Time Varying Risk Aversion and Risk-Taking Behavior of Dutch Individuals

Master Thesis

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Abstract

This study uses a repeated survey of Dutch households to investigate how individuals' risk aversion changes and drives risk-taking behavior from 2006 to 2013. I find that the qualitative measure of risk aversion, based on the DHS-questionnaire about investment strategies, increases substantially after the stock market crash of 2008. These fluctuations in risk attitudes are stronger for stockholders than they are for non-stockholders. As the Dutch economy is rebounding, individuals' risk aversion also seems to recover. Furthermore, I provide evidence that the qualitative risk aversion measure can be considered as a reliable predictor of households' risk taking behavior. While the equity holdings of Dutch households are positive related to the Amsterdam Exchange index, total household risky assets holdings are not. The findings show that households reduce their risk-taking behavior by holding less risky assets in their portfolios, as from 2008. This reduction in risk taking does not seem to recover as the Dutch economy starts to improve nor as individual risk aversion decreases.

Table of Content

1. Introduction

It has been over six years since investment bank Lehman Brothers filed for bankruptcy and set-off a financial crisis. The collapse of the bank, in September 2008 was followed by an era that saw the bail-out of many financial institutions and the meltdown of the stock and housing markets.

The article 'Six lessons you should have learned from the financial crisis' in the Wall Street Journal on September 22, 2013 was subtitled: 'Are we any wiser than we were five years ago?' The fourth lesson says that people are more risk-averse than they think, selling their stocks when the stock market is collapsing, at precisely the wrong time. As the stock market is currently rebounding, many individuals remain confused about what they should have learned from the recent tumultuous times. As a result, people are still wrestling with fundamental questions about how to manage their finances. Some individuals are comfortable again with risk-taking as the stock market is recovering whereas others remain cautious of stocks and worry that the markets could face more upheaval in the future. Time varying risk aversion and risk-taking behavior of Dutch individuals is therefore the subject of this research. I study risk aversion and risk-taking behavior of 332 respondents to the CentERpanel annually from 2006 till 2013. Previous research has also focused on time-varying risk aversion, especially during the 2008-2009 financial crisis. To my knowledge, I am the first to examine changes in Dutch individuals' risk aversion and risk-taking behavior over the crisis period. It is important to study individual risk-taking behavior as this can affect asset prices. Moreover, individuals are increasingly being asked to take on responsibility for their financial well-being and their retirement preparation. Hence, the importance of Dutch individual finance management rises.

To examine how individual risk aversion as well as their risk-taking changes over time, I use a panel-data set which combines data from the DNB Households Survey (DHS) with a matching experiment. This provides two approaches of risk aversion. One, which will be labeled the quantitative risk aversion measure, is based on an investment decision experiment designed by Gneezy and Potters (1997). The second measure, labeled as the qualitative one, relies on the annual DHS questionnaire about investment strategies. These measures are validate with DHS data on households' assets and liabilities, which also provides information in the individuals' risk-taking behavior.

Guiso, Sapienza and Zingales (2013) find that risk aversion among clients of an Italian bank increases substantially after the 2008 financial crisis. These changes seem to be correlated with portfolio choices, indicating that individuals also reduce their risk-taking. In fact, the data shows support for a fear model, which predicts that following a sharp drop in stock prices individuals should sell their stocks. They provide evidence for the experience hypothesis of Malmendier and Nagel (2011) that investors who experienced abnormal low stock returns report higher risk aversion and are less likely to invest in stock.

Various approaches to measure risk attitudes are discussed in this study. To ensure a valid measurement, I compare the different approaches of risk aversion and risk taking. The results show that the qualitative risk aversion measure can be considered as the best predictor of individuals' risk attitudes and risk-taking behavior. Therefore qualitative risk aversion will be the main indicator of individual time-varying risk aversion.

My findings on the time-varying of Dutch individual risk aversion and risk-taking are in line with the results of Guiso et al. (2013). First, I use univariate analyses, or *t*-tests to check if risk aversion and risk-taking changes significantly over time. Individuals' risk aversion reaches its highest level in 2009, during the first interview moment after the major stock market decline of September – October 2008. However, in years with improving AEX returns risk aversion indicators report some significant positive changes in line with the findings of Hofmann, Post and Pennings (2013) that risk attitudes recover towards the end of the crisis. On the other hand, it seems as though individuals keep reducing their risk-taking behavior over the whole sample period, also as the economy and the stock market is recovering.

The final part of my panel data analyses are regression on both qualitative risk aversion and risk-taking. Qualitative risk aversion is significantly negative related to the Amsterdam Exchange (AEX) Index. This relation is stronger for equity holders as a decrease in the AEX relates to an almost twice as high increase in risk aversion of stockholders than it does for non-stockholders. The regressions on risk taking show that there is a significantly negative relation between qualitative risk aversion and households' risk taking. The results also provide evidence for decreasing relative risk aversion, as risk-taking seems to increase with wealth.

2. Literature Survey & Hypothesis Development

2.1 Literature Survey

Dutch investors were hit hard by the 2008 financial crisis. Dramatic events like the bankruptcy of Lehman Brothers, the bail-out of AIG and the nationalization of banks as ABN AMRO and Fortis lead to tumbling stock markets all around the world. The Amsterdam Exchange index value more than halved during 2008, falling by 52.2 percent. For the decade between 1998 and 2008, the AEX even had the dubious honor of being the second worst performing stock index, after the OMX Iceland 15. Questions regarding bank solvency, declines in credit availability and damaged investor confidence had its impact on global stock markets and likely induced individual investors to change their perceptions and investment behavior during this crisis (Hudomiet, Kézdi and Willis, 2011).

Time varying risk perceptions

Hoffmann, Post and Pennings (2013) investigate the impact of the crisis on investors' risk tolerance and risk-taking behavior. Their study among clients of a large discount broker in the Netherlands documents that investors' perceptions significantly fluctuate over the course of the crisis. During the substantial AEX index pullback individual investor risk perception increases while return expectations and risk tolerance decreases. These variables quickly recover as the stock markets start to rebound. Interestingly Dutch individual investors do not de-risk their portfolio during the crisis, as they continue to trade actively. In addition, investors' portfolio risk seems to move in parallel with market risk. This would indicate that the changes in risk tolerance have no impact on portfolio choices. A possible explanation for this effect might be the short timeframe used in this study or it might be investor inertia, which refers to the large fraction of investors not trading during the sample period. Also investors do not try to reduce risk by shifting from risky investments to more safe ones like cash. Instead, they seem to use the depressed asset prices as a chance to enter the stock market.

Earlier research of Hoffmann, Post and Pennings (2011) shows that a sharp increase in the overall share of investors trading during the height of the 2008 crisis. Overall, investors who are successful during the market crash also perform better in the months prior to the crisis. Yet these investors become less risk averse in the subsequent period and are then no longer able to outperform their peers. This might suggest that the crisis and the related higher returns made them overconfident (Gervais and Odean, 2001). Hoffman et al. (2011) also find that investor perceptions fluctuate significantly during the crisis, with risk attitudes and risk perceptions being less volatile than return expectations.

Roszkowski and Davey (2010) confirm this change in investors' risk perception due to the crisis as almost half of the respondents in the survey agreed with the statement that the stock market is now

more “dangerous” than it has been in the past. Risk tolerance on the other hand, is not drastically affected by economic circumstances according to this study.

Weber, Weber and Nosić (2013) conduct a study among UK online-brokerage customers to determine what drives investors to change their risk taking during the financial crisis. Other than in previous studies they examine the relation between changes in risk taking, risk expectations and risk attitude. According to their research the changes in risk taking are mainly driven by changes in subjective expectations of risk and return, whereas risk attitudes remain remarkably stable over time.

Stability of risk aversion

The previous mentioned papers mainly find stable or rather less volatile risk aversion levels among investors during the crisis period whereas risk perception and risk taking fluctuate. Some researchers view risk aversion as a unitary phenomenon and therefore believe that the same degree of risk aversion will be evident across different situations (Dohmen, Falk and Huffman, 2011). Others belief that risk aversion fluctuates from moment to moment based on factors such as one’s mood, like the writer of the book *Your Money and Your Brain*, Mr. Zweig (2007). In this book he argues that risk tolerance tends to change due to the asymmetric relationship of loss aversion, which refers to the phenomenon that most investors experience a much greater pain after losing ten percent as compared to the rush they receive over gaining ten percent. Roszkowski (2009) also examines the relative and absolute stability of financial risk tolerance and finds no evidence for neither of these two extreme viewpoints. His findings confirm the position endorsed by most economists that risk aversion is relatively stable but not fixed. Education, experiences and changes in individual circumstances can cause changes in risk attitudes over time. Sahm (2012) confirms this point of view as she estimates a model in which risk aversion is decomposed into a time-constant and a time-varying component. She argues that risk aversion differs greatly across individuals but is relatively stable for a particular individual. Most of the time-constant components are personal characteristics like gender and ethnicity. However sources of systematic changes, like an improvement in macroeconomic conditions, are time-varying components that do lead to a decrease in individual’s risk aversion. Remarkable is the finding that attitudes towards risk do not seem to be sensitive to changes in income or wealth, which is consistent with the hypothesis of constant relative risk aversion.

Wealth and risk aversion

During the 2008 crisis the AEX index value more than halved, the Dutch unemployment rates reached its highest level in 30 years and the burst of the housing bubble lead to an average fall in Dutch house prices of 4 percent a year until 2012 (Eurostat). These significant market events caused a severe shock to Dutch households’ capital, leaving the Dutch with high mortgages, and induced a decline in total spending partly because of the low consumer confidence (Centraal Bureau voor de Statistiek, 2014).

A survey among U.S. families between 2007 and 2009 documents that most families experience a decline in wealth during the survey period. As might be expected, these changes in wealth reflect the decline in values of homes, stocks and businesses rather than shifts in portfolio composition. As a result, families appear more cautious at the end of the crisis than at the beginning, as most families report a greater desired buffer of savings and many express concerns about future income and employment (Bricker et al., 2011). Likewise the crisis might have had a significant impact on total Dutch households' wealth. Therefore it is important to investigate the relation between risk aversion, risk taking and wealth.

Economics have been analyzing the relation between wealth and risk aversion for centuries. Almost three hundred years ago, Bernoulli (1954) was one of the first mathematicians to study the measurements of risk by analyzing a simple experiment of flipping a coin. In this experiment the gambler only got paid if the coin came up tails and then got offered a second flip to double his winnings. However the gamble would stop if the coin came up heads. This experiment, called the St. Petersburg Paradox, raised the question how much an individual would be willing to pay to partake in this gamble. Bernoulli (1954) resolved this paradox by distinguishing price from utility. He argued that the value of an item must not be based on its price, while the price of an item is only dependent on the thing itself and is equal for everyone. The utility, however, is dependent on the particular circumstances of the person making the estimate and so it becomes evident that no valid measurement of the value of a risk can be obtained without consideration being given to the individual's utility. Next to this proposition, Bernoulli (1954) provided two insights in his research that continue to animate how we think about risk today. First, he indicates that the value attached to a gamble will vary across individuals as a function of their risk aversion. Second, he argues that the utility from gaining an additional dollar will decrease with wealth.

These two propositions provide the foundations for the Arrow and Pratt measurements of absolute and relative risk aversion. In the mid-1960s, John Pratt and Kenneth Arrow introduced the hypothesis that relative risk aversion should decrease with wealth. Since that time, many researchers have been examining the relationship between risk aversion and wealth. Riley and Chow (1992) examine individual asset allocation and risk-taking behavior among U.S. households. Their results show that risk aversion decreases as individuals rise above the poverty level and decreases significantly for the very wealthy. These findings are in line with the earlier study of Cohn et al. (1975) who document a strong pattern of decreasing relative risk aversion with wealth. The data shows that as wealth increases, a higher proportion of the total wealth gets invested in risky assets. These findings are in line with the research of Finke and Huston (2003) who document that investors with high willingness to take risks have significantly higher net worth, with almost four times the accumulated financial assets and eight times the amount invested in stocks, than respondents unwilling to accept financial risk. The respondents with high willingness to take risks are also more likely to have a higher average

income. Additional research on the relation between income and risk aversion of Guiso and Paiella (2008) provides evidence that individuals who are more likely to face income uncertainty or to become liquidity constrained exhibit a higher degree of risk aversion.

Wealth and risk-taking behavior

The study of Brunnermeier and Nagel (2006) investigates how households' portfolio allocation changes in response to wealth fluctuations. They suggest that persistent habits, consumption commitments and subsistence levels will lead to time-varying risk aversion as wealth changes. As a result, changes in a household liquid wealth should lead to a similar change in a household holdings of risky assets. However their findings show that households' portfolio allocation is not affected by wealth changes. Inertia might explain this absence of a wealth affect while households rebalance their portfolio very slowly following capital gains or losses. Chiappori and Paiella (2011) confirm this relation as they find no significant response of portfolio structure to changes in financial wealth. Remarkably, they do find a negative relation between risk aversion and wealth.

Based on data from a German household panel, Necker and Ziegelmeyer (2013) investigate whether changes in wealth due to the financial crisis affect households' risk attitudes, stock market expectations and risk taking behavior. The results of the study show that risk attitudes of German households remain rather stable over the course of the crisis. However suffering an income loss or feeling increased job uncertainty seems to decrease risk aversion while, remarkably, actually suffering a job loss increases risk aversion. Necker and Ziegelmeyer explain this rather opposing results by arguing that the German strong social security net might bias the findings of the study. They also document that future risk taking behavior is influenced by changes in expected return but not in changes of risk attitudes. Having experienced a "wealth shock" thus indirectly increases risk taking via increased return expectations. These findings are in line with the results of Weber et al. (2013) who also document that changes in risk taking are mainly driven by changes in subjective expectations of risk and return.

Time varying risk-taking behavior

On December 22, 2008, the Wall Street Journal headlined "Stock Investors Lose Faith, Pull Out Record Amounts". This article report stated that investors pulled a record $72 billion from stock funds in October 2008 alone and moved their money into safer assets like government bonds and cash holdings. Responding to this article, the study of Dorn and Weber (2013) investigates the overall equity allocation and diversification of 40,000 self-directed clients at one of the three largest retail banks of Germany from January 2007 to October 2011. During this period, the overall equity allocation of these investors remains fairly stable. The composition of their equity portfolios however, changes substantially during the crisis. In particular, German investors shift their equity portfolio away from actively managed funds towards individual stocks or, to a lesser extent, passive funds and

exchange-traded funds. This shift from stock funds to individual stocks results in portfolios that are 30 percent riskier in terms of volatility than they were pre-crisis. According to Dorn and Weber (2013) the main driver of this trend is the drop in value of portfolio which seems to have shaken investors' confidence in the ability or trustworthiness of active fund managers.

The research of Kallberg et al. (2012) among Chinese investors finds similar results. Individual investors, on average, did not withdraw their capital from the equity market during the financial crisis. Instead, they seem to invest proportionately more capital relative to the period before the crisis. Furthermore, they show that net flows are asymmetrically return sensitive: investors are more likely to sell after experiencing gains and to hold as they have experienced losses. This investment behavior is consistent with the disposition effect, which predicts that investors are more likely to realize their gains than their losses. This effect is present over the entire sample period and gets even stronger during the crisis. Additionally, the study shows that investors adjust their portfolios by shifting to relatively safer and more liquid stock.

