DID COGNITIVE ABILITY AFFECT THE STOCK REALLOCATION DECISIONS OF OLDER INVESTORS DURING THE GREAT RECESSION?

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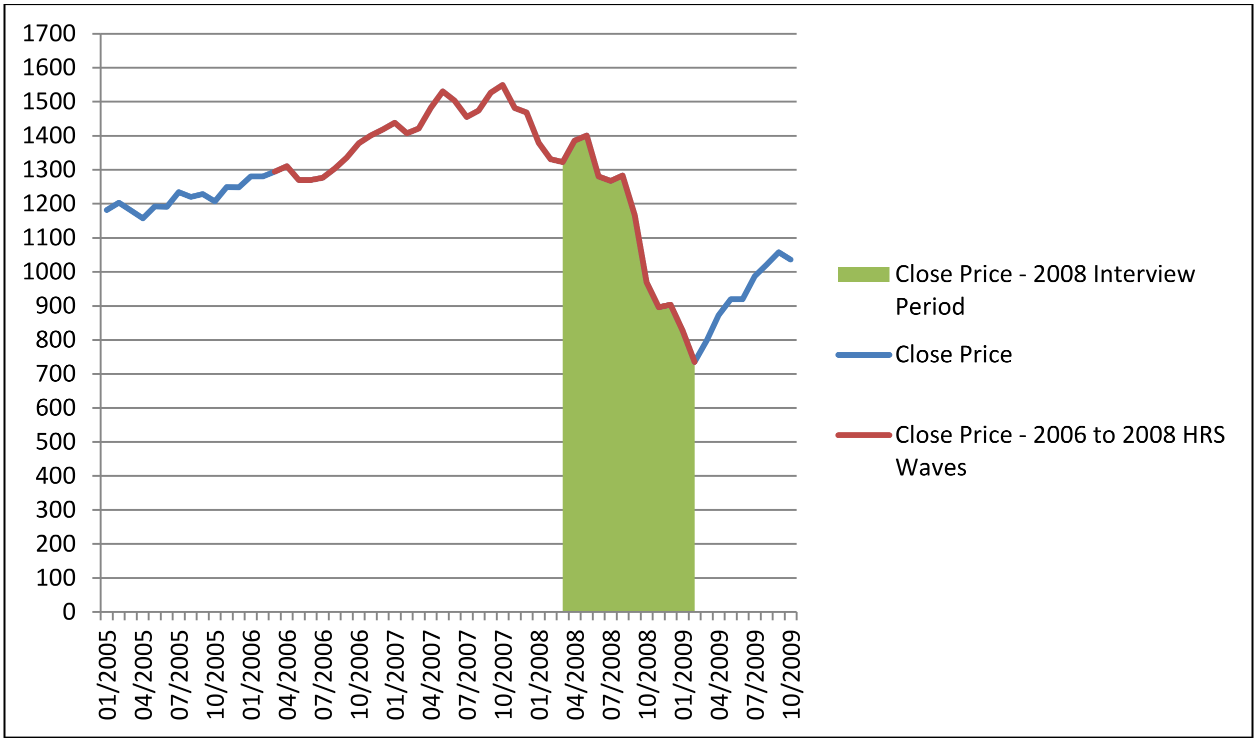
Introduction

The financial decisions of households are important for both households and the greater economy. Of particular interest are the decisions of households related to retirement planning. The frameworks for making decisions related to retirement are complex and require the accurate estimation and effective use of multiple inputs for individuals to be successful in meeting their long-term goals. When considering long-term investment goals the rational expectation is that individuals will make decisions based on the utility gained from wealth over their lifetime, not the current state of the marketplace they are participating in. However individual investors have been found to be loss averse - more sensitive to losses than gains. In the midst of a negative financial event, this causes a shift in focus from long-term consumption to the variability of recent returns as investors become distracted by their desire to minimize dissatisfaction from an experienced loss. The recent great recession provides an excellent opportunity to observe the portfolio reallocation decisions of individual investors when they face severe reductions in stock values, as shown in Figure 1, and are most vulnerable to loss averse decisions.

Figure 1. Monthly S&P 500 Close Price



There is concern that individuals with diminished cognitive ability are more susceptible to behavioral biases such as loss aversion when making investment decisions when asset prices fall. Greater cognitive ability is related to increased stock market participation (Christelis, Jappelli, & Padula, 2010; Cole & Shastry, 2009) and a lower susceptibility to the disposition effect and other behavioral biases (Grinblatt, Keloharju, & Linnainmaa, 2012). Using the Health and Retirement Study (HRS) we explore the relationship between cognitive ability and the stock reallocation decisions of older investors during the great recession. We provide evidence that older investors with lower levels of cognitive ability are more likely to allocate away from stocks after they have fallen in value.

Literature Review

Mean Variance Optimization

Individuals invest to accumulate resources that can be used to meet their consumption needs in retirement in an attempt to maximize lifetime utility from wealth (Ando & Modigliani, 1963). The most commonly used model to explain investor trading and allocation decisions is the mean-variance model (Markowitz, 1952). Under modern portfolio theory, the investor will allocate their portfolio between a risky and riskless asset based on their level of risk tolerance. Because investors have stable risk preferences and incorporate all available historical data when forming beliefs about risky outcomes, they will select an optimal portfolio that is unaffected by short-run market performance. For this to hold true, the risk perceptions and subsequent allocation decisions of individuals must be unaffected by biases and economic experiences. There is evidence that individuals are loss averse and do not operate under expected utility theory (Kahneman & Tversky, 1979). Loss aversion causes individuals to be more sensitive to decreases in well-being than they are to increases. The dissatisfaction yielded from losses oftentimes causes individuals to make decisions in the short-term that are unrelated to or detrimental to efforts aimed at maximizing lifetime utility from consumption. This problem is compounded by the myopic, boundedly rational nature of individual investors (Benartzi & Thaler, 1995).

Common portfolio advice is for individuals to decrease equity holdings as they get older. This idea is supported theoretically if it is based on the relationship between human capital and financial wealth. Human capital is highest when individuals are young and have a flexible labor supply. As individuals age their human capital and labor flexibility diminishes. As human capital, a bond-like asset, diminishes rebalancing the portfolio towards lower risk investments is required to maintain the appropriate mix between risky and riskless asset classes. Upon retirement human capital is depleted. This eliminates the need to allocate away from stocks and shift the risk characteristics of the portfolio after retirement (Bodie, Merton, & Samuelson, 1992). In other words, older individuals should not reduce their stock holdings after retirement just because they are getting older.

