrow and the aforementioned reduced profitability, firms had to consolidate by making cuts in their dividends as well as their other expenditures (Campello et al., 2010). Floyd et al. (2014) show that dividends were cut smoothly from 2007 until 2009, a period considered as the peak of the financial crisis.

To summarize, during 2007, debtors did not meet the payments of their mortgage backed loans to the banks and, as a result, the latter faced illiquidity and capital restrictions. They could not meet demands for new loans from individuals and companies, simply because the funds were scarce. The cost of issuing new debt increased through interest rates and the number of new debt issues decreased. The core of crisis sprung and originated in the United States, but subsequent consequences were transmitted to other markets worldwide.

## **2.4 The effect of the crisis on individual investor's behaviour**



The negative aspects of the crisis were not carried out only from financial institutions. Individuals were struck by the crisis as well, especially those who invested in the market. In the context of portfolio choice, it is critical to mention the various studies who examined how individuals were affected by the crisis. A more detailed discussion is focused on the portfolio choice of individuals during crisis.

During the crisis of 2007-2009, the value of assets plummeted sharply and the market experiences abnormally high volatility of asset returns (Marsh and Pfleiderer, 2013). The burning issue for investors was the formulation of a way to adjust their portfolios in order to hedge from significant losses that had already suffered due to the instability of the financial markets.

Hoffmann et al. (2013) state that the decline in share prices and the decrease in the dividends paid by firms to shareholders, possibly affected individual investors, considering that they actively participate in the stock market. Chai et al. (2011) state that during a financial and economic crisis, the economy is shrinking and stock market is characterized by losses in stock returns. In periods of financial and economic stability, stock market is not affected by exogenous limitations.

Hoffman et al. (2013), using data from Netherlands brokerage records, state that the value of their portfolio plummeted during the worst months of the crisis and they suffered substantial losses and negative stock market returns. Bucher-Koene and Ziegelmeyer (2011), using detailed information about German households, find that 1 out of 5 German households was affected by losses due to financial crisis, losing around 3.6% of the value of their financial assets.

In addition to stock returns, wages are also significantly different during periods of recession and growth in the market (Chai et al., 2011). Respectively, wages are higher in periods of economic expansion in the market and lower during contraction periods. Employment prospects flourish during bull market conditions, while the likelihood of unemployment increases during bear market conditions. This reciprocity kept in mind, to state that income and employment are connected with household wealth is, of course, to state the obvious. What needs to be stressed, however, is that negative consequences of the crisis to

household wealth are expected to seriously influence individual's decisions to invest in the market.

Malmendier and Nagel (2011) maintain that during the financial crisis, uncertainty was the main characteristic of the financial market environment, which was unpleasant information. On a par, Zhang (2006) considers the impact of information uncertainty to the stock market returns and finds evidence that individual investors overreact when information provided is not certain. Investors remain -indeed- skeptical towards new information which can be characterized as imperfect. High information ambiguity results in low future stock returns after bad news, whereas greater future returns are promised after good news. In other words, good news is perceived by investors as far better than it actually is, and bad news as worse than what is truly the case. Application of this behavior may hold to the financial crisis, since as mentioned above information uncertainty is high during such period.

Amidst this environment, individual investors are expected to recognize the real risk of participating in the stock market, reduce their return predictions and tolerance to risk, increase their understanding about real risk, and eventually lower the risk in their investments in the financial market (Malmendier and Nagel, 2011).

Barber and Odean (2001) suggest that individual investors do not in fact gain knowledge from past experiences. In this light, Glaser and Weber (2007) support that individual investors do not change their decisions based on their past actions and are not fully aware of the return performance. Therefore, experiences and behavior seem to be independent when financial markets have stability. On the other hand, unexpected shocks, such as a financial crisis may affect individual investors because of their importance (Khaneman and Tversky, 1972). Malmendier and Nagel (2011) indeed advocate that extreme events might have an eternal effect on investors' perceptions and risk preferences.

Hoffman et al. (2013) show that during the financial crisis, individual investors' return expectations move in the same direction with return experiences: when the market finds itself at the peak of the crisis, investors' return expectations

decrease, while when the market recovers, investors' return expectations recover as well. Hence, crisis does not provide investors with a permanent shock in their returns related expectations. The same pattern applies for risk preferences and risk perception, which are depressed during the worst months of the crisis, but recover when the market returns to pre-crisis conditions. Overall, Hoffman et al. (2013) claim that a financial crisis causes depression on investors' perceptions only when the market performs badly. Investors lower their risk tolerance and return prospects and simultaneously increase risk perceptions. However, this effect is temporal and ceases after the crisis.

During the financial in question here, the risk in the market was unexpectedly increased, with results asserting that investors tend to take higher risk during a crisis. Since they invest in small amounts, it is difficult for them to well diversify their portfolios and keep risk in low levels (Goetzmann and Kumar, 2008). It can be assumed, as a matter of fact, that individual investors perceive low prices as an opportunity to buy assets; thereby, they tend to buy more when asset prices are falling, and less (or start selling) when prices are rising.

Hoffman et al. (2013) reveal that crisis does not make individual investors lower the risk of their portfolios. In addition, results show that individual investors trade more during crisis than when the market conditions are more stable. These very results reinforce the argument of Goetzman and Kumar (2008). They argue that the rise in trading activity is not related with the frequent arrival of information during the crisis, but rather with changes in investment insight and differences in perceptions.

Butcher-Koenen and Ziegelmeyer (2011) examine how, and to what extent, private households are affected by the recent financial crisis, and how the investment decisions are influenced by this shock. In this study the authors try to relate education, cognitive skills and the stock market participation and performance. The empirical analysis reveals that individuals with low levels of financial literacy are less likely to participate in the stockholding and, as a result, are less likely to have incurred losses in their wealth. However, they tend to sell their assets when they lost value. This behavior towards the short-term losses

can possibly disclose long-term effects, if individuals do not invest in markets once crisis is over and end up generating lower returns.

Chai et al. (2011) indicate that not all the households are affected by the crisis in the same way. The authors create two groups of households according to how they perform during the crisis; some households performed well, while others crucially suffer from the crisis. Furthermore, the authors give evidence to support that economic and financial crisis does not exert deep impacts on both young and old groups in the short term. Those who suffer the most are old individual investors who are close to retirement because they face substantial reductions in income and consumption. In general, old groups are more sensitive to the stock price changes during financial crisis, as they hold more stocks comparing to younger people.

Discussing indirect ways in which a financial crisis influence households, Shapiro (2010) claims that people who were close to retirement were affected significantly by the market crisis, increasing work hours and decreasing consumption. In addition, there is the possibility that those individuals will delay the retirement date (Gustman et al., 2010)

Chai et al. (2011) find that the economic and financial crisis does not exert a significant impact on young households' work and retirement decisions, but does cause decline in their consumption and saving behavior, and forces them to alter portfolio decisions. Young households, struck deeply by the crisis, tend to work, consume and save less than what might do in normal market conditions. Older people work more hours during crisis and choose to retire at a later age than in normal conditions. They suffer from consumption reductions and change their preferences towards less risky investments. As a result, the age factor seems to be a variable that exerts a significant effect on stock market participation and investment decisions.

## **2.5 Gap in literature**

The aim of this research is to contribute to the existing literature, in the sense it tries to elaborate on and extend existing knowledge. Admittedly, there is a wide range of studies which try to define optimal portfolio construction (Markowitz, 1952; Merton 1969; Samuelson, 1969). More recently studies, in particular, were focused on other factors such as income, education age and cognitive skills that have an impact on individual investor's portfolio decisions (Hallis and Bertaut, 1995; Vissing-Jorgensen 2003; Christelis et al., 2010). Yet, research on the way a financial crisis alters the investment decisions of households is very limited. Although recent research is focused on the ways in which unexpected events are influencing individual's behavior, the academic papers engaged with stock market during economic depression are remarkably limited. Further research is needed in order to find out how individuals behaved in the stock market during the recent crisis of 2008 in Europe. More specifically, the paper will analyze the behavior of European investors before and after the financial crisis. Since there are currently no papers investigating how investment decisions are affected by the specific characteristics of individual investors during the financial crisis, this research will focus on and examine this relation in the context of the crisis.

### **3. Theoretical framework and hypotheses development**

This study examines the behavior of individuals in the stock market and focuses on psychological factors (cognitive skills) which influence their investment choices. The relation between cognitive abilities and decision making is discussed in both behavioral finance and cognitive psychology literature. Ritter (2003) claimed that behavioral finance is based on cognitive psychology and defines cognition as the process of how people think.

Cognitive psychology is defined as a part of psychology science which focuses on the study of mental process, specifically the way people understand their environment, use their language to interact with other people, recall information and make decisions (Gobet et al., 2011).

Gobet et al. (2011) state that the basic processes related to mental function of human brain is visual perception, attention and memory. Perception is the mental process by which human brain understands and represents the environment. Attention is defined as the level of concentration on important aspects in the environment. Memory is the ability to remember and recall specific information and include two separate brain functions: short-term and long-term memory.

