# Risk taking after the financial crisis[*]

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## Abstract

The economic and financial crisis in 2008 and 2009 offers an excellent opportunity to investigate whether and how wealth changes affect households' risk attitudes, stock market expectations, and risk taking behavior. Based on data from the German SAVE study, we analyze the effects of "regular" wealth changes and having experienced a "wealth shock", i.e., self-assessed suffering from the economic and financial crisis. We find little evidence for the common contention that the willingness to take risks is decreasing in "regular" decreases of wealth. In contrast, suffering a "wealth shock" seems to negatively affect risk taking. The effect does not run via risk attitudes but influences risk taking via return expectations and directly.

Keywords: Financial crisis, risk attitudes, stock market expectations, risk taking, wealth fluctuations, emotions
JEL-Codes: D81, D14, G11

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# 1 Introduction

The economic and financial crisis in 2008 and 2009 presented a shock to financial market actors. The German DAX, e.g., fell by 40% in 2008. Due to the sudden decline of stock markets, institutional as well as private investors generated substantial financial losses. German households lost 3.6-8.5% of their financial wealth (Börsch-Supan et al., 2009, 2010). A common contention and central idea in microeconomic theory is that risk aversion is decreasing in wealth (e.g., Gollier, 2001).[1] Theory predicts that those individuals suffering financial losses reacted by increasing their risk aversion. Except for fluctuation with wealth, risk preferences are traditionally assumed to be exogenously given and stable. In recent years, however, this assumption has been challenged. Past stock market experiences have been shown to have a long-run influence on financial risk taking independent from own exposure (Malmendier and Nagel, 2011). An increasing number of studies shows that emotions play a role for choices under risk (e.g., Loewenstein et al., 2001; Kuhnen and Knutson, 2011). This literature predicts that that the event of the financial crisis itself affected the willingness to take risks.

In normative expected utility theory and risk-return models, differences in risk preferences only depend on risk attitude. Recent research, however, emphasizes that risk preferences are influenced by a broader set of variables, in particular subjective expectations of risk and returns (e.g., Weber, 2010). This decomposition provides different ways in which the financial crisis can have affected the willingness to take financial risks. Updating of expectations has been related to the overall stock market performance (e.g., Hurd et al., 2011) as well as own past portfolio-returns (Vissing-Jorgensen, 2003). Changes in wealth may hence not only have affected risk attitudes but also subjective expectations. In addition, psychological processes influence sub-

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[1]The following definitions are employed throughout the text. Risk preference or risk taking is defined as the choice of a risky or less risky option and assumed to be influenced by risk attitude and expectations. Risk attitude is the decision-maker's predisposition to take risks; an individual can be risk averse, risk neutral or risk seeking. Subjective return expectations refer to the perceived expected value of a risky option. Subjective risk expectations refer to the perceived variance of possible outcomes of a risky option. See e.g. Weber (2010).

jective expectations (Weber, 2010; Kuhnen and Knutson, 2011). Hudomiet et al. (2011) find a temporary increase in the population average of return expectations after the stock market crash in September 2008. From that perspective, experiencing losses may have affected subjective expectations not only financially but also emotionally.

Previous literature analyzes whether risk attitudes, subjective expectations, and risk taking vary in the course of the crisis. Focusing on self-reported risk attitudes, Guiso et al. (2011) find an increase in financial risk aversion of Italian bank clients from 2007 to 2009 which seems to be unrelated to changes in expectations. Dutch brokerage clients surveyed on a monthly basis from April 2008 to March 2009 by Hoffmann et al. (2013) report time-varying risk attitude as well as subjective risk and return expectations. A de-risking of portfolios, however, cannot be observed. Weber et al. (2012) survey UK online-brokerage customers at three-month intervals and find that that self-reported willingness to invest into the stock market decrease substantially from September 2008 to March 2009 and increase again by June 2009. Risk attitudes remain constant during that time.

Causes for the observed variation are analyzed by Guiso et al. (2011). The authors find that the development of risk attitudes can neither be explained by changes in wealth nor by other "conventional" approaches. In line with previous literature, they speculate that the observed increase in risk aversion is an emotional reaction to the crisis. An accompanying experiment shows that fear and anger evoked by watching a horror movie produces an increase in risk aversion of a magnitude similar to the one observed from 2007 and 2009. A more direct test of the effect of suddenly suffering financial losses is, however, not performed. Furthermore, an analysis of the causes for variation in risk taking and subjective expectations is outstanding.

Our aim is to unite the approaches of Weber et al. (2012) and Hoffmann et al. (2013) - distinguishing the components of risk taking - on the one side, and Guiso et al. (2011) - analyzing the causes of change - on the other side. In particular, we are interested in the effect of changes in financial wealth and experiencing a "wealth shock" on risk taking, risk attitudes and subjective expectations. The analysis is based on the German SAVE household

panel which is representative for the German population. It contains annual information on households' savings behavior and risk attitudes. In 2009 and 2010, the survey endorsed a special section with regard to households' consequences from and reactions to the financial crisis. Respondents were asked to assess whether they plan to change their portfolio share in risky assets, how much they lost or gained due to the crisis (i.e., experienced a "wealth shock"), and report their change in risk and return expectations.

An advantage of German data is that there was no housing or mortgage crisis in 2007/2008. The wealth losses of households are hence largely related to the composition of financial portfolios in the course of the crisis which are more salient than real estate losses. With regard to the wealth losses incurred, economic theory predicts that private households' suffering is to some extent related to their earlier risk taking behavior. The suddenness, scope and pervasion with which wealth losses were generated during 2008 yet suggest that losses hit individuals unexpectedly. Previous analyses are based on client data from banks. It remains an open question whether the results can be generalized to the entire population (Campbell, 2006). Our study is the first that analyzes whether also expected long-run behavior is affected.

Our analysis shows that risk attitudes of German households remain rather stable over the course of the crisis. Respondents report high uncertainty with respect to the change of long-run risks and returns due to the crisis, almost half of them are unable to provide an outlook. Planned risk taking behavior tends to be more risk averse. The empirical analysis shows that changes in risk attitudes from 2007-2010 are unrelated to "regular" changes in financial wealth as well as those experienced due to the crisis. Changes in financial wealth - regular as well as those due to the crisis - seem to reveal information on how risks and returns will develop, respondents are less likely to report that they cannot provide an assessment. Having experienced a "wealth shock" increases the likelihood that someone expects mean reversion, i.e., increased returns. Future risk taking behavior is influenced by expected changes in returns but not in risks or changes in risk attitude. Having experienced a "wealth shock" thus indirectly increases risk taking via increased return expectations. At the same time, however, the likelihood

that someone plans to decrease the share of risky assets is decreased if he experienced a loss due to the crisis.

In sum, we find little evidence for the common contention that willingness to take risk is decreasing in wealth. In contrast, suffering a "wealth shock" due to an event like the financial crisis seems to affect risk taking. Interestingly, the effect does not run via risk attitudes but via (return) expectations or risk taking behavior directly. We are thus able to contribute to the understanding whether and how the emotional response to the financial crisis affects risk taking. Our findings are in line with evidence from psychology suggesting that cross-situational differences in risk preferences can be explained by differences in expectations but not in attitudes (Weber and Milliman, 1997).

The paper is organized as follows. Section 2 contains a discussion of previous literature. In section 3, the approach and results from our empirical analysis are described. Section 4 concludes.

## 2    Previous literature

Normative expected utility theory and risk-return models provide two different approaches how decisions under risk ought to be made. Expected utility theory assumes that individuals view risky options as distributions of possible outcomes and opt for the alternative with the greatest expected value, influenced by their risk attitude, i.e., the shape of the utility function. In contrast, Markowitz (1952) proposes to model people's willingness to pay for risky options as a trade-off of the first (expected value) and second moment (variance) of the distribution of possible outcomes. The trade-off between risk and return is determined by the risk attitude. In both types of models, wealth changes influence an individual's risk preference by altering risk attitude (e.g., Sarin and Weber, 1993; Gollier, 2001).

The theoretical prediction has been tested in several empirical studies. Using data from the Panel Study of Income Dynamics, Brunnermeier and Nagel (2008) find that changes in liquid wealth do not explain changes in households' investments in risky assets. The absence of wealth effects in

principle suggests constant relative risk aversion. Their analysis, however, also shows that portfolio allocations seem to be determined by inertia, i.e., households adjusting their portfolio only slowly. Using responses to hypothetical gamble questions in the Health and Retirement Study, Sahm (2008) finds no effect of changes in wealth or income on changes in relative risk aversion. Guiso and Paiella (2008) use a measure of absolute risk aversion derived from a hypothetical gamble asked in the Bank of Italy Survey of Household Income and Wealth. The authors find that risk tolerance is a concave function of wealth. Guiso et al. (2011) find that the observed increase in self-reported risk aversion from 2007 to 2009 cannot be explained by changes in wealth. Empirical results hence do not unambiguously support the theoretical prediction.

As Campbell (2006) points out, predictions on the relationship between wealth and risk attitude may be different for different risk aversion measures and utility functions. To some extent, however, the ambiguity of results may also be explained by the neglect of important aspects. Normative models have been found to be insufficient in at least two perspectives.[2]

Traditionally risk attitudes are assumed to be constant at least during adulthood (Roberts and DelVecchio, 2000). However, the importance of (emotional) experiences for financial risk attitudes and behavior has been emphasized. Malmendier and Nagel (2011) show a long-run effect of a dramatic stock market experience like the Great Depression in the 1930s. Birth-cohorts that experienced high stock market returns throughout their life report lower willingness to bear risk in financial matters and invest a lower fraction of their liquid assets in stocks even several decades later. An experiment shows that evoking emotions affects financial choices (Kuhnen and Knutson, 2011). Negative emotions induce people to take less risks. Guiso et al. (2011) show in an experiment that watching a horror movie produces a change in risk attitudes similar to the one observed over the financial crisis. Since "conventional approaches" cannot explain the change in risk attitudes, the authors conclude that the emotional reaction to the financial crisis affects

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[2]A variety of modifications exists. We focus on those that are most important for the central question of this paper.

risk attitudes.