The study of Ameriks, Madamba and Stephen (2009) among U.S. investors also shows evidence for inertia or persistence in investment decisions of equity investors. According to this study six out of ten respondents make no changes to their stock holdings during the market crash of 2008. The remaining 40 percent of the investors pursue a variety of strategies during the downturn of the market, with 21 percent reducing their equity holdings, 5 percent selling all their equity and 17 percent raising stock exposure. These findings underscore the fact that individual investors do not monolithic respond to the 2008 market downturn but instead pursue a variety of strategies.

Time-varying risk aversion

Guiso, Sapienza and Zingales (2013) investigate the time varying of risk aversion among clients of an Italian bank following the 2008 financial crisis. According to their paper, individual risk aversion increases after the crisis. The changes in risk aversion seem to be correlated with changes in portfolio choices, indicating that individuals also reduce their risk-taking. Since this increase in risk aversion cannot be explained by changes in wealth, habits or background risk, the researchers argue that these fluctuations might be mainly driven by psychological factors like fear. The data shows support for a fear model, which predicts that following a sharp drop in stock prices individuals should sell their stocks while the habit model forecasts that people should actively buy equity to bring the risky assets to the new optimal level. These results are partially at odds with the finding of Weber et al. (2013) that risk attitudes remain stable during the financial crisis. This discrepancy in results might be explained by the difference in measure of risk attitudes, as the approximation of Weber et al. (2013) might tend to mix risk expectations and risk aversion. Moreover this study starts measuring risk attitudes in September 2008 while the stock market was already crashing. This might bias the conclusions about the change in individuals' risk aversion due to the financial crisis.

The proposition of Bernoulli (1954) that risk aversion can vary widely across human beings and is dependent on particular circumstances of the individual, forms the basis for the study of Malmendier and Nagel (2011). Their research examines whether individuals who live through different economic times differ in their willingness to take financial risks. The results show that personal experiences shape individual investment behavior. According to the research, those investors who experienced abnormal low stock market returns report higher risk aversion, are less likely to invest in stocks and allocate a lower proportion of their liquid assets to the equity market. Additionally, it seems that the relation between experience and risk taking is partly affected by beliefs rather than risk preferences. Suggesting that individuals attempt to learn from their experience, the experience effect can be explained by the findings that higher experienced stock returns are associated with more optimistic beliefs about future stock returns. The study of Bucher-Koenen and Ziegelmeyer (2011) adds additional layers of complexity to these findings of Malmendier and Nagel. An important result of this study is that not all individuals are equally prone to shy away from the assets that burned them: Investors with less financial expertise are more likely to react in this fashion than more informed investors are. As a result, the financial illiterate households fail to benefit from markets' resurgence in the short-run and from the equity premium in the long-run. This asymmetry in reaction of households potentially gives rise to serious effects with respect to wealth accumulation and distribution, as it tends to reinforce and exacerbate inequalities.

2.2. Hypothesis Development

It has been well documented how the financial downturn and economic crisis of 2008 stretched financial institutions, politicians and corporations to their limits. Less is known about how Dutch individuals responded to the stock market shock. Did the Dutch experience a decline in willingness to take risks? And if so, is this decline temporarily or permanent? Did individuals cut their losses and changed their investment strategy or did they continue their investments as they did prior crisis? These questions I will examine in this research. Therefore the topic of investigation for my Master thesis is:

Time Varying Risk Aversion and Risk-Taking Behavior of Dutch Individuals

I will investigate this topic by means of five hypotheses. Firstly, it is questionable if risk aversion is a constant measure or a variable one. As described in the literature survey, empirical studies are not unanimous about the stability of individual risk aversion. Additionally, a lot of researchers have examined the differences in risk aversion across demographic groups. To begin with the basis, gender differences affect attitudes towards risk, as women are more likely to be risk averse. Throughout life, changes caused by aging as well as socialization and experiencing education, marriage and employment can alter risk attitudes (Croson and Gneezy, 2009; Dohmen, 2005 and Grable, 2000). Moreover, as mentioned in the literature survey, wealth and income levels might affect individual risk

aversion (Finke and Huston, 2003 and Guiso and Paiella. 2008). In my first hypothesis, I will test the effects of these differences in demographic and financial characteristics on individual risk attitudes.

$\boldsymbol{H_1}$ **:** Risk aversion is negatively correlated with being male, older, in a relationship, higher educated, professionally employed and having higher income and wealth.

The correlation between individuals' wealth and risk attitudes has been a central subject of empirical research ever since Kenneth Arrow and John W. Pratt (1965) have defined a measure of risk aversion. As explained by Cohn (1975): "*Pratt and Arrow independently developed the concepts of absolute and relative risk aversion as ways to indicate, as a function of wealth, the amount and proportion of wealth placed by the investor into a risky asset when his portfolio decision is limited to choosing combinations of a riskless asset and that one risky asset*". Cohn finds evidence for decreasing relative risk aversion: as wealth increases, a higher proportion of the total is committed by the individual involved to risky assets. Later research of Morin and Suarez (1983) supports this assumption, with the exception of the lower wealth segment of the population. This group shows increasing relative risk aversion. A potential bias of this result might be the absence of any asset data on pension funds, life insurance and other social benefits of a contractual nature. Since it is more likely for the lower wealth group not to have such assets, the inclusion of contractual savings data might erase the effect of increasing risk aversion for this group.

Theory of choice under uncertainty implies that differences in individual risk aversion levels should be very important in explaining observed differences in behavior. I expect a negative relation between wealth and risk aversion. If this relation holds it can be expected that an increase in wealth should lead to an increase in risky asset ownership.

$\boldsymbol{H_{2A}}$: Household wealth is positively related to the household risky assets ownership, consistent with the theory of decreasing relative risk aversion.

High risk aversion most likely indicates that an individual will invest his money more prudent and therefore is less likely to participate in the stock market, as argued by Barsky et al. (1997). They document that risk aversion is negatively related to risky behaviors like smoking and drinking, but also to holding stocks rather than Treasury bills. Paiella and Guiso (2004) show that more risk averse individuals choose lower returns in exchange for lower risk exposure when they invest their assets. The study of Schooley and Worden (1996) compares a household's reported willingness to take financial risks to the riskiness of their portfolios and find evidence that households do allocate portfolio holdings consistent with their professed attitudes toward risk taking to increase returns. These findings suggest that households' relative risk aversion can be assessed by responses to questions about risk aversion, as well as by measuring asset allocation. Also it indicates that

households do understand the basic risk-return relationship: an investor must be willing to accept more risk to earn a higher expected return.

$\boldsymbol{H_{2B}}$: Risk aversion of individuals is negatively correlated to their risky assets ownership.

Furthermore, I will investigate whether the crash in the stock market has an effect on individual risk attitudes in line with the experience hypothesis of Malmendier and Nagel (2011). Their findings show that individuals who have experienced low stock market returns throughout their lives report lower willingness to take financial risks. In addition, Barberis et al. (2001) present an alternative model in which investors derive direct utility not only from consumption but also from changes in the value of their financial wealth. This contrasts with the traditional approach which holds that the only thing investors take into account, when choosing a portfolio, is the future consumption utility their wealth will bring. The researchers include the feature of loss aversion in their model as they argue that investors' loss aversion level depends on their prior investment performance. After prior gains, investors will be less concerned about future losses because any loss will be cushioned by the prior gains. In contrast, after a prior loss, the investor will be more loss averse since the initial loss will make him or her more sensitive to additional setbacks. Thaler and Johnson (1990) find evidence which supports this model while their study shows that a prior gain can increase subjects' willingness to accept gambles. Conversely, prior losses can decrease the willingness to take risk.

I will mainly focus on the AEX performance as an index for the stock market value while my survey consists of Dutch households. In contrast with earlier studies, where gambles or lotteries are used to investigate the effect of prior performance on an individual risk taking, this research will investigate the impact of the AEX index value on individuals' risk attitudes and risk taking by hypothesizing further.

$\boldsymbol{H_{3A}}$: Risk aversion of Dutch individuals is negatively related to the AEX index value.
$\boldsymbol{H_{3B}}$: Individual risk taking is positively related to the AEX index value.

If there is indeed a relation between the AEX index value and the risk aversion of Dutch individuals, it is expected for this effect to be greater for investors since they are more likely to closely monitor the stock market and therefore will notice changes in the index earlier. Moreover they will be more affected by these changes as a part of their wealth depends on the AEX performance. Research of Hudomiet et al. (2011) shows that seventy percent of stockholders claim to follow the stock market while of non-stockholders only thirty percent claims to do so. They also find that stockholders have more positive and less uncertain expectations about the one-year-ahead return on the Dow Jones stock market index than non-stockholders do. These differences might be explained by the fact that these different groups receive different signals or process the signals in very different ways. In my study I will focus on risk attitudes rather than stock market expectations. Since stockholders are more exposed

to the effects of a stock market crash, I expect risk aversion of stockholders to change more than for non-holders after the crisis.

$\boldsymbol{H_4}$: The fluctuations in individuals' risk aversion level are stronger for stockholders than for non-stockholders.

The AEX index value more than halved during the financial crisis, but has been recovering ever since. If Dutch individual risk attitudes are indeed related the AEX index, the changes in attitudes and risk taking might not be permanent. Hoffmann et al. (2013) argue that, although individual investors' risk aversion increase during the crisis, the changes seem to be temporarily as this variable quickly recovers towards the end of the crisis. Harrison et al. (2005) argue that individual risk aversion is stable. The researchers find no significant shift in risk aversion of individuals given the same test separated by six months. However they do argue that stability over longer periods of time requires that possible changes in the 'states of nature' that individuals might condition are taken into account as risk aversion might change with major life events such as marriage or the birth of children. When controlled for these variables however, risk aversion should remain stable according to the study. The model estimated by Sahm (2012) decomposes risk preference into a time-constant and a time-varying component. The results of this study show that while risk aversion changes with age and macroeconomic conditions, demographic difference across individuals like gender and education account for 73% of the systematic variation.

The financial crisis caused changes in macroeconomic conditions of the Dutch, like a drop in gross domestic product and higher unemployment rates. However, these drops expected to be temporarily. Therefore I expect any change in risk attitudes of the Dutch individual to recover as soon as the Dutch economy is improving. For that reason I will investigate the stability of risk attitudes of Dutch individuals in the long run.

$\boldsymbol{H_5}$: The risk aversion level of Dutch individuals remains stable in the long run.

3. Data and Methodology

3.1 Data

The data in this thesis have been collected from the CentERdata, an institute for applied economic and survey research for the social sciences that is affiliated with Tilburg University. CentERdata carries out its survey research mainly by using its own panel called CentERpanel. This panel is representative of the Dutch population, comprising 2,000 households in the Netherlands. The members of those households answer a questionnaire performed on the internet, at the convenience of the respondent and without intervention of an interviewer. Participants who do not have internet access are provided with a device and technical support.[1] The final dataset of this thesis is a combination of data collected from the households in the DNB Household Survey (hereafter DHS) and an investment decision experiment conducted by CentERdata. These questionnaires are both collected from households participating in the CentERpanel, which made it possible to match these datasets using a unique identifier number for each respondent.

To test whether there is a relation between the financial crisis and individuals' risk aversion, data about individuals' risk aversion levels over time are required. The final dataset consists of two different approaches to measure risk aversion. The first approach is data of an one-time-only experiment conducted by CentERdata about a risky investment decision task. The second part consists of the DHS dataset which provides annually data of the households as a whole and on individuals residing within the household, regarding aspects of individual demography and financial situation over the period 2006-2013.

The experimental test conducted by CentERdata is designed by Gneezy and Potters (1997) and involves three rounds of an investment task. In each round, subjects are endowed with 2 euros and have to decide how much of this amount they want to invest in a lottery in which there is a 2/3 chance to lose the invested amount and a 1/3 chance to win 2.5 times the invested amount. The lotteries in each round are independent. Moreover, subjects cannot invest money accumulated in previous rounds, that is, the maximum investment in each round is 2 euros.

At the start of the experiment the respondent has to choose between two treatments: The high-frequency treatment and the low-frequency treatment. In the former treatment, the investment decision has to be made round by round. At the beginning of round 1 the respondent has to choose the amount x_1 of their endowment of 2 euros to invest in round 1 of the lottery. Next they are informed about the outcome of the first round of the lottery and have to decide on part x_2 of their new endowment of 2 euros that they like to invest in round 2. Again they are informed about the result and asked to make

[1] For more information about the CentERpanel and the way it is administered see http://www.centerdata.nl/en/.

their decision x_3 for round 3 following feedback about the result. In the low-frequency treatment respondents make just one investment decision for all three rounds, which imposes the constraint $x_1 = x_2 = x_3$. The combined results of rounds 1, 2 and 3 are revealed at the end of the third round. In this part of the experiment all subjects are paid according to their decisions.

The DHS is a panel survey managed by CentERdata on behalf of the Dutch National Bank. The data are collected annually since year 1993. The DHS consists out of six questionnaires. The topics that are covered by the questionnaires are:

1. General Information on the Household
2. Household and Work
3. Accommodation and Mortgages
4. Health and Income
5. Asset and Liabilities
6. Economic and Psychological Concepts

A major advantage of the DHS panel survey is the fact that the panel is part of an annual long questionnaire, which provides a lot of annually individual-specific information as wealth, demographic characteristics and the economic environment of the respondent. Information about the demographics of the individuals are obtained from the first questionnaire. Annual information about the respondents' ownership and quantity of different categories of assets, liabilities and mortgages is gathered from questionnaire five. Lastly, questionnaire six includes a set of self-assessed qualitative questions about different aspects of risk aversion. To create my dataset I downloaded the data of questionnaire one, five and six for the years 2006 – 2013.

The final dataset is a merge of the data collected from the Gneezy and Potter (1997) designed experiment of the CentERpanel and the data of the three DHS questionnaires in up to eight waves between 2006 and 2013. Since only a small part of the panel has responded to both the CentERpanel experiment and all eight years of the DHS questionnaires the merged dataset has a smaller number of observations because after the merge all respondents with missing data were deleted from the dataset. A few respondents show extreme fluctuations in their financial assets. These nonrepresentive outliers were excluded from the dataset. This results in a final dataset made of 286 households with a total of 332 respondents.

Finally the dates of collection of the DHS data on 'Economic and Psychological Concepts', which includes the self-assessed questions on risk aversion, were matched to the Amsterdam Exchange index value at the time of the interview. The Amsterdam Exchange index is composed of 25 of the most actively traded securities on NYSE Euronext Amsterdam and can be considered as a leading indicator of the economy as changes in stock prices reflect investors' expectations for the future of the Dutch

economy. Combining the AEX index value with the self-assessed questionnaire on individuals' risk aversion makes it possible to determine if there is a relation between the Dutch economy and the individuals' risk aversion level and risk-taking behavior.

3.2 Methodology

This paragraph discusses the methodology for this research. My empirical research can be divided into three different parts. First, I define different measures of individual risk aversion and highlight the assumptions and limitations of these different measures. Next I conduct univariate tests and perform multivariate regressions to test the different hypotheses.