In addition to these basic aspects, there are more complex cognitive functions, such as problem solving and decision making. Eysenck and Keane (2010) define problem solving as the mental activity that helps people to understand the existence of a problem and follow steps to find a way to solve it. Problems are graded according to the skills required in order to be solved. Expertise problems require special skills to be solved, in contrast to no-special-knowledge problems that do not require any particular skills to be solved (Eysenck and Keane, 2010). Decision making is a brain function used to make choices among different options under uncertain circumstances when information is partly available (Gobet et al., 2011). The fundamental rule of the decision making is that people making decisions in order to maximize their personal utility.

In order for the reader to be able to understand thoroughly the concept of cognitive abilities, it is rational to highlight some of the main findings in existing literature about psychology. In theory of psychology, cognition refers to the abilities of individuals to perform mathematical skills, processing information, remember information (short-term, long-term memory), speed of processing information and speed in making decisions/reacting (Lassiter et al., 2013).

From a psychological perspective, the ability of individuals to make decisions is related with decision-making features, socioeconomic characteristics, age, cognitive skills and experience (Bruine de Bruin et al., 2007). Del Missier et al. (2012) state that the executive function and memory influence decisions, especially when decision-making demands for difficult tasks that demand complex processing of information.

For the Del Missier et al. (2012) cognitive abilities consist of the following: fluid intelligence, which is related to reasoning and solving problems, and numeracy, which is related with understanding numbers and executing calculations. Frederic (2005) mentions that the basic characteristics that influence this decision making performance are 'reading comprehension and mathematical skills'. Lang et al. (2010) in their research about cognitive abilities identify 6 major characteristics that form mental abilities: word fluency, speed of perception, memory, verbal interpretation, logic facility and spatial visualization.

In general, from the existing literature in psychology and behavioral finance journals, cognition broadly has several facets, some of which include language, memory, attention, perception and executive function. For the purpose of this research, the focus is placed on three main cognitive abilities: 1) numeracy, which is the ability to execute numerical calculations, 2) verbal fluency, which is the ability to plan and to perceive things, and 3) memory, which the ability to recall information.

Having mentioned the relevant theory behind mental abilities, the focus shifts to the financial impact of cognition on individual investors. Kimball and Shumway (2010) suggest that individuals with little financial education and

cognitive skills tend to make mistakes in their investment decisions. The reason behind these mistakes is that financial education is positively correlated with sophistication. Goetzman and Kumar (2008) find that investors do not diversify their portfolios and diversification in portfolio is positively correlated with the specific characteristics of the investor. As age, wealth, education and experience increases individuals tend to hold more diversified portfolios.

Benjamin et al. (2006) study cognitive abilities of Chilean high-school students in order to examine possible relation of intellectual abilities with irrational behavior. The find evidence that students with high intellectual abilities are more likely to behave rationally and avoid mistakes and biases. Relaxing this assumption in the market context, an individual investor with high numerical skills will be in a position to perform critical calculation of their portfolio.

Individual investors with higher cognitive abilities are less likely to be influenced by behavioral biases (Oechssler et al., 2009). In this study, the authors examine the effects of cognitive abilities to economic and financial decision making. The results show that individuals with high scores in the cognition test take more risk in order to benefit from the potential return. In addition, they are more patient, which means they are willing to get a delay return than an instant one, if the former is higher than the latter. Thus, Oechssler et al. (2009) imply that individuals with high intellectual skills are not significantly affected by behavioral biases and are more likely to make better decisions in their saving accounts and in assets choices. Individuals with low level of cognition can easily make mistakes in their financial and economic decisions because they are more likely to be influenced by behavioral biases.

Frederic (2005) investigates the effect on cognition in decision making, specifically in individuals preferences regarding time horizon and risk. Instead of using the IQ test as a measure of cognitive traits he uses the Cognitive Reflection Test. Results support that people who had a high score in the test were more patient and more careful. In addition, people with high cognitive skills tend to have risk-lover behavior. They are willing to take more risk in order to compensate from a possible future return, or they prefer a sure loss instead of



a low return. It is clear, that cognitive behavior exerts a positive influence in investors' decisions.

Calvet et al. (2008) examine the changes in individual portfolios held by Swedish households during 1999-2002. They indicate that more financially educated households hold diversified portfolios and also make adjustments in securities more actively. During 1999-2002, the prices of the stocks were falling and the equity market conditions were characterized as bear. Households adjust their portfolios by selling their risky assets in an attempt to search for more financial security. In brief, the higher the financial literacy of the households the more they invest in equity. However, after experiencing a shock they sold their equity.

Therefore, the positive effect of cognitive abilities (numeracy, fluency and memory) on stock holding seems to apply during stable market conditions. However, as investors face both high volatility in returns and uncertainty during financial crisis (Hoffman et al., 2013), it is expected that the positive effect is stronger under normal market conditions and weaker or even negative during abnormal market conditions (the financial crisis). As a result, the hypotheses are based on the positive impact of each of the cognitive abilities in the tendency to invest in stocks before and after the financial crisis, noting that the impact is stronger, that is more positive, before the crisis. In other words, the financial crisis exerts a negative influence on the relationship between cognitive skills and investment decisions. The hypotheses are:

H1: Crisis exerts a negative effect on the relationship between numeracy and stockholding: numeracy exerts a positive effect on equity investing before the crisis and a less positive effect on equity investment after crisis.

H2: Fluency exerts a positive effect on equity holding both before and after crisis, but the effect is stronger (more positive) before crisis comparing to the period after it.

H3: Memory exerts a positive effect on stockholding before the financial crisis, but the effect is weaker (positive to a smaller amount) after the crisis.

## 4. Data analysis and methodology

### 4.1 Sample

The study is based on data from the survey of Health Ageing and Retirement in Europe (SHARE). SHARE is a cross-national panel database including data on health, social and economic conditions of more than 90,000 individual households aged 50 or above in 20 different countries in Europe.

The purpose of the SHARE is to examine the process of population ageing in depth. It is one of the few studies for Europe which tries to examine the different ways in which people aged 50 and older live in 20 European countries, covering the relationship between economic, health, and social factors in determining living status of older people. The survey covers a wide range households and individual characteristics, including demographics, consumption, health, employment, assets income, and many more.

SHARE consists of 5 waves, which in essence are 5 different surveys on European households in different years. The graph shows details on the period that the surveys took place and the countries which were included in each survey. For the purpose of this study, the data available for Wave 2 and Wave 4 are used.

Wave 3 (SHARELIFE) would be significant for this research because the survey was conducted between 2008 and 2009, a period described as the peak of the crisis. However, this survey is slightly different from the others because focuses only on the historical background of the European households. Specifically, information about cognitive function and assets is not part of the SHARELIFE.

To overcome the problem of the missing information regarding cognitive abilities and security investments during the financial crisis a crucial assumption is made. The data available from wave 2 (2006-2007) are assumed to represent the period during crisis, namely the years from 2008 until 2009. Thus, in the rest of this paper, wave 2 is used to refer to the period before (and during)

crisis, namely the period from 2006 until 2009, while wave 4 the period after it, in particular, the years from 2010 until 2012.

The main variables used in the empirical analysis are stock investment and cognitive abilities. Since the study is concerned with the possible influence of cognitive abilities in the stock market participation, three main independent variables cognitive abilities (numerical trait, fluency and ability to recall) are taken into consideration in the empirical analysis. As independent variables the empirical model uses stock investment of households, in form of the amount of wealth invested in this class of securities.

In order to examine the possible relation between cognitive abilities and stock market participation data about cognitive function and financial status of individuals are used. The data available from SHARE include information for three basic cognitive abilities: verbal fluency, memory and numerical skills. The data available on cognitive function include a verbal fluency score, which is based on individual's ability to name as many animals as they can within a specified time (1 min). The number of the animals they are able to name is their score for the verbal fluency.

For testing the memory skills of individuals, an indicator of memory was constructed. For this purpose, during the survey individuals are testing in their ability to recall. Firstly, they can observe 10 words and then they are asked which of them they remember. Thus, the scale of these scores is from 0 to 10.

To measure numerical ability of individuals, there are 4 questions which are representative of fundamental conceptions about mathematics and finance. In SHARE data there are available only the correct or wrong answers of these questions. Therefore, there emerges a need to extract the score from these 4 questions. In order to obtain the numeracy score of each individual, the same approach as Christelis et al. (2010) use in their study is followed. The scale of numeracy ranges from 1-5.

As far as the assets are concerned, SHARE includes detailed information about how people distribute their wealth. There are details about their bank accounts, pension accounts, life insurance as well as in the assets they invest. This

research employs information available on stock ownership. The amount of household holdings in assets is expressed in Euro (€) even for the countries that do not use the € as principal currency. The denomination of all amounts in the same currency helps to avoid comparison problems arising from different types of currencies.