Secondly, the approach to explain heterogeneity in risk preferences only by differences in risk attitudes has been criticized. Psychophysical risk-return models take into account that risk preferences are influenced by a broader set of variables. In these models not only risk attitude but also risk and return expectations are subjective variables (e.g., Weber, 2010). Previous studies (e.g., Kezdi and Willis, 2008) claim that subjective expectations can solve the "stockholding puzzle", i.e., the observation of low stock market participation despite high historical performance of stocks. Evidence from psychology suggests that cross-situational differences in risk preferences can be explained by differences in risk perceptions but not in attitudes (Weber and Milliman, 1997). Investors' actual portfolio risk is found to be related to stated risk attitude and expectations over the course of the financial crisis (Hoffmann et al., 2013). Weber et al. (2012) find that changes in subjective (but not objective) return and risk expectations explain the variation in risk taking. Changes in risk attitude are, however, found to be unrelated. These results emphasize the importance to take into account subjective expectations when trying to explain risk behavior.

Previous literature agrees that there is substantial heterogeneity in stock market expectations of households (e.g., Dominitz and Manski, 2011; Kezdi and Willis, 2008; Hudomiet et al., 2011; Hurd et al., 2011; Gouret and Hollard, 2011). Three possible expectation types are considered (Dominitz and Manski, 2011). A random-walk type believes that returns are iid and that long run historical returns can predict future returns. A persistence type uses recent realizations to update his beliefs assuming that recent performance will persist. People that believe in mean-reversion, however, expect stock market performance to be reversed. Updating of perceptions is usually related to overall stock market performance (e.g., Kezdi and Willis, 2008; Hurd et al., 2011; Dominitz and Manski, 2011). A relationship to own past portfolio-returns, however, has also been established (Vissing-Jorgensen, 2003).[3] Wealth changes may thus not only have an effect on attitudes but

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[3]Dominitz and Manski (2007); Hurd et al. (2011) further demonstrate a relationship with stock ownership, Vissing-Jorgensen (2003) with the size of equity investments in stock-

also on expectations.

In addition, the shock of the financial crisis may have affected subjective risk and return expectations. Subjective expectations are influenced, e.g., by experiencing excitement (Weber, 2010). Kuhnen and Knutson (2011) find that emotions influence updating of beliefs about risky investments. Their study shows that subjects do not fully incorporate news that contradict prior choices to avoid a negative emotional state. However, Hudomiet et al. (2011) find a temporary increase in the population average of return expectations directly after the stock market crash caused by the bankruptcy of Lehman in September 2008.

# 3 Empirical analysis

Previous literature emphasizes two important causes for changed risk taking in the aftermath of the financial crisis: wealth changes in terms of material endowment and the shock of experiencing them. Modern finance theory suggests three different channels via which these factors may have affected risk preferences: risk attitudes, risk expectations and return expectations. In the empirical analysis, we hence analyze the following relationships

$\Delta$ Risk taking=f($\Delta$ risk attitude=g($\Delta$ fin. wealth, "shock"), $\Delta$ subj. risk expectation =g($\Delta$ fin. wealth, "shock"), $\Delta$ subj. return expectation=g($\Delta$ fin. wealth, "shock")).

## 3.1 Data

The analysis is based on the German SAVE dataset, a representative household panel which started in 2001 and contains detailed information on the financial and socio-economic situation of household members. The survey is conducted annually from spring until early summer. The SAVE data is imputed using an iterative multiple imputation procedure (Schunk, 2008; Ziegelmeyer, 2012). To make the assumption that households are involved in financial markets, the sample is restricted to those that report positive

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holders portfolios.

financial wealth in 2007. In appendix B.2, a description of all variables is provided.

**Measuring changes in risk attitude**   Risk attitudes can be quantified by inference from actual choices, elicitation in experiments, or via survey questions. To validate the reliability of a single measure, approaches often employ and compare different measures (e.g., Reynaud and Couture, 2010; Anderson and Mellor, 2009). If measures from experiments are unavailable, as is normally the case with large-scale surveys, the explanatory power of stated attitudes for actual risky behaviors can be studied (e.g., Dohmen et al., 2011). The SAVE provides individuals' self-reported financial risk attitude measured on a scale from 0 to 10, see appendix B.1. Kapteyna and Teppa (2011) show that such "a-theoretical" risk aversion measures have more explanatory power than sophisticated measures for portfolio choices. Coppola (2011) investigates the reliability of different risk attitude questions in SAVE by analyzing their internal consistency and behavioral validity. She concludes that self-assessed risk attitude in different domains are more informative with respect to actual behavior than lottery questions. We employ the change of risk attitude with respect to financial matters from 2007 to 2010 as a dependent and independent variable in the analysis.

**Measuring changes in subjective expectations**   Households' subjective expectations can be obtained using probability formats or using discrete-response alternatives and verbal descriptors such as 'very likely', 'likely', and 'somewhat unlikely'. Both types of measures have advantages and disadvantages (e.g., Manski, 2004). Verbal responses express little of the richness of the uncertainty. While probability questions provide a well-defined absolute numerical scale for responses, however, a lot of papers find inconsistent answers which are then excluded from the sample. In the 2010 SAVE study, households were asked to report whether they expect risks and returns to change in the long run due to the financial crisis, see appendix B.1. We employ responses to this question to measure expected change in risk and returns as a dependent and independent variable.

**Measuring changes in risk taking** Risk taking is frequently measured by observing actual choices. If agents do not instantaneously readjust their portfolio (due to costs in time and money), however, a significant drop in stock prices will be followed by a drop in the portfolio share invested in risky assets. Established relationships between wealth changes and changes in risk aversion can then be due to a spurious correlation rather than changed behavior Guiso et al. (2011). The results by Brunnermeier and Nagel (2008) and Hoffmann et al. (2013) suggest that inertia indeed influences portfolio allocations. This might be the reason why Weber et al. (2012) - using a self-reported measure - but not Hoffmann et al. (2013) find changes in risk taking behavior in the course of the financial crisis. In the 2010 SAVE study, household members were asked to report how they plan to proceed with their share of risky assets, see appendix B.1. The variable allows us to overcome the influence of inertia on the portfolio allocation.

**Measuring changes in financial wealth** Previous studies measure changes in financial wealth using administrative data from banks (e.g., Guiso et al., 2011) or survey data (e.g., Brunnermeier and Nagel, 2008). All measures have assets and drawbacks.[4] The SAVE study contains detailed information on households' self-reports of their wealth which allows us to test the hypothesis that changes in endowment influence changes in risk preferences. As has been pointed out in section 1, in Germany the financial crisis mainly affected financial portfolios. In the analysis, the change of the logarithm of financial wealth between end of 2007 and 2009 is included to measure "regular" changes in financial wealth.

**Measuring the "wealth shock"** To quantify the effect of having experienced a "wealth shock", a measure of the household's subjective experience thereof is required. The SAVE study provides a unique measure. In 2010, re-

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[4] Approaches using the records of companies provide highly accurate records of holdings but do not necessarily represent the population and do not contain the total wealth of customers. Survey data offer the advantage that they are representative for the entire population but wealth data are only reported at aggregated levels and their reliability depend on the willingness to report accurately (Campbell, 2006).

spondents were asked whether they had suffered from wealth losses or made profits since the beginning of the economic and financial crisis at the end of 2007 and the end of 2009 and if yes, how high the losses or gains were, see appendix B.1.[5] Börsch-Supan et al. (2010) investigate the reliability of subjective losses reported in SAVE in a simulation study and find that they largely correspond to simulated losses.[6] We employ two variables to measure the "wealth shock". Firstly, two binary variables are included which are one if the respondent reports having experienced gains or losses, respectively, and zero otherwise. Secondly, the amount lost or gained in relation to financial wealth prior to the crisis, i.e. at the end of 2007, is employed. Taking into account changes in financial wealth, this measure would only have an effect on risk taking and its components if losses experienced due to the crisis have a different effect than "regular" wealth changes.

**Measuring other consequences from the crisis**  Recent literature devotes attention to the importance of background risk for financial risk taking. In order to cut their overall exposure to risk, investors may reduce their share of risky assets if earning risk increases (e.g., Heaton and Lucas, 2000). Guiso et al. (1996) find that households facing uninsurable income risk hold a lower proportion of risky assets. Guiso and Paiella (2008) show that past unexplained variance of per capita GDP in one's province increases self-reported risk aversion. Guiso et al. (2011), however, find that government employees or retired individuals, i.e., groups which did not experience a change in background risk due to the crisis, do not show a significantly different change in risk attitudes between 2007 and 2009. Whether their finding can be generalized to other groups of occupation remains open. In the 2010 SAVE study, participants were asked to report whether they had experienced losses in income or lost their job, whether they had to work short time or felt an

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[5]A similar question was asked in the 2009 SAVE survey. Respondents were asked to report whether they suffered any losses in wealth due to the financial crisis and if yes, how high the total loss was in 2008. In that year, however, information on expectations and planned behavior were not surveyed. The losses reported in 2009 and 2010 are highly correlated suggesting reliability of the measure.

[6]Bucher-Koenen and Ziegelmeyer (2010) employ the questions to analyze the question who generated losses.

increased job uncertainty as a consequence of the financial crisis. We study the effect of experiencing one of those consequences by including four binary variables indicating whether the individual states that he or his partner suffered one of those job market consequences due to the crisis.

