CAHIER D'ÉTUDES
WORKING PAPER

N° 85

HOUSEHOLD RISK TAKING AFTER THE FINANCIAL CRISIS

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JANUARY 2014

BANQUE CENTRALE DU LUXEMBOURG
EUROSYSTÈME

Household Risk Taking after the Financial Crisis*

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Abstract

This study investigates whether and how the crisis in 2008/2009 affects households' risk attitudes, subjective risk and return expectations, and planned financial risk taking using the German SAVE study. Households' wealth change from end-2007 to end-2009 is not found to have an effect. However, households that attribute losses to the crisis decreased their risk tolerance and planned risk taking; the probability of expecting an increase in risks and returns is raised. According to economic theory, wealth changes attributed to a dramatic event should not have a different effect than other wealth changes. The results suggest an emotional reaction.

Keywords: Financial and economic crisis, risk preferences, stock market expectations, wealth fluctuations, emotions
JEL-Codes: D81, D14, G11
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*We thank Ekkehard Köhler and Paolo Guarda for very helpful comments. We benefited from comments of participants of a seminar at the Banque centrale du Luxembourg in 2013.

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Nichttechnische Zusammenfassung

Die Finanz- und Wirtschaftskrise von 2008/2009 ist, zumindest seit dem zweiten Weltkrieg, ein beispielloses Ereignis. Der Luxemburger Aktienindex LUXX verlor zwischen Ende 2007 und Ende 2009 mehr als 40%, der deutsche Aktienindex DAX verbuchte Kursverluste von 25%. Auch das reale Bruttoinlandprodukt pro Kopf brach im beschrieben Zeitraum massiv ein, beispielsweise in Luxemburg um 8% oder in Deutschland um 5%. Die Entwicklungen überraschten die Marktteilnehmer. Ein nicht unerheblicher Anteil der Haushalte verlor Vermögen. Diese Studie untersucht, wie sich die Entwicklungen der Jahre 2008/2009 auf die Bereitschaft von Haushalten, finanzielle Risiken einzugehen, ausgewirkt hat.

Die Analyse basiert auf dem SAVE Datensatz, einer repräsentativen Panelbefragung von Haushalten in Deutschland. Der Datensatz enthält Informationen darüber, ob und in welcher Höhe deutsche Haushalte Vermögensverluste auf die Wirtschafts- und Finanzkrise zurückführen. Untersucht wird, ob sich ein Einfluss auf die Bereitschaft, Anlagerisiken einzugehen, feststellen lässt. Weiterhin wird analysiert, ob diese Erfahrung die Finanzmarkterwartungen der Haushalte bezüglich Risiko und Renditen beeinflusst hat.

Es zeigt sich, dass die mit der Finanzkrise verbundenen Vermögensverluste eines Haushaltes einen direkten Einfluss auf dessen Risikoeinstellung, Anlageverhalten und Erwartungen haben. Haushalte, die Vermögensverluste auf die Krise zurückführen, werden risikoaverser und zeigen eine größere Bereitschaft, zukünftig ihre Investitionen in riskante Anlagen zu reduzieren. Diese Haushalte erwarten zukünftig höhere Renditen, aber auch größere Risiken am Aktienmarkt.

Theoretisch sollten Vermögensverluste, die auf die Finanzkrise zurückgeführt werden, keinen anderen Effekt als "gewöhnliche" Veränderungen des Vermögens haben. Der Effekt scheint nicht durch das Risikoverhalten vor der Finanzkrise, verändertes Arbeitsmarktrisiko, Finanzwissen oder Gesamtvermögensveränderungen in diesem Zeitraum verursacht. Für diese Faktoren wird in der Analyse kontrolliert.

Wir interpretieren die Veränderungen der Risikobereitschaft als Konsequenz einer emotionalen Reaktion auf den Vermögensverlust durch die Krise. Obwohl die Rolle von Emotionen bereits von Adam Smith und John M. Keynes hervorgehoben wurde, wurden diese in der ökonomischen Literatur bisher größtenteils ausgeblendet. Erst in den letzten Jahren haben verschiedene ökonomische Experimente den Zusammenhang zwischen Emotionen und Entscheidungen unter Unsicherheit offengelegt. Die Ergebnisse dieser Studie legen nahe, dass Emotionen auch Erwartungen, Risikobereitschaft und das Anlageverhalten einer repräsentativen Stichprobe beeinflussen.