Additional independent variables that are included in the empirical model are health, income, and age. For the health, self-reported health indicator is constructed from responses of individuals over their health condition. In other words, this is how people view their own health and the scale is from 1 to 5 (excellent, very good, good, fair, poor health as reported by individuals is interpreted as 1, 2, 3, 4, and 5 respectively). The total household income is measured as total income received by all household members one year before the survey. Age is also available in the demographics data and is given indirectly (as exact date of birth) so the data were being processed to find the age of each individual.

## **4.2 Empirical model and method of estimation**

In order to proceed with the multiple regression analysis and results of the data, the construction of the model will be presented. For this reason, this section introduces some of the empirical models used in previous similar studies. This brief description will give a more general idea of the type of variables that were used in previous studies. This provides additional reasons of the examining relationship and the specific variables used in this study.

Guiso and Japelli (2008) in their study run two multiple regressions to examine the connection of financial education in portfolio asset allocation decisions. In the first regression they use portfolio diversification as dependent variable and in the second the number of stocks held by individuals. In both models the dependent variables depend on the age, financial wealth and risk aversion of individual investors.

In their research, Christelis et al. (2010) construct a model to run the regression between stock market participation and intellectual abilities. They state that individual investors evaluate the possible benefits of investing in stocks with the fixed cost of stock market participation. To form the portfolio decision they examine the net gain in the utility from stockholding. They examine both direct stock investment by individuals and indirect stock investment through mutual funds. As variables that affecting stock market participation they use amongst others cognitive skills, and health.

In the regression analysis of their study, van Rooij et al. (2011) use as dependent variable the stock market participation of households and as main independent variable use financial knowledge. In this model, financial literacy is measured by the responses of individuals in questions regarding the survey. The questions are related to basic financial calculation and concepts. In addition, age wealth and (school and university) education are used in the regression as independent variables.

Bucher-Koenen and Ziegelmeier (2011) use a model to estimate how intellectual abilities influence household losses during the financial crisis. In the model they use, the dependent variable were household losses incurred during the crisis and, among the independent variables, the main were cognitive skills, financial literacy and household capital. To test different hypothesis, the authors adjust the model examining the incurred losses as a fraction of the total household wealth.

In order to examine individual investor behavior during unstable market conditions, Hoffman et al. (2013) use model which has trading activity and turnover as dependent variables. Some of the independent variables that are used in the regression are individual investor's return prospects, tolerance towards risk, age and income.

In order to examine portfolio choices of individual investors and the relationship with the cognitive skills, the amount of money individual investors hold in stocks is used as dependent variable (y). The main independent variables (x) in the model are, as mentioned in section 4a, cognitive abilities.

As additional explanatory variables (x), age, health (as reported by individuals) and income are included in the empirical model.

However, the relationship between investing in stocks and the other variables included in the model is examined as non-linear. In other words, the function that gives the relationship between y and the all the x variables is not in a linear form. In situations where the relationship between dependent and independent variable is not linear, a suitable functional form that fits the relationship accurately needs to be created as an assumption (Maddala and Lahiri, 2009). The logarithmic uses the logarithm of independent or dependant variables transformation converts the non-linear model into a new one which is linear in parameters (Gujarati and Porter, 2010).

For this reason, specific variables of the model have been transformed, using the logarithm of their values instead of the real values, before included in the regression function. Logarithms of the variables stocks, age and income are included in the empirical regression function. The main reason that logarithm is used instead of the real values is that the model is more accurate in capturing the relationship between the dependent and independent variables.

As explained above, numeracy, verbal fluency and ability to recall are all part of cognitive behavior. These cognitive skills are highly endogenous, which means that one affect the other. In order to avoid *endogeneity* problems in the multiple regression results, the relationship of stock market participation is examined in relation to each cognitive ability separately.

After these adjustments, the model that is used in the study is the following:

$$\ln(y_i) = \alpha + \beta_1 * x_{1i} + \beta_2 * \ln(x_{2i}) + \beta_3 * x_{3i} + \beta_4 * \ln(x_{4i}) + \varepsilon_i, \text{ where}$$

$y_i$  stands for amount of household income invested in stocks ownership.  $\alpha$  is the intercept term and represents a constant number. It is the value of  $y_i$  when the values of the other variables affecting  $y_i$  are zero.  $\beta_1$  is the slope coefficient of  $x_{1i}$  and represents the percentage change (due to the logarithm) in the value of  $y_i$  caused by a unit change in value of  $x_{1i}$ , which stands for each cognitive factor

respectively (numeracy, verbal fluency and memory) according to the occasion.  $x_{2i}$  stands for the age of individual investors and  $\beta_{2i}$  its slope coefficient.  $x_{3i}$  stands for the self-reported health condition and  $\beta_3$  is its slope coefficient.  $x_{4i}$  is the household income,  $\beta_4$  its slope coefficient, and  $\varepsilon_i$  is the disturbance (error) term of the estimated model. The natural logarithm (ln) is taken in the model for stocks, age and income.

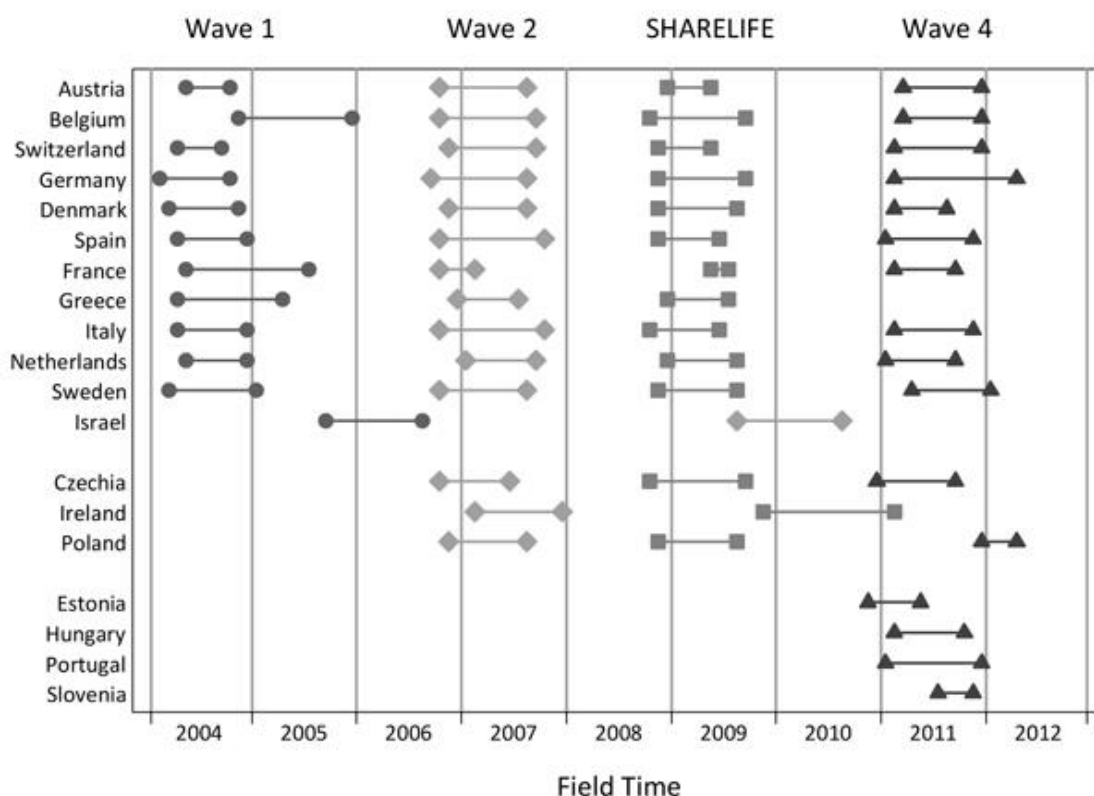
To examine if our results remain stable, the regression is tested for robustness another time including samples with less observations from the originals. In these samples, the countries with few observations available are taken out. This applies for the two periods of the study, leaving out two samples which include the first 8 countries, as measured by observations available, from each initial sample. In this way, the robustness check tests if the results remain the same after controlling for the size of the sample.

### **4.3 Data summary**

The data are organized by data identifiers which are unique for each individual investor. To solve the problems with missing variables (especially in variables of stockholding) the data were filtered. The final sample includes only observations that have available all the variables included in the empirical model. This data contains the two periods mentioned above, one during 2006-2009 (before financial crisis) and 2010-2012(after financial crisis).

Wave 2 provides detailed data about households and individuals for 15 countries of Europe. For the study of Wave 2 almost 37000 individuals were interviewed during 2006 and 2007. Wave 4 provides data about 16 European countries and includes detailed data approximately 58500 individuals. There are differences between waves 2 and since 3 countries (Greece, Ireland and Israel) are not included in wave 4, and there is an addition of 4 new countries (Estonia, Hungary, Portugal and Slovenia) (See table 1). To make the comparison valid, the samples used for the pre and post crisis compare consists of the same 12 countries, data of which are available for both periods.