**Further control variables**  In order to avoid capturing past risk taking behavior in the wealth change variables, i.e., to overcome the possible endogeneity issue, we control for the observed risk taking behavior prior to the financial crisis. Included are the fraction of financial wealth invested in stock and real estate funds, bonds and other corporate fixed-income securities and other securities at the end of 2007. In regressions on changes in risk attitude, we control for the the initial level of risk attitude. This allows us to also take into account that the measure is bounded and possible changes are censored (see also  Guiso et al., 2011). Since we do not have the initial level of expectations and behavior, we control for risk attitude and the logarithm of the level of financial wealth (calculated as an inverse hyperbolic sine transformation) in 2010 as a proxy in these regressions. Furthermore, we control for financial literacy in 2007. It is measured by an ordinal variable that contains information how many of three quiz-like questions were correctly answered.[7] In all regressions, we control for socio-demographic characteristics (gender, age, family status, education, income).

## 3.2   Descriptive statistics

All descriptive statistics are based on observed data and calculated using the 2010 weighting scheme.  The weighting scheme establishes representativeness of the sample for the German population.[8] In appendix B.2, summary statistics are given for all variables.

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[7]A set of three quiz-like questions was developed by Lusardi and Mitchell (2011).  A more detailed description of the variable used here can be found in Bucher-Koenen and Ziegelmeyer (2010).

[8]The reference to which income and age classes are adjusted is the German Mikrozensus. For a detailed description see Börsch-Supan et al. (2009).

**Households' suffering from the financial crisis**   In 2010, 19.8% report that they suffered losses between the end of 2007 and end of 2009.[9] The average loss is Euro 2.054. A gain due to the crisis is reported by 2.9%; their average profit is Euro 431. The survey also allowed respondents to state that they are unaffected because they did not possess any wealth. This alternative is chosen by 25.8%. To get an insight into households' relative suffering from the financial crisis, losses and gains are divided by financial wealth in 2007. Households lost 5.8% of their financial wealth. Those with more risky assets more often suffered financial consequences from the crisis; 38.4% of those owning stocks report having experienced losses. The average stock market participation rate between 2006 and 2010 was 66% for those who suffered losses while it was 22% among those those who did not suffer.

Having experienced job market consequences since the beginning of the crisis is reported by 36.2%.[10] Job market consequences were specified as a loss of income, loss of job, having to work short time or perceived job uncertainty. A loss of income was reported by 12.5% in 2009 and 10.7% in 2010 (unconditional); 2.8% in 2009 and 3.4% in 2010 reported a loss of their job. That they had to work short time due to the crisis was reported by about 6.1% (2009 and 2010). 11% in 2009 and 8.1% in 2010 perceived their job to be more uncertain. Some overlap of financial and job market consequences exists. The fraction that experienced both is 8.8%.

**Changes in risk attitudes**   On average, individuals report a willingness to take risk in financial matters of 2.24 in 2007 and 2.24 in 2010 (measured on a scale from 0 to 10, a lower value indicates higher risk aversion). According to a t-test, the difference between the two years is not statistically significant.

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[9]The following numbers are, unless otherwise specified, unconditional, i.e., based on all households with positive financial wealth. Only 3% without financial wealth report losses in 2010. Compared to a similar question in 2009, 87.2% consistently report either having or not having suffered losses. Of those who report in 2009 that they had a loss in 2008, 36% state in 2010 that they had not suffered losses, 4% report a profit, 3.7% report a loss in 2010 which they did not declare in the previous year (conditional).

[10]The question was asked for the first time in 2009. In 2010, it was asked whether the respondent had suffered consequences since the last survey. Reported are the fraction of respondents with affirmative answers either in 2009 or 2010.

The distribution of values shows a tendency towards zero risk tolerance in all years (see figure 1). A two sample Kolmogorov-Smirnov test for equality shows that the distribution of values does not statistically significantly differ between the two years. At the individual level risk attitudes are also rather stable. Spearman's rank correlation coefficient is higher than 0.4 for all combination of years.

Figure 2 shows the distribution of changes in risk attitudes from 2007 to 2010. Less than 10% increase or decrease their willingness to take risks by more than three points, respectively; 34% do not change their risk aversion at all. A two sample Kolmogorov-Smirnov test for equality shows that the distribution of changes does not statistically significantly differ between different years. The statistics suggest low variation in individuals' risk attitude from 2007 to 2010. This result is at odds with the findings by Guiso et al. (2011) and Hoffmann et al. (2013) who report that risk attitudes vary over the course of the financial crisis and in line with Weber et al. (2012) who report temporal stability.

**Changes in risk and return expectations** As can be seen in figures 3 and 4, high uncertainty exists with respect to the development of long-run risks and return. Forty-eight percent of respondents state that they "cannot assess" the change of long-run returns due to the financial crisis. The change of long-run risks cannot be assessed by 47.8%. The fraction of respondents that cannot provide an answer is usually high in surveys. Hurd et al. (2011) report that 13%-21.1% report that they "don't know" how the value of an investment will be changed in one year (Dutch CentER Panel); Dominitz and Manski (2011) report rates of 8.2% (Michigan Survey of Consumers) and 36% (Survey of Economic Expectations). Uncertainty seems to be particularly high among German households which may to some extent be due to inquiring long-run development.

Figure 3 shows that less than 1% of respondents expect returns to increase strongly, 20.8% expect a slight increase. Unchanged returns are expected by 10.3%. A negative outlook is expressed by 13.9% (slight decrease) and 5.4% (strong decrease). Hence, among those that are able to provide an answer

disagreement about future development of returns exists. With respect to the long-run development of risks, 8% report that they expect a strong increase while 20% expect a slight increase, as can be seen in figure 4. Unchanged risks are expected by 14.6%. A decrease of long-run risk is expected by 6.9% (slight) and 2.7% (strong), respectively. Respondents that are able to provide an answer are hence rather pessimistic with respect to long-run risks. Due to a low fraction of respondents expecting "strong" changes, "strong" and "slight" are combined in the empirical analysis.

**Changes in risk taking behavior**   As can be seen in figure 5, households are rather reluctant to invest in risky assets. To the question how they plan to proceed with their share of risky assets, 68.5% respond that they do not invest in risky assets. This is a plausible result; in the same year stocks are held by 28.5%. It has to be taken into account, however, that this category may contain respondents that turned away from stock markets after the financial crisis. The fraction holding stocks in 2007 is 34%. Uncertainty also exists how households plan to proceed with their share of risky assets. That they are unable to assess their future risk taking behavior is indicated by 9.8%. Two percent of respondents plan to increase their portfolio share of risky assets, 11.7% intend to keep it constant and 8% aim to reduce it in the long run. Responses to this question hence indicate a tendency to increase risk averse behavior.

## 3.3   Empirical approach

In the empirical analysis, the hypothesized relationships are analyzed employing the variables described in the section 3.1. All five multiply imputed data sets are used and the results are derived using Rubin's method (Rubin, 1987, 1996). We do not use imputed data with respect to the dependent variables (financial risk attitude, risk behavior, expectations) and the self-reported change of wealth due to the crisis. Regressions are unweighted.[11]

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[11]We follow Deaton (1997) who points out that "when the sectors [sub populations] are homogeneous, OLS is more efficient, and when they are not, both estimators are inconsistent. In neither case is there an argument for weighting."(p. 70).

The empirical analysis consists of three sets of regressions: for studying the determinants of changes in attitudes, in expectations, and in behavior.

$$\Delta risk\ attitude = \beta_0 + \beta_1 controls + \beta_2 \Delta fin\ wealth+ \\ \beta_3 wealth\ shock + \epsilon \tag{1}$$

The impact of experiencing changes of financial wealth or a "wealth shock" on the change of risk attitude from 2007 to 2010 is analyzed by estimating the model shown in equation 1 using ordinary least squares (OLS). The specification resembles the one chosen by Guiso et al. (2011).

$$P(\Delta expectation:\ m = 1|X) = \phi(\beta_0 + \beta_1 controls + \beta_2 \Delta fin\ wealth+ \\ \beta_3 wealth\ shock) \tag{2}$$

The impact of the financial crisis on the change of risk end return expectations is analyzed by estimating the model shown in equation 2. As described in section 3.1, six responses, for the analysis grouped to four responses, were possible which are partly ordered. The large fraction of respondents who chose that option suggests that the unordered alternative (I cannot assess) also contains valuable information. Ordered probit estimation is hence unfeasible. A problem of multinomial logit and probit is that they require strong assumptions whose validity cannot be tested. In addition, interpretation of results is not straightforward. Williams (2006) and Greene and Hensher (2009) caution against using this approach. Another approach is to create four binary variables which are one if the respective alternative (m=increase, constant, decrease, cannot assess) was chosen, and zero otherwise, and estimate the regressions using binary probit. While this comes at the cost of ignoring possible correlation of errors across alternatives, it has

the advantage that the interpretation of results is straightforward.[12]

$$P(\Delta risk\ behavior:\ n=1|X) = \phi(\beta_0 + \beta_1 controls + \beta_2 \Delta risk\ attitude+ \\ \beta_3 \Delta expectations + \beta_4 \Delta fin\ wealth + \beta_5 wealth\ shock) \tag{3}$$

The responses to the question how households plan to change their risk behavior are regressed expected returns and risks, risk attitude and the wealth change variables, as shown in equation 3. Response possibilities are also partly ordered. We proceed as described in the previous paragraph and create five binary variables which are one if the respective alternative (n=increase, constant, decrease, cannot assess, does not apply) was chosen, and zero otherwise. The models are estimated using binary probit.

## 3.4   Regression results

### 3.4.1   Results: Changes in risk attitude

The results of an OLS regression of the set of controls as specified in equation 1 on changes in risk attitudes are reported in table 1. A positive coefficient implies a higher increase in risk tolerance from 2007 to 2010.