Investor Biases

Much of the current literature suggests that biases (Kahneman & Tversky, 1972; DeBondt, 1993; Sirri & Tufano, 1998; Barber & Odean, 2008; Yuan, 2011) and prior economic experiences (Caplin and Leahy, 2001; Malmendier & Nagel, 2011) play a significant role in shaping the risk perceptions of individual investors, leading to trading and allocation decisions motivated by something other than stable, rational preferences.

Baye's rule indicates that individuals will react correctly to new information when revising probability estimates. This rule is frequently violated in experimental studies of how individuals actually respond to new data (Kahneman & Tversky, 1982). When updating expectations individuals tend to overestimate recent information and underestimate older event. Much of the susceptibility of individuals to behavioral biases is likely related to the overwhelming amount of information that must be acquired and processed to accurately estimate risk levels and future return probabilities. Because the acquisition of information is costly, many individuals only consider information that is readily available and easy to process. This causes investors to focus heavily on past performance (Sirri & Tufano, 1998, Barber & Odean, 2008) and other attention grabbing events when making investment decisions (Barber & Odean, 2008; Yuan, 2011). This may increase one's susceptibility to the representativeness heuristic, where individuals overestimate the degree to which a single event has the same characteristics as the population it is drawn from (Kahneman & Tversky, 1972). This may lead investors to overestimate the predictability of returns, and make allocations decisions that are less than rational.

The Impact of Experiences

The psychological literature has also considered the impact of personal experiences, especially recent ones, on personal decisions. Nisbett and Ross (1980), Weber et al. (1993), and Hertwig et al. (2004) find that recent personal experiences have a significant influence on personal decisions. Malmendier and Nagel (2011) investigate whether the macro-economic experiences of individuals impact their risk attitudes. They find that risk taking is strongly related to return experiences, and more recent returns have a greater influence on risk taking than those experienced early in life. Additionally, they find that individuals that have experienced low market returns are less likely to take financial risk and invest a smaller portion of their liquid assets in stocks.

Experiences may cause feelings about specific situations that lead to biased risk perceptions (Slovic, et al. 2002). A negative event, such as a market crash, may lead to higher levels of perceived risk than what would be experienced in an unbiased situation (Fischer & Gerhardt, 2007), resulting to suboptimal portfolio reallocations. Negative events may also cause anxiety, an anticipatory emotion that varies across time and states (Caplin & Leahy, 2001). Feelings of anxiety shift individuals' focus from probabilities to possibilities, biasing risk perceptions and causing overreactions to small probability events (Caplin & Leahy, 2001). This may lead to increased levels of perceived risk and an over-weighted probability of low future returns among individual investors following a negative event. Hoffman, Post, and Pennings (2012) find that investors' risk perceptions increased while their return expectations decreased during the great recession, resulting in increased trading among individual investors. Findings that individuals make decisions in the current period based on recent experiences are consistent with loss aversion. These short-term reactions have potential long-term consequences to the retirement wealth of older investors who fail to participate in the recovery of the market and expose themselves to decreased long-term returns.

Costly Mistakes of the Biased Investor

Ippolito (1992) established that investor trading is strongly correlated with past performance. This is consistent with the idea that investor sentiment in the market is closely related to recent returns. Baker and Wrugler (2007) define investor sentiment as "a belief about future cash flows and investment risks that is not justified by the facts at hand." It is the result of over-optimism (pessimism) related to recent returns that drives markets away from their intrinsic values, with high (low) sentiment being associated with high (low) stock values. DeBondt (1993) provides evidence of this as he finds that the percentage of investors with bullish attitudes increases following an increase in the DJIA. Two key findings from this study are that (i) investor sentiment trails the market, and that (ii) individuals are subject to extrapolation bias, the expected continuation of past market performance. Both lead individuals to be over-optimistic (pessimistic) and buy (sell) shares in bull markets (bear markets) highlighting the role of recent return experiences on the preferences and actions of individual investors.

Such trading has been associated with portfolio reallocations that lead to diminished long-term investment returns. DeBondt and Thaler (1985) hypothesize that investor overreactions to recent returns predicts future portfolio performance. They find that loser (winner) portfolios persistently outperform (underperform) the market for up to 36 months. This is consistent with the P/E hypothesis where investors become overly pessimistic (optimistic) following negative (positive) returns. This causes stocks to become temporarily under (over) valued leading to reversals in performance (Basu, 1977). Friesen and Sapp (2007) measure the impact of investor timing decisions on investment performance. They find that investors make poor timing decisions that are consistent with return chasing and detrimental to investment returns, costing investors 1.56% annually between 1991 and 2004. They attribute these losses to the idea that returns are serially uncorrelated and mean reverting. Maymin & Fisher (2011) find that investors shift their portfolio allocations towards bonds following a market downturn, evidence that when one asset class outperforms another investors allocate towards the winner and away from the loser. This sentiment-driven return chasing behavior leads to pricing adjustments in the market that lowers the future returns of recent good performers and raises the future returns of recent poor performers (Ben-Rephael, Kandel and Wohl, 2012). Individual investors have been labeled “dumb money” for their willingness to allocate away from winners and towards losers, a behavior found to cost investors between 4% and 10% annually (Frazzini & Lamont, 2008).

Cognitive Ability, Age, and Financial Decisions

When evaluating the susceptibility of older households to allocating away from stocks during a down market, we must consider that impact of cognitive ability on financial decisions. Evidence exists that cognitive ability both decreases with age and matters when making financial decisions. The cognitive ability of an individual is made up of both their fluid and crystallized ability. Fluid ability is one’s innate ability to use reason and logic absent of acquired knowledge. There is strong evidence that fluid cognitive function decreases significantly over one’s lifetime (Cattell, 1987; Salthouse, 2005; Agarwal, Driscoll, Gabaix, & Laibson, 2008). Fluid function has been shown to decrease as much as 1% per year from age 20 to 80, with declines attributable to cohort effects, normal aging effects, and dementia. In adults over age 85, about 30% have been diagnosed with dementia. Even those who have not been diagnosed with dementia may experience significant cognitive impairment. For example, approximately 30% of adults between the ages of 80 and 89 have been diagnosed with cognitive impairment without dementia (Agarwal et al., 2008).