3.2.1 Measuring Individual Risk Aversion

To test if risk aversion changes over time it is necessary to infer a measure of risk aversion that is independent of asset prices. Two different approaches exist: the first relies on a revealed preference strategy, the second on direct measurements of risk attitudes from choices in experiments or survey questions.

Revealed Preferences

Individual investors' differences in risk aversion imply that, given an identical opportunity set (that is, a risk-free rate and a reward-to-volatility ratio), different investors will choose different position in the risky asset. In particular, the more risk-averse investor will choose to hold less of the risky asset and more of the risk-free asset. An investor who faces a risk-free rate, r_f, and a risky portfolio with expected return $E(r_P)$ and standard deviation σ_P will find that, for any choice of proportion in the risky asset, y, the expected return of the complete portfolio, $E(r_C)$, is given by the following equation:

$$E(r_C) = r_f + y\,(E(r_P) - r_f)$$

The variance of the overall portfolio, σ_C^2, can be calculated in the following way:

$$\sigma_C^2 = y^2\sigma_P^2$$

Investors attempt to maximize utility by choosing the best allocation to the risky asset. The utility function can be measured as follows:

$$U = E(r_C) - \frac{1}{2}A\sigma_C^2$$

where U is the utility value and A the Arrow-Pratt degree of relative risk aversion of the individual.

As the allocation to the risky asset increases (higher y), expected return increases, but so does volatility, so utility can increase or decrease. The utility maximization problem can be solved as follows:

$$Max\ U\ (y) = E\ (r_C) - \frac{1}{2} A\ \sigma_C^2 = r_f + \ y\ \left[E(r_P) - \ r_f\right] - \frac{1}{2} A\ y^2 \sigma_P^2$$

$$FOC\ (y): E(r_P) - \ r_f - \frac{1}{2} \times 2\ \times A\ \times\ y\ \sigma_P^2 = 0$$

$$y^* = \frac{E(r_p) - \ r_f}{A\sigma_P^2}$$

This solution shows that the optimal position in the risky asset, y^*, is, as one would expect, inversely proportional to the level of risk aversion and the level of risk (measured by the variance) and directly proportional to the risky premium offered by the risky asset. Under the (common) assumption that beliefs about stock market returns and riskiness ($E(r_p) - \ r_f$ and σ_P^2) are the same for all investors, individual investor's risk aversion is given by:

$$A = \frac{E(r_p) - \ r_f}{y^* \sigma_P^2}$$

Let's apply this approach to the experimental test designed by Gneezy and Potters (1997). In the experiment there is a 2/3 chance to lose the invested amount and a 1/3 chance to win 2.5 times that amount. Therefore the expected return can be computed by:

$$E(r_p) - \ r_f = \tfrac{2}{3} \times -1 + \tfrac{1}{3} \times 2.5 = \tfrac{1}{6}$$

The riskiness of the experiment is defined by the variance of the experiment:

$$\sigma_P^2 = \frac{\sum(x_i - \bar{x}\ )^2}{n} = \frac{\left(-1 - \frac{1}{6}\right)^2 + \left(-1 - \frac{1}{6}\right)^2 + \left(2.5 - \frac{1}{6}\right)^2}{3} = \frac{8\,{}^1\!/_6}{3} = 2.722$$

where $\bar{x}$ is the mean or expected value of the experiment and n is the total of possible outcomes.

And so it follows that the *revealed preference measure* of the respondent's risk aversion is given by the following equation:

$$A = \frac{E(r_p) - \ r_f}{y^* \sigma_P^2} = \frac{(1.167\ )}{(\frac{b}{200})2.722}$$

where b is the mean amount of the 200 cents invested in each round the experiment.

This approach, derived from the risk aversion and capital allocation to risky assets equations of Bodie et al. (2011), is easy to apply, but has several shortcomings. For instance, the fact that risk aversion can only be computed for those with a positive amount invested in risky assets. Individuals who do not participate in the risky assets market, possibly because they are highly risk averse, can therefore not be tested on risk aversion. A second limitations of this approach might be investors' inertia. To estimate the time varying changes in risk aversion, portfolio shares should be instantaneously adjusted according to the individual's risk aversion level. If not, any adjustment costs imply that inferences drawn about risk aversion are biased (Bonaparte and Cooper, 2009).

Quantitative Measure of Risk Aversion

To overcome these problems, researchers have resorted to direct measures of risk aversion by relying on specifically designed questions asked through field experiments. In such experiments, individuals are confronted with specific risky prospects, like the experiment conducted by CentERdata designed by Gneezy and Potters (1997). As described in the previous paragraph of this thesis, during this experiment individuals are endowed with 2 euros in each of three periods. In each round they can invest a fraction of these 2 euros. Then, three lotteries are played. In each round, the individual may lose the invested b euros, with probability 2/3, or win $2.5b$ euros, with probability 1/3. There are two treatments. In the high frequency treatment, respondents are allowed to make the investment decision round by round. This way they are able to change the invested amount in the second and third round depending on the outcome in the round before. In the low frequency treatment, this is not possible, as respondents make one decision for all three rounds.

Gneezy and Potter (1997) findings support the behavioral hypothesis of myopic loss aversion, which assumes that a longer evaluation period makes a risky option with positive expected return look more attractive. This indicates that the more frequently returns are evaluated, the more risk averse investors will be. The results of the experiment conducted by CentERdata are in line with this hypothesis, while the low frequency group has invested more than the high frequency group did (see Table A.1).

The constant relative risk aversion function in which utility is defined over wealth x is measured in the following way:

$$U(x) = \begin{cases} \dfrac{x^{1-\rho}}{1-\rho} & if\ \rho \neq 1 \\ \ln(x) & if\ \rho = 1 \end{cases}$$

where ρ is the probability of a certain outcome.

Respondents will aim to maximize their expected utility EU by choosing b, the mean amount of cents invested in each round of the experiment:

$$Max\ EU\ (b) = \frac{2}{3} U\ (2 - b) + \frac{1}{3}\ U\ (2 + 2.5\ b)$$

The expected utility, EU, of the experiment can thus be calculated by using the following formula:

$$EU(b) = \frac{2}{3} \times \frac{(2-b)^{1/3}}{1/3} + \frac{1}{3} \times \frac{(2+2.5b)^{2/3}}{2/3}$$

The inverse function gives the certainty equivalent, CE, of expected utility EU,

$$CE = U^{-1}(EU) = \begin{cases} \sqrt[1-\rho]{EU\ (1-\rho)} & if\ \rho \neq 1 \\ \exp(EU) & if\ \rho = 1 \end{cases}$$

where U is the utility value and ρ is the probability of a certain outcome. The certainty equivalent of the experiment is the amount of payoff, offered for certain, which gives the respondent exactly the same utility as the experiment. The certainty equivalent, CE, of the experiment can be computed in the following way:

$$CE = U^{-1}(EU) = \frac{2}{3} \sqrt[1-2/3]{EU\ (1 - 2/3)} + \frac{1}{3} \sqrt[1-1/3]{EU\ (1 - 1/3)}$$

Note that the function is divided into two sections. The first part includes the possible loss of the experiment and the second part comprehends the possible gain. This formula can be completed by adding the expected utility of both outcomes:

$$CE(b) = U^{-1}(b) = \frac{2}{3} \sqrt[1/3]{\frac{(2-b)^{1/3}}{1/3}\ (1/3)} + \frac{1}{3} \sqrt[2/3]{\frac{(2+2.5b)^{2/3}}{2/3}\ (2/3)}$$

It follows that a risk averse individual's certainty equivalent will be less than the expected value of the experiment, as they will have a positive risk-premium. Simply put, risk averse respondents need an additional incentive to make them want to take on the risk of the gamble. A risk neutral individual will have a zero risk premium and a certainty equivalent equal to the expected value of the gamble. Similarly a risk loving respondent will have a negative risk premium and will need an extra incentive to accept the expected value over the risky experiment and so the certainty equivalent has to be greater than the expected value of the experiment. Thus risk aversion is negatively related to the certainty equivalent.

The final risk aversion approach based on the Gneezy and Potters (1997) experiment is to simply rely on the mean invested amount of each round of the experiment, b. Highly risk averse individuals will

chose to invest less in each round than risk loving individuals will do. Therefore the purest approach to measure respondents' risk aversion is simply computed by:

$$A = 200 - b$$

where A is the risk aversion level and b is the mean amount of 200 cents invested in each round of the experiment. This approach can be considered as the purest indication of risk aversion based on the experiment. I will refer to this measure based on as *the quantitative risk aversion* variable.

Qualitative Measure of Risk Aversion

Another approach to obtain a risk aversion measure is by relying on specifically designed questions on risk attitudes asked in household surveys. These questions have been shown to predict risk aversion behavior in various domains (Dohmen et al., 2011) and can be used to sort people into risk aversion groups. The DHS-questionnaire contains six direct questions about investment strategies, as shown in Table 1, which provides a qualitative indicator of risk aversion. Respondents can express their agreement or disagreement with these statements on a seven point scale, from 1 ("complete disagreement") to 7 ("complete agreement"). Notice that question one, two and four are framed in such a way that a high agreement on these statements would indicate more risk aversion, while for the remaining questions (the third, fifth and sixth ones) a high agreement would indicate less risk aversion. For sake of comparability, the answers to questions three, five and six were converted in such a way that higher values indicate more risk aversion. The final measure of *qualitative risk aversion* is the mean of the individual answers to the six self-assessed risk aversion questions, and so the value can fluctuate from 1 to 7.

Table 1 Self-assessed questions on risk aversion

No.	Label in our analysis	Question
1	Guaranteed returns	*I think it is more important to have safe investments and guaranteed returns, than to take a risk to have a chance to get the highest possible returns.*
2	No investment	*I would never consider investments in shares because I find this too risky.*
3	Borrowing	*If I think an investment will be profitable, I am prepared to borrow money to make this investment.*
4	Safe investment	*I want to be certain that my investments are safe.*
5	Financial risk	*I get more and more convinced that I should take greater financial risks to improve my financial position.*
6	Chance to gain	*I am prepared to take the risk to lose money, when there is also a chance to gain money.*

Notes: Answers to Questions 1 to 6 are coded in a 1-7 scale, from 1 ("complete disagreement") to 7 ("complete agreement").

The main drawback of this approach is that it does not distinguish between risk aversion and risk perception. Some respondents may show higher risk aversion because they perceive more risk. This shortcoming can be partly addressed by evaluating the riskiness of the household's portfolio at the time of the questionnaire, but also by analyzing a question of the DHS-questionnaire about the self-

perception of the risk exposure of the individual in past investment decisions. This question reads as follows:

"What would you say was the risk factor that you have taken with investments over the past few years? If you haven't made any investments, choose 'not applicable'."

Possible answers:

1. *I have taken no risk at all*
2. *I have taken small risks every now and then*
3. *I have taken some risks*
4. *I have sometimes taken great risks*
5. *I have often taken great risks*
6. *Not applicable*
7. *Don't know*

The respondents have to make an approximation about the degree of riskiness of their past investments. While this question might be interpreted with ambiguity, for instance because one can have different interpretations of years to consider as "the past few years", it is still interesting to use this information as a proxy for the individual perception of risk bearing. Therefore two dummies are considered in the analysis. The first dummy will indicate if the respondent has made any investment in the past. This variable will be equal to one if the respondent reports any value between 1 (no risk) and 5 (great risk). Additionally a dummy considering past risk exposure will be included, with a value equal to one if the respondent reports a value between 3 (some risk) and 5 (great risk). It is important to note that the DHS-questionnaire data is collected annually, in contrast with the experiment of the CentERdata. The qualitative measure of risk aversion can thus also be calculated annually for the period 2006 – 2013 while the quantitative measure of risk aversion is only available for 2006.

3.2.2 Methodology for Univariate Analysis

First a correlation matrix, using the Pearson correlation matrix, of all variables is made to analyze the correlation between all the variables within the model. Subsequently, I perform univariate tests to investigate if qualitative risk aversion shows significant differences across individual demographics and wealth. To check if risk aversion changes significantly over time and if these changes are greater for stockholders than for non-stockholders I performed different *t*-tests. This is the most commonly used test to check differences in means between samples and over time and can be conducted as a paired *t*-test (also known as the repeated samples *t*-test, as the data consist out of the same subjects or respondents measured at different points in time) or as a unpaired *t*-test (when the data is collected from two different and independent subjects). The test statistic for the paired *t*-tests is:

$$T = \frac{\bar{x}_{1-}\bar{x}_2}{\sqrt{\left[\frac{1}{n_1}+\frac{1}{n_2}\right]s^2}}$$

where the pooled sample variance, s^2, is estimated by:

$$s^2 = \frac{\sum_{j-1}^{n_1}(x_j - \bar{x}_1)^2 + \sum_{i-1}^{n_2}(x_i - \bar{x}_2)^2}{n_1 + n_2 - 2}$$

where $\bar{x}_1$ and $\bar{x}_2$ are the two sample means and n_1 and n_2 are the two sample sizes. The hypothesis for these tests will be:

$H_0: \bar{x}_{1-} \bar{x}_2 = 0$
$H_1: \bar{x}_{1-} \bar{x}_2 \neq 0$

Hypothesis H_0 is rejected for highly unusual values of T. The threshold beyond which H_0 is rejected, is called critical value and is determined from the *t*-distribution in such a way that the significance level has the pre-assigned value. The two-sided threshold at significance level α is denote *t*, so that the 'rejection region' for the two-sided t-test is given by:

$$|T| > t_{n-1}(1 - \alpha/2)$$

To test if respondents' risk aversion changes over time, I perform a paired two sided t-test, testing the null hypothesis that $RAQual_t - RAQual_{t-1} = 0$ using comparable statistics as above (where $RAQual_t$ is the qualitative risk aversion variable). A paired test is necessary as the sample is the same for all years from 2006 till 2013. By conducting *t*-tests on risk aversion for all successive years in this period, result can indicate if risk aversion varies over time.

Next, I conduct a two sided *t*-test to check if the changes in risk aversion are stronger for stockholders than for non-stockholders. However this time, the two samples in the test are not dependent as the amount of respondents who are stockholders can change annually. Therefore I will conduct an unpaired *t*-test for these groups. I test the null hypothesis that $RAQual_t - RAQual_{t-1} = 0$ in a similar way as before, using the following test statistic:

$$T = \frac{\bar{x}_{1-} \bar{x}_2}{\sqrt{\left[\frac{s_1^2}{\bar{x}_1} + \frac{s_2^2}{\bar{x}_2}\right]}}$$

where s_1^2 and s_2^2 are estimated by:

$s_1^2 = \frac{\sum_{j-1}^{n_2}(x_j - \bar{x}_1)^2}{n_1 - 1}$ and $s_1^2 = \frac{\sum_{j-1}^{n_2}(x_j - \bar{x}_2)^2}{n_1 - 1}$

3.2.3 Methodology for Panel Data Analysis

This research makes use of panel data analyses. For each hypothesis, I conduct the following regression:

$$Y_{i,t} = \alpha_i + \beta_1 X_{1,t} + \ldots + \beta_i X_{i,t} + \varepsilon_{i,t}$$

where $Y_{i,t}$ is the dependent variable, $X_{i,t}$ are the independent variables, β represents the slope, $\varepsilon_{i,t}$ is the error term and α_i represents the individual effect.