A change in logarithm of financial wealth from 2007 and 2009 does not have an effect on the change in risk attitudes, the coefficient is far from significance. Our results hence confirm the finding by Guiso et al. (2011). The same applies to having experienced a "wealth shock" due to the financial crisis. Neither the binary variables (positive or negative "wealth shock", first column) nor the amount in relation to financial wealth (second column) statistically significantly affect the change in risk attitudes. This result contradicts the conjecture by Guiso et al. (2011) that the observed change in risk attitudes is due to an emotional reaction at least insofar as being personally affected by wealth changes due to the crisis does not have an effect.

As found by Guiso et al. (2011), having suffered other consequences during the economic/financial crisis, i.e., changes in background risk, are unrelated to changes in risk attitudes. Surprisingly, however, the coefficients for having

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[12]Results are largely unchanged using multinomial probit. Available upon request.

suffered an income loss or feeling increased job uncertainty are positive suggesting that experiencing these increases risk tolerance. In contrast, having suffered a job loss or short time work as expected decrease risk tolerance. It has to be taken into account that Germany has a strong social security net which may bias effects. Taken together, neither financial nor job market consequences experienced due to the financial crisis seem to be related to changes in risk attitudes.

The level of willingness to take financial risk prior to the crisis is a highly significant predictor of the change in risk attitudes. Those with a higher initial level show a higher increase of risk aversion. The coefficient has almost the same magnitude as the one found by Guiso et al. (2011). Those with a higher share of risky assets in 2007 increased their predisposition to take risks. In line with previous literature (e.g., Dohmen et al., 2011), we find that older respondents show a lower increase in risk tolerance. Females are less likely to increase their risk tolerance.

### 3.4.2 Results: Changes in expectations

Average marginal effects of probit regressions on the four possible outcomes of how individuals expect return to change using binary variables to measure the wealth shock are reported in table 2. In table 3, results for the same regressions using the wealth shock relative to financial wealth are shown. Results of probit regressions on the four possible outcomes of expected changes in long-run risk are reported in table 4 (using binary variables to measure the wealth shock) and table 5 (wealth shock relative to financial wealth).

As can be seen in all tables, the change in log financial wealth seems to affect in particular whether or not someone is able to assess future risk and returns. The marginal effect of a change of logarithm of financial wealth from 2007 to 2009 is statistically significant and positive. A negative change hence decreases the likelihood that someone cannot assess the change in returns that has to be expected due to the crisis. In contrast, the marginal effects for the three ordered alternatives are all negative and insignificant. The finding that all ordered alternatives change by a similar magnitude with a change

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in financial wealth suggests that our sample consists of different expectation types. A similar pattern is observed with respect to risk expectations, as can be seen in tables 4 and 5. A negative change in financial wealth yet statistically significantly increases the likelihood that someone expects risks to increase in the future.[13]

Those that experienced losses due to the crisis are 11.3%-points less likely to report that they cannot assess future returns, as can be seen in table 2. Experiencing a "wealth shock" also seems to reveal information on how returns will develop. Those that experienced a negative wealth shock are 8.6%-points more likely to expect an increase in long-run returns, suggesting the expectation of mean reversal. Similar but less significant marginal effects are found with respect to having experienced a positive wealth shock. Table 3 shows that these findings hold when the amount lost or gained relative to financial wealth in 2007 is considered. An increase of the relative wealth loss (i.e., a decrease of this variable) by one standard deviation increases the likelihood that someone expects long-run returns to increase by 2.7%-points. As can be seen in tables 4 and table 5, the marginal effects indicate a similar relationship with respect to long-run risk expectations. The effect is, however, at most significant at the 10%-level.

Having experienced labor market consequences due to the financial crisis does not have an effect on risk and return expectations, almost all marginal effects are insignificant. A loss of income increases the likelihood that someone reports that he expects future risk to increase (significant at the 5%-level). Income losses thus seem to have a similar effect as wealth losses.

A higher level of financial wealth makes it more likely that someone expects risk and returns to increase and less likely that he cannot provide an answer. In line with previous literature (e.g., Hudomiet et al., 2011), females are less likely to expect an increase in risk and returns. Higher education (having graduate instead of high education) implies a more pessimistic outlook. Gouret and Hollard (2011) write that respondents with lower financial

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[13]This result cannot be interpreted as evidence for mean reversion. As pointed out by Dominitz and Manski (2011), "the idea of mean reversion does not suggest a particular way to form expectations for future volatility", it only applies to returns.

literacy are more likely to report biased responses to subjective expectation questions. This may be the consequence of a lack of knowledge. Our results show that respondents with lower financial literacy are more likely to respond that they "cannot assess" future risks and returns. In addition, the results suggest that higher financial literacy leads to an increased likelihood to expect that returns will increase and risks will increase or remain constant.

### 3.4.3 Results: Changes in risk taking behavior

Average marginal effects of a probit regression for the five possible outcomes are reported in table 6 (including binary variables to measure the wealth shock) and table 7 (including the relative wealth shock).

We find that return expectations but not risk expectaions have a significant influence on planned changes in risk taking behavior. Compared to those that cannot assess the change in long-run returns, respondents that expect long-run returns to increase are 5%-points more likely to increase their share of risky assets and 8%-points more likely to keep it constant. These effects are slightly lower for those that expect long-run returns to remain constant. Those that expect decreasing returns are roughly 6%-points more likely to plan a decrease of their share of risky assets. Someone who has an opinion on how long-run returns will develop is less likely to report that the household does not own stocks (compared to those who report that they cannot assess). Our results are in line with Weber et al. (2012) with respect to return expectations and contradict their findings of a significant influence of risk expectations. Hoffmann et al. (2013) find that changes in risk and return expectations are unrelated to the level of risk taking.

As can be seen in tables 6 and table 7, changes in risk attitude are unrelated to changes in risk taking behavior. This result is in line with Weber et al. (2012) and contradicts the one by Guiso et al. (2011). In contrast, the level of self-reported willingness to take financial risk seems to matter. A high level of risk tolerance in 2010 significantly increases the likelihood that the household plans to increase the share of risky assets or keep it constant.

A change in logarithm of financial wealth does not significantly affect

planned financial risk taking which is in contrast to Guiso et al. (2011) who find a significantly positive relationship. It has to be taken into account, however, that their dependent variable is based on administrative portfolio data which may naturally vary with changes in wealth if agents do not readjust their portfolio after a drop in stock prices, as has been described in section 3.1. We find that the experience of a "wealth shock" directly affects risk taking behavior. A negative wealth shock (measured binary) statistically significantly increases the likelihood that a household plans to decrease the share in risky assets by 11.9%-points, as can be seen in table 6. An increase in the amount lost or gained relative to financial wealth by one standard deviation increases the likelihood that a household plans to decrease their share of risky assets by 1.2%-points.

Having experienced labor market consequences over the course of the financial crisis also does not have a systematic effect on future risk taking behavior. Those that report a loss of job are 2.6%-points more likely to plan to increase their share of risky assets, those that perceive increased job uncertainty are 4.7%-points more likely to plan to keep the share constant. A higher level of financial wealth decreases the likelihood that someone reports that the household does not own stocks and increases the likelihood of choosing an ordered alternative. Those with higher financial literacy are more likely to plan to decrease their share of risk assets. Future financial risk taking varies little with socio-demographic characteristics.

# 4    Conclusion

The financial crisis presented a shock not only to institutional actors but also to private households. Previous literature emphasizes two important causes for changed risk taking in the aftermath of the financial crisis: wealth changes in terms of material endowment and the shock of experiencing them. Modern finance theory suggests three different channels via which these factors may have affected risk preferences: risk attitudes, risk expectations and return expectations. The present study analyzes these relationships.

We find little evidence for the common contention that willingness to take

risk is decreasing in wealth. In contrast, suffering a "wealth shock" due to an event like the financial crisis seems to affect risk taking. Interestingly, the effect does not run via risk attitudes but via (return) expectations or risk taking behavior directly. We are thus able to contribute to the understanding whether and how the emotional response to the financial crisis affects risk taking. Our findings are in line with evidence from psychology suggesting that expectations but not attitudes can explain differences in cross-situational differences in risk taking.

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# A    Figures and tables
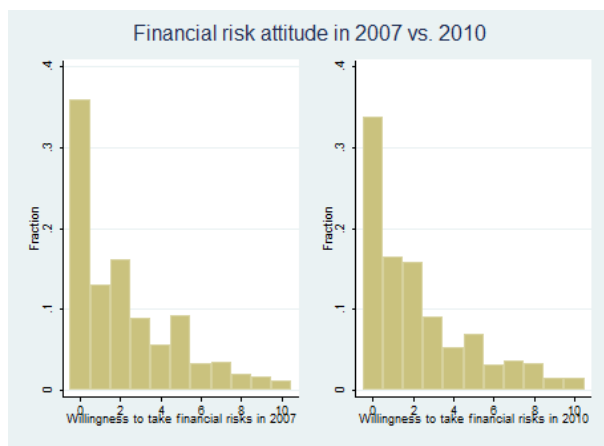


Figure 1: Financial risk attitudes in 2007 and 2010
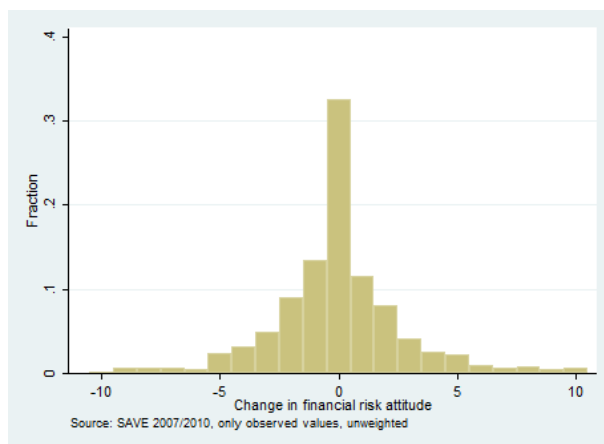