While fluid function is decreasing with age crystallized function is increasing, an effect of individuals gaining education and experience as they get older. This causes the quality of financial decisions over the lifecycle to follow a hump-shaped pattern, with peak decision making ability around age 50 (Agarwal et al., 2008). Younger adults are prone to financial mistakes due to a lack of experience. Such mistakes can oftentimes be overcome by large amounts of unspent human wealth and the ability to increase participation in the labor market. Declines in cognitive function also make older adults susceptible to financial mistakes, which are much more difficult to overcome as human wealth is depleted and labor market participation is more difficult. Agarwal et al., (2008) show that the ability to make good financial decisions follows an age-based pattern, with decision quality diminishing in older age.

Korniotis and Kumar (2011) find that older investors have greater investment knowledge, but apply it less effectively and have less investment skill. They also find that investors with low levels of cognitive ability earn lower risk adjusted returns in comparison to investors with greater cognition. Christelis, Jappelli, & Padula (2010) and Cole & Shastry (2009) find that cognitive ability is positively related with stock market participation. Bucher-Koenen & Ziegelmeyer (2011) find cognitive ability to be negatively correlated with loss aversion and other behavioral biases, while Benjamin, Brown, and Shapiro (2005), Dohmen, Falk, Huffman, and Sunde (2010), and Frederick (2005) find that cognitive ability is positively related to patience and negatively related to risk aversion. Additionally, investors with higher IQs have been found to select better investments and exhibit fewer behavioral biases when compared to low IQ investors (Grinblatt, Keloharju, and Linnainmaa, 2012).

Methods

Data

This study uses the Health and Retirement Study (HRS) to model the impact of cognitive ability on the portfolio reallocation decisions of older investors following the great recession. The HRS, a nationally representative longitudinal data set of Americans age 50 and older, has been administered by the University of Michigan on a biennial basis since 1992 and is supported by the National Institute on Aging and the Social Security Administration.

Sample

The sample is made up of individuals that held stock investments between 2006 and 2008. Investments in stocks held individually, in mutual funds, and in IRAs are all considered investments in stock. Individuals with data missing that is necessary for the construction of the dependent variable, or variables measuring cognitive ability, are excluded from the sample. To reduce the impact of extreme observations within the dependent variable, individuals with beginning stock values less than $10,000 are also excluded.

Conceptual Model

To test the research question we propose the following conceptual model:

Stock Reallocations = f(cognitive ability, risk tolerance, recent returns, demographics)

When measuring cognitive ability we consider fluid cognitive function. Fluid ability is one’s capacity to solve problems using logic and reason, without regard to acquired intelligence (Cattell, 1971). Both primary aging, an innate maturational process, and secondary aging, effects related to environment and disease, have been found to contribute to decreases in fluid ability over time (Anstey, Stankov, & Lord, 1993). Fluid ability is important when solving complex unstructured problems, and has a strong negative relationship with age (Salthouse, 2005; Salthouse, 2010). This relationship is oftentimes captured by decrements in working memory and processing speed (Postlethwaite, 2011). Here we proxy for fluid ability by evaluating the working memory and numeracy of respondents.

Numeracy has been found to be an important aspect of financial decisions, with indications that greater math ability is positively associated with patience and negatively associated with financial mistakes. This is especially important when financial decisions include an element of time tradeoff, as with retirement planning (Agarwal & Mazumder, 2013). Pure measures of crystallized intelligence are not available in the HRS, therefore crystallized intelligence is not included in our study.

We look at three factors associated with risk tolerance. Variables measuring stocks as a percentage of total assets, overall wealth, and the existence of a defined benefit plan are used as proxies to measures investor willingness and ability to take risk. The existence of a defined benefit plan and high overall wealth are viewed as increasing the investor's ability to take risk, and high stocks as percentage of wealth are viewed as increasing the investor's willingness to take risk. The risk aversion measure included in the HRS is not used in this study. Recent measures of risk aversion are not available for the majority of the sample. Additionally, Anderson and Mellor (2009) show that risk preferences are not stable when comparing risk aversion in the HRS to risk aversion measured in an experiment with real monetary costs and rewards.

Recent returns are measured using the returns from the S&P 500. For each individual in the sample we capture the returns of the S&P 500 three months and six months prior to their interview date in 2008. This is included to capture the effect of recent market performance on willingness to hold stocks and serves as a proxy for the influence of behavioral biases, such as loss aversion and sentiment, on portfolio allocation decisions.

The demographic variables used in the model include planning horizon, age, retirement status, income, sex, and race. They are included to capture life-cycle and demographic effects on stock holdings.

Dependent Variable

The dependent variable in this study is measured as the difference between the actual percentage change in portfolio allocations to stocks between 2006 and 2008 and the expected percentage change in portfolio allocations to stocks between 2006 and 2008. To calculate the actual percentage change in stock allocations we first calculate the 2006 stock value for each respondent in the sample by adding the value of individual stocks to the value of stocks held in mutual funds and IRAs. We then calculate the percentage of the portfolio made of up stock holdings in 2006 by dividing the stock value by total financial assets. We calculate the 2008 stock value and portfolio percentage using the same approach. The difference between the 2008 and 2006 allocations becomes the actual percentage change in stock allocations.

After calculating the actual percentage change we estimate the expected percentage change in stock allocations. To do this we estimate an expected 2008 stock value by multiplying the 2006 stock value by the S&P 500 returns experienced between the interview dates for each respondent. We then multiply the remaining portion of the 2006 portfolio, (financial assets – stock investments)/financial assets, by the combined average returns of the Barclay's Aggregate Bond Index and 3-month CD rates between the 2006 and 2008 interview dates. After the expected 2008 values for each portion of the portfolio have been estimated we calculate the expected allocation to stocks in the portfolio by dividing the expected 2008 stock value by the expected value of total financial assets in 2008. The difference between the expected 2008 allocation and actual 2006 allocation equals the expected percentage change in stock allocations for each respondent. Once this has been calculated the dependent variable becomes the difference between the actual percentage change in portfolio allocation to stocks and the expected percentage change in portfolio allocation to stocks. Negative values represent an allocation away from stocks, while positive values represent stock allocations greater than expected after considering market returns.