**Table 1**



**Source:** SHARE (Survey of Health, Ageing and Retirement in Europe) available at <http://www.share-project.org/home0/overview.html>

To analyze how the crisis affects the relationship between cognitive abilities and investing in stocks the regressions for the model are run twice: one for the period before and during crisis and one for the period after crisis. Afterwards, the results are compared to investigate whether they are similar for the pre-crisis and post crisis period or they are significantly different, explaining and interpreting the results in detail. Therefore, financial crisis is not a part of the empirical model as a separate dummy variable. The effect it exerts on investment choices is examined indirectly through the comparison of the two periods.

The descriptive statistics of the two samples are provided in Tables 2 and 3. The descriptive statistics of all variables are reported in Table 2 for the period before the financial crisis and in table 3 for the period after the crisis. From these two tables can be seen that only a small fraction of the total households surveyed hold stocks. Only 6.46% (2374 out of 36730) of the households invested in stocks before crisis and after this percentage reduced further to 5.04%.



In general, there are no major differences between two tables. Before crisis, the mean for log\_stocks, and log\_income is around 13.8 units, while the standard deviation is approximately 4 units. The range, which is the difference between max and min, for these variables is almost the same. Numeracy has a mean of almost 4 points, which means that on average individuals scored 4 points in numeracy questions. For fluency, the average value is 23.27 points, the standard deviation is almost 7 points, and range is high due the score scale. For the memory test, individuals recalled on average 6 out of 10 words and the variation of the average was 1.55 points. The mean for log\_age is 4.14 and for health is 2.5 and both variables have small variance and range.

**Table 2: Descriptive statistics (before crisis)**

Variable	Obs	Mean	Std. Dev.	Min	Max
log_stocks	2374	13.8739	3.833771	-1.64673	18.4196
numeracy	2374	3.98315	0.983926	1	5
fluency	2368	23.2779	6.937684	0	58
memory	2368	5.71199	1.553928	0	10
log_age	2374	4.14804	0.149402	3.610918	4.57471
health	2372	2.56788	1.070692	1	5
log_income	2203	13.7665	4.349936	0	18.3976

*Note:* The table shows the descriptive statistics for log\_stocks, log\_bonds, cognitive abilities, log\_age, health, and log\_income for the period 2006-2009 before the financial crisis.

During 2010-12 the descriptive statistics (table 3) follow similar patterns, with slight changes comparing before crisis. For log\_stocks and log\_income the mean is about 13.1 units and the standard deviation is around 4.5 units. The difference comparing to table 2 is that the range is higher for log\_stocks during 2010-12. For numeracy the mean is 1.8 points, significantly decreased after crisis. For fluency the average value is 23 points, the variance is just above 7 points and the range 83 points. The average for memory is above 5 and the standard deviation almost 2. The descriptive statistics for health and log\_age do not show major differences after crisis, since are similar to those before crisis.

**Table 3: Descriptive statistics (after crisis)**

Variable	Obs	Mean	Std. Dev.	Min	Max
log_stocks	2945	13.1211	4.351373	-5.62419	29.9336
Numeracy	2945	1.80781	2.071515	0	5
Fluency	2935	23.0467	7.174773	0	83
Memory	2945	4.74431	1.926861	0	10
log_age	2945	4.16556	0.154558	3.713572	7.60639
Health	2944	2.67323	1.038447	1	5

log_income	2773	13.061	4.656805	-0.21075	18.4175
------------	------	--------	----------	----------	---------

Note: The table shows the descriptive statistics for log\_stocks, log\_stocks, cognitive abilities, log\_age, health, and log\_income for the period 2010-2012 after the financial crisis.

Table 4 shows the correlations between the (logarithm of) stock ownership and the other explanatory variables for the pre-crisis period. The correlation depicts the changes in Y caused by a change in X (for example, if the score of numeracy increases by one unit, the logarithm of investing in stocks decreases by about 0.0091).

The table shows a positive correlation between the logarithm of stockholding and the mental abilities, in line with the expectations. According to table 4, the cognitive ability which appears to have the strongest correlation with stockholding is verbal fluency, since it has the highest correlation. Log\_income is positively correlated with log\_stocks and this is rational because the higher the income of the household, the more money is available to be invested in stocks.

Table 4 shows that the correlation between age and investment in stocks is positive. This means that as the higher the person's age, the more likely is to invest in stocks. However, this relationship is more complex because it combines of two effects. Firstly, age has a negative link with cognition and this is justified by the table from the negative correlations between each cognitive ability and log\_age. As people in the age of 50 plus grow older their mental skills tend to perish and this might have a negative effect on stockholding. Secondly, as the correlation between age and income is positive, people are more likely to have higher income as they age, and as a result can invest more in the stock market. In this particular case, the positive correlation of income and age seems to influence more the link between stockholding and age.

For health the matrix shows a negative correlation with log\_stocks, as expected. As the variable of health increases, or in other words health condition gets worse, people tend to invest less in stocks due to health risk and expenses. From all the variables, the highest correlation is between log\_stocks and log\_income, while only among cognitive abilities the highest is the one between log\_stocks and fluency.

**Table 4: Correlation matrix (2006-2009)**

	log_stocks	numeracy	fluency	memory	log_age	health	log_income
log_stocks	1						
numeracy	0.0091	1					
fluency	0.0615	0.2721	1				
memory	0.0173	0.2458	0.3371	1			
log_age	0.0526	-0.0501	-0.0975	-0.1125	1		
health	-0.0717	-0.1873	-0.1817	-0.1857	0.0803	1	
log_income	0.8176	0.0107	0.0834	-0.0037	0.0106	-0.114	1

*Note:* The table shows the correlations between logarithm of stock ownership and all the independent variables for the period before crisis.

Table 5 presents the correlation matrix for logarithm of stockholding and all the variables for the after-crisis period. Correlations between the dependent variable and the independent variables show similar patterns as for the before crisis period and are all as expected.

After crisis, numeracy fluency and ability to recall are again all positively correlated with the logarithm of stockholding and, in addition to this, all these correlations with are higher as comparing to the period before the financial crisis. For fluency and memory the correlation with log\_stocks after crisis is positive and higher comparing to those before crisis. When fluency and numeracy score increases by one point, the logarithm of stockownership increases by 0.0807 and 0.029, respectively. The ability to solve numerical problems has the highest correlation with stockownership according to the correlation matrix of 2010-2012. That means that during this period among all the cognitive abilities numeracy is the one which has the strongest connection with stockownership.

From the secondary independent variables, income has the strongest correlation with stockholding, equal to almost 0.82. Therefore, the positive link between income and investing in stocks is justified once again. Log\_age has a positive correlation with stockholding, while health has a negative one. According to the correlations the amount of money invested in stocks increases with the age of individuals and decreasing as health condition deteriorates.

**Table 5: Correlation matrix (2010-2012)**

	log_stocks	numeracy	fluency	memory	log_age	health	log_income
log_stocks	1						
numeracy	0.1728	1					
fluency	0.0807	0.0866	1				
memory	0.0286	0.0449	0.3312	1			
log_age	0.0718	-0.2915	-0.2291	-0.2415	1		
health	-0.1061	-0.0206	-0.1591	-0.1912	0.1648	1	
log_income	0.8182	-0.1515	0.0707	0.02	0.0767	-0.1281	1

*Note:* The table shows the correlations between logarithm of stock ownership and cognitive abilities for the period after crisis

## **5. Empirical results and discussion**

### **5.1 Baseline results and discussion**

To estimate the model, the method of Ordinary Least Square (OLS) is most prominently employed. The reason why the OLS method is the dominant method used in regression analysis because it has very useful statistical attributes (Gujarati and Porter, 2009). The main advantage of OLS regression is the proximity of the estimation. The coefficients derived from OLS regression are as near as possible to the observations (Stock and Watson, 2007). The method minimizes the sum of square difference between the actual and the estimated responses so that the residual sum of squares is the smallest possible (Gujarati and Porter, 2010). Another advantage of this regression method is that the estimators have all the three desirable theoretical characteristics of estimators: They are unbiased, consistent and efficient (Stock and Watson, 2007).

On the other hand, OLS regression analysis has some limitation as an estimation method. Gauss-Markov theorem states that under certain assumption the OLS estimators are the best linear unbiased estimators (Gujarati and Porter, 2009). When those assumptions are not satisfied OLS might not produce accurate results.

First of all, the OLS method examines the relationship between dependent and independent variables as a linear one (Gujarati and Porter, 2009). This hypothesis, however, might not hold since some variables have a more complicated relationship which cannot be defined as linear. Another assumption of the OLS method is that the explanatory variables are independent, or, in other words, are not correlated. If the explanatory variables are highly correlated with each other, then the OLS results might be distorted (Maddala and Lahiri, 2009). This problem is called *autocollinearity* of the dependent variables. In the empirical model, for example, age total income and health may be correlated; if income increases the expenditures in health increase and as a result health condition improves. Besides the *autocollinearity*, another problem of OLS in this case might be the *endogeneity* of the variables. The variables which have a degree of correlation with each other or with the disturbance term are called endogenous (Stock and Watson, 2007).