Figure 2: Changes in financial risk attitudes 2007-10
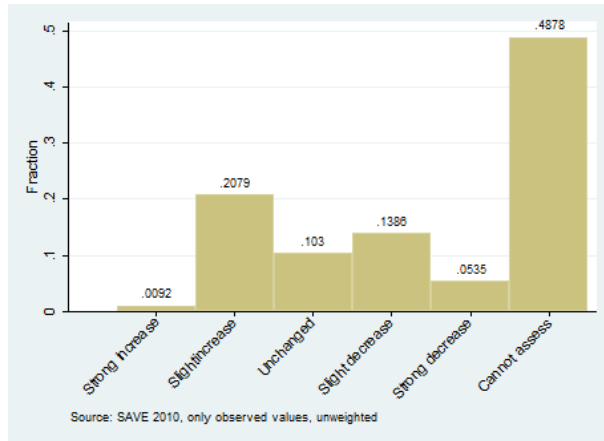
Figure 3: Expected change of long-run returns
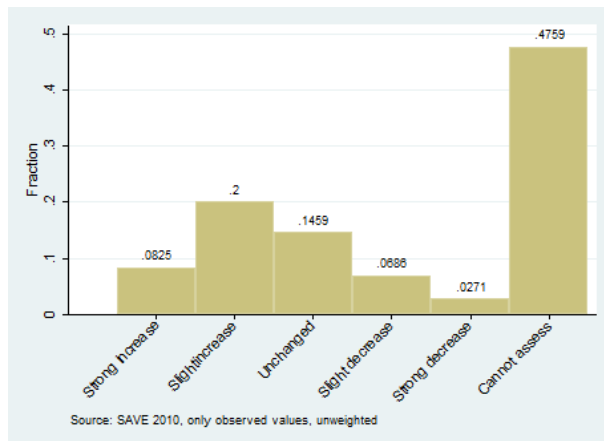


Figure 4: Expected change of long-run risks
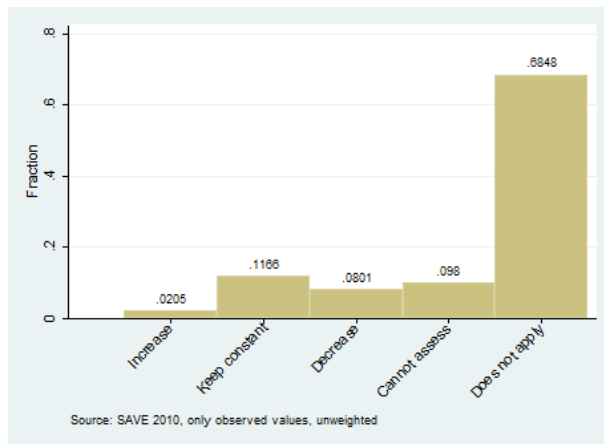
Figure 5: Planned change of portfolio share in risky assets

## Table 1: Determinants of changes in risk attitudes

|  | Change risk attitude b/se | Change risk attitude b/se |
|---|---|---|
| $\Delta$ log fin. wealth 07-09 | 0.001 | 0.004 |
|  | (0.028) | (0.028) |
| Neg. wealth shock (yes) | 0.128 |  |
|  | (0.170) |  |
| Pos. wealth shock (yes) | 0.163 |  |
|  | (0.435) |  |
| Wealth shock/fin.wealth 07-09 |  | 0.015 |
|  |  | (0.084) |
| Other cons.: income loss | 0.168 | 0.192 |
|  | (0.188) | (0.184) |
| Other cons.: job loss | -0.199 | -0.192 |
|  | (0.278) | (0.280) |
| Other cons.: short time work | -0.193 | -0.203 |
|  | (0.229) | (0.228) |
| Other cons.: job uncertain | 0.093 | 0.090 |
|  | (0.190) | (0.191) |
| Risk attitude level 2007 | -0.615*** | -0.613*** |
|  | (0.031) | (0.031) |
| Stocks/fin. wealth 2007 | 0.471** | 0.524** |
|  | (0.227) | (0.225) |
| Bonds/fin. wealth 2007 | 0.389 | 0.425 |
|  | (0.359) | (0.359) |
| Securities/fin. wealth 2007 | 0.714 | 0.771 |
|  | (0.844) | (0.836) |
| Not Married | 0.208 | 0.209 |
|  | (0.158) | (0.157) |
| Basic education | -0.098 | -0.110 |
|  | (0.291) | (0.291) |
| Undergraduate education | -0.126 | -0.128 |
|  | (0.181) | (0.180) |
| Graduate education | -0.011 | -0.008 |
|  | (0.168) | (0.167) |
| Net income | 0.009** | 0.009** |
|  | (0.004) | (0.004) |
| Age | -0.097*** | -0.097*** |
|  | (0.032) | (0.032) |
| Age squared | 0.001*** | 0.001*** |
|  | (0.000) | (0.000) |
| female | -0.363** | -0.360** |
|  | (0.142) | (0.142) |
| Financial literacy | -0.009 | -0.002 |
|  | (0.115) | (0.115) |
| R2 | 0.31 | 0.31 |
| N max | 1256 | 1256 |
| N min | 1249 | 1249 |

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. The dependent variable takes values from -10 to +10, a higher value indicates a higher increase in risk tolerance. Hypothesis tests are based on robust standard errors. Significance levels : $*$ : 10%    $**$ : 5%    $***$ : 1%. R2 refers to a regression with one imputation. Reference categories are Married, High education, Male.

Table 2: Determinants of return expectations - including binary wealth shock

| | Increase ME/SE | Constant ME/SE | Decrease ME/SE | Don't Know ME/SE |
|---|---|---|---|---|
| Δ log fin. wealth 07-09 | -0.007 | -0.008 | -0.010 | 0.024** |
| | (0.009) | (0.007) | (0.009) | (0.010) |
| Neg. wealth shock (yes) | 0.086*** | -0.013 | 0.022 | -0.113*** |
| | (0.027) | (0.022) | (0.028) | (0.034) |
| Pos. wealth shock (yes) | 0.098* | 0.007 | -0.036 | -0.130* |
| | (0.055) | (0.042) | (0.066) | (0.075) |
| Other cons.: income loss | 0.030 | -0.031 | 0.051* | -0.046 |
| | (0.029) | (0.023) | (0.028) | (0.034) |
| Other cons.: job loss | -0.083 | 0.041 | 0.056 | -0.034 |
| | (0.054) | (0.040) | (0.049) | (0.059) |
| Other cons.: short time work | -0.003 | -0.034 | 0.013 | 0.017 |
| | (0.040) | (0.035) | (0.041) | (0.049) |
| Other cons.: job uncertain | 0.007 | -0.039 | -0.026 | 0.059 |
| | (0.032) | (0.028) | (0.032) | (0.039) |
| log financial wealth | 0.017** | 0.015** | 0.011 | -0.039*** |
| | (0.008) | (0.007) | (0.008) | (0.009) |
| Risk attitude level | 0.009** | 0.003 | 0.002 | -0.017*** |
| | (0.004) | (0.003) | (0.004) | (0.005) |
| Stocks/fin. wealth 2007 | 0.078** | 0.056** | -0.016 | -0.139*** |
| | (0.036) | (0.028) | (0.042) | (0.047) |
| Bonds/fin. wealth 2007 | 0.006 | -0.023 | 0.037 | -0.016 |
| | (0.058) | (0.055) | (0.060) | (0.077) |
| Securities/fin. wealth 2007 | -0.049 | -0.020 | 0.053 | -0.013 |
| | (0.108) | (0.089) | (0.104) | (0.129) |
| Not Married | -0.007 | 0.000 | 0.022 | -0.020 |
| | (0.025) | (0.019) | (0.025) | (0.030) |
| Basic education | -0.014 | -0.084 | -0.038 | 0.071 |
| | (0.061) | (0.054) | (0.051) | (0.060) |
| Undergraduate education | 0.037 | 0.006 | -0.043 | -0.002 |
| | (0.028) | (0.022) | (0.029) | (0.033) |
| Graduate education | 0.060** | -0.005 | -0.050* | -0.016 |
| | (0.027) | (0.021) | (0.029) | (0.033) |
| Net income | 0.001* | 0.000 | 0.001 | -0.002** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Age | 0.002 | -0.002 | 0.013** | -0.011** |
| | (0.005) | (0.004) | (0.005) | (0.006) |
| Age squared | -0.000 | 0.000 | -0.000** | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| female | -0.058*** | -0.049*** | -0.006 | 0.117*** |
| | (0.022) | (0.017) | (0.022) | (0.025) |
| Financial literacy | 0.080*** | 0.012 | 0.013 | -0.087*** |
| | (0.020) | (0.014) | (0.018) | (0.020) |
| Chi 2 min | 142.89 | 142.89 | 142.89 | 142.89 |
| Chi 2 max | 149.36 | 149.36 | 149.36 | 149.36 |
| N min | 1392 | 1392 | 1392 | 1392 |
| N max | 1399 | 1399 | 1399 | 1399 |

Data Source: SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : ∗ : 10% ∗∗ : 5% ∗ ∗ ∗ : 1%. Chi2/N min/max refer to results from individual imputations.