I will investigate the risk aversion of Dutch households as well as their risk-taking. Therefore the dependent variable of the different regressions will differ per hypothesis. The following equation presents the first regression:

- $RAqual_{i,t} = \alpha_0 + \beta_1 GEN_{i,t} + \beta_2 AGE_{i,t} + \beta_3 EMPL_{i,t} + \beta_4 RET_{i,t} + \beta_5 LC_{i,t} + \beta_6 MAR_{i,t} + \beta_7 EDU_{i,t} + \beta_8 HI_{i,t} + \beta_9 \Delta LnWLTH_{i,t} + \beta_{10} PINV_{i,t} + \beta_{11} RISKEXP_{i,t} + \beta_{12} LnAEX_{i,t} + \varepsilon_{i,t}$

The dependent variable of interest is individual risk aversion measured by qualitative risk aversion (defined as $RAqual_{i,t}$). Also other researchers have used a risk aversion measure based on self-assessed risk questions on risk attitudes as the dependent variable, like Hoffmann et al. (2013), Weber et al. (2013) and Bucciol and Miniaci (2011). The latter even uses the exact same questionnaire on risk aversion.

Additionally I investigate the relation between individual risk-taking and risk aversion, the AEX index quote and household wealth. Therefore I conduct the following regression models:

- $RFAOwn_{i,t} = \alpha_0 + \beta_1 RAqual_{i,t} + \beta_2 GEN_{i,t} + \beta_3 AGE_{i,t} + \beta_4 EMPL_{i,t} + \beta_5 RET_{i,t} + \beta_6 LC_{i,t} + \beta_7 MAR_{i,t} + \beta_8 EDU_{i,t} + \beta_9 HI_{i,t} + \beta_{10} \Delta LnWLTH_{i,t} + \beta_{11} PINV_{i,t} + \beta_{12} RISKEXP_{i,t} + \beta_{13} LnAEX_{i,t} + \varepsilon_{i,t}$

- $\frac{RFA}{WLTH_{i,t}} = \alpha_0 + \beta_1 RAqual_{i,t} + \beta_2 GEN_{i,t} + \beta_3 AGE_{i,t} + \beta_4 EMPL_{i,t} + \beta_5 RET_{i,t} + \beta_6 LC_{i,t} + \beta_7 MAR_{i,t} + \beta_8 EDU_{i,t} + \beta_9 HI_{i,t} + \beta_{10} \Delta LnWLTH_{i,t} + \beta_{11} PINV_{i,t} + \beta_{12} RISKEXP_{i,t} + \beta_{13} LnAEX_{i,t} + \varepsilon_{i,t}$

The dependent variable of interest in the first model is individual's risky financial assets ownership. This variable is measured by a dummy variable (defined as $RFAOwn_{i,t}$) with value 1 if the respondent is holding any risky financial assets and 0 otherwise. The dependent variable in the second regression is a ratio variable (defined as $\frac{RFA}{WLTH_{i,t}}$) which is calculated by the value of the household risky

financial assets divided by total household wealth. The models are elaborated with other explanatory variables. These variables are added in the basic model to create the best fit model, based on their significance and result in a higher R^2. Table A.2 of the Appendix provides a more detailed description of the explanatory variables of the equations.

I examine the economic significance by multiplying the estimated coefficient of the explanatory variable with one standard deviation of this explanatory variable. This is a one standard deviation change in the dependent variable. I will refer to the percentage change in the dependent variable relative to the average value, obtained by dividing the one standard deviation change by the mean value of the dependent variable times 100%.

4. Empirical Findings

The empirical findings are presented in this chapter. First the descriptive statistics of this study are presented. Next the different approaches to measure risk aversion are discussed. The third and fourth part of this chapter describe the results of the univariate and regression analyses.

4.1 Descriptive Statistics

The sampling design employed within this thesis yields a sample of 332 respondents within 286 different households. Table A.6 of the Appendix shows the demographic- and financial descriptive statistics of the sample for every year of the survey period 2006 – 2013. The table includes the mean and standard deviation for the independent and dependent variables in the models. The average household income of €21,377 is comparable to the Dutch national 2006 – 2013 average standardized household income of €23,000. Also the mean net worth (€163,500) and mean safe financial assets (€32,000) are close to the national mean (of respectively €166,000 and €40,000). However the respondents' risky asset ownership is considerably low in comparison to the Dutch population. Only 11.4 percent of the respondents own any shares, while 23.6 percent of the overall Dutch population do (CBS, 2014). This may be an indication for relatively high risk aversion among the respondents, but only if there consists a negative relation between risk aversion and risky asset ownership. Altogether the sample can be considered as a representative panel of the Dutch population.

Over 80 percent of the respondents in the sample are 45 years of age or older, with over one-half of those no longer in the labor force. These respondent's primary occupation is work in the own household or they are retired or partly disabled. About three-fourth of the respondents are married or living as partners and three-fifth of the respondents are male. Over 50 percent of the respondents have at least some post-secondary education.

To compare the mean levels of the different demographic groups I performed a pair wise comparison of the means, taking the mean of the first group of the variable as indicator. Results are shown in the third part of Table 2 and indicate that the mean level of qualitative risk aversion does vary significantly across some groups in the sample. An examination of life cycle stages reveals that single parents and older respondents who are no longer in the labor force have, on average, a significantly (1% and 10% level) higher risk aversion level than respondents who are in their family formation years. Females mean risk aversion level are higher than the males mean, at the 1% significance level. As the education level of the respondent increases, the risk aversion level decreases, however these differences are not significant. Household income shows no clear relation to respondents' risk aversion. Strikingly is the significant low risk aversion mean for the income level €40,000 to €75,000. One reason for this result may be that higher income households are less sensitive to risk than lower

income households are. However it is more likely that the small risk aversion level can be explained by gender differences (70% of the household income group €40,000 - €75,000 are male, compared to 42% males in the €10,000 – €14,000 income group). The multivariate analysis presented in paragraph 4.3 will examine the relationship of each of the respondent's socioeconomic characteristics to the level of risk aversion further, to provide a clear understanding of these factors.

Table 2 Demographic- and Financial Characteristics of the Sample

Demographic Characteristics		Mean Value
Age (in 2006)		53.7
Employed		49.5%
Retired		30.6%
Main Wage Earner		72.3%
Risky Asset Ownership Dummy		25.7%
Risky Asset Share Dummy		11.4%
Financial Characteristics		**Mean Value**
Risky Financial Assets		€ 6,628
Safe Financial Assets		€ 32,218
Wealth		€ 36,396
Net Worth (All Assets – All Debt)		€ 163,728
Household Income (mean of 3.922 is equivalent to)		€ 21,377
Risk Aversion Qualitative		5.449
Characteristic of Respondent	**Distribution (%)**	**Risk Aversion Qualitative**
Life Cycle		
Married or with partner, < 45 yr	13.2	5.333
Single parent, any age	1.5	6.171***
Single, < 45 yr, no children	3.2	5.388
Older, in labor force, ≥ 45 yr	34.2	5.379
Older, retired, not in labor force, ≥ 45 yr	47.9	5.513*
Marital Status:		
Married or living with partner	75.8	5.455
Single	24.2	5.431
Gender		
Male	60.8	5.288
Female	39.2	5.698***
Education		
No High school Diploma	4.3	5.504
High School Diploma	43.6	5.506
Some College	16.4	5.471
College degrees	35.7	5.362
Household Income		
Between € 10,000 and € 14,000	4.6	5.540
Between € 14,000 and € 22,000	20.9	5.547
Between € 22,000 and € 40,000	53.7	5.480
Between € 40,000 and € 75,000	19.4	5.238**
€ 75,000	1.4	5.408

Notes: The Dunnett's method is used to compare the mean Qualitative Risk Aversion level of the group to the mean of the reference group, which is the first level of each variable.
*, **,*** Mean variables are significantly different at the 10%, 5% and 1% level respectively.

Figures 1 and 2 show the Dutch stock market index (AEX) performance as well as the evolution of the respondents' risk aversion level and past investment behavior. Figure 1 clearly highlights the period of major stock market decline in 2008. It is important to know that the vast majority of the survey data of 2008 was collected in the eighth week of that year in which the AEX index reaches a value of a 450. Exactly one year later, when the 2009 questionnaire took place, the AEX value almost halved to a value of 240. Therefore the relation between the stock market crash and the individuals' risk aversion- and risk taking levels can be best examined by the changes in the data from 2008 to 2009.

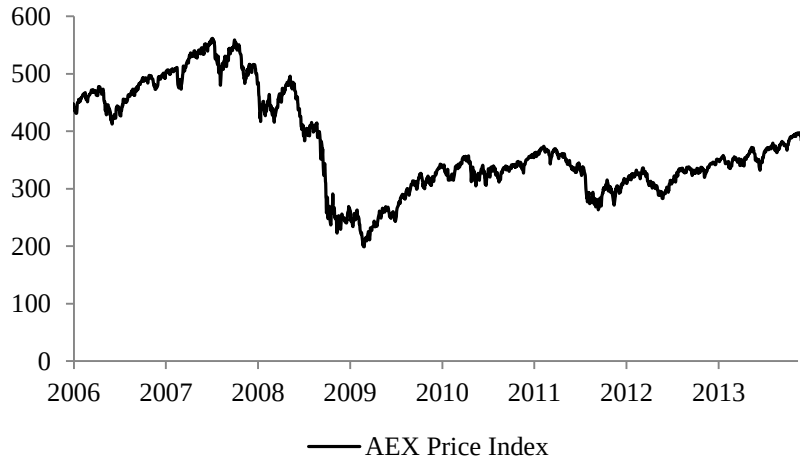

Figure 1. AEX Price Index for the period 01/01/2006 until 31/12/2013

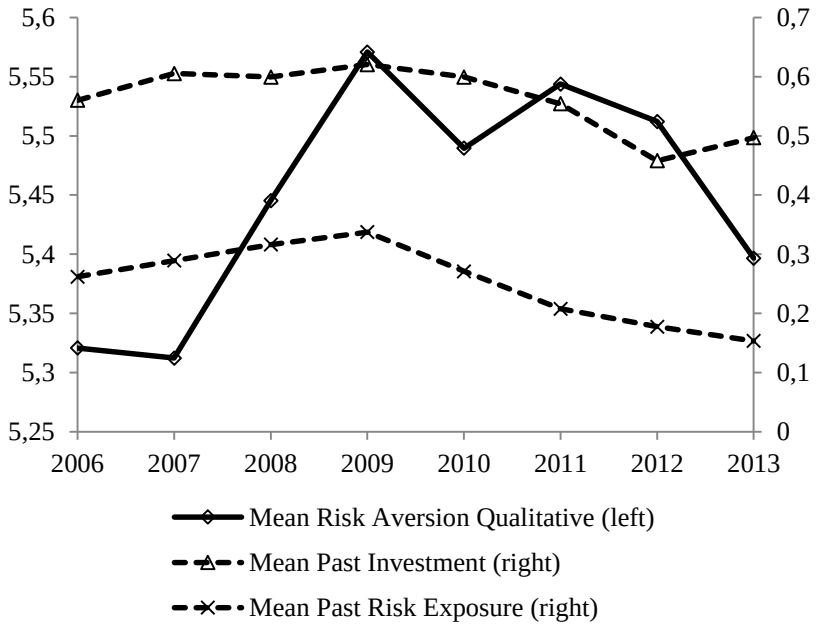

Figure 2. Qualitative Risk Aversion, Past Investment and Past Risk Exposure.
Notes: Qualitative Risk Aversion is measured on six self-assessed questions about risk aversion on a 7-point scale (see Table 1). Past Investment and Past Risk Exposure are measured on a similar question indicating if the respondent has taken high risks in the past. For all three variables the sample mean is shown.

4.2 Measuring and Comparing Individual Risk Aversion and Risk Taking

Measuring Risk Aversion

As described in the previous chapter, I define different measures of risk aversion. The first measure, patterned after the experimental test designed by Gneezy and Potters (1997), is based on preferences for risk-return combinations. As described in the previous chapter, individual's risk aversion, A, is given by:

$$A = \frac{E(r_p) - r_f}{y^* \sigma_P^2} = \frac{(1.167)}{(\frac{b}{200})2.722}$$

where r_f is the risk-free rate of the experiment, $E(r_p)$ the expected return of the investment, y^* the optimal amount invested, σ_P^2 the variance of the investment and b the mean amount of the 200 cents invested in each round of the experiment.

An alternative approach that can be used to measure individual risk aversion is to rely on the certainty equivalent of the experiment. This variable will reflect the respondents risk aversion level using the following equation:

$$CE(b) = \frac{2}{3} \sqrt[1/3]{\frac{(2-b)^{1/3}}{1/3}\left(1/3\right)} + \frac{1}{3} \sqrt[2/3]{\frac{(2+2.5b)^{2/3}}{2/3}\left(2/3\right)}$$

Since higher risk averse individuals will give up the risky experiment for lower certainty sums, a higher certainty equivalent will indicate a lower individual risk aversion level. Therefore it is expected for this measure to be negative related to the other risk aversion measures.

The final risk aversion approach based on the Gneezy and Potters (1997) experiment, the *quantitative indicator* of individual risk aversion, is to simply rely on the mean invested amount of each round of the experiment computed by:

$$A = 200 - b$$

where A is the risk aversion level and b is the mean amount of 200 cents invested in each round of the experiment.

The fourth risk aversion measure contains the DHS self-assessed questions on risk aversion (see Table 1), which provides a *qualitative indicator* of individual risk aversion. From this questions I construct a categorical variable ranging from 1 to 7 with larger values corresponding to greater dislike of risk. The DHS data are collected annually while the experiment of CentERdata is only collected once, in 2006.

As a result the qualitative measurement of risk aversion is the only variable in the dataset to rely on when testing if risk aversion levels of individuals do vary over time.

Measuring Household Risk Taking

Additionally four indicators of risk taking among households are defined. These variables are based on observed portfolio compositions of the households:

- Risky Asset Ownership Dummy: A dummy variable equal to 1 if the household does hold any risky financial assets and 0 otherwise.
- Risky Assets to Wealth Ratio: Households' holdings of risky assets per euro of wealth.
- Share Ownership Dummy: A dummy variable equal to 1 if the household does hold shares and 0 otherwise.
- Shares to Wealth Ratio: Households' holdings of shares per euro of wealth.

Figure 3 shows the evolution of households' risk taking over time. Complete definitions of this study's assets and wealth measures are presented in Table A.3 of the Appendix.