After running the OLS regression for the empirical model, the results are highly insignificant. This may be related with the limitations of the OLS method, and in particular, with the *endogeneity* of cognitive abilities. For this reason a different regression method is used, giving significant results. The results from the OLS regressions are not included in the empirical analysis of this study.

The second method of estimation used is the method of Instrumental Variables (IV) regression. IV regression is useful when regression model includes endogenous variables, where the relation of  $y_i$  and  $x_i$  is not clearly defined due to the correlation of  $x_i$  and  $u_i$  (Gujarati and Porter, 2010). IV regression uses a relevant and exogenous instrumental variable in order to captures movements in  $x_i$  that are related with the error term (Stock and Watson, 2007). The coefficient of  $x_i$  is given by the two-stage least squares (2SLS) and involves the application of OLS twice, the first neutralize the influence of the error term to the independent variable, and the second estimates the relationship between  $y_i$  and  $x_i$  without the influence of  $u_i$  (Gujarati and Porter, 2010). Originating country of household is used as an instrumental variable for the IV regression. The results from the regressions are presented below.

**Table 8: Regression results for numeracy (2006-2009)**

log_stocks	Coef.	Std. Err.	z	P>z
<b>numeracy</b>	1.051969	0.302629	3.48	0.001
<b>log_age</b>	0.8100751	0.3524693	2.3	0.022
<b>health</b>	-0.118756	0.0715829	-1.66	0.097
<b>log_income</b>	0.7141843	0.0118611	60.21	0
<b>_cons</b>	5.232767	2.19463	2.38	0.017
<b>No of obs</b>	2172			
<b>F( 17, 2154)</b>	9.42			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.0692			
<b>Adj R-squared</b>	0.0619			

Note: The table shows the regression results of the model before crisis. Numeracy is selected in the regression as the main cognitive skill.

**Table 9: Regression results for numeracy (2010-2012)**

log_stocks	Coef.	Std. Err.	z	P>z
<b>numeracy</b>	0.2859955	0.041504	6.89	0
<b>log_age</b>	-0.8143229	0.351753	-2.32	0.021
<b>health</b>	-0.010573	0.047252	-0.22	0.823
<b>log_income</b>	0.7452501	0.010703	69.63	0
<b>_cons</b>	7.329899	1.496481	4.9	0
<b>No of obs</b>	2749			
<b>F( 18, 2730)</b>	105.94			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.4112			
<b>Adj R-squared</b>	0.4074			

Note: The table shows the regression results of the model after crisis. Numeracy is selected in the regression as the main cognitive skill.

Tables 8 and 9 show the multiple regressions results when numeracy is included in the model as the main cognitive skill. The two coefficients of numeracy are positive and this represents a statistically significant positive effect of numeracy on stock investing. Before the crisis, an increase in numeracy score by one point increases stock ownership by 105%, net the effect of the changes in stockownership from other variables. After crisis the effect of numeracy on stock investing decreases: a point increase in numeracy score causes individual investor to increase stockholding by 29%. The two coefficients show that the positive effect weakens and the possible cause can

be traced to the financial crisis. The results are significant in both 1% and 5% level of significance.

Income exerts a positive effect on stockholding, statistically significant at 1% and 5% confidence level. Thus, when income increases by 1%, individuals tend to invest more of their money in stocks, since stockholding increases by 71% before crisis and 74% after crisis, *ceteris paribus*.

Before the crisis the coefficient for age shows that as individual investors grew older, they were more likely to hold more stocks. However, the opposite applies after the crisis, as the effect of age is negative. As a result, after crisis, age exerts a negative effect on stockholding. The results for age both before and after the financial crisis are statistically significant only at 5% confidence level.

As far as health is concerned, it exercises a negative effect on stockholding effect is important only at 10% level of significance in both periods. Net of the effect of other variables on stockholding, when health deteriorates by one unit point, the total stockownership falls by 11% and 1% before and after crisis, respectively. However, the results for health are significant only at 10% confidence level, which is very high.

The F-test, which is an indicator of total statistical significance of any multivariate model, is 9.4 before and 106 after crisis. Overall, the two empirical models for numeracy are statistically significant at 1% and 5% significance levels because the p-value is zero in both cases. However, they differ deeply in the goodness of fit of the data, as it is depicted by the  $R^2$ . In table 8 the fit of the data is characterized as quite low because the model explains only the 6.92% of the total variation of stock investment before crisis. The model is considered better for 2010-12, since explains 41% of the stockholding variation.

In general, the results provide enough evidence at both 1% and 5% level of significance in support to the first hypothesis. Interestingly, the regression results show that the influence of numeracy on stockholding is positive in line with the expectations for positive relationship. This means that stockholding increases when the numerical skill of individual investors is higher. The same

applies for the period after the crisis, but the positive effect of numeracy on stockholding is less strong.

**Table 10: Regression results for fluency (2006-2009)**

log_stocks	Coef.	Std. Err.	z	P>z
fluency	0.0990969	0.0341653	2.9	0.004
log_age	1.475433	0.3573204	4.13	0
health	0.1714026	0.0590078	2.9	0.004
log_income	0.7063128	0.0118828	59.44	0
_cons	-4.684765	1.96363	-2.39	0.017
<b>No of obs</b>	2167			
<b>F( 17, 2149)</b>	12.12			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.0875			
<b>Adj R-squared</b>	0.0803			

*Note:* The table shows the regression results of the model before crisis. Fluency is selected in the regression as the main cognitive skill.

**Table 11: Regression results for fluency (2010-2012)**

log_stocks	Coef.	Std. Err.	z	P>z
fluency	0.064118	0.027255	2.35	0.019
log_age	0.914171	0.417483	2.19	0.029
health	0.038572	0.052105	0.74	0.459
log_income	0.754046	0.010896	69.2	0
_cons	-2.10434	2.205231	-0.95	0.34
<b>No of obs</b>	2739			
<b>F( 18, 2720)</b>	23.05			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.1323			
<b>Adj R-squared</b>	0.1266			

*Note:* The table shows the regression results of the model after crisis. Fluency is selected in the regression as the main cognitive skill.

Tables 10 and 11 show the regression results when fluency is included in the model as the factor of cognition. Fluency applies a positive impact on stock market participation. When fluency score augments by 1 point, ceteris paribus, total stockholding increases by 10%, before crisis. The result is statistically significant at the two critical levels of significance (1%, 5%) because the p-value is 0.004. After crisis, the positive impact of fluency on stockholding drops to



6.4%, which is statistically significant only at 5% level of significance (p-value=1.9%).

The coefficients for logarithm of income are positive, justifying the positive impact of income on the amount of money invested in stocks. The coefficients are similar with those of the regression results for numeracy: if income increases by 1%, individual investors tend to increase total stock ownership by 70% before the financial crisis and 75% after it, *ceteris paribus*.

For  $\log\_age$ , the coefficient is positive for both periods and is higher before than after crisis. This shows that in general, as individual investors age increases, they tend to invest more in the stock market. Interestingly, in this case, the regression results show that health condition exerts a positive influence in stockholding. In other words, when health declines individual investors tend to hold more stocks. The coefficient of health is statistically significant at 1% and 5% levels of significance before the crisis, but is statistically insignificant at both levels of significance after the crisis.

The F-test for the model that examines the period before the financial crisis is 12.12 and is statistically significant at 1% and 5% level of significance.  $R^2$  is quite low, since the independent variables help to explain only 8.75% of the total change in stock ownership. For the period 2010-2012 the value of F-test is 23.05 and the model is statistically important at both confidence levels. The  $R^2$  value for this model is low, around 13%, which is far below 50%, the minimum value desired for a good model (Gujarati and Porter, 2009).

Overall, the regression results give enough evidence to accept the second hypothesis at 1% and 5% significance levels. Fluency does exert a positive influence in stock ownership and this effect is stronger before than after the financial crisis. That is to say that people with higher fluency skills are more likely to participate in the stock market.

**Table 12: Regression results for memory (2006-2009)**

log_stocks	Coef.	Std. Err.	z	P>z
memory	0.4417873	0.225318	1.96	0.05
log_age	1.536655	0.40406	3.8	0
health	-0.1800307	0.074837	2.41	0.016
log_income	0.7202046	0.011541	62.41	0
_cons	-5.372978	2.788642	-1.93	0.054
<b>No of obs</b>	2167			
<b>F( 17, 2149)</b>	8.71			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.0644			
<b>Adj R-squared</b>	0.057			

Note: The table shows the regression results of the model before crisis. Memory is selected in the regression as the main cognitive skill.

**Table 13: Stockholding against memory (2010-2012)**

log_stocks	Coef.	Std. Err.	z	P>z
memory	0.081712	0.188717	0.43	0.045
log_age	0.498566	0.60782	0.82	0.412
health	-0.007638	0.071759	0.11	0.915
log_income	0.761189	0.010455	72.8	0
_cons	0.709318	3.443163	0.21	0.837
<b>No of obs</b>	2749			
<b>F( 18, 2730)</b>	17.34			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.1026			
<b>Adj R-squared</b>	0.0967			

Note: The table shows the regression results of the model after crisis. Memory is selected in the regression as the main cognitive skill.