Table 3: Determinants of return expectations - including relative wealth shock

|  | Increase ME/SE | Constant ME/SE | Decrease ME/SE | Don't Know ME/SE |
|---|---|---|---|---|
| Δ log fin. wealth 07-09 | -0.013 | -0.007 | -0.011 | 0.030*** |
|  | (0.009) | (0.007) | (0.009) | (0.010) |
| Wealth shock/fin.wealth 07-09 | -0.040** | -0.001 | -0.010 | 0.049* |
|  | (0.020) | (0.008) | (0.016) | (0.026) |
| Other cons.: income loss | 0.038 | -0.034 | 0.054* | -0.057* |
|  | (0.028) | (0.023) | (0.028) | (0.034) |
| Other cons.: job loss | -0.083 | 0.040 | 0.057 | -0.038 |
|  | (0.054) | (0.040) | (0.049) | (0.060) |
| Other cons.: short time work | -0.009 | -0.034 | 0.010 | 0.026 |
|  | (0.041) | (0.035) | (0.041) | (0.049) |
| Other cons.: job uncertain | -0.002 | -0.039 | -0.027 | 0.069* |
|  | (0.032) | (0.028) | (0.032) | (0.039) |
| log financial wealth | 0.024*** | 0.015** | 0.012 | -0.046*** |
|  | (0.008) | (0.006) | (0.008) | (0.009) |
| Risk attitude level | 0.010** | 0.003 | 0.002 | -0.018*** |
|  | (0.004) | (0.003) | (0.004) | (0.005) |
| Stocks/fin. wealth 2007 | 0.106*** | 0.051* | -0.009 | -0.177*** |
|  | (0.035) | (0.027) | (0.040) | (0.046) |
| Bonds/fin. wealth 2007 | 0.025 | -0.025 | 0.040 | -0.040 |
|  | (0.057) | (0.055) | (0.060) | (0.076) |
| Securities/fin. wealth 2007 | -0.032 | -0.023 | 0.055 | -0.033 |
|  | (0.101) | (0.089) | (0.104) | (0.127) |
| Not Married | -0.002 | 0.001 | 0.022 | -0.024 |
|  | (0.025) | (0.019) | (0.025) | (0.029) |
| Basic education | -0.023 | -0.083 | -0.038 | 0.079 |
|  | (0.061) | (0.054) | (0.051) | (0.061) |
| Undergraduate education | 0.037 | 0.007 | -0.044 | -0.003 |
|  | (0.028) | (0.022) | (0.029) | (0.034) |
| Graduate education | 0.060** | -0.005 | -0.051* | -0.018 |
|  | (0.027) | (0.021) | (0.029) | (0.033) |
| Net income | 0.001* | 0.000 | 0.001 | -0.002** |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| Age | 0.002 | -0.002 | 0.013** | -0.011* |
|  | (0.005) | (0.004) | (0.005) | (0.006) |
| Age squared | -0.000 | 0.000 | -0.000** | 0.000*** |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| female | -0.059*** | -0.050*** | -0.007 | 0.117*** |
|  | (0.022) | (0.017) | (0.022) | (0.026) |
| Financial literacy | 0.085*** | 0.012 | 0.014 | -0.091*** |
|  | (0.020) | (0.014) | (0.018) | (0.020) |
| Chi2 min | 134.08 | 134.08 | 134.08 | 134.08 |
| Chi2 max | 140.83 | 140.83 | 140.83 | 140.83 |
| N min | 1392 | 1392 | 1392 | 1392 |
| N max | 1399 | 1399 | 1399 | 1399 |

Data Source: SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : ∗ : 10%  ∗∗ : 5% ∗ ∗ ∗ : 1%. RChi2/N min/max refer to results from individual imputations.

Table 4: Determinants of risk expectations - including binary wealth shock

|  | Increase ME/SE | Constant ME/SE | Decrease ME/SE | Don't Know ME/SE |
|---|---|---|---|---|
| Δ log fin. wealth 07-09 | -0.018* | -0.006 | -0.004 | 0.026*** |
|  | (0.010) | (0.007) | (0.006) | (0.010) |
| Neg. wealth shock (yes) | 0.057* | 0.002 | -0.010 | -0.062* |
|  | (0.031) | (0.025) | (0.022) | (0.034) |
| Pos. wealth shock (yes) | -0.030 | 0.054 | -0.013 | -0.049 |
|  | (0.067) | (0.049) | (0.049) | (0.074) |
| Other cons.: income loss | 0.075** | -0.015 | -0.005 | -0.056 |
|  | (0.032) | (0.026) | (0.022) | (0.035) |
| Other cons.: job loss | 0.099* | -0.054 | 0.013 | -0.078 |
|  | (0.054) | (0.050) | (0.036) | (0.060) |
| Other cons.: short time work | -0.003 | -0.013 | -0.009 | 0.025 |
|  | (0.046) | (0.034) | (0.031) | (0.050) |
| Other cons.: job uncertain | -0.001 | 0.003 | -0.015 | 0.024 |
|  | (0.036) | (0.028) | (0.024) | (0.039) |
| log financial wealth | 0.027*** | 0.008 | 0.005 | -0.038*** |
|  | (0.009) | (0.007) | (0.006) | (0.009) |
| Risk attitude level | 0.006 | 0.002 | 0.004 | -0.015*** |
|  | (0.005) | (0.004) | (0.003) | (0.005) |
| Stocks/fin. wealth 2007 | 0.035 | 0.055 | 0.017 | -0.110** |
|  | (0.045) | (0.033) | (0.029) | (0.048) |
| Bonds/fin. wealth 2007 | 0.081 | 0.028 | -0.020 | -0.089 |
|  | (0.067) | (0.055) | (0.057) | (0.078) |
| Securities/fin. wealth 2007 | 0.137 | -0.140 | -0.022 | -0.057 |
|  | (0.112) | (0.136) | (0.078) | (0.125) |
| Not Married | 0.023 | 0.029 | -0.008 | -0.047 |
|  | (0.028) | (0.021) | (0.018) | (0.030) |
| Basic education | -0.108* | -0.015 | -0.019 | 0.093 |
|  | (0.066) | (0.050) | (0.035) | (0.060) |
| Undergraduate education | 0.007 | -0.002 | -0.022 | 0.016 |
|  | (0.032) | (0.025) | (0.021) | (0.034) |
| Graduate education | 0.062** | 0.043* | -0.081*** | -0.055 |
|  | (0.031) | (0.023) | (0.025) | (0.034) |
| Net income | 0.000 | 0.001** | 0.000 | -0.002** |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| Age | 0.008 | -0.007* | 0.010** | -0.009 |
|  | (0.006) | (0.004) | (0.004) | (0.006) |
| Age squared | -0.000* | 0.000 | -0.000** | 0.000** |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| female | -0.065*** | -0.058*** | 0.001 | 0.122*** |
|  | (0.025) | (0.019) | (0.017) | (0.026) |
| Financial literacy | 0.068*** | 0.069*** | -0.021* | -0.085*** |
|  | (0.021) | (0.018) | (0.011) | (0.020) |
| Chi2 min |  |  |  |  |
| Chi2 max |  |  |  |  |
| N min | 1391 | 1391 | 1391 | 1391 |
| N max | 1398 | 1398 | 1398 | 1398 |

Data Source: SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : ∗ : 10%    ∗∗ : 5%    ∗ ∗ ∗ : 1%. Chi2/N min/max refer to results from individual imputations.

Table 5: Determinants of risk expectations - including relative wealth shock

|  | Increase ME/SE | Constant ME/SE | Decrease ME/SE | Don't Know ME/SE |
|---|---|---|---|---|
| Δ log fin. wealth 07-09 | -0.021** | -0.006 | -0.004 | 0.029*** |
|  | (0.010) | (0.007) | (0.006) | (0.010) |
| Wealth shock/fin.wealth 07-09 | -0.040 | -0.003 | 0.007 | 0.033 |
|  | (0.025) | (0.010) | (0.015) | (0.021) |
| Other cons.: income loss | 0.081*** | -0.016 | -0.005 | -0.062* |
|  | (0.031) | (0.026) | (0.022) | (0.034) |
| Other cons.: job loss | 0.100* | -0.055 | 0.014 | -0.080 |
|  | (0.054) | (0.050) | (0.037) | (0.060) |
| Other cons.: short time work | -0.010 | -0.012 | -0.008 | 0.029 |
|  | (0.046) | (0.034) | (0.031) | (0.050) |
| Other cons.: job uncertain | -0.006 | 0.001 | -0.014 | 0.030 |
|  | (0.036) | (0.028) | (0.024) | (0.039) |
| log financial wealth | 0.031*** | 0.009 | 0.004 | -0.042*** |
|  | (0.009) | (0.007) | (0.006) | (0.009) |
| Risk attitude level | 0.007 | 0.002 | 0.004 | -0.016*** |
|  | (0.005) | (0.004) | (0.003) | (0.005) |
| Stocks/fin. wealth 2007 | 0.052 | 0.055* | 0.014 | -0.130*** |
|  | (0.043) | (0.032) | (0.028) | (0.046) |
| Bonds/fin. wealth 2007 | 0.089 | 0.030 | -0.022 | -0.101 |
|  | (0.066) | (0.054) | (0.056) | (0.078) |
| Securities/fin. wealth 2007 | 0.140 | -0.131 | -0.024 | -0.065 |
|  | (0.111) | (0.135) | (0.077) | (0.123) |
| Not Married | 0.024 | 0.031 | -0.009 | -0.049 |
|  | (0.028) | (0.021) | (0.018) | (0.030) |
| Basic education | -0.110* | -0.017 | -0.019 | 0.096 |
|  | (0.066) | (0.050) | (0.035) | (0.060) |
| Undergraduate education | 0.006 | -0.001 | -0.022 | 0.015 |
|  | (0.032) | (0.025) | (0.021) | (0.034) |
| Graduate education | 0.060** | 0.044* | -0.081*** | -0.054 |
|  | (0.030) | (0.023) | (0.025) | (0.033) |
| Net income | 0.000 | 0.001*** | 0.000 | -0.002** |
|  | (0.001) | (0.001) | (0.001) | (0.001) |
| Age | 0.008 | -0.007* | 0.010** | -0.009 |
|  | (0.006) | (0.004) | (0.004) | (0.006) |
| Age squared | -0.000* | 0.000 | -0.000** | 0.000** |
|  | (0.000) | (0.000) | (0.000) | (0.000) |
| female | -0.067*** | -0.058*** | 0.001 | 0.123*** |
|  | (0.025) | (0.019) | (0.017) | (0.026) |
| Financial literacy | 0.069*** | 0.069*** | -0.022* | -0.087*** |
|  | (0.021) | (0.018) | (0.011) | (0.020) |
| Chi2 min |  |  |  |  |
| Chi2 max |  |  |  |  |
| N min | 1391 | 1391 | 1391 | 1391 |
| N max | 1398 | 1398 | 1398 | 1398 |

Data Source: SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : ∗ : 10% ∗∗ : 5% ∗∗∗ : 1%. Chi2/N min/max refer to results from individual imputations.