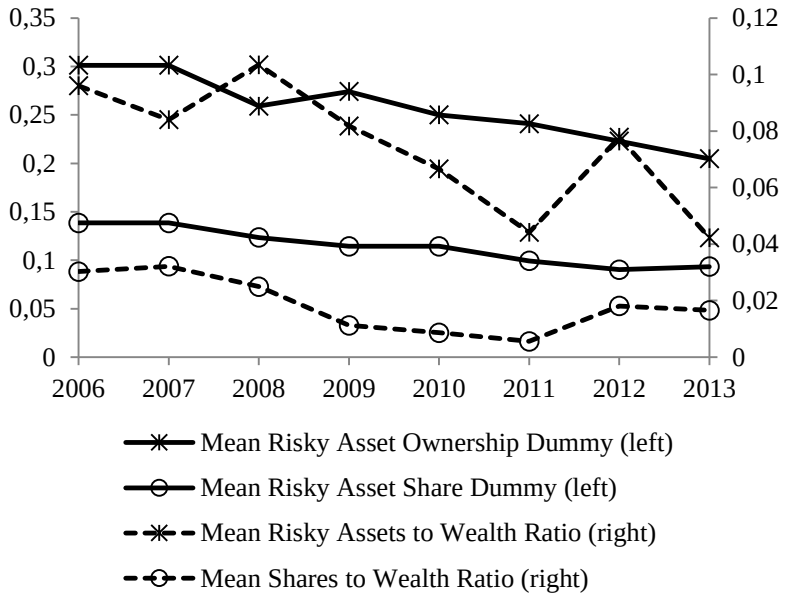

Figure 3. Household Risk Taking.
Notes: Household risk taking is based on four different variables: Two dummies indicating if the household owns any risky financial assets and/or shares and two ratio variables measuring the household holdings of risky assets/shares per euro of wealth. For all four variables the sample mean is shown.

Comparing Different Measures of Risk Aversion and Risk-Taking

To ensure a valid measurement, the different approaches to measure risk aversion are tested for correlation using the Pearson correlation matrix (as shown in Table 3). Remarkable is the significant low correlation (of 0.097) between the qualitative risk aversion indicator and the quantitative indicator. There are a few possible explanations for this low correlation. Firstly, in the experiment of CentERpanel actual money is involved. As a result, these studies are not subject to the incentive distortions of the hypothetical survey questions of the DHS questionnaire. Also, the experiment's odds of a bet are quite different than the expected return of the financial market, which might affect individual's investment decision and consequently their risk aversion level (Guiso et al, 2013). The study of Ding et al. (2010) finds a similar result as they compare individual risk attitudes based on self-assessment questions and the reservation price of a hypothetical lottery. Their findings show that correlations between the two different measures are in the right direction, but not very high. Moreover Table A.1 and A.4 of the Appendix show that the difference in treatment of the CentERdata experiment (high versus low) affects a respondent's bet and thus risk aversion level. For instance the correlation between the quantitative - and the qualitative risk aversion measure is smaller (0.059) for the high frequency treatment respondents than it is for the low frequency (0.105). This difference can be explained by the fact that the return of financial investments like mutual- and growth funds and shares have a longer evaluation period and so, the qualitative risk aversion measure based on these investment options will show a higher correlation with the low frequency group.

Furthermore, the work of Dohmen et al., (2005) and Kapteyn and Teppa (2011) shows that a measure based on answers to a number of simple risk preference questions has the most explanatory power. This finding is consistent with the correlation between a respondents' risk aversion level and the corresponding households' risk-taking behavior (as shown in Table 3). Of all three risk aversion measures the qualitative one, based on the self-assessed risk aversion questions, does not only report the highest negative correlation with the household risk-taking behavior but it is also the only significant one. Overall the qualitative risk aversion measure can be considered as the best predictor of individuals' risk attitudes and will therefore be the main indicator of individual time-varying risk aversion.

Table 3 Correlation between Risk Aversion, Risky Asset Ownership and the AEX value

Panel A: Correlation Matrix for Levels in Risk Aversion, Risky Asset Ownership and the AEX index value

	Risk Aversion Quantitative[a]	Risk Aversion Qualitative	Risky Assets Ownership Dummy	Risky Asset to Wealth Ratio	Share Ownership Dummy	Shares to Wealth Ratio
Risk Aversion Qualitative	0.097**					
Risky Asset Ownership Dummy	0.012	− 0.327***				
Risky Assets to Wealth Ratio	− 0.007	− 0.141***	0.368***			
Share Owner-ship Dummy	0.004	− 0.314***	0.611***	0.242***		
Shares to Wealth Ratio	0.039	− 0.157***	0.224***	0.464***	0.366***	
LnAEX	0.031	− 0.080***	0.030	0.018	0.034*	0.049**

Panel B: Correlation Matrix for Changes in Risk Aversion, Risky Asset Ownership and the AEX index value

	Δ Risk Aversion Qualitative	Δ Risky Assets Ownership Dummy	Δ Risky Assets to Wealth Ratio	Δ Risky Asset Share Dummy	Δ Shares to Wealth Ratio
Δ Risky Asset Ownership Dummy	0.000				
Δ Risky Assets to Wealth Ratio	− 0.002	0.172***			
Δ Risky Asset Share Dummy	− 0.020	0.448***	0.059***		
Δ Shares to Wealth Ratio	− 0.067***	− 0.005	0.006	0.015	
Δ LnAEX	− 0.088***	− 0.042**	− 0.007	0.018	0.210***

Notes: This table presents the Pearson correlation coefficient between individual's qualitative risk aversion measure, risky asset ownership and the corresponding (i.e., for the same week) value on the Dutch stock market index (AEX). Panel A presents correlations between risk aversion, risky asset ownership and the AEX value, while Panel B shows correlations between changes in risk aversion, risky asset ownership and AEX value.

[a] The correlation of the variables Risk Aversion Revealed Preference and Risk Aversion Quantitative is only tested for year 2006 as Qualitative Risk Aversion is measured one time only.

*,**,*** represent significance at the 10%, 5% and 1% level respectively.

4.3 Univariate Analysis

Figures 2 and 3 show the changes in individual risk aversion and risk-taking over time, as well as the evolution of the Dutch stock market index (Figure 1). Table A.7 of the Appendix presents the results of the univariate *t*-tests that show the significance of these changes. The table includes the qualitative risk aversion measure, all risk-taking measures and the AEX Index indicator. Panel A of the table compares the means of each variable betweens adjacent year pairs and the last year values versus the first year. Panel B, on the other hand, shows the difference between the variable annual means and the mean over the total sample period.

Individual risk aversion (Figure 2) increases when the AEX is experiencing a year of decline (see Panel A of Table A.7 of the Appendix). These changes in risk aversion are always significant except for the period 2011 versus 2012. The mean individual risk aversion level reaches its highest level in 2009. In years with improving AEX returns like 2010 and 2013, risk aversion indicators report significantly negative changes. Towards the end of the survey period, the risk attitude level is still statistically higher from their level at the beginning of the sample period while the AEX index value is still 90 points lower in 2013 when compared to 2006. The negative relation between risk aversion and the AEX index value suggests that individuals did not experience an enduring shock to their risk aversion levels, but instead regularly adapt their risk attitudes to changes in the market. The findings of adaptive evolution of risk aversion are in line with the findings of Hofmann et al. (2013) and Luigo et al. (2013) as both studies argue that the financial crisis depresses individual investors' risk attitudes. Their findings do indeed show that risk aversion increases during the worst months of the crisis. Towards the end of the crisis, however, the risk attitudes seem to recover.

The changes in risk-taking behavior (Figure 3) display less fluctuations over the survey period compared to risk aversion. As qualitative risk aversion seems to decrease as the AEX index recovers, the risk taking behavior of individuals does not increase. Both the risky asset ownership dummy and the share ownership dummy report some significant negative values from the height of the crisis in 2008 until 2012, but no significant positive ones (see Panel A of Table A.7 of the Appendix). Individuals seem to reduce their risk-taking by holding less risky assets in their portfolios. They do not seem to use the depressed asset prices as a chance to enter the market.

Individual risk aversion and risk-taking measures reach their lowest and highest levels in 2007 when compared to the average levels of these measures during the complete survey period (as shown in Panel B of Appendix Table A.7). To test if risk aversion and risk-taking are fully recovered from the financial crisis I compare the means of 2006 and 2013 of these variables. The result show that individuals are significantly slightly more risk averse and take a little less risk in 2013 as compared to 2006. These findings are in line with study of Malmendier and Nagel (2011) and Guiso et al. (2013). The latter find a supporting model to explain the changes in risk taking during the crisis. The study

shows that following a sharp drop in stock prices, a fear model predicts that individuals should sell stock, while the habit model forecasts that people should actively buy equity to bring the risky assets to the new optimal level. The results of the *t*-tests in Table A.7 show that after the drop in the AEX individuals rebalance their portfolio in a way consistent to the fear model.

To measure if time-varying risk aversion is stronger for stockholders than for non-stockholders, I conducted an unpaired *t*-test for these two different groups. Results are shown in Panel C & D of Appendix Table A.7. Especially during 2008-2009, when the AEX dropped over 200 points, risk aversion of stockholder increases significantly at the 10% level, with a value of 0.309, whereas the small change in non-stockholders risk aversion level, of 0.010, is not significant. The risk attitudes of non-stockholders seem to recover faster than that of the stockholders, as the former experiences a notable significant decrease of -0.126 in risk aversion from 2012 to 2013. Figure A.1 of the Appendix shows the difference in risk aversion of the two groups. The stockholders' risk aversion stays considerably smaller over the whole survey period. Therefore changes in stockholders' risk aversion seem greater in relative terms. However the overall differences between the groups are not that clear. Both report the highest level of risk aversion in 2009 (See Panel E and F of Appendix Table A.7). The differences in means between years of stock- and non-stockholders are both not consistent in direction and magnitude. Therefore, based on the unpaired *t*-test, there cannot be found a specific difference in time-varying risk aversion between stockholders and non-stockholders.

4.4 Panel Data Analysis

To gain more insight in the factors that drive individual risk aversion and risk-taking behavior, different regression models are conducted. First a panel regression is done in which demographic and financial characteristics and the AEX-indicator are included as explanatory variables to infer how they influence risk aversion. First I analyze the regression on qualitative risk aversion including all explanatory variables controlled for time fixed effects to test the time-invariant influence of these independent variables on risk aversion. The other three regressions do not include time fixed effects as the difference in years and corresponding changes in AEX performance are one of the main subjects of investigation in this study. The third and fourth regression infer how the difference between households that do own shares and households that do not affect the explanatory variables on individuals' risk aversion. The results are presented in Table 4.

The estimated coefficient on gender is significantly positive for all four regressions, indicating that women are more risk-averse than men. The age variable is significant (although only at the 10% confidence level) and slightly positive, with a coefficient of 0.009. This suggests that risk aversion slowly increases with age, which is in contrast with the developed hypothesis H_1. As mentioned before, it is important to note that the dataset under examination consists out of relatively older respondents, with an average age of 57 (see Appendix Table A.6). To check if this age effect

influences the relation between age and risk aversion two dummies are created. One taking the value one for all respondents until age 65 and zero otherwise and the other one has the exactly opposite value for all respondents older than 65. The Pearson correlation matrix in Table A.8 of the Appendix indeed shows a significant negative correlation between risk aversion until age 65, at which risk aversion switches to a positive correlation to age. Thus the small positive coefficient of age, as shown in Table 4, is likely to be biased by the high amount of elderly in the sample. This result is in line with the findings of Halek and Eisenhauer (2001), who show that after the age of 65 individuals' risk aversion increases significantly.

Characteristics such as age, gender and unemployment may clearly affect one's level of risk aversion, but the relationship between risk aversion and other characteristics such as education level and marriage status is not as clear. While it can be argued that these traits may affect one's risk aversion, it may also be the case that one's risk aversion affects these lifestyle choices. For example, marriage. While it can be argued that marriage affects one's risk aversion it may also be that one's risk aversion affects these lifestyle choices as more risk-averse individuals choose to marry (Halek and Eisenhaer, 2001). This reverse causality problem might even arise between individuals risk aversion and the AEX indicators when in response to an increase in individuals' risk aversion, households' are selling their stocks and as a result the AEX will experience a decline. Therefore, the causation of the regression analyses of these variables need to interpreted with caution.

The coefficients for the life cycle variable reveal that single parents report a significantly higher risk aversion level than respondents in their family formation years do. A possible explanation for this result might be that single parents are merely responsible for their children and can therefore not afford any high risk financial decisions. Note that the other life cycle variables do not differ significantly from those in their family formation years. This result may suggest that when other socioeconomic factors are held constant, employment and relationship status do not impact qualitative risk aversion. This result is amplified by the individual indicators of employment, retirement and marital status. None of these measures report a significant relation to risk aversion. The coefficients pertaining to education, household income and changes in wealth are not significant and thus there is no evidence for an effect of these variables on risk aversion. The findings that there exists no clear influence between risk aversion and a total households' income or wealth are in line with previous research of Weber, Weber and Nosic (2012) and Bucciol and Miniaci (2011) who also find no effect of these variables on risk aversion.

The unclear relation between education and risk aversion is clearly present in the different literature studies on this context. For instance the study of Schooley and Worden (1996) argues that education affects the propensity to take risk as higher educated respondents would be more financially sophisticated and would thus make more riskier investments. Alternatively, Halek and Eisenhauer

(2001) belief that it could be that the degree of risk aversion affects a respondent's decision to leave or stay in school. The results of regression analyses on qualitative risk aversion are partially in line with other findings of Halek and Eisenhauer (2001) who also find no noticeable influences of education nor employment on risk aversion. Contrarily they do find a positive relation between being married and risk aversion. This difference in result might be explained by the difference in description of the marital status variable as, in this study, not only married respondents are included in the variable but also respondents who are living with their partner.

The two variables that reflect stockholders' interpretation of their household portfolio risks report remarkable results. Respondents who report to have taken some or even great risks on their past investments are, as expected, less risk averse as respondents who did not. Contrarily, the variable that indicates if the respondent has made any investment in the past shows no significant effect on risk aversion. Notable is the finding in column 3 of Table 4, in which the risk aversion of stockholders is tested, which shows a significant positive relation between risk aversion level and the past investment variable but a significant negative for past risk exposure. This difference can be explained by the fact that, most likely, all stockholders will report to have made some investments in the past. However, only the ones that report to have taken investments with great risk, for which the past risk exposure dummy equals 1, will be more risk averse than the stockholders who did only take small investment risks.

The results in Table 4 show that the natural logarithm of the AEX index value, ceteris paribus, affects risk aversion negatively. The reported coefficient is higher when tested in a regression of only stockholders but remains significantly negative, at the 1% confidence level, in all regressions with excluding time fixed effects. This indicates that individual risk aversion is developing in the opposite direction of the AEX index performance. As shown in the first column of the table, the LnAEX variable is no longer significant when the regression corrects for time fixed effects. This result is as expected while the time dummies will estimate the stability of risk aversion over time. The coefficient of LnAEX in the second column of -0.309 shows that one standard deviation decrease of the natural logarithm of the AEX index indicates on average to a 1.24% increase in the respondents' qualitative risk aversion measure. This positive small economically effect of the AEX on individual risk aversion corresponds to hypothesis H_{3A}.

The regressions conducted on the two different groups, stockholders and non-stockholders, show some small differences as compared to the whole sample. For instance, stockholders who graduated from high school are less risk averse than stockholders who did no. As discussed before, the past investment variable in the stockholders model is positively related to their risk aversion level. The coefficients of the LnAEX variable are significantly negative (at the 1% level) for both groups. In addition, a one standard deviation decrease of the natural logarithm of the AEX index goes hand in hand with an on

average increase of 2.47% and 1.06% in the stockholders' and non-stockholders' qualitative risk aversion measure. Hence, stockholder' risk aversion level is more sensitive to changes in the AEX than non-stockholders' risk aversion level is.