The HRS does not provide detailed information on the investment holdings of each respondent. For the purpose of our analysis the financial assets of each respondent are broken up into two asset classes, 1) stocks and 2) bonds and cash. The S&P 500 was chosen as a proxy for estimating stock returns because it is the best gauge of the US equities market, representing a wide variety of industries and covering approximately 75% of US equities (Standard & Poors, 2012). Movement in the S&P 500 is also used to predict shareholder sentiment in the market (Investment Company Institute, 2012). A similar approach was used by Hoffman, Post, and Pennings (2012) when they used the Amsterdam Exchange index (AEX) to estimate portfolio returns and volatility following the 2008 market crash for a sample of Dutch investors, for which detailed portfolio information was not available. Returns for each respondent are calculated based on the respondents 2006 and 2008 interview months.

To estimate bond and cash returns we use the combined average returns from Barclays Aggregate Bond Index (AGG) and 3-month CD rates between 2006 and 2008. Barclays Aggregate Bond Index was chosen because it includes most investment grade bonds traded in the United States, including treasury securities, mortgage-backed bonds, and corporate bonds. 3-

month CD rates were chosen because they represent a high return option on cash, while still providing liquidity. Savings rates between 2006 and 2008 were very similar to 3-month CD rates; however CD rates for the period were far more accessible and therefore used in our analysis.

Independent Variables

Cognitive Ability

We proxy for fluid ability, by looking at the word recall, series 7, and numeracy problem variables available in the HRS. These variables are used to develop constructs that measure the working memory and numeracy of respondents in the sample. Immediate word recall is used to measure working memory. In the each wave of the HRS respondents are verbally given a list of 10 words. Upon hearing the list of words each respondent is asked to recall as many words as they can from the list. For each word they recall correctly they are given a point, resulting in word recall scores that range from 0 to 10. In this study we use the raw word recall scores from 2006 to create dummy variables for varying levels of working memory. To do this we first calculate the mean word recall score for the sample. We then compare the word recall score of each respondent to the mean score. The sample had a mean word recall score of 5.97 and an inter-quartile range from 5 to 7. If respondents have a score that falls within the inter-quartile range they are considered to have average working memory. Respondents' scores that fall in the top quartile, above 7, are considered to have above average working memory. Respondents' scores that fall in the bottom quartile, below 5, are considered to have below average working memory.

The numeracy of each respondent, one's ability to apply reason to mathematical concepts is also included as a measure of fluid ability. To construct this variable we first consider each respondents performance on the Seriers 7 questions, where each respondent is asked to perform 5 consecutive subtractions of 7, starting with 100 minus 7. Scores for this question range from 0 to 5, with the respondent getting a point for each correct subtraction in the series. Because of the simplicity of this question it is used to capture extremely low levels of numeracy.

To capture higher level numeracy we consider responses to the following questions. .

If the chance of getting a disease is 10 percent, how many people out of 1,000 would be expected to get the disease?

If 5 people all have the winning numbers in the lottery and the prize is two million dollars, how much will each of them get?

Let's say you have $200 in a savings account. The account earns 10% interest per year. How much would you have in the account at the end of two years?

Only respondents who answered the first two questions correctly in their interview are asked the third question. For each correct response the respondent is given a point, resulting in question scores that range from 0 to 3. Respondents with series 7 scores in the bottom quartile, below 4, and question scores of 0 are considered to have low numeracy. Respondents with series 7 scores of 4 and above and question scores of 1 or 2 are considered to have some numeracy, and those with question scores of 3 are considered to have high numeracy.

Risk Tolerance

We look at three factors associated with risk tolerance. Total wealth and the existence of a defined benefit plan are used to measure the investor’s ability to take risk, and high stocks as a percentage of total assets is used to measure the investor’s willingness to take risk. Total wealth and the existence of a defined benefit plan are measured as dummy variables. Wealth above median wealth for the sample is considered high wealth and wealth below median wealth for the sample is considered low wealth. Stocks as a percentage of total assets is also measured as a dummy variable. To create this variable we calculate total assets by adding all debt back to the total wealth variable. We then divide the value of stocks by the value of total assets to get stocks as a percentage of total assets. Respondents with stocks as a percentage of assets above the median are considered to have a high percentage of stocks and those with percentages below the median are considered to have a low percentage of stocks.

Recent Returns

When considering the impact of recent market performance on stock reallocations we look at both three and six month returns. Returns for each respondent are calculated based on the respondents 2008 interview months. This is done to accurately capture the three and six month returns experienced by each respondent. Respondents with double digit negative three month returns are considered to have low three month returns. Respondents that experienced a double digit negative change in returns between three and six months are considered to have low six month returns. We use this approach, rather than simply considering the overall six month returns, to capture the timing of significant changes in stock values under the assumption that sudden large changes in stock values have a greater impact on sentiment than absolute changes in stock values over time.

Demographics

The demographic variables used in the model include age, retirement status, income, sex, and race. Age is broken into four different categories, less than 60, between 60 and 69, between 70 and 79, and over 80. These four categories are used to capture individuals in different phases of the life-cycle. Retirement status is included as a dummy variable to measure the difference in behavior for those accumulating assets versus those decumulating assets. Income, sex, race are also included as dummy variables. The income variable may, in part, serve as a proxy for education under the assumption that education and income are positively correlated. Education is excluded from the primary analysis because of its positive correlation with the independent variable of interest, cognitive ability. Income is measured as a binary variable where 1 represents income above the median and 0 represents income below the median. Sex is measured as a dummy variable where 1 represents male and 0 represents female. The race variable is constructed in a similar fashion where 1 represents white and 0 represents non-white.

Results

Univariate Analysis

Descriptive statistics for stock reallocations are presented in Table 1. Over half of the sample, 58.81%, decreased their portfolio allocations to stock above what can be explained by portfolio returns. Approximately 10% of the sample reduced their allocation to stocks by 70% or more than expected, about 25% reduced their allocations by 30% or more, and about 40% reduced their stock allocations by 15% or more than expected.