Tables 12 and 13 show the regression results when memory is the main factor of cognitive behavior included in the empirical model. Memory exerts a positive influence on the amount of household income invested in stocks. If the score in memory test rises by 1 point, total stockholding rises by 44%, ceteris paribus, before crisis. The result is significant only at 5% level of significance, but not at 1%. In addition, memory exerts a positive, yet less strong, effect on stockownership after the financial crisis. The coefficient of memory drops to 0.0817, meaning that an increase in memory test score by 1 point, individual investors tend to increase their total stock ownership by 8.17%.

The coefficient of logarithm of income has similar values as in the two previous models. The coefficient for income is equal with 0.72 and 0.76 before and after the crisis, respectively. Both of them are statistically significant at 1% and 5% level of significance, and as a result, it can be said that as income increases, individual investors are more likely to invest in the stock market.

The results from the regressions present that age positively affect the stockholding, since the coefficient of logarithm of age is positive. The stock market investment increases by 1.5 times before the crisis, as compared to 0.5 times after the crisis, if the age of the individual investor increases by 1%. As a result, stockholding increases along with the age of individual investors. However, the value of the coefficient after the financial crisis is statistically insignificant, even at the highest possible level of significance (10%), since the p value is equal with 0.412.

The coefficient for health is negative, pointing out a negative relationship between health condition and stock investment. When individual investor believe that their health condition worsens they are less likely to invest in the stock market. This negative influence applies for both periods of the study, yet is statistically significant at 5% only during the first period of the study (2006-09).

Despite the fact that before crisis the model (table 12) is statistically significant at 1% and 5% level of significance, it describes just 6.5% of the total change stockholding. The same results apply for the period 2010-12 (table 13), for which the value of F-test is 23.05 and the model is statistically significant at the confidence levels of 1% and 5%. The  $R^2$  value is 0.1026. This means that the model can capture about 10% of the variation caused in the stockholding, which is a small amount.

Altogether, the results provide enough evidence to accept the third hypothesis at 1% and 5% confidence levels. Memory, does exercise a positive impact on stock market participation, yet the financial crisis wakened this effect. The higher the memory of the individual investors, the more amount of money they tend to invest in the stock market.

## 5.2 Robustness test

This section presents the results from the robustness analysis. In particular, from each sample, only the 8 countries with the most observations regarding stockownership are selected and included in the robustness analysis regressions. The results from the regressions are presented below.

**Table 14: Robustness results for numeracy 2006-2009**

log_stocks	Coef.	Std. Err.	z	P>z
numeracy	1.831542	0.446545	4.1	0
log_age	0.5657926	0.443808	1.27	0.202
health	-0.2447278	0.097984	-2.5	0.013
log_income	0.6852973	0.015709	43.62	0
_cons	10.18004	3.167521	3.21	0.001
<b>Number of obs</b>	1984			
<b>F( 12, 1971)</b>	10.68			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.0611			
<b>Adj R-squared</b>	0.0554			

*Note:* The table shows results of the robust check for numeracy before crisis.

**Table 15: Robustness results for numeracy 2010-2012**

log_stocks	Coef.	Std. Err.	z	P>z
numeracy	0.2790113	0.046397	6.01	0
log_age	-0.9557647	0.37364	-2.56	0.011
health	-0.0014005	0.05008	0.03	0.978
log_income	0.7276591	0.011745	61.95	0
_cons	8.181962	1.599829	5.11	0
<b>Number of obs</b>	2434			
<b>F( 11, 2422)</b>	138.65			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.3864			
<b>Adj R-squared</b>	0.3836			

*Note:* The table shows results of the robust check for numeracy after crisis.

Tables 14 and 15 show the regression results when numeracy is the characteristic of cognitive function. Results prove to be statistically significant and confirm the positive association between numeracy and stockholding. Individual investors who possess higher numerical skills are more likely to

invest in the stock market. After the crisis, nevertheless, the positive relationship between numeracy and stockholding declines.

The results for the other variables are strikingly similar to the baseline results. In both periods, income coefficient is positive and statistically significant. Although the coefficients for health show a negative association with stockholding for both periods, they are highly insignificant. As far as age is concerned, it is positively linked with stock investment before crisis, although this relationship becomes negative after the crisis.

**Table 16: Robustness results for fluency 2006-2009**

log_stocks	Coef.	Std. Err.	z	P>z
fluency	-0.03158	0.060707	-0.52	0.603
log_age	1.012939	0.443698	2.28	0.022
health	0.040731	0.08407	0.48	0.628
log_income	0.702099	0.01207	58.17	0
_cons	0.750277	3.146769	0.24	0.812
<b>No of obs</b>	1979			
<b>F( 12, 1966)</b>	10.34			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.0594			
<b>Adj R-squared</b>	0.0536			

*Note:* The table shows results of the robust check for fluency before crisis.

**Table 17: Robustness results for fluency 2010-2012**

log_stocks	Coef.	Std. Err.	z	P>z
fluency	0.0478067	0.031391	1.52	0.128
log_age	0.59711	0.449099	1.33	0.184
health	0.0352574	0.054699	0.64	0.519
log_income	0.7414068	0.011601	63.91	0
_cons	-0.1699743	2.437003	-0.07	0.944
<b>Number of obs</b>	2426			
<b>F( 11, 2414)</b>	28.56			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.1152			
<b>Adj R-squared</b>	0.1111			

*Note:* The table shows results of the robust check for fluency after crisis.

The robustness check results for fluency are presented in tables 16 and 17. In contrast to robustness check for numeracy, results for fluency cannot confirm the positive association between fluency and stockholding found in the baseline analysis. This is not to say, however, that they provide evidence against it.

Indicating a negative effect on stock ownership, the coefficient for fluency is negative before crisis and positive after crisis. These results, though, are not meaningful, because the values of the coefficients are not statistically different from zero at 1% and 5% confidence level.

The coefficients for the rest variables remain similar as in the baseline case. All the secondary independent variables are positively related with stockholding both before and after the financial crisis. However, the results are statistically significant only for income coefficient. As a consequence, the results change notably for the fluency model when controlling the size of the two samples.

**Table 18: Robustness results for memory 2006-2009**

<b>log_stocks</b>	<b>Coef.</b>	<b>Std. Err.</b>	<b>z</b>	<b>P&gt;z</b>
<b>memory</b>	0.5952761	0.306538	1.94	0.052
<b>log_age</b>	1.781235	0.484581	3.68	0
<b>health</b>	0.2223964	0.090412	2.46	0.014
<b>log_income</b>	0.7098289	0.013693	51.84	0
<b>_cons</b>	-7.180466	3.663352	-1.96	0.05
<b>No of obs</b>	1979			
<b>F( 12, 1966)</b>	9.33			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.0539			
<b>Adj R-squared</b>	0.0481			

*Note:* The table shows results of the robust check for memory before crisis.

**Table 19: Robustness results for memory 2010-2012**

<b>log_stocks</b>	<b>Coef.</b>	<b>Std. Err.</b>	<b>z</b>	<b>P&gt;z</b>
<b>memory</b>	0.06544	0.882042	3.01	0.003
<b>log_age</b>	-6.9187	2.449582	-2.82	0.005
<b>health</b>	-0.73242	0.266882	-2.74	0.006
<b>log_income</b>	0.740578	0.025129	29.47	0
<b>_cons</b>	47.02627	14.94425	3.15	0.002
<b>Number of obs</b>	2434			
<b>F( 11, 2422)</b>	20.18			
<b>Prob &gt; F</b>	0			
<b>R-squared</b>	0.084			
<b>Adj R-squared</b>	0.0798			

Note: The table shows results of the robust check for numeracy after crisis.

The robust regression results for memory are presented in tables 18 and 19. In short, the results verify the positive influence of memory on stockownership. The coefficient for memory is positive for both periods, but what needs to be stressed here, is that after the financial crisis it gets lower, a decrease implies that crisis slightly distorts this positive effect. Individual investors who have sharp memory are more likely to invest in the market.

The results for the rest variables do not tell of major change from the baseline results. Coefficient of income is positive for both periods and slightly higher after, rather than before crisis. On the other hand, health and age exert a positive influence on stockholding before the crisis, while the influence changes into negative after the crisis.

All in all, the robustness checks show that the results are quite robust. For the two of the three cognitive variables, numeracy and memory the result remain quite similar with the baseline analysis, after controlling the size sample. However, the robustness for the fluency remains less clear due to more sporadic results that cannot be taken into consideration since are unimportant from a statistical perspective.

## 5.3 Discussion

The conclusion that can be derived from the empirical analysis of this study are as follows: Firstly, the data highlight and corroborate that European individual investors aged 50 and above, do not participate actively in the stock market. These findings are consistent with the results of previous studies (Benartzi and Thaler, 1995; Campbell, 2006) which find evidence of low stock market participation for households.