To examine how risk aversion changes over the years details of the time-fixed effects results of the regression analyses on qualitative risk aversion are shown in Table A.5 of the Appendix. In addition I conducted a regression containing only the qualitative risk aversion measure as dependent variable and the year dummies as independent variables to test the equality of risk aversion over time. Result are shown in the second column of Table A.5. The coefficients confirm the belief that qualitative risk aversion increases over the sample period and reaches its highest value in 2009. Moreover the results in the second column of Table A.5 show that individual risk aversion is significantly higher in the period 2008 – 2013 as compared to the value in 2006. The positive coefficients on risk aversion do get smaller over the years, but risk aversion remains slightly higher at the end of the sample period compared to the beginning. Therefore it cannot be concluded that the individuals' post-crisis risk aversion level rebounds to its pre-crisis value of 2006 during this study period. Hereby it has to be kept in mind that the AEX index value of 2013 is still remarkably lower than is was in 2006, and so it can be argued that the Dutch economy is still recovering from the crisis which might be a possible explanation for the slightly higher risk aversion level. Besides the qualitative risk aversion variable does show the tendency to recover (see Figure 1).

Note that the models' overall explanatory power is relatively low with a R^2 ranging from 4.8% to 34.3%. These goodness of fit measures are comparable to the explanatory power of similar studies on risk aversion levels like the study of Kapteyn and Teppa (2011), Weber et al., (2013) and Bucciol and Muniaci (2012).

Table 4 Regression Analyses on Qualitative Risk Aversion

Dependent Variable	Risk Aversion Qualitative	Risk Aversion Qualitative	Stockholders Qualitative Risk Aversion	Non-Stockholders Qualitative Risk Aversion
Constant	7.647***	6.771***	7.012***	6.758***
	(2.983)	(0.504)	(1.497)	(0.532)
Gender	0.401***	0.394***	0.903***	0.284***
	(0.094)	(0.093)	(0.277)	(0.094)
Age	0.009*	0.006	0.027**	0.005
	(0.005)	(0.004)	(0.011)	(0.004)
Employed	− 0.094	− 0.106	− 0.739	− 0.139
	(0.151)	(0.151)	(0.827)	(0.154)
Retired	− 0.010	0.021	− 0.006	− 0.034
	(0.098)	(0.098)	(0.279)	(0.103)
Lifecycles Dummies				
Single Parent	0.661*	0.669*		0.638*
	(0.370)	(0.370)		(0.363)
Young Single	0.142	0.147		0.106
	(0.184)	(0.184)		(0.186)
Older Working	− 0.051	− 0.035	− 0.062	− 0.020
	(0.097)	(0.097)	(0.244)	(0.104)
Older Retired	− 0.144	− 0.136	− 1.059	− 0.094*
	(0.157)	(0.157)	(0.818)	(0.161)
Marital Status	0.089	0.097	0.354	0.085
	(0.083)	(0.083)	(0.229)	(0.085)
Education Dummies				
High School Diploma	0.110	0.099	− 1.065**	0.093
	(0.184)	(0.184)	(0.443)	(0.187)
Some College	0.173	0.157	− 0.229	0.116
	(0.203)	(0.203)	(0.468)	(0.207)
College Degrees	0.073	0.055	− 0.638	0.144
	(0.195)	(0.194)	(0.441)	(0.199)
Household Income	− 0.014	− 0.016	0.019	− 0.014
	(0.028)	(0.028)	(0.080)	(0.030)
ΔLnWealth	0.005	0.005	0.033	0.005
	(0.005)	(0.005)	(0.024)	(0.005)
Past Investment	0.055	0.055	0.332***	0.037
	(0.036)	(0.036)	(0.106)	(0.038)
Past Risk Exposure	− 0.102***	− 0.100***	− 0.291***	− 0.077*
	(0.036)	(0.036)	(0.087)	(0.039)
LnAEX	− 0.490	− 0.309***	− 0.517***	− 0.270***
	(0.502)	(0.057)	(0.153)	(0.062)
Time Fixed Effects[2]	Yes	No	No	No
N observation	2324	2324	257	2067
N respondents	332	332	60	314
R^2	0.080	0.077	0.343	0.048

Notes: Standard errors reported in parenthesis. *, **,*** represent significance at the 10%, 5% and 1% level respectively.

[2] Details of the Time Fixed Effects are shown in Table A.5 of the Appendix

To investigate what factors drive risk-taking, four different regressions are conducted. The first two regressions take the dummy that indicates if the corresponding household owns any risky financial assets as dependent variable while the third and fourth regression take the ratio risky assets to wealth as dependent variable. Again the regressions are conducted including and excluding time fixed effects.

Table 5 shows how studying the dynamics of individuals' risk aversion leads to a better understanding of their risk-taking behavior. As expected, the risk aversion level of respondents' is negatively associated with risk-taking. Not only does a low level of individuals' risk aversion indicate that it is more likely that an individual is holding risky assets, it is also associated with a higher level of risky assets holdings per euro of wealth. Column 1 of Table 5, shows the regression on risky asset ownership. In line with the results on risk aversion, the regression on risk-taking shows that men own significantly more risky assets than women do. Likewise, young single respondent are, holding other factors constant, more likely to hold risky assets than respondents who are in their family formation years. Being older, having a college degree and an increase in wealth are all factors that are positively related to having risky assets. Moreover the direction of the age coefficient changes when time fixed effects are excluded from the regression. However, the coefficients of these variables remain really small.

The results in Table 5 reveal that individuals in the sample are aware of the level of riskiness in their portfolios: those who report to have made investments in the past do own risky financial assets and invest a higher portion of their wealth in risky assets.

Column 3 and 4 of Table 5 show the regressions on risky assets per euro of wealth. The qualitative risk aversion coefficient is significant, at the 1% confidence level, when regressed to the risky assets to wealth ratio. A one standard deviation decrease in qualitative risk aversion leads on average to 55.44% higher risky assets per euro of wealth. In addition, respondents that have completed a college education are expected to have more risky assets relative to wealth than respondents who did not graduate from high school. The estimated coefficient on the change in the natural log of wealth is significantly positive at the 1% confidence level. This suggests that, when other factors are held constant, an increase in household risky assets per euro of wealth are positively related to increases in their wealth. These results are in line with the theory of decreasing relative risk aversion as examined by Schooley and Worden (1996). Their study shows that, as wealth increases, households allocate a greater portion of their portfolio risk to risky assets.

Unlike the negative relation between risk aversion and the Dutch stock market index (AEX), risk-taking behavior does not show a significant relation to the AEX index value. These results indicate that the risk-taking behavior of households' is not related to the AEX index.

To investigate this effect more closely, I conduct the same analyses taking household share ownership as the dependent variable. The results are presented in Appendix Table A.9. The dependent variable in the regressions of column 1 and 2 indicate if the household holds any shares while in column 3 and 4 this variable represents the household holdings of shares per euro of wealth. The results show, as logically can be expected, that the AEX index is significantly positive related to the total number of households that own shares and the total shares per euro of wealth. It is important to notice that only 11 percent of the respondents reports to own shares, resulting in a total of 62 respondents who did own any shares in the period of 2006 – 2013. Since this is not a very large sample the result should be interpreted with caution.

The LnAEX variable in the regression on the shares to wealth ratio is significant at the 5% confidence level. The coefficient of 0.025 suggest that an increase of the natural logarithm of the AEX with one standard deviation, goes together with an increase of 29.59% of the households' holdings of shares per euro of wealth.

Keep in mind that the risk aversion measure is conducted on an individual level while the risk-taking behavior is based on a households' total risky assets holding. While some individuals in the sample might not be primarily responsible of the household's portfolio composition, the risk-taking measures might be biased. To check this effect, I conducted the same analyses on a sample that only includes individuals that are head of the household, i.e. the main wage earner of the household. The results regarding qualitative risk aversion are presented in Table A.10 of the Appendix. Table A.11 presents the results on risk-taking behavior. Apart from a positive relation between being retired and owning risky assets, significant at the 5% and 1% confidence interval, the regression analyses on household heads show no remarkable differences as compared to the analyses on all household members.

Table 5 Regression Analyses on Risky Asset Ownership

Dependent Variable	Risky Assets Ownership Dummy	Risky Assets Ownership Dummy	Risky Assets to Wealth Ratio	Risky Assets to Wealth Ratio
Constant	− 0.133	0.384*	− 0.176	0.083
	(1.137)	(0.203)	(1.679)	(0.229)
Risk Aversion Qualitative	− 0.039***	− 0.038***	− 0.041***	− 0.041***
	(0.008)	(0.008)	(0.008)	(0.008)
Gender	− 0.106***	− 0.125***	0.011	0.010
	(0.038)	(0.038)	(0.019)	(0.019)
Age	0.003*	− 0.002*	0.001	0.000
	(0.002)	(0.002)	(0.001)	(0.001)
Employed	0.072	0.068	− 0.026	− 0.026
	(0.058)	(0.058)	(0.057)	(0.057)
Retired	0.026	0.041	0.013	0.017
	(0.038)	(0.038)	(0.030)	(0.030)
Lifecycles Dummies				
Single Parent	− 0.006	− 0.010	0.083	0.088
	(0.149)	(0.150)	(0.077)	(0.077)
Young Single	0.144**	0.143**	0.029	0.029
	(0.071)	(0.072)	(0.055)	(0.055)
Older Working	0.020	0.036	0.039	0.044
	(0.037)	(0.037)	(0.036)	(0.036)
Older Retired	0.021	0.042	0.037	0.044
	(0.060)	(0.061)	(0.062)	(0.062)
Marital Status	− 0.035	− 0.026	0.009	0.011
	(0.033)	(0.033)	(0.022)	(0.022)
Education Dummies				
High School Diploma	0.073	0.057	0.027	0.0126
	(0.073)	(0.073)	(0.042)	(0.042)
Some College	0.096	0.066	0.072	0.070
	(0.080)	(0.081)	(0.045)	(0.045)
College Degrees	0.188**	0.157**	0.101**	0.101**
	(0.077)	(0.078)	(0.043)	(0.044)
Household Income	0.005	− 0.006	0.003	− 0.000
	(0.011)	(0.011)	(0.011)	(0.011)
ΔLnWealth	0.006***	0.007***	0.009***	0.009***
	(0.002)	(0.002)	(0.003)	(0.003)
Past Investment	0.036***	0.037***	0.051***	0.049***
	(0.014)	(0.014)	(0.017)	(0.017)
Past Risk Exposure	− 0.015	− 0.012	− 0.017	− 0.013
	(0.014)	(0.014)	(0.018)	(0.018)
LnAEX	0.035	0.015	0.043	0.011
	(0.191)	(0.022)	(0.284)	(0.033)
Time Fixed Effects	Yes	No	Yes	No
N observation	2324	2324	2324	2324
N respondents	332	332	332	332
R^2	0.156	0.132	0.049	0.046

Notes: Standard errors reported in parenthesis. *, **,*** represent significance at the 10%, 5% and 1% level respectively

5. Conclusions & Recommendations

This research focuses on the relation between individuals' risk aversion, households' risk taking behavior and the financial crisis based on the Dutch stock market index. Some interesting results about the relation between the AEX index and Dutch individual risk aversion and risk-taking levels are documented.

5.1 Conclusions with respect to the First Hypothesis

The first hypothesis of this research focuses on the difference in risk aversion among different demographic subgroups (H_1). As expected there is a negative relation between risk aversion and being male. Contrary to the developed hypothesis I find risk aversion is to increase slightly with age. This effect can be explained by the old average age of the sample, as risk aversion seems to decline until the age of 65 but rises after this age. Somewhat surprisingly, neither education, employment nor a respondent's marital status corresponds to noticeable influences on risk aversion. As for households' income, the results should be interpreted with caution. Risk aversion is significantly lower for the households' with income ranging from €40,000 to €75,000 as compared to the households' with income of €10,000 to €14,000. In addition the income variable is negatively correlated to qualitative risk aversion but the variable shows no significant relation in the regression model. Therefore it cannot be concluded that risk aversion in negatively related to a household' income. Finally, I find no evidence to support the negative relation between risk aversion and households' wealth.

5.2 Conclusions with respect to the Second Hypothesis

The second part of this research examines the effect of household wealth and risk aversion to the households' risk-taking behavior. First the relation between household wealth and risky financial assets ownership is determined (H_{2A}). The correlation matrix shows that total wealth is significantly positive related to the household's risky asset ownership. To get a more complete view of the effect of wealth changes on individuals risk aversion, the average yearly changes in household wealth are computed. The positive coefficients on changes in the natural logarithm of wealth on the risk-taking regressions indicate that for an increase in household wealth, ceteris paribus, there is a small increase in individual risk taking. Thus there is a positive relation between household holdings of risky assets per euro of wealth and household wealth, indicating decreasing relative risk aversion. Further research is needed to explain the exact direction of this relationship.

In addition, the relation between the individual's risk aversion and the corresponding risk-taking behavior is examined (H_{2B}). As expected, the qualitative risk aversion measure is negative correlated to all risk-taking behavior measures. The positive and significant coefficients of the qualitative risk aversion measure on risky asset ownership imply that measuring individual risk attitudes can explain household portfolio allocation. These results remain the same for the regressions with share ownership

and shares to wealth ratio as dependent variables. Hence, the qualitative risk aversion indicator can be considered as a reliable predictor of households' risk taking behavior.

5.3 Conclusions with respect to the Third Hypothesis

Next I examine whether the stock market crash of 2008 is related to the Dutch individual risk aversion level (H_{3A}). The univariate *t*-tests provide the significance of these changes. The results of these tests show that individual risk aversion increases significantly when the AEX index is tumbling. Individual risk aversion reaching its highest level in 2009, during the first interview moment after the major stock market decline of September – October 2008. However, in years with improving AEX returns risk aversion indicators report some significant positive changes. This relationship is in line with the results of the regression analyses on qualitative risk aversion. For all conducted regressions without time fixed effects on risk aversion, the coefficients of the natural logarithm of the AEX value report a significantly negative coefficient. Thus the risk aversion of Dutch individuals seems to be negative related to the AEX index value.

The next hypothesis examines whether experiencing the financial crisis is interrelated with changes in individual risk taking (H_{3B}). However the differences in risk-taking behavior do not go hand in hand with changes in the AEX index. The *t*-tests show that individuals seem to reduce their risky assets holdings over the whole sample period, also as the AEX index is rising. The regression analyses also show no significant relation between households' risky assets holdings and the stock market index. Hence, there is no evidence for a clear relation between households' risk-taking behavior and the AEX value. These results suggest that households reduce their risk-taking behavior by holding less risky assets in their portfolios. Unlike risk aversion, this reduction in risk taking does not seem to increase as the Dutch economy and AEX index start to recover.