Auch wenn die Ergebnisse auf einem deutschen Datensatz basisieren, sollten sich die Erkenntnisse auf das Verhalten von Haushalten in Luxemburg und anderen Ländern übertragen lassen. Auch Haushalte in Luxemburg mussten Vermögenseinbußen durch die Finanzkrise hinnehmen. Von den Haushalten, die im Rahmen des Luxemburger HFCS befragt wurden, antworteten 16%, dass sie nicht mehr in Vermögenskategorien investieren möchten, in die sie vor der Finanzkrise investiert hatten. Für knapp 50% sind dies Aktien oder (Aktien-)Fonds. Der Anteil der Luxemburger Haushalte, die in Aktien oder (Aktien-)Fonds investiert haben, liegt mit 24% auf einem niedrigen Niveau (Ende 2010/Beginn 2011). Gemäß unserer Ergebnisse wirkt die Finanzkrise zusätzlich hemmend auf die Aktienmarktpartizipation. Gerade dieses Verhalten kann in der langen Frist zu niedrigeren Renditen führen, die einem ausreichenden Vermögensaufbau für das Alter im Wege stehen können.

1 Introduction

In its unexpectedness and severity, the crisis in 2008/2009 is unprecedented in the post-World-War II-era. Starting in December 2007, countries all over the world experienced a marked economic downturn. Between early 2008 and late 2009, the German DAX fell by 25%, German real GDP per capita by 5%. The Luxembourg LUXX fell by more than 40%, Luxembourg real GDP per capita by 8%. The precipitous decline of stock markets exposed institutional as well as private investors to substantial financial losses. Negative wealth developments were reported by 14% of German and 16% of Luxembourg households (BCL 2013). The event was a shock. This study aims to examine the effects on households' willingness to take risks.

Microeconomic theory commonly assumes that the willingness to take risks decreases as wealth decreases (e.g., Gollier 2001). An increasing number of studies find that emotions (e.g., Loewenstein et al. 2001; Kuhnen and Knutson 2011) or traumatic events (e.g., Cameron and Shah 2012) influence risk taking. Malmendier and Nagel (2011) show that the experience of a dramatic stock market decline has a long run influence on financial risk taking independent from own exposure to losses.

Several studies investigate whether the willingness to take risks changes during the crisis. Focusing on self-reported risk attitudes, Guiso et al. (2013) find that Italian bank clients increased their financial risk aversion from 2007 to 2009. Dutch brokerage clients surveyed on a monthly basis from April 2008 to March 2009 report time-varying risk attitude (Hoffmann et al. 2013). Their subjective risk and return expectations - which are important determinants of risk taking according to modern finance theory - also vary. An adjustment of portfolios is not observed. Weber et al. (2013) surveyed UK online-brokerage customers at three-month intervals. They find that the stated willingness to invest in the stock market decreases from September 2008 to March 2009 and increases again in June 2009. While risk and return expectations vary by and large with reported risk behavior, risk attitudes remain constant. Hudomiet et al. (2011) find that the population average of return expectations temporarily increases after the stock market crash in 2008.

Only Guiso et al. (2013) analyze potential causes for the observed increase in risk aversion. They find that the increase is unrelated to changes in wealth. Other "conventional" approaches (background risk, consumption habit) also cannot explain the change. The authors conduct an experiment which shows that fear and anger evoked by watching a horror movie causes an increase of a similar magnitude to the one observed from 2007 and 2009. However, a more direct test of the effect of sudden financial losses is not performed. The question how the dramatic event

affected subjective expectations and risk taking behavior remains open.

Our aim is to study the question how the crisis affects the willingness to take risks in more detail. The analysis is based on the representative German SAVE household panel. The SAVE study provides information on household wealth and the perceived consequences of the crisis. Households were asked to assess whether and how much they lost or gained since the beginning of the crisis end-2007 and end-2009. We analyze the relationship of total wealth changes from end-2007 to end-2009 and wealth changes attributed to the crisis to changes in the willingness to take risks. We consider the changes in risk attitude from 2007 to 2010, in subjective long run expectations and in planned long run risk taking behavior.

According to standard economic theory, wealth changes associated with a dramatic event should have the same effects as other wealth changes. Wealth changes attributed to the crisis should have no effect when it is controlled for the total change in wealth. We assume that an effect indicates an emotional reaction in the willingness to take risks. Examining subjective expectations allows us to consider that different individual experiences may have led to different updating of beliefs.

A possible objection to our approach is that it is difficult to assess whether and to what extent wealth changes are attributable to the crisis. An advantage of the German setting is that the country experienced no housing or mortgage crisis