Another finding of this study is the relationship between mental abilities and stockownership. The results from the IV regressions show similar patterns for the effect of each cognitive skill on stock market participation. Each of the cognitive abilities, namely numerical skill, fluency, and ability to recall, exerts a positive impact on stock market participation both before and after the financial crisis. This positive relationship strengthens the findings of similar studies (Christelis et al., 2010; Bucher-Koenen and Ziegelmeier, 2011) that suggest an all the more increasing spiral movement: the higher the cognitive abilities of individual investors, the more amount of their money they are willing to invest in stocks.

The main contribution of this study is that examine the impact of cognitive abilities in the context of the recent financial crisis of 2008-2009 in Europe. After the financial crisis, cognitive abilities are positively associated on stockownership. In other words, the results show that the positive impact of cognitive abilities on stock market participation does hold, even after the shock of the financial crisis. However, the financial crisis, indeed, skews and distorts this relation, since the relationship between cognition and stock investments is less strong after 2009, that is, post-crisis. The financial crisis of 2008-09, in short, significantly affected the portfolio decisions of individual investors.

Moreover, this research work does not only expose low stock market participation of individual investors as such, but goes further on to fathom the reasons and dynamics behind this inactivity. The positive relation between intellectual skills and the stock market participation is related with the constraints of the stock market. In agreement with previous studies conducted



by Halliasos and Bertaut (1995) and by Vissing-Jorgensen (2004) the findings provide evidence that information cost and the fees individual investors have to bear discourage investors to invest in stocks. Therefore, the results reinforce the conclusions of previous findings, suggesting that fixed and information costs –rather than psychological factors or personal preferences- are the main reasons why individual hold few stocks. This tendency, it needs to be stressed, does not only hold when the market conditions are stable, but even when the market is unstable due to an undergoing crisis.

In addition, this study contributes in the existing literature of behavioral finance, in the sense that it particularly focuses on the individual impact that each one of the cognitive abilities exerts on stock market participation. The results show that numeracy exerts the strongest effect on stock ownership, while verbal fluency exerts the least strong influence. To put it differently, it is only logical that the higher the ability of individual investors to solve numerical problems, the more active is their participation in the stock market. This implies that these investors are more likely to accurately calculate the risk and return of the stocks in which they invest, thereby making more accurate portfolio decisions. The cognitive ability that holds the second strongest effect on stockholding is memory. This can be attributed to the fact that individual investors with good memory skills can gain knowledge from past experience in the stock market (Glaser and Weber, 2007).

Interestingly enough, the results show that age is positively associated with stockholding. In almost all regressions the coefficient of logarithm of age is positive and higher before, rather than after, the crisis. Results suggest that as individual investors who are 50 years old or older grow up, they are more likely to invest in stocks. The same tendency holds after the financial crisis as well, even though it becomes less positive. These results come in contrast with the view of previous papers suggesting that as individual investors age, they should invest less of their disposable income in risky assets such as stocks (Chai et al., 2011).

As far as health is concerned, it seems to exhibit a negative association with investing in the stock market, albeit results in most cases are insignificant. This

negative relationship gives support to the view that poor health condition is related with high expenditures for health care, leaving less income available to invest in stocks (Rosen and Wu, 2004).

Last but not least, another interest finding is the effect of income on stock ownership. For both periods of the study, the higher the income, the higher is the amount of money invested in stocks. In particular, the effect gets significantly higher after the financial crisis, thus corroborating the results from previous studies about transaction and information barriers in stockholding. As individuals have more income to dispose, they are more likely to participate in the stock market. During the crisis, for example, households faced large cuts in their portfolio values and households with low income were forced to sell their stocks and, consequently, stopped investing in stocks (Bucher-Koenen and Ziegelmeyer, 2011). Thus, the results confirm that only wealthy households which are able to afford stock market entry cost continue investing in the stock market after crisis.

## 6. Conclusion

The motivation for this research stems from existing literature on household behavioral finance. The central purpose is to contribute to the existing knowledge by completing the hitherto gap related to how households invest in the stock market during turbulent periods. The main focus of this effort is located on the effect of cognitive skills on the stock market participation of individual investors. In particular, this study examines whether, and to what extent, the possible positive influence of cognitive abilities on stock investments changes during the European financial crisis of 2008-2009.

In order to examine this relationship, data from the Survey of Ageing, Health and Retirement in Europe (SHARE) is employed. To study the impact of the crisis in portfolio decisions of individual investors, two surveys conducted by SHARE are used: the first refers to the period before, while the second attends to the period after the financial crisis. The SHARE database provides analytical details about stockholding, cognitive skills, health, income and age of European households. An empirical model is constructed to capture the relationship between stockholding and cognitive skills, including the additional explanatory variables.

The results from the multiple regression analysis reinforce findings of previous studies and provide further knowledge about individual investors' behavior in the stock market. The results, in particular, provide evidence that three cognitive abilities (numeracy, verbal fluency and memory) are positively affecting individual investors' stock market participation. Namely, individual investors who possess high cognitive skills are more likely to invest in the stock market. More specifically, the ability to execute numerical calculation is found to be the most important factor in enhancing the possibility to invest in the stock market.

On the contrary, the financial crisis changes individual investors' financial behavior: after the crisis cognitive abilities are still positively associated with stockholding, although the effect is moderate comparing to the one before crisis. The results also suggest that transaction fees and information costs are two

reasons explaining a household's low stock market participation not only during periods of prosperity, but also during periods of recession.

A unique characteristic of this study is related with the way the relationship of cognition on the decision to invest in stocks is examined. For the purpose of the study, three cognitive abilities are taking into account: the skill to execute numerical calculation, the ability to perceive and interpret information, and the ability to recall. Specifically, the study examines the effect of each cognitive ability on stockholding separately, and not as an aggregate effect of the entire corpus of cognitive abilities. Furthermore, a second contribution of this study to the existing literature is that this relationship is examined in the context of the recent financial crisis of 2008-2009 in Europe.

From a practical perspective, the results highlight the importance of financial education for individual investors who are the decision-makers of their households. The positive link between cognitive skills and stock market participation renders financial literacy of households significantly crucial for the investment decisions; well-informed and financially literate individuals could more profitably exploit opportunities and increase their household utility by investing in stocks. In addition, highly educated individual investors would need to rely less on professionals (e.g. brokers, dealers) for information or advice regarding stocks, thus gaining independency and limiting the cost of participating in the stock market. Therefore, policymakers who are concerned about household investment behavior could make reforms aiming to enhance financial education in Europe.

It must be noted that this research is restricted in several ways by several limitations. The model specification, the time constraint, and the data availability are some of the major limitations of the study. The empirical model used in the multiple regression analysis does not take into consideration additional explanatory variables. The level of education, the social activities and the bequest motives of individuals are among various factors that can influence the decisions to invest in stocks. However, these variables are not included in the model due to time and word count restrictions.

In addition, a crucial assumption is made in order to conduct the study. The data for the years 2008-2009 are not available from the survey of SHARE and to overcome this problem data for the period of 2006-2007 are used instead to examine the period before the financial crisis. This assumption is based on the view that stockownership and the cognitive skills of individual investors did not change during this period, a suggestion which remains controversial and allows space for more debate.

These limitations recommend further research in order to overcome the existing restrictions of this study and examine further the effects of cognitive abilities on stock market participation during the European financial crisis of 2008-2009. Moreover, future studies could extend the findings focusing on the effect of cognitive abilities in other types of securities, such as bonds or mutual funds, in order to investigate whether cognitive abilities influence the portfolio choices of individual investors in other classes of assets.

## References

1. Andersen, S., and Nielsen, K. M. (2011). Participation constraints in the stock market: Evidence from unexpected inheritance due to sudden death. *Review of Financial Studies*, 24(5), pp. 1667-1697.
2. Barber, B. M., and Odean, T. (2001). Boys will be boys: Gender, overconfidence, and common stock investment. *The Quarterly Journal of Economics*, 116(1), pp. 261-292.
3. Barberis, N., and Thaler, R. (2003). A survey of behavioral finance. *Handbook of the Economics of Finance*, 1, pp. 1053-1128.
4. Benartzi, S., and Thaler, R. H. (1995). Myopic loss aversion and the equity premium puzzle. *The quarterly journal of Economics*, 110(1), pp. 73-92.
5. Benjamin, D. J., Brown, S. A., and Shapiro, J. M. (2013). Who is 'behavioral'? Cognitive ability and anomalous preferences. *Journal of the European Economic Association*, 11(6), pp. 1231-1255.
6. Bruine de Bruin, W., Parker, A. M., and Fischhoff, B. (2007). Individual differences in adult decision-making competence. *Journal of personality and social psychology*, 92(5), pp. 938-956.
7. Bucher-Koenen, T., and Ziegelmeyer, M. (2011). *Who Lost the Most?: Financial Literacy, Cognitive Abilities, and the Financial Crisis*. European Central Bank. Working Paper Series 1299.
8. Campbell, J. Y. (2006). Household finance. *The Journal of Finance*, 61(4), pp. 1553-1604.
9. Calvet, L. E., Campbell, J. Y., & Sodini, P. (2008). *Fight or flight? Portfolio rebalancing by individual investors*. National Bureau of Economic Research. Working Paper Series 14177.
10. Campello, M., Giambona, E., Graham, J. R., and Harvey, C. R. (2011). Liquidity management and corporate investment during a financial crisis. *Review of Financial Studies*, 24(6), pp. 1944-1979.
11. Campello, M., Graham, J. R., and Harvey, C. R. (2010). The real effects of financial constraints: Evidence from a financial crisis. *Journal of Financial Economics*, 97(3), pp. 470-487.