5.4 Conclusions with respect to the Fourth Hypothesis

Reasonably stockholders will be more exposed to the effects of the stock market crash during the crisis. This might influence their changes in risk aversion more than it does for non-stockholders (H_4). To check this effect, separate *t*-tests and regression analyses for these two different groups are conducted. Although the *t*-tests shows no clear distinction between the two groups, the regression analyses shows that a decrease in the AEX relates to a twice as a high increase in risk aversion of stockholders versus non-stockholders. Also the *t*-test shows that stockholders' risk aversion increased significantly as the AEX tumbled after the 2008 stock market crash. This significant effect in 2009 is not reported for the respondents that did not hold any stock. Therefore the relation between the AEX index and individuals' risk aversion seems to be stronger for stockholders than it is for non-stockholders.

5.5 Conclusions with respect to the Fifth Hypothesis

The fifth and last hypothesis examines if the changes in risk aversion are temporarily or permanent (H_5). As mentioned, individuals' risk attitudes seem to return to their pre-crisis level as the Dutch economy is recovering. However, even in 2013, the individuals' risk aversion levels are significantly higher than they were in 2006. Therefore it cannot be concluded that individual risk aversion is fully recovered from the substantial increase following the 2008 financial crisis and thus completely stable in the long run. However the qualitative risk aversion variable does show the tendency to resume to its initial level of 2006. Further research might explain the persistence of the risk aversion increase.

5.5 Recommendations

During this research the negative relation between individuals risk aversion and the AEX index value was proved for Dutch households, during the period 2006-2013. It would be interesting for further research to analyze the exact direction for this negative relationship. Does individual risk aversion increase due to fluctuations in individuals risk perception during the crisis or does an increase in risk aversion lead to lower individual risk taking which, in turn, causes a decline in the stock market value? Another interesting research topic would be the long lasting changes in risk aversion. By enlarging the survey period, this effect can be better examined. Moreover it might be interesting for future research to investigate the impact of a crisis on a quantitative measure of risk aversion based on a lottery survey. While the self-assessed questions on risk aversion all rely on financial risk aversion, it might be interesting to see if individuals also adjust their risk attitudes in lotteries that are independent of the economy.

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7. Appendix

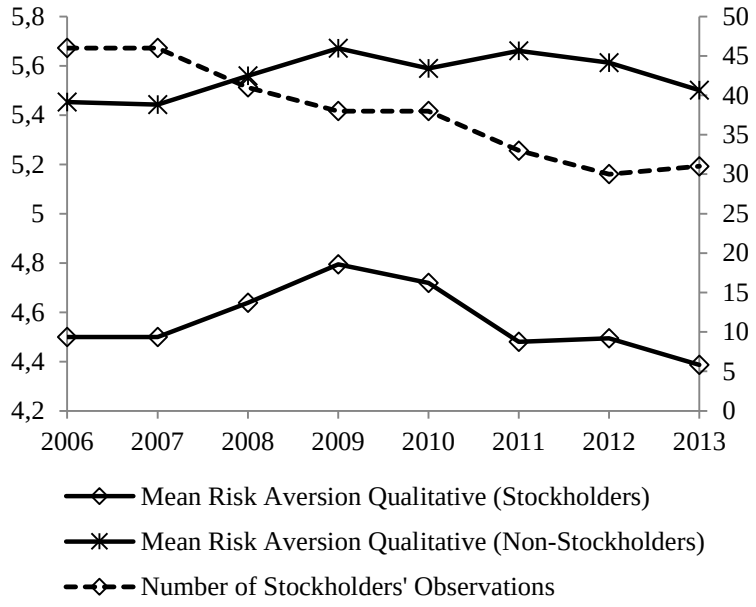

Figure A.4. Qualitative Risk Aversion of Stockholders versus Non-Stockholder and the annual number of stockholders' observations
Notes: Qualitative Risk Aversion is measured on six self-assessed questions about risk aversion on a 7-point scale (see Table 1).

Table A.1 Mean Risk Aversion levels of high- and low frequency group and over demographic groups

Mean Risk Aversion levels of high- and low frequency group			
		High Freq. Treatment (n = 197)	Low Freq. Treatment (n = 135)
Risk Aversion Revealed Preference		2.168	1.520
Certainty Equivalent		214.061	218.097
Risk Aversion Quantitative		115.632	91.419
Risk Aversion Qualitative		5.359	5.265
b		84.368	108.581
Mean Qualitative Risk Aversion level of high- and low frequency groups			
		Treatment	
		High Freq. Treatment	Low Freq. Treatment
Gender	Female	113.450	94.774
	Male	117.119	89.085
Age	Age ≤ 64	115.981	92.392
	Age ≥ 65	114.361	88.000
Employed	Employed	113.746	90.464
	Unemployed	117.899	92.212
Retired	Retired	117.616	89.421
	Not Retired	115.097	92.062
Lifecycles	Family Formation	115.315	81.808
	Single Parent	47.222	125.000
	Young Single	95.714	91.667
	Older Working	119.313	95.122
	Retired	117.112	91.683
Marital Status	Married/Living with partner	116.192	90.808
	Single	113.924	93.032
Education	No High School Diploma	128.333	84.333
	High School Diploma	115.583	94.869
	Some Colleges	120.938	77.000
	College Degree	112.114	94.756

Notes: This table presents the mean values of the different individual's risk aversion measures for the year 2006.

Table A.2 Variable Definitions

Mnemonic	*Variable Name*	*Definition*
GEN	Gender	Indicator variable that has the value 0 for male respondents and 1 for female respondents
AGE	Age	Age of respondent in years as of 2006
EMPL	Employed	Indicator variable that has the value 1 if the respondent is employed and 0 otherwise
RET	Retired	Indicator variable that has the value 1 if the respondent is retired and 0 otherwise
LC	Life Cycle of Respondent	
LC1	*Family Formation*	A dummy variable that has the value 1 if respondent is < 45 years old, married, with or without children and 0 otherwise
LC2	*Single Parent*	A dummy variable that has the value 1 if respondent is any age, single, with children and 0 otherwise
LC3	*Young Single*	A dummy variable that has the value 1 respondent is < 45 years old, single, without children and 0 otherwise
LC4	*Older Working*	A dummy variable that has the value 1 if respondent is ≥ 45 years old, in labor force and 0 otherwise
LC5	*Older Retired*	A dummy variable that has the value 1 if respondent is ≥ 45 years old, retired, or otherwise not in labor force and 0 otherwise
MAR	Marital Status	Indicator variable taking the value 1 if the respondent is married or living with a partner and 0 otherwise.
EDU	Education	
EDU1	*No High school Diploma*	A dummy variable that has the value 1 if the respondent only completed special or primary education and 0 otherwise
EDU2	*High School Diploma*	A dummy variable that has the value 1 if the respondents only completed pre-vocational or pre-university education and 0 otherwise
EDU3	*Some College*	A dummy variable that has the value 1ual to 1 if the respondents only completed secondary vocational education and 0 otherwise
EDU4	*College Degrees*	A dummy variable that has the value 1 if the respondents only completed vocational colleges or university education and 0 otherwise
HH	Household head	Indicator variable taking the value 1 if the individual is the main wage earner of the household and 0 otherwise
HI	Household Income	Total net income of the household which consists of the income of all members of the households in the past 12 months (in euros). This variable is divided into five categories; 1 = less than 10,000; 2 = between 10,000 and 14,000; 3 = between 14,000 and 22,000; 4 = between 22,000 and 40,000; 5 = between 40,000 and 75,000; 6 = 75,000 or more
PINV	Past Investment	Indicator variable that has the value 1 if the respondent has made an investment in the past years
RISKEXP	Past Risk Exposure	Indicator variable that has the value 1 if the respondent is exposed to risky investment in the past years
ΔLnWLTH	ΔLnWealth	Difference in the natural logarithm of the households wealth (in euros)
LnAEX	LnAEX	Natural logarithm of the AEX index value in the week of the risk aversion questionnaire
RAQual	Risk Aversion Qualitative	Reflects a respondent's general predisposition toward financial risk. Details on the survey questions are given in Table 1.
RAQuan	Risk Aversion Quantitative	Reflects a respondent's general predisposition toward financial risk based on the experiment of Gneezy and Potters (1997).

Table A.3 Portfolio Variables Description[3]

Mnemonic	*Name Variable*	*Description*
RFA	Risky Financial Assets	Mutual funds Growth funds Shares Bonds Options
SFA	Safe Financial Assets	Checking account with positive balance Saving and deposit accounts Bank certificates and deposits Saving certificates Saving or endowment insurance policy Mortgage-related life insurance Life-cycle savings plan Single premium annuity insurance policy
NFA	Non-Financial Assets (excl. real estate)	Durables Business equity Money lent to family and/or friends Assets not mentioned in other categories
TRE	Total Real Estate	Primary housing Secondary housing Other real estate
TNMD	Total Non-Mortgage Debt	Credit card debt Extended lines of credit Private loan Checking account with negative balance Student loan
TMD	Total Mortgage Debt	Money borrowed from friend and/or family Debt not mentioned in other categories Mortgage on primary housing Mortgage on secondary housing Mortgage on other real estate
HW	Household Wealth	Risky Financial Assets + Safe Financial Assets – Total Non-Mortgage Debt
NW	Net Worth	Total Assets – Total Debt = Risky Financial Assets + Safe Financial Assets + Non-Financial Assets + Total Real Estate – Total Non-Mortgage Debt – Total Mortgage Debt

[3] For the description of the portfolio variables this research has used the descriptions given by Gaudecker (2011)

Table A.4 Correlation Matrix Risk Aversion measures

Panel A: Correlation Matrix for Levels in Risk Aversion for the whole sample (n = 332)			
	Risk Aversion Revealed Preference	Certainty Equivalent	Risk Aversion Quantitative
Certainty Equivalent	− 0.348***		
Risk Aversion Quantitative	0.348***	1.000***	
Risk Aversion Qualitative	0.010	− 0.097***	0.097***
Panel B: Correlation Matrix for Levels in Risk Aversion for the high frequency treatment group of the CentERdata experiment (n = 197)			
	Risk Aversion Revealed Preference	Certainty Equivalent	Risk Aversion Quantitative
Certainty Equivalent	− 0.368***		
Risk Aversion Quantitative	0.368***	− 1.000***	
Risk Aversion Qualitative	− 0.056**	− 0.059**	0.059**
Panel C: Correlation Matrix for Levels in Risk Aversion for the low frequency treatment group of the CentERdata experiment (n = 135)			
	Risk Aversion Revealed Preference	Certainty Equivalent	Risk Aversion Quantitative
Certainty Equivalent	− 0.326***		
Risk Aversion Quantitative	0.326***	− 1.000***	
Risk Aversion Qualitative	0.090***	− 0.105***	0.105***

Notes: This table presents the Pearson correlation coefficients between the different individual's risk aversion measures. The different measures are only correlated for the measurements collected in year 2006 while the Gneezy and Potter (1997) experiment is conducted once by CentERdata in 2006.
Panel A presents correlations between the different risk aversion measures for the whole sample. Panel B only shows the correlations for the high frequency treatment group of the CentERpanel Experiment while Panel C shows the correlations for the low frequency treatment group.
*,**,*** represent significance at the 10%, 5% and 1% level respectively.

Table A.5 Regression Details on Time Fixed Effects.

Dependent Variable	Risk Aversion Qualitative	Risk Aversion Qualitative
Constant	7.869***	5.321***
	(3.053)	(0.055)
2007	0.111	− 0.009
	(0.157)	(0.045)
2008	0.184*	0.124***
	(0.105)	(0.045)
2009	− 0.002	0.250***
	(0.221)	(0.045)
2010	0.085	0.169***
	(0.058)	(0.045)
2011	0.150***	0.223***
	(0.047)	(0.045)
2012	0.064	0.191***
	(0.077)	(0.045)
2013		0.076*
		(0.045)
N observation	2324	2656
N respondents	332	332
R^2	0.080	0.082

Notes: The first column shows details of the time fixed effects of column 1, Table 4 (page 38): Regression Analyses on Qualitative Risk Aversion. Standard errors reported in parenthesis. *, **, *** represent significance at the 10%, 5% and 1% level respectively.

Table A.6 Descriptive Statistics for every year of the survey period 2006-2013

Year		2006	2007	2008	2009	2010	2011	2012	2013	2006-2013
Respondents	*N*	332	332	332	332	332	332	332	332	2656
Risk Aversion Qualitative	Mean	5.321	5.312	5.445	5.571	5.489	5.544	5.512	5.397	5.449
	Std	(1.010)	(1.023)	(1.017)	(0.994)	(0.952)	(1.031)	(0.991)	(1.017)	(1.008)
Risky Asset Ownership	Mean	0.301	0.301	0.259	0.274	0.250	0.240	0.223	0.204	0.257
Dummy	Std	(0.459)	(0.459)	(0.439)	(0.447)	(0.434)	(0.428)	(0.417)	(0.404)	(0.437)
Risky Assets to Wealth	Mean	0.096	0.084	0.103	0.082	0.067	0.044	0.078	0.042	0.075
Ratio	Std	(0.236)	(0.396)	(0.393)	(0.212)	(0.259)	(0.450)	(0.232)	(0.462)	(0.345)
Risky Asset Share Dummy	Mean	0.139	0.139	0.123	0.114	0.114	0.099	0.090	0.093	0.114
	Std	(0.346)	(0.346)	(0.329)	(0.319)	(0.319)	(0.300)	(0.287)	(0.291)	(0.318)
Shares to Wealth Ratio	Mean	0.030	0.032	0.025	0.011	0.009	0.006	0.018	0.017	0.018
	Std	(0.133)	(0.141)	(0.114)	(0.065)	(0.183)	(0.210)	(0.115)	(0.108)	(0.140)
Gender	Mean	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392	0.392
	Std	(0.489)	(0.489)	(0.489)	(0.489)	(0.489)	(0.489)	(0.489)	(0.489)	(0.488)
Age	Mean	53.699	54.699	55.699	56.699	57.699	58.699	59.699	60.699	57.199
	Std	(12.575)	(12.575)	(12.575)	(12.575)	(12.575)	(12.575)	(12.575)	(12.575)	(12.766)
Employed	Mean	0.524	0.524	0.506	0.509	0.500	0.485	0.458	0.452	.495
	Std	(0.500)	(0.500)	(0.501)	(0.501)	(0.501)	(0.501)	(0.499)	(0.499)	(0.500)
Retired	Mean	0.253	0.271	0.289	0.301	0.304	0.328	0.346	0.358	0.306
	Std	(0.435)	(0.445)	(0.454)	(0.459)	(0.461)	(0.470)	(0.477)	(0.480)	(0.461)
Life Cycle	Mean	3.810	3.867	3.949	4.003	4.063	4.102	4.160	4.208	4.020
	Std	(1.480)	(1.431)	(1.375)	(1.325)	(1.275)	(1.256)	(1.227)	(1.180)	(1.327)
Marital Status	Mean	0.774	0.762	0.765	0.756	0.756	0.753	0.75	0.744	0.758
	Std	(0.419)	(0.426)	(0.425)	(0.430)	(0.430)	(0.432)	(0.434)	(0.437)	(0.429)
Education	Mean	2.834	2.828	2.831	2.834	2.840	2.838	2.840	2.840	2.836
	Std	(0.968)	(0.970)	(0.972)	(0.971)	(0.972)	(0.970)	(0.969)	(0.969)	(0.969)
Household Income	Mean	3.804	3.804	3.877	3.910	3.925	3.994	4.027	4.036	3.922
	Std	(0.786)	(0.805)	(0.781)	(0.791)	(0.787)	(0.793)	(0.809)	(0.803)	(0.798)
Past Investment	Mean	0.560	0.605	0.599	0.620	0.599	0.554	0.458	0.497	0.562
	Std	(0.792)	(0.935)	(0.936)	(0.999)	(0.865)	(0.708)	(0.499)	(0.501)	(0.801)
Past Risk Exposure	Mean	0.262	0.289	0.316	0.337	0.271	0.208	0.178	0.154	0.252
	Std	(0.758)	(0.917)	(0.923)	(0.993)	(0.840)	(0.647)	(0.383)	(0.361)	(0.764)
LnWealth	Mean	8.727	8.564	8.404	8.435	8.435	8.475	8.367	8.112	8.440
	Std	(3.417)	(3.614)	(3.722)	(3.741)	(3.736)	(3.677)	(3.699)	(4.033)	(3.707)
LnAEX	Mean	6.132	6.208	6.095	5.481	5.844	5.887	5.787	5.912	5.918
	Std	(0.005)	(0.029)	(0.037)	(0.029)	(0.008)	(0.026)	(0.025)	(0.010)	(0.218)

Notes: This table presents yearly summary statistics of the sample. The first row of every variable represents the yearly mean. The second row represents the responding standard deviation in parenthesis.