The average age of the sample is 68.58 and 43.87% are 70 or older. Those between 60 and 69 make up 34.23% of the sample while those younger than 60 make up 21.9%. The average working memory score is 5.97 out of 10, the average series 7 score is 4.19 out of 5, and the average numeracy problem score is 1.63 out of 3. Over 67% of the sample are in the average working memory category, while 16.5% are in the below average category and 15.79% are in the above average category. These percentages are consistent with the percentage of respondents in each of the numeracy categories. It is interesting to note that 41.84% of the sample had numeracy problem scores less than or equal to 1, and only 15.1% got all three numeracy problems correct.

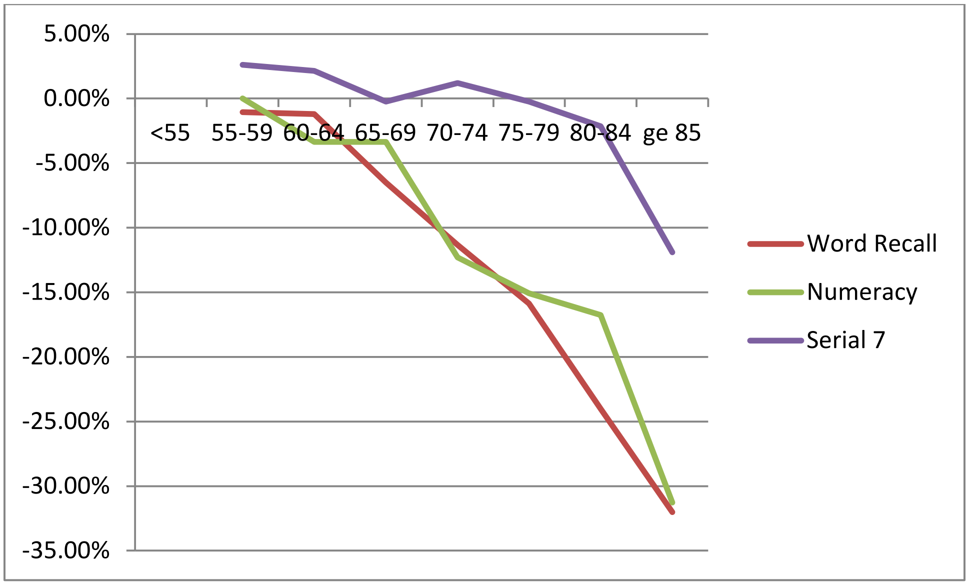
Only a small percentage of the sample, 8.64%, experienced double digit negative three month returns, while over half experienced a double digit decrease in returns between three and six months. The majority of the sample, 50.2%, indicated that they had a planning horizon of at least 5 years when considering financial matters, while 27.99% indicated a planning horizon between 1 and 5 years and 21.81% state a horizon of 1 year or less.

Table 1. Descriptive Statistics for the Total Sample (N = 3,205)

Variable	Min	Max	*Md*	*M*	*SD*
Actual % Δ in stock – Expect % Δ in stock	-100.00	92.52	-5.10	11.80	37.05
Cognitive Ability – Word Recall	0.00	10.00	6.00	5.97	1.62
Cognitive Ability – Numeracy	0.00	3.00	2.00	1.63	0.86
Cognitive Ability – Serial 7	0.00	5.00	5.00	4.19	1.24
	Count	%			
Fluid Cognitive Ability					
Below average word recall (reference)	529	16.50			
Average word recall	2170	67.71			
Above average word recall	506	15.79			
Low numeracy (reference)	484	15.10			
Some numeracy	2237	69.8			
High numeracy	484	15.10			
Risk Measures					
High wealth	1603	50.02			
High stocks as a percent of wealth	1603	50.02			
Defined benefit plan	250	7.80			
No defined benefit plan	2955	92.20			
Recent Returns					
Low 3 month returns	277	8.64			
High 3 month returns	2928	91.36			
Low 6 month returns	1630	50.86			
High 6 month returns	1575	49.14			
Demographics					
≤ 1 year (reference)	699	21.81			
The next few years	897	27.99			
≥ 5 years	1609	50.20			
Age < 60 (reference)	702	21.90			
Age 60 to 69	1097	34.23			
Age 70 to 79	882	27.52			
Age ≥ 80	524	16.35			
Retired	1819	56.76			
Not retired	1386	43.24			
High income	1603	50.02			
Male	1462	45.62			
Female	1743	54.38			
White	3019	94.20			
Other than white	186	5.80			

When considering the relationship between age and fluid cognitive ability we find a strong negative relationship for both working memory and high level numeracy.

Graph 1. % Difference in Fluid Cognitive Ability Scores by Age



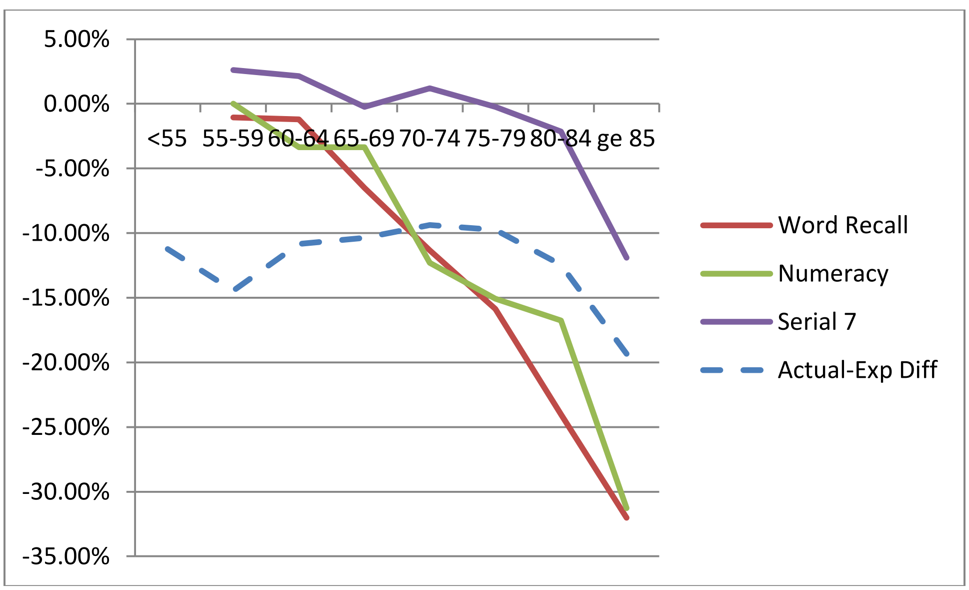
There is a 32.02% difference in the average working memory score between those younger than 55 and those older than 85. A similar result exists for numeracy, where average scores are 31.28% lower for the oldest respondents in comparison to the youngest respondents. The relationship between age and low level numeracy, captured by series 7 scores is negative, but not as strong.