Table 6: Determinants of risk behavior - including binary wealth shock

| | Increase ME/SE | Constant ME/SE | Decrease ME/SE | Cannot Assess ME/SE | No stocks ME/SE |
|---|---|---|---|---|---|
| Return increase | 0.049*** | 0.080*** | 0.009 | 0.034 | -0.144*** |
| | (0.016) | (0.030) | (0.027) | (0.030) | (0.039) |
| Return constant | 0.031* | 0.060* | 0.004 | -0.013 | -0.047 |
| | (0.017) | (0.035) | (0.030) | (0.037) | (0.046) |
| Return decrease | 0.027 | -0.013 | 0.051** | 0.025 | -0.053 |
| | (0.019) | (0.034) | (0.026) | (0.031) | (0.040) |
| Return dont know (ref.) | | | | | |
| Risk increase | -0.008 | 0.052* | 0.009 | -0.042 | -0.023 |
| | (0.014) | (0.029) | (0.025) | (0.027) | (0.036) |
| Risk constant | -0.004 | 0.044 | 0.021 | -0.017 | -0.036 |
| | (0.015) | (0.034) | (0.028) | (0.033) | (0.044) |
| Risk decrease | -0.006 | 0.035 | -0.014 | -0.016 | -0.002 |
| | (0.017) | (0.037) | (0.032) | (0.037) | (0.049) |
| Risk dont know (ref.) | | | | | |
| Risk attitude change | 0.000 | 0.001 | 0.002 | -0.005 | 0.005 |
| | (0.001) | (0.003) | (0.003) | (0.003) | (0.005) |
| Risk attitude level | 0.004** | 0.012*** | -0.002 | 0.006 | -0.024*** |
| | (0.002) | (0.004) | (0.003) | (0.004) | (0.005) |
| $\Delta$ log fin. wealth 07-09 | 0.001 | 0.001 | -0.009 | 0.004 | 0.005 |
| | (0.004) | (0.007) | (0.007) | (0.006) | (0.010) |
| Neg. wealth shock (yes) | 0.002 | 0.016 | 0.119*** | 0.009 | -0.188*** |
| | (0.008) | (0.020) | (0.015) | (0.021) | (0.026) |
| Pos. wealth shock (yes) | 0.010 | 0.062 | 0.028 | 0.013 | -0.150*** |
| | (0.014) | (0.038) | (0.033) | (0.042) | (0.054) |
| log financial wealth | 0.006** | 0.020*** | 0.017*** | 0.001 | -0.028*** |
| | (0.003) | (0.007) | (0.006) | (0.006) | (0.009) |
| Other cons.: income loss | -0.011 | -0.016 | 0.001 | -0.001 | 0.037 |
| | (0.009) | (0.021) | (0.018) | (0.021) | (0.030) |
| Other cons.: job loss | 0.026** | -0.040 | 0.003 | 0.014 | -0.019 |
| | (0.012) | (0.046) | (0.033) | (0.036) | (0.054) |
| Other cons.: short time work | -0.018 | -0.010 | 0.035 | 0.021 | -0.021 |
| | (0.013) | (0.031) | (0.025) | (0.029) | (0.042) |
| Other cons.: job uncertain | -0.007 | 0.047** | 0.002 | 0.009 | -0.035 |
| | (0.009) | (0.022) | (0.021) | (0.023) | (0.030) |
| Stocks/fin. wealth 2007 | 0.012 | 0.137*** | 0.045* | 0.093*** | -0.284*** |
| | (0.012) | (0.026) | (0.024) | (0.028) | (0.036) |
| Bonds/fin. wealth 2007 | -0.025 | 0.043 | 0.062** | 0.106** | -0.173*** |
| | (0.024) | (0.046) | (0.031) | (0.044) | (0.059) |
| Securities/fin. wealth 2007 | 0.010 | 0.122* | -0.049 | 0.098 | -0.170 |
| | (0.023) | (0.069) | (0.066) | (0.076) | (0.117) |
| Not Married | -0.002 | -0.008 | 0.013 | 0.025 | -0.027 |
| | (0.008) | (0.019) | (0.015) | (0.018) | (0.025) |
| Basic education | 0.012 | -0.117** | -0.023 | 0.002 | 0.035 |
| | (0.016) | (0.058) | (0.041) | (0.041) | (0.062) |
| Undergraduate education | -0.001 | 0.017 | -0.000 | 0.014 | -0.029 |
| | (0.009) | (0.021) | (0.018) | (0.021) | (0.028) |
| Graduate education | -0.001 | 0.007 | 0.016 | 0.014 | -0.035 |
| | (0.008) | (0.019) | (0.017) | (0.020) | (0.027) |
| Net income | 0.000 | 0.001 | -0.000 | 0.000 | -0.001** |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) |
| Age | -0.001 | -0.003 | -0.001 | -0.001 | 0.007 |
| | (0.001) | (0.004) | (0.003) | (0.004) | (0.005) |
| Age squared | 0.000 | 0.000 | 0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| female | -0.004 | 0.035** | -0.012 | -0.013 | 0.008 |
| | (0.007) | (0.016) | (0.014) | (0.017) | (0.023) |
| Financial literacy | -0.002 | -0.006 | 0.026** | -0.028** | 0.019 |
| | (0.006) | (0.014) | (0.013) | (0.012) | (0.018) |
| Chi2 min | 173.98 | 212.63 | 208.64 | 51.29 | 334.58 |
| Chi2 max | 176.10 | 201.00 | 210.98 | 58.23 | 353.97 |
| N min | 1355 | 1355 | 1355 | 1355 | 1355 |
| N max | 1362 | 1362 | 1362 | 1362 | 1362 |

Data Source: SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*: 10\%$  $**: 5\%$  $***: 1\%$. N/Chi2 min/max refer to results from individual imputations.

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## Table 7: Determinants of risk behavior - including relative wealth shock

| | Increase ME/SE | Constant ME/SE | Decrease ME/SE | Cannot Assess ME/SE | No stocks ME/SE |
|---|---|---|---|---|---|
| Return increase | 0.050*** | 0.084*** | 0.027 | 0.034 | -0.178*** |
| | (0.017) | (0.030) | (0.027) | (0.030) | (0.039) |
| Return constant | 0.032* | 0.063* | 0.011 | -0.013 | -0.063 |
| | (0.018) | (0.035) | (0.031) | (0.037) | (0.047) |
| Return decrease | 0.028 | -0.012 | 0.065** | 0.024 | -0.074* |
| | (0.020) | (0.034) | (0.026) | (0.030) | (0.040) |
| Return dont know (ref.) | | | | | |
| Risk increase | -0.009 | 0.050* | 0.002 | -0.042 | -0.008 |
| | (0.015) | (0.029) | (0.025) | (0.027) | (0.037) |
| Risk constant | -0.005 | 0.042 | 0.010 | -0.017 | -0.020 |
| | (0.016) | (0.033) | (0.028) | (0.032) | (0.044) |
| Risk decrease | -0.007 | 0.032 | -0.022 | -0.015 | 0.018 |
| | (0.018) | (0.037) | (0.032) | (0.037) | (0.049) |
| Risk dont know (ref.) | | | | | |
| Risk attitude change | 0.000 | 0.001 | 0.000 | -0.005 | 0.008 |
| | (0.001) | (0.003) | (0.003) | (0.003) | (0.005) |
| Risk attitude level | 0.004** | 0.013*** | 0.000 | 0.006 | -0.027*** |
| | (0.002) | (0.004) | (0.003) | (0.004) | (0.005) |
| $\Delta$ log fin. wealth 07-09 | 0.001 | 0.000 | -0.017** | 0.003 | 0.014 |
| | (0.004) | (0.007) | (0.008) | (0.006) | (0.010) |
| Wealth shock/fin.wealth 07-09 | 0.004 | 0.017 | -0.015 | -0.012 | 0.006 |
| | (0.005) | (0.011) | (0.010) | (0.010) | (0.016) |
| log financial wealth | 0.007** | 0.022*** | 0.029*** | 0.002 | -0.041*** |
| | (0.003) | (0.007) | (0.006) | (0.006) | (0.009) |
| Other cons.: income loss | -0.010 | -0.013 | 0.025 | -0.001 | 0.003 |
| | (0.010) | (0.021) | (0.019) | (0.021) | (0.030) |
| Other cons.: job loss | 0.027** | -0.039 | 0.008 | 0.013 | -0.037 |
| | (0.012) | (0.047) | (0.035) | (0.036) | (0.056) |
| Other cons.: short time work | -0.018 | -0.010 | 0.018 | 0.020 | -0.007 |
| | (0.013) | (0.030) | (0.027) | (0.029) | (0.044) |
| Other cons.: job uncertain | -0.007 | 0.047** | -0.010 | 0.008 | -0.024 |
| | (0.009) | (0.022) | (0.022) | (0.023) | (0.032) |
| Stocks/fin. wealth 2007 | 0.012 | 0.144*** | 0.092*** | 0.094*** | -0.353*** |
| | (0.011) | (0.025) | (0.023) | (0.026) | (0.035) |
| Bonds/fin. wealth 2007 | -0.025 | 0.048 | 0.080** | 0.108** | -0.206*** |
| | (0.024) | (0.046) | (0.032) | (0.043) | (0.061) |
| Securities/fin. wealth 2007 | 0.013 | 0.138** | -0.006 | 0.097 | -0.236** |
| | (0.022) | (0.067) | (0.072) | (0.076) | (0.116) |
| Not Married | -0.002 | -0.007 | 0.012 | 0.027 | -0.032 |
| | (0.008) | (0.019) | (0.016) | (0.019) | (0.025) |
| Basic education | 0.011 | -0.128** | -0.042 | 0.002 | 0.062 |
| | (0.016) | (0.058) | (0.041) | (0.041) | (0.065) |
| Undergraduate education | -0.001 | 0.017 | -0.004 | 0.015 | -0.023 |
| | (0.009) | (0.021) | (0.019) | (0.021) | (0.029) |
| Graduate education | 0.000 | 0.008 | 0.013 | 0.014 | -0.033 |
| | (0.008) | (0.019) | (0.018) | (0.020) | (0.028) |
| Net income | 0.000 | 0.001 | -0.001 | 0.000 | -0.001 |
| | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) |
| Age | -0.001 | -0.003 | 0.001 | -0.001 | 0.006 |
| | (0.001) | (0.004) | (0.003) | (0.004) | (0.005) |
| Age squared | 0.000 | 0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| female | -0.004 | 0.036** | -0.010 | -0.014 | 0.006 |
| | (0.007) | (0.016) | (0.015) | (0.017) | (0.024) |
| Financial literacy | -0.002 | -0.005 | 0.036** | -0.028** | 0.011 |
| | (0.006) | (0.014) | (0.014) | (0.012) | (0.018) |
| Chi2 min | 151.93 | 194.60 | 139.57 | 51.63 | 282.96 |
| Chi2 max | 156.95 | 203.03 | 144.83 | 58.31 | 300.13 |
| N min | 1355 | 1355 | 1355 | 1355 | 1355 |
| N max | 1362 | 1362 | 1362 | 1362 | 1362 |