Table A.7 Univariate tests

Years	2007 vs. 2006	2008 vs. 2007	2009 vs. 2008	2010 vs. 2009	2011 vs. 2010	2012 vs. 2011	2013 vs. 2012	2013 vs. 2006
Panel A: differences in means between year pairs								
Risk Aversion Qualitative	−0.009	0.133***	0.126***	−0.081**	0.054	−0.032	−0.115***	0.076*
RA to Wealth ratio	−0.012	0.019	−0.022	−0.015	−0.022	0.034	−0.035	−0.054**
RA Ownership Dummy	0	−0.042***	0.015	−0.024**	−0.009	−0.018**	−0.018*	−0.096***
Shares to Wealth ratio	0.002	−0.007	−0.014**	−0.003	−0.003	0.013	−0.002	−0.014*
Share Ownership Dummy	0	−0.015**	−0.009	0	−0.015**	−0.009*	0.003	−0.045***
AEX Quote	36.50***	−53.01***	−203.98***	105.03***	15.33***	−34.14***	43.14***	−91.12***
Years	2006	2007	2008	2009	2010	2011	2012	2013
Panel B: differences in means between years and total sample period								
Risk Aversion Qualitative	−0.128**	−0.137***	−0.004	0.122**	0.041	0.095**	0.063	−0.052
RA to Wealth Ratio	0.022**	0.009	0.029*	0.007	−0.008	−0.030	0.003	−0.032
RA Dummy	0.044**	0.044**	0.003	0.017	−0.007	−0.016	−0.034*	−0.052***
Shares to Wealth Ratio	0.012*	0.014**	0.007	−0.007**	−0.010	−0.013	−0.000	−0.002
Share Ownership Dummy	0.024*	0.024*	0.009	0.000	0.000	−0.015	−0.024*	−0.021*
AEX Quote	80.18***	116.69***	63.68***	−140.31***	−35.28	−19.94***	−54.09	−10.94***
Years	2007 vs. 2006	2008 vs. 2007	2009 vs. 2008	2010 vs. 2009	2011 vs. 2010	2012 vs. 2011	2013 vs. 2012	2013 vs. 2006
Panel C: Differences in means between year pairs for stockholders								
Risk Aversion Qualitative	0.000	0.076	0.309*	0	−0.136	0.010	−0.006	0.145
Panel D: Differences in means between year pairs for non-stockholders								
Risk Aversion Qualitative	−0.010	0.142**	0.010	−0.092	0.079	−0.036	−0.126*	0.069
Years	2006	2007	2008	2009	2010	2011	2012	2013
Panel E: Differences in means between years and total sample period for stockholders								
Risk Aversion Qualitative	−0.069	−0.069	0.069	0.225*	0.151	−0.089	−0.074	−0.182
Panel F: Differences in means between years and total sample period for non-stockholders								
Risk Aversion Qualitative	−0.109*	−0.119**	−0.003	0.109*	0.027	0.099**	0.051	−0.062

Notes: This table presents *t*-tests to show significance differences in means.
Panel A shows the differences in means between adjacent year pairs and the last year and first year of the sample period, respectively.
Panel B shows differences between yearly means and the means of the total sample period.
Panel C and D show the differences in means between adjacent year pairs for (non-)stockholders.
Panel E show differences between yearly means of stockholders and the means of stockholders of the total sample period.
Panel F show differences between yearly means of non-stockholders and the means of non-stockholders of the total sample period.
*, **,*** Statistical significance 10%, 5% and 1% level, respectively based on *t*-tests.

Table A.8 Pearson's Correlation Matrix

Variables	Risk Aversion Quantitative [a]	Risk Aversion Qualitative	RFA Ownership	RFA/Wealth ratio	Past Investment	Past Risk Exposure	Gender	Age
Risk Aversion Qualitative	0.097**							
RFA Ownership	0.012	− 0.327***						
RFA/Wealth ratio	− 0.007	− 0.141***	0.368***					
Past Investment	0.030	− 0.157***	0.318***	0.131***				
Past Risk Exposure	0.007	− 0.199***	0.271***	0.111***	0.826***			
Gender	0.001	0.199***	− 0.182***	− 0.046**	− 0.099***	− 0.080***		
Age	0.027	0.069***	0.039**	0.050***	− 0.027	− 0.039**	− 0.147***	
Age ≤ 64	0.040	0.061***	0.001	− 0.023	0.052***	0.059***	0.128***	− 0.760***
Age ≥ 65	− 0.040	− 0.061***	− 0.001	0.023	− 0.052***	− 0.059***	− 0.128***	0.760***
Employed	− 0.026	− 0.087***	0.032*	− 0.035*	0.085***	0.085***	− 0.078***	− 0.633***
Retired	− 0.010	− 0.017	0.067***	0.063***	0.002	− 0.018	− 0.266***	0.694***
Lifecycle	0.056	0.039**	0.039**	0.054***	− 0.034*	− 0.023	− 0.064***	0.792***
Marital Status	0.005	0.010	− 0.082***	− 0.007	0.014	− 0.016	− 0.090***	0.025
Education	− 0.018	− 0.062**	0.198***	0.094***	0.120***	0.103***	− 0.103 ***	− 0.190 ***
Income	− 0.022	− 0.088***	0.137***	0.040**	0.132***	0.086***	− 0.121***	− 0.090***
LnWealth	0.063	− 0.051***	0.324***	0.222***	0.166***	0.104***	− 0.193***	0.044**
ΔLnWealth		0.026	0.037*	0.063***	− 0.026	− 0.032	0.001	0.006
LnAEX	0.033	− 0.080***	0.030	0.018	0.004	− 0.002	− 0.000	− 0.090***

Variables	Employed	Retired	Lifecycle	Marital Status	Education	Income	LnWealth	ΔLnWealth
Retired	− 0.657***							
Lifecycle	− 0.595***	0.491***						
Marital Status	− 0.120***	0.113***	− 0.015					
Education	0.239***	− 0.074***	− 0.226***	− 0.071***				
Income	0.250***	− 0.030	− 0.138***	0.232***	0.320***			
Wealth	0.067***	0.057***	0.009	− 0.064***	0.210***	0.155***		
ΔLnWealth	− 0.019	0.004	0.000	− 0.021	0.000	− 0.019	0.388***	
LnAEX	0.022	− 0.037*	− 0.056***	0.011	0.002	− 0.056***	0.017	− 0.026

Notes: Each row presents the Pearson correlation of the variable.

[a] The correlation of the Quantitative Risk Aversion is only tested for year 2006 as Qualitative Risk Aversion is measured one time only.

*, **,*** Statistical significance 10%, 5% and 1% level.

Table A.9 Regression Analyses on Share Ownership

Dependent Variable	Share Ownership Dummy	Share Ownership Dummy	Shares to Wealth Ratio	Shares to Wealth Ratio
Constant	− 0.300	0.178	0.111	− 0.033
	(0.822)	(0.150)	(0.660)	(0.092)
Qualitative Risk Aversion	− 0.025***	− 0.025***	− 0.016***	− 0.016***
	(0.006)	(0.006)	(0.003)	(0.003)
Gender	− 0.077***	− 0.088***	− 0.003	− 0.004
	(0.030)	(0.030)	(0.009)	(0.009)
Age	0.002	− 0.001	0.000	− 0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Employed	− 0.018	− 0.021	− 0.011	− 0.012
	(0.042)	(0.042)	(0.024)	(0.024)
Retired	− 0.010	− 0.003	0.000	0.001
	(0.028)	(0.028)	(0.013)	(0.013)
Lifecycles Dummies				
Single Parent	− 0.054	− 0.058	− 0.001	− 0.000
	(0.118)	(0.118)	(0.034)	(0.034)
Young Single	− 0.041	− 0.040	− 0.018	− 0.018
	(0.053)	(0.053)	(0.024)	(0.024)
Older Working	0.016	0.024	0.010	0.011
	(0.027)	(0.027)	(0.015)	(0.015)
Older Retired	− 0.014	− 0.002	0.006	0.007
	(0.044)	(0.044)	(0.026)	(0.026)
Marital Status	− 0.021	− 0.016	− 0.016*	− 0.016*
	(0.025)	(0.024)	(0.010)	(0.010)
Education Dummies				
High School Diploma	− 0.018	− 0.029	− 0.012	− 0.012
	(0.056)	(0.056)	(0.019)	(0.019)
Some College	0.041	0.023	0.008	0.007
	(0.062)	(0.062)	(0.020)	(0.020)
College Degrees	0.044	0.023	− 0.002	− 0.002
	(0.060)	(0.060)	(0.019)	(0.019)
Household Income	0.014*	0.008	0.003	0.003
	(0.008)	(0.008)	(0.005)	(0.005)
ΔLnWealth	0.003**	0.003**	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Past Investment	− 0.007	− 0.007	0.001	0.000
	(0.010)	(0.010)	(0.007)	(0.007)
Past Risk Exposure	0.011	0.013	0.004	0.005
	(0.010)	(0.010)	(0.007)	(0.007)
LnAEX	0.069	0.028**	− 0.003	0.025**
	(0.138)	(0.016)	(0.111)	(0.013)
Time Fixed Effects	Yes	No	Yes	No
N observation	2324	2324	2324	2324
N respondents	332	332	332	332
R^2	0.098	0.083	0.031	0.030

Notes: Standard errors reported in parenthesis. *, **, *** represent significance at the 10%, 5% and 1% level respectively

Table A.10 Head of the Household Regression Analyses on Qualitative Risk Aversion

Dependent Variable	Risk Aversion Qualitative	Risk Aversion Qualitative
Constant	9.121**	7.370***
	(3.725)	(0.655)
Gender	0.426***	0.429***
	(0.155)	(0.155)
Age	0.009	0.006
	(0.006)	(0.005)
Employed	− 0.150	− 0.151
	(0.300)	(0.300)
Retired	0.226*	0.247*
	(0.135)	(0.134)
Lifecycles Dummies		
Single Parent	0.559	0.558
	(0.398)	(0.397)
Young Single	0.042	0.042
	(0.199)	(0.199)
Older Working	− 0.112	− 0.096
	(0.118)	(0.118)
Older Retired	− 0.410	− 0.399
	(0.293)	(0.293)
Marital Status	0.077	0.080
	(0.101)	(0.101)
Education Dummies		
High School Diploma	0.029	0.027
	(0.247)	(0.247)
Some College	0.106	0.097
	(0.270)	(0.270)
College Degrees	− 0.039	− 0.047
	(0.258)	(0.258)
Household Income	− 0.052	− 0.054
	(0.036)	(0.035)
ΔLnWealth	0.001	0.002
	(0.006)	(0.006)
Past Investment	0.030	0.029
	(0.041)	(0.041)
Past Risk Exposure	− 0.106**	− 0.104*
	(0.041)	(0.041)
LnAEX	− 0.682	− 0.347***
	(0.627)	(0.066)
Time Fixed Effects	Yes	No
N observation	1680	1680
N respondents	240	240
R^2	0.082	0.079

Notes: Standard errors reported in parenthesis. *, **,*** represent significance at the 10%, 5% and 1% level respectively

Table A.11 Head of the Household Regression Analyses on Risky Asset Ownership

Dependent Variable	Risky Assets Ownership Dummy	Risky Assets Ownership Dummy	Risky Assets to Wealth Ratio	Risky Assets to Wealth Ratio
Constant	− 0.211	0.540*	0.258	0.240
	(1.529)	(0.286)	(2.308)	(0.322)
Risk Aversion Qualitative	− 0.041***	− 0.041***	− 0.051***	− 0.051***
	(0.010)	(0.010)	(0.010)	(0.010)
Gender	0.038	0.044	0.047	0.048
	(0.071)	(0.071)	(0.034)	(0.034)
Age	0.002	− 0.004*	0.000	− 0.001
	(0.003)	(0.002)	(0.002)	(0.002)
Employed	0.140	0.131	− 0.032	− 0.035
	(0.124)	(0.124)	(0.141)	(0.141)
Retired	0.126**	0.157***	− 0.000	0.009
	(0.057)	(0.057)	(0.045)	(0.045)
Lifecycles Dummies				
Single Parent	− 0.097	− 0.124	0.069	0.072
	(0.182)	(0.183)	(0.090)	(0.090)
Young Single	0.119	0.109	0.015	0.011
	(0.084)	(0.085)	(0.067)	(0.067)
Older Working	0.016	0.029	0.044	0.051
	(0.049)	(0.049)	(0.047)	(0.047)
Older Retired	0.005	0.004	0.059	0.063
	(0.121)	(0.121)	(0.148)	(0.148)
Marital Status	0.006	0.020	0.023	0.026
	(0.044)	(0.044)	(0.028)	(0.028)
Education Dummies				
High School Diploma	0.118	0.102	0.010	0.009
	(0.109)	(0.109)	(0.060)	(0.060)
Some College	0.152	0.120	0.058	0.055
	(0.120)	(0.120)	(0.064)	(0.065)
College Degrees	0.251**	0.222*	0.064	0.064
	(0.115)	(0.115)	(0.062)	(0.062)
Household Income	0.005	− 0.007	0.018	0.013
	(0.015)	(0.015)	(0.016)	(0.015)
ΔLnWealth	0.008***	0.008***	0.015***	0.015***
	(0.002)	(0.002)	(0.004)	(0.004)
LnAEX	0.044	(0.022)	− 0.019	0.002
	(0.257)	− 0.010	(0.390)	(0.042)
Time Fixed Effects	Yes	No	Yes	No
N observation	1680	1680	1680	1680
N respondents	240	240	240	240
R^2	0.092	0.065	0.044	0.040

Notes: Standard errors reported in parenthesis. *, **,*** represent significance at the 10%, 5% and 1% level respectively