Table 2. Cognitive Ability and Stock Reallocations by Age

	Age							
Variable	<55	55 -59	60-64	65-69	70-74	75-79	80-84	>=85
% w/ College Degree	45.54	48.60	42.18	36.33	34.38	40.48	36.57	29.69
Mean CA - Memory	6.62	6.55	6.54	6.19	5.87	5.57	5.03	4.50
% Diff CA - Memory	---	-1.06	-1.21	-6.5	-11.33	-15.86	-24.02	-32.02
Mean CA - Numeracy	1.79	1.79	1.73	1.73	1.57	1.52	1.49	1.23
% Diff CA - Numeracy	---	0.00	-3.35	-3.35	-12.29	-15.28	-16.76	-31.28
Mean CA – Serial 7	4.20	4.31	4.29	4.19	4.25	4.19	4.11	3.70
% Diff CA – Serial 7	---	2.62	2.14	-0.24	1.19	-0.24	-2.14	-11.90
Mean Beg Stock %	67.74	67.37	65.07	67.42	67.79	67.02	66.70	63.43
Mean Dep Var	-11.23	-14.46	-10.85	-10.37	-9.38	-9.74	-12.45	-19.34

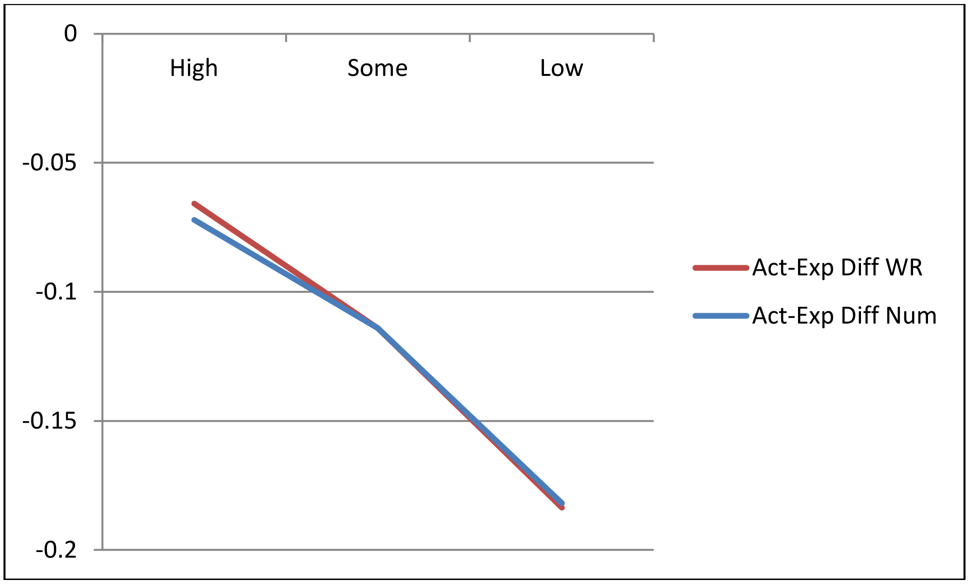
When looking at stock reallocations by age we show what appears to be an insignificant relationship.

Graph 2. % Difference in Fluid Cognitive Ability Scores by Age, with Actual % Δ – Expected % Δ in Stocks as a % of the Portfolio Overlay



Only at ages greater than 80 does it appear that age has a strong relationship with stock reallocations. This is consistent with the much lower levels of fluid ability at those ages. When we look at stock reallocations by fluid ability we show a strong negative relationship that is almost identical between word recall and numeracy.

Graph 3. Actual % Δ – Expected % Δ in Stocks as a % of the Portfolio by Fluid Cognitive Ability



For those with the highest levels of working memory the mean difference between actual and expected stock reallocations is -6.58%. This difference is much higher for the lowest levels of working memory at -18.36%. When comparing high and low levels of numeracy the median differences are -7.21% and -18.18% respectively. Evidence here indicates that fluid ability may be a much better predictor of reallocations than age alone. This is somewhat surprising given the strong relationship between cognitive ability and age shown in Graph 1, and likely indicates that effects related to age, such as experience and wealth, have an impact on stock reallocation decisions.

Table 3. Actual - Expected Difference by Fluid Cognitive Ability

Variable	Average Beginning Stock Percentage	Median Actual – Expected Difference
Below Average Working Memory	65.65	-18.36
Average Working Memory	66.93	-11.41
Above Average Working Memory	65.65	-6.58
Low Numeracy	66.47	-18.18
Some Numeracy	66.37	-11.41
High Numeracy	67.25	-7.21

In Table 4 we look at crosstabs on allocation decisions by respondent characteristics. Here we report the percentage of respondents that allocated their portfolios away from stocks between 2006 and 2008. We find a negative monotonic relationship between fluid ability and the percentage of respondents allocating away from stocks, consistent with what we show in Table 3 and Graph 3. When looking at our risk measures we see that lower levels of wealth are more strongly associated with allocations away from stocks than higher levels of wealth. This is consistent with expectations, as increased wealth is associated with increased ability to take risk. We also observe that those more willing to take risk, proxied by stocks as a percentage of overall wealth, have a larger percentage that allocate away from stocks than their counterparts. This and the percentage of respondents with defined benefit plans who allocated away from stocks is contradictory to expectations. Because defined benefit plans increase one's general capacity to hold risky assets, we expect to see a lower percentage of defined benefit holders allocating away from stocks. This may indicate that individuals do not consider defined benefit plans when making portfolio allocation decisions, and therefore do not incorporate them into decisions to hold risky investments. It may also suggest that defined benefit plan holders have less market experience on average and therefore are more prone to biases when making investment decisions.

When considering high versus low three and six month returns, there is little difference in the percentage of respondents allocating away from stocks. Planning horizon appears to impact stock reallocations, with those allocating away from stocks decreasing as planning horizon increases. Approximately 56% of those with a planning horizon of at least 5 years allocate away from stocks, while 62% with a planning horizon of less than 1 year allocate away. A smaller percentage of retired versus non-retired households allocate away stocks. This may indicate a difference in the perceived time horizon related to the retirement goal between the two groups. A smaller percentage of male and white respondents allocate away from stocks when compared to females and those who are not white.