12. Chai, J., Maurer, R., Mitchell, O. S., and Rogalla, R. (2011). *Lifecycle impacts of the financial and economic crisis on household optimal consumption, portfolio choice, and labor supply*. National Bureau of Economic Research. Working Paper Series 17134.
13. Chava, S., and Purnanandam, A. (2011). The effect of banking crisis on bank-dependent borrowers. *Journal of Financial Economics*, 99(1), pp. 116-135.
14. Christelis, D., Georgarakos, D., and Haliassos, M. (2013). Differences in portfolios across countries: Economic environment versus household characteristics. *Review of Economics and Statistics*, 95(1), pp. 220-236.
15. Christelis, D., Jappelli, T., and Padula, M. (2010). Cognitive abilities and portfolio choice. *European Economic Review*, 54(1), pp. 18-38.
16. Cocco, J. F., Gomes, F. J., and Maenhout, P. J. (2005). Consumption and portfolio choice over the life cycle. *Review of Financial Studies*, 18(2), pp. 491-533.
17. Del Missier, F., Mäntylä, T., and Bruin, W. B. (2012). Decision-making competence, executive functioning, and general cognitive abilities. *Journal of Behavioral Decision Making*, 25(4), pp. 331-351.
18. Eysenck, M.W., Keane, M.T., (2010). *Cognitive psychology: a student's handbook*. 6<sup>th</sup> edn. Sussex: Psychology Press
19. Floyd, E., Li, N., and Skinner, D. J. (2014). *Payout policy through the financial crisis: The growth of repurchases and the resilience of dividends*. The University of Chicago Booth School of Business, Working Paper No. 12-01.
20. Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic perspectives*, 19(4), pp. 25-42.
21. Glaser, M., and Weber, M. (2007). Why inexperienced investors do not learn: they do not know their past portfolio performance. *Finance Research Letters*, 4(4), pp. 203-216.
22. Gobet, F., Chassy, P., and Bilalić, M. (2011). *Foundations of cognitive psychology*. Berkshire: McGraw-Hill.
23. Goetzmann, W. N., and Kumar, A. (2008). Equity portfolio diversification. *Review of Finance*, 12(3), pp. 433-463.

24. Graham, J. R., Harvey, C. R., and Huang, H. (2009). Investor competence, trading frequency, and home bias. *Management Science*, 55(7), pp. 1094-1106.
25. Guiso, L., Haliassos, M., and Jappelli, T. (2003). Household stockholding in Europe: where do we stand and where do we go?. *Economic Policy*, 18(36), pp. 123-170.
26. Gujarati, D. N., & Porter, D. C. (2010). *Essentials of econometrics*. 4<sup>th</sup> edn. McGraw Hill.
27. Gujarati, D., & Porter, D. C. (2009). *Basic econometrics*. 5<sup>th</sup> edn. McGraw-Hill.
28. Gustman, A. L., Steinmeier, T. L., and Tabatabai, N. (2009). *What the stock market decline means for the financial security and retirement choices of the near-retirement population*. National Bureau of Economic Research. Working Paper Series 15435.
29. Haliassos, M., and Bertaut, C. C. (1995). Why do so few hold stocks?. *The Economic Journal*, 105, pp. 1110-1129.
30. Hellwig, M. F. (2009). Systemic risk in the financial sector: An analysis of the subprime-mortgage financial crisis. *De Economist*, 157(2), pp. 129-207.
31. Hoffmann, A. O., Post, T., and Pennings, J. M. (2013). Individual investor perceptions and behavior during the financial crisis. *Journal of Banking & Finance*, 37(1), pp.60-74.
32. Horne, J. C. V., Blume, M. E., and Friend, I. (1975). The asset structure of individual portfolios and some implications for utility functions. *The Journal of Finance*, 30(2), pp. 585-603.
33. Ivashina, V., and Scharfstein, D. (2010). Bank lending during the financial crisis of 2008. *Journal of Financial economics*, 97(3), pp. 319-338.
34. Iyer, R., Peydro, J. L., da-Lopes, S., and Schoar, A. (2013). Interbank liquidity and the firm credit crunch: Evidence from the 2007-2009 crisis. *Review of Financial Studies*, 24(4), pp. 1337-1377.
35. Kahneman, D., and Tversky, A. (1974). Subjective probability: A judgment of representativeness. In *The Concept of Probability in Psychological Experiments* (pp. 25-48). Springer Netherlands.



36. Korniotis, G., and Kumar, A. (2007). *Does investment skill decline due to cognitive aging or improve with experience?*. Social Sciences Research Network.
37. Kimball, M. S., & Shumway, T. (2010). *Investor sophistication and the home bias, diversification, and employer stock puzzles*. University of Michigan. Working Paper Series.
38. Lang, J. W., Kersting, M., Hülshager, U. R., and Lang, J. (2010). General mental ability, narrower cognitive abilities, and job performance: The perspective of the nested-factors model of cognitive abilities. *Personnel Psychology*, 63(3), pp. 595-640.
39. Lassiter, K.S., Veal, M.L., Matthews, T.D., and Trez, C. (2013). Comparing general cognitive abilities using the general ability measure for adults and the Woodcock-Johnson tests of cognitive abilities. *North American Journal of Psychology*, 15(2), pp. 279-286.
40. Lusardi, A., & Mitchell, O. S. (2011). *Financial literacy and planning: Implications for retirement wellbeing*. National Bureau of Economic Research. Working Paper Series 17078.
41. Maddala, G. S., and Lahiri, K. (2009). *Introduction to econometrics* 4<sup>th</sup> edn. John Wiley and Sons Ltd
42. Malmendier, U., and Nagel, S. (2011). Depression Babies: Do Macroeconomic Experiences Affect Risk Taking?. *The Quarterly Journal of Economics*, 126(1), pp. 373-416.
43. Mankiw, N. G., and Zeldes, S. P. (1991). The consumption of stockholders and nonstockholders. *Journal of Financial Economics*, 29(1), pp. 97-112.
44. Markowitz, H. (1952). Portfolio selection. *The journal of finance*, 7(1), pp. 77-91.
45. Marsh, T., & Pfleiderer, P. (2013). Flight to Quality and Asset Allocation in a Financial Crisis. *Financial Analysts Journal*, 69(4), pp. 43-57
46. Merton, R. C. (1969). Lifetime portfolio selection under uncertainty: The continuous-time case. *The review of Economics and Statistics*, 51(3), pp. 247-257

47. Oechssler, J., Roider, A., and Schmitz, P. W. (2009). Cognitive abilities and behavioral biases. *Journal of Economic Behavior & Organization*, 72(1), pp. 147-152.
48. Ritter, J. R. (2003). Behavioral finance. *Pacific-Basin Finance Journal*, 11(4), pp. 429-437.
49. Rosen, H. S., and Wu, S. (2004). Portfolio choice and health status. *Journal of Financial Economics*, 72(3), pp. 457-484.
50. Shapiro, M. D. (2010). *The effects of the financial crisis on the well-being of older Americans: evidence from the cognitive economics study*. University of Michigan, Michigan Retirement Research Center, Working Paper Series 2010-228
51. Samuelson, P. A. (1969). Lifetime portfolio selection by dynamic stochastic programming. *The review of economics and statistics*, 51(3), pp. 239-246.
52. Spaniol, J., and Bayen, U. J. (2005). Aging and conditional probability judgments: a global matching approach. *Psychology and aging*, 20(1), pp. 165-181.
53. Stock, J. H., and Watson, M. W. (2012). *Introduction to econometrics*. 3<sup>rd</sup> edn. Pearson Education Limited
54. Tobin, J. (1958). Liquidity preference as behavior towards risk. *The review of economic studies*, 25(2), pp.65-86.
55. Van Rooij, M., Lusardi, A., & Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial Economics*, 101(2), pp. 449-472.
56. Van Rooij, M. C., Lusardi, A., & Alessie, R. J. (2012). Financial Literacy, Retirement Planning and Household Wealth. *The Economic Journal*, 122(560), pp. 449-478.
57. Vissing-Jorgensen, A. (2004). Perspectives on Behavioral Finance: Does "Irrationality" Disappear with Wealth? Evidence from Expectations and Actions. *NBER Macroeconomics Annual 2003*, 18, pp. 139-208.
58. Zhang, X. (2006). Information uncertainty and stock returns. *The Journal of Finance*, 61(1), pp. 105-137.