Data Source: SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$ : 10%   $**$ : 5%   $***$ : 1%. N/Chi2 min/max refer to results from individual imputations.

# B Appendix

## B.1 Measures of risk taking, risk attitude and expectations

1. *Financial risk attitude*
   "To what extent do the following statements apply to you? Please answer on a scale of 0 to 10, where 0 means "does not apply at all" and 10 means "applies very well". I do not mind taking risk with respect to ... (Health, career, financial matters, sport/leisure, car driving)."

2. *Financial risk taking*
   "What is your long-run plan with respect to your portfolio share in risky assets like equity (funds) or property funds? Increase/Keep constant/Decrease/I cannot assess/Does not apply, I don't invest in risky assets?".

3. *Return expectations*
   "According to your opinion, how do you expect long-run returns in stock markets to change on average? Due to the financial and economic crisis, long-run returns will ... strongly increase/slightly increase/remain constant/slightly decrease/strongly decrease/I cannot assess"

4. *Risk expectations*
   "According to your opinion, how do you expect long-run risks in stock markets to change on average? Due to the financial and economic crisis, long-run risks will ... strongly increase/slightly increase/remain constant/slightly decrease/strongly decrease/I cannot assess"

5. *Wealth changes due to economic/financial crisis*
   "Have you or your partner generated wealth losses or wealth gains since the beginning of the economic and financial crisis at the end of 2007 and the end of 2009 in total? Yes, gains/losses in the amount of .../No, neither gains nor losses/Does not apply, I do not possess wealth"

## B.2 Data

Table 8: Variable description

| Variable | Survey wave | Description |
|---|---|---|
| Change risk taking: | | See appendix B.1 |
| Change risk taking: increased | 2010 | One if individual reported "increase", zero otherwise |
| Change risk taking: constant | 2010 | One if individual reported "keep constant", zero otherwise |
| Change risk taking: decreased | 2010 | One if individual reported "decrease", zero otherwise |
| Change risk taking: cannot assess | 2010 | One if individual reported "I cannot assess", zero otherwise |
| Change risk taking: not applicable | 2010 | One if individual reported "Does not apply, I do not invest in risky assets", zero otherwise |
| Change return expectation: | | See appendix B.1 |
| Change return expectation: increase | 2010 | One if individual reported "increase", zero otherwise |
| Change return expectation: constant | 2010 | One if individual reported "constant", zero otherwise |
| Change return expectation: decrease | 2010 | One if individual reported "decrease", zero otherwise |
| Change return expectation: cannot assess | 2010 | One if individual reported "I cannot assess", zero otherwise |
| Change return expectation: | | See appendix B.1 |
| Change risk expectation: increase | 2010 | One if individual reported "increase", zero otherwise |
| Change risk expectation: constant | 2010 | One if individual reported "constant", zero otherwise |
| Change risk expectation: decrease | 2010 | One if individual reported "decrease", zero otherwise |
| Change risk expectation: cannot assess | 2010 | One if individual reported "I cannot assess", zero otherwise |
| Financial risk attitude 2007/10 | 2007/2010 | See appendix B.1 |
| Change risk attitude | 2007/2010 | Change of self-reported willingness to accept financial risks from mid-2007 to mid-2010 |
| "wealth shock" | 2010 | See appendix B.1 |
| Financial wealth | 2008/2010 | Logged financial wealth (deposits in savings accounts, building saving contracts, fixed income securities, stock holdings and real estate funds, other financial assets) at the end of 2007/2009. |
| Change financial wealth | 2008/2010 | Change in financial wealth from end of 2007 to end of 2009. |
| Other consequences | 2010 | Four binary variables which are one if a member of HH lost income or job, had to work short time or felt an increased job uncertainty as a consequence of the financial crisis, zero otherwise |
| Share of securities on financial wealth 2007 | 2008 | Ownership of "other securities", e.g., discount certificates, hedge fonds, money market fonds, and other finance innovations, in relation to financial wealth in 2007 |
| Share of stocks on financial wealth 2007 | 2008 | Ownership of "equity funds and real estate funds", e.g., reverse convertible, exchange traded funds, mixed funds, in relation to financial wealth in 2007 |
| Share of bonds on financial wealth 2007 | 2008 | Ownership of "bonds", e.g., savings bonds, corporate or pension funds, in relation to financial wealth in 2007 |
| Financial literacy 2007 | 2007 | Ordinal, 0-3, measuring how many of three questions designed to measure financial skills are correctly answered |
| Basic education | 2010 | One if individual has 9/10 years of education, zero otherwise |
| Higher education (reference) | 2010 | One if individual has 13/14 years of education, zero otherwise |
| Undergraduate education | 2010 | One if individual has 16/17 years of education, zero otherwise |
| Graduate education | 2010 | One if individual has 18/19 years of education, zero otherwise |
| Net income | 2010 | Monthly net household income |
| Age | 2010 | Age of the respondent |
| Female | 2010 | One if individual is female, zero otherwise |
| Not married | 2010 | One if individual is not married, zero otherwise |

## Table 9: Summary statistics

|  | Mean | Std. Dev. |
|---|---|---|
| Change risk taking: increased | 0.0199 | 0.1395 |
| Change risk taking: constant | 0.1193 | 0.3242 |
| Change risk taking: decreased | 0.0848 | 0.2787 |
| Change risk taking: cannot assess | 0.1013 | 0.3017 |
| Change risk taking: not applicable | 0.6747 | 0.4685 |
| Change return expectation: increase | 0.2264 | 0.4186 |
| Change return expectation: constant | 0.1101 | 0.3130 |
| Change return expectation: decrease | 0.1942 | 0.3956 |
| Change return expectation: cannot assess | 0.4693 | 0.4991 |
| Change risk expectation: increase | 0.2981 | 0.4575 |
| Change risk expectation: constant | 0.1504 | 0.3575 |
| Change risk expectation: decrease | 0.0917 | 0.2886 |
| Change risk expectation: cannot assess | 0.4597 | 0.4984 |
| Change risk attitude | -0.0709 | 2.7233 |
| Risk attitude 2010 | 2.2232 | 2.5031 |
| Financial wealth | 8.9422 | 3.2364 |
| Wealth shock/financial wealth 2007 | -0.0696 | 0.6898 |
| Neg. wealth shock | 0.2188 | 0.4135 |
| Pos. wealth shock | 0.0299 | 0.1702 |
| Change of log financial wealth 07-10 | -0.7767 | 2.7897 |
| Financial literacy 2007 | 2.5241 | 0.6654 |
| Other cons: income loss | 0.1854 | 0.3886 |
| Other cons: job loss | 0.0509 | 0.2199 |
| Other cons: work short time | 0.0853 | 0.2793 |
| Other cons: income uncertainty | 0.1518 | 0.3588 |
| Share of stocks on financial wealth 2007 | 0.1782 | 0.3001 |
| Share of bonds on financial wealth 2007 | 0.0673 | 0.1866 |
| Share of securities on financial wealth 2007 | 0.0171 | 0.1028 |
| not married | 0.2938 | 0.4555 |
| Basic education | 0.0509 | 0.2199 |
| Undergraduate education | 0.2009 | 0.4007 |
| Graduate education | 0.2158 | 0.4114 |
| Net income | 26.3608 | 15.6873 |
| Age | 55.7831 | 15.0265 |
| Female | 0.4824 | 0.4997 |