Table 4. Crosstabs on Allocation Decisions by Participant Characteristics

Variable	Allocations Away from Stocks	N
Fluid Cognitive Ability		
Below average word recall	64.08	529
Average word recall	58.57	2170
Above average word recall	54.35	506
Low numeracy	63.84	484
Some numeracy	58.74	2237
High numeracy	54.13	484
Risk Measures		
High wealth	54.96	1603
Low wealth	62.67	1602
High stocks as a percent of wealth	62.01	1603
Low stocks as a percent of wealth	55.62	1602
Defined benefit plan	65.60	250
No defined benefit plan	58.24	2955
Recent Returns		
Low 3 month returns	60.29	277
High 3 month returns	58.67	2928
Low 6 month returns	58.65	1630
High 6 month returns	58.98	1575
Demographics		
≤ 1 year	61.80	699
The next few years	61.32	897
≥ 5 years	56.12	1609
Age < 60	61.40	702
Age 60 to 69	57.06	1097
Age 70 to 79	57.26	882
Age ≥ 80	61.64	524
Retired	56.13	1819
Not retired	62.34	1386
High income	57.45	1603
Low income	60.17	1602
Male	58.00	1462
Female	59.50	1743
White	58.00	3019
Other than white	72.04	186

Multivariate Analysis

A binary logistic regression is used to measure the impact of the predictor variables on stock reallocations, where allocations away from stock of 50% or greater than expected is the dependent variable. Fluid cognitive ability is significantly related to allocations away from stock. When compared to those with low working memory, respondents with average working memory are about 30% less likely to allocate away from stock, while respondents with high working memory are approximately 50% less likely to allocate away from stocks. Those with average and above average numeracy are 25% and 45% less likely to allocate away from stocks than those with below average numeracy. This is consistent with the prior findings that indicate numeracy and IQ as significant predictors of market participation and willingness to hold equities (Grinblatt, Keloharju, and Linnainmaa, 2012). It also supports findings that those with lower levels of cognitive ability are more subject to behavioral biases, such as loss aversion, and more willing to sell stocks at a loss (Bucher-Koenen & Ziegelmeyer, 2011).

We also find some significance between our risk measures and the likelihood of allocating away from stocks. Those with higher levels of wealth are 48% less likely to allocate away from stocks than those with lower levels of wealth, evidence that those with higher levels of wealth recognize their increased ability to take risk in the financial marketplace. We also find a significant relationship between stocks as a percentage of wealth and allocations away from stocks. Those with higher levels of stock as a percentage of wealth are approximately 22% more likely to allocate away during the great recession. This could be evidence that these individuals are trying to minimize losses and preserve their wealth. Alternatively, this may indicate that two decision making systems are at work within individuals, one that is neutral and takes into account long-term considerations and one that is impulsive when faced with risk. Because it takes effort to suppress the latter, those with lower levels of cognitive ability may be more prone to fear driven efforts to minimize risk (Shiv, Lowenstein, Bechara, Damasio, & Damasio, 2005).

We use three and six month S&P returns to proxy for the impact of market sentiment on stock trading between 2006 and 2008. We fail to show a significant relationship between three month and six month returns and stock reallocations. We do not believe this to be evidence that sentiment has no impact on stock reallocation decisions during the great recession. Rather, it appears that the effects of sentiment are pervasive, and would be difficult to carve out of return experiences at any time period. To illustrate this point we consider S&P returns in correspondence with 2008 interview dates. The 2008 surveys were administered from March 2008 through February 2009. For those interviewed in March 2008 the S&P 500 had already decreased by approximately 15% from its October 2007 value. Between March 2008 and February 2009 the S&P 500 fell another 44%. Approximately 60% of the sample decreased their stock allocations by more than expected. 10% of the sample reduced their stock allocations by 70% or more than expected, 25% reduced their allocations by 30% or more, and 40% reduced their stock allocations by 15% or more than expected. These things in combination provide evidence that investor sentiment did impact stock reallocations during the great recession.

Planning horizon is also found to be significantly related to the likelihood of allocating away from stocks. When comparing those with a planning horizon related to financial decisions of 1 year or less to those with a planning horizon covering the next few years there is no significant difference. However when we compare those with a short planning horizon to those with a planning horizon of at least 5 years, we find that those with a long planning horizon are 25% less likely to allocate away from stocks during the great recession. We also find that retired respondents are significantly less likely to allocate away from stocks than non-retired respondents. This may be indicative of a difference in perceived time horizon related to the retirement goal between the two groups. Those approaching retirement may frame the retirement goal to be short-term, with their retirement date being the target for completion. If this is the case those who are not retired may try to de-risk the portfolio during a negative financial event to preserve their goal. In contrary, those who are retired may view the retirement goal as long-term and recognize the need to maintain an appropriate allocation to equities to maximize their utility from wealth and support their long-term consumption needs.

Table 5. Binary Logistic Regression Results for Allocations Away from Stocks

	Away from Stocks (Odds Ratios)		
Variable		Robustness Checks	
Fluid Cognitive Ability	50%	25%	75%
Average word recall	**0.712	*0.816	***0.523
Above average word recall	***0.495	*0.744	***0.371
Some numeracy	*0.757	*0.805	0.771
High numeracy	**0.554	**0.641	*0.639
Risk Measures			
High wealth	***0.515	***0.629	***0.384
High stocks as a percent of wealth	*1.224	1.033	***1.662
Defined benefit plan	0.983	1.053	0.738
Recent Returns			
Low 3 month returns	1.127	*1.328	1.046
Low 6 month returns	1.169	1.059	1.061
Planning Horizon			
The next few years	0.993	1.005	0.916
≥ 5 years	*0.745	*0.794	**0.641
Demographics			
Age 60 to 69	0.912	0.970	0.843
Age 70 to 79	0.847	0.932	0.846
Age ≥ 80	1.061	1.251	0.860
Retired	**0.700	***0.667	*0.680
High Income	*0.799	*0.817	*0.722
Male	1.079	1.007	1.151
White	***0.570	***0.605	**0.536

*$p < .05$, **$p < .01$, *** $p < .001$

Robustness Checks

To check for robustness, we ran logistic regressions with 25% and 75% as the allocation away cutoffs. In all cases we found a significant negative relationship between fluid ability and the likelihood of allocating away from stocks. An interesting observation from this analysis is how cognitive ability is related to allocations away from stocks at varying levels. With 25% as the cutoff numeracy appears to be the more important determinant of investor behavior. However, as the allocations away from stock get bigger we see the effect of working memory become more significant.

All other findings are consistent and support the findings of our original analysis. This is further confirmed by the results of an OLS regression, found in Table 6, used to measure the impact of the model factors on allocations away from stock measured as a linear variable. Our final robustness test is included to address the varying levels of education among the cohorts in our sample. We show in Table 2 that the greatest variation in percentage of respondents with a college degree is found between respondents under 65 and respondents over 85. The variation in the percentage of respondents with a college degree between the ages of 65 and 85 is relatively small. We use an OLS regression in Table 7 to measure the impact of the model factors on allocations away from stock with the sample limited to only those with a college degree. Despite the positive correlation between fluid ability and education, we still provide evidence that the level of cognitive ability is related to investors' decisions to allocate away from stocks during the great recession.

Table 6. OLS Regression Results for Stock Reallocations

Variable	Estimate	t Value
Intercept	***-39.373	-10.20
Fluid Cognitive Ability		
Average word recall	***5.943	3.18
Above average word recall	***9.585	3.87
Some numeracy	**4.126	2.32
High numeracy	**6.314	2.54
Risk Measures		
High wealth	***8.732	6.40
High stocks as a percent of wealth	***-8.801	-6.74
Defined benefit plan	0.111	0.04
Recent Returns		
Low 3 month returns	1.122	0.49
Low 6 month returns	-1.792	-1.39
Planning Horizon		
The next few years	0.924	0.50
≥ 5 years	**5.044	2.97
Demographics		
Age 60 to 69	1.166	0.61
Age 70 to 79	1.940	0.86
Age ≥ 80	-0.732	-0.28
Retired	***7.095	4.28
High Income	*2.601	1.79
Male	-0.705	-0.52
White	***11.078	3.99

Adj. R^2 0.0523***, *$p < .05$, **$p < .01$, *** $p < .001$

Table 7. OLS Regression Results for Stock Reallocations, Censored to Respondents with a College Degree, n-=1,262

Variable	Estimate	t Value
Intercept	***-24.766	-3.95
Fluid Cognitive Ability		
Average word recall	3.726	1.23
Above average word recall	**9.853	2.75
Some numeracy	3.054	0.88
High numeracy	4.149	1.07
Risk Measures		
High wealth	***6.377	3.14
High stocks as a percent of wealth	***-8.421	-4.43
Defined benefit plan	-3.857	-1.20
Recent Returns		
Low 3 month returns	5.612	1.73
Low 6 month returns	1.829	0.97
Planning Horizon		
The next few years	2.591	0.90
≥ 5 years	2.742	1.06
Demographics		
Age 60 to 69	-3.095	-1.18
Age 70 to 79	-2.522	-0.79
Age ≥ 80	-3.231	-0.83
Retired	**5.582	2.34
High Income	2.211	1.01
Male	-1.453	-0.73
White	*7.226	1.84

Adj. R^2 0.0523***, *$p < .05$, **$p < .01$, *** $p < .001$

Conclusions and Implications

We look specifically at the stock reallocation decisions of older households during the great recession. By evaluating these decisions during a negative event we observe investor behavior when financial decisions are further complicated by loss aversion and other behavioral biases. We provide evidence that older households are subject to lower levels of fluid cognitive ability. We also find that fluid ability is significantly related to allocations away from stock during the great recession. However, we do not show a significant relationship between increased age and allocations away from stock. This suggests that where fluid ability is absent, regardless of age, investors may be prone to engage in behavior that is suboptimal when compared to the rational norm.

Despite the absence of a significant relationship between sentiment and allocations away from stock during the great recession, the number of respondents that allocated away from stock and the levels at which they did so is evidence that sentiment was low and that it had an impact on investor behavior. Loss aversion and sentiment are closely related during a negative event as they both shift investor focus to recent poor performance and lead to trading and reallocations motivated by a desire to minimize the effects of current period losses. Although not directly tested in this study, it is likely that investors with low fluid cognitive ability are more prone to the effects of sentiment, as sentiment reflects beliefs about future investment risks and returns not justified by available information. An inability to use reason in the absence of information, or the inability to acquire and effectively use information both indicate cognitive deficiencies that likely lead to low sentiment, increased loss aversion, and suboptimal investment behavior during the great recession. Because sentiment drives markets away from their intrinsic values, loss averse investors engaging in portfolio reallocations motivated by recent returns face reversals in future investment performance that are detrimental to their long-term portfolio returns and overall wealth.

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Appendix A – Dependent Variable Calculation (Actual % ∆ - Expected % ∆ in portfolio allocations to stocks, 2006-2008)

The following example is used to outline how the dependent variable is calculated in the study: Assume an individual has financial wealth in 2006 equal to $100 and that the $100 is allocated 70% stocks and 30% bonds/cash in an investment portfolio. Also assume that the individual's financial wealth is 50% stocks and 50% bonds/cash in 2008 and that the cumulative S&P returns experienced between 2006 and 2008 are -40%, and the bond/cash returns are 4% per year.

Actual % ∆ = 2008 stock % - 2006 stock %

From example = 50% - 70% = -20%

Expected % ∆ = 2008 expected stock %[1] - 2006 stock %

From example = 56.4% - 70% = -13.6%

[1]2008 expected stock % = expected value of stocks in 2008/expected value of portfolio in 2008

From Example =

1. $100*.7 = $70 (value of stocks in 2006)
2. $70*(1-.4) = $42 (expected value of stocks in 2008)
3. $100*.3 = $30 (value of bonds/cash in 2006)
4. $30*1.04^2 = $32.45 (expected value of bonds cash in 2008)
5. $42 + $32.45 = 74.45 (expected value of portfolio in 2008)
6. $42/74.45 = <u>56.4%</u> (2008 expected stock %)

Actual % ∆ - Expected % ∆ (from example) **= -20% - (-13.6%) = -6.4%**

Negative numbers represent allocations away from stock between 2006 and 2008 in greater than what can be explained by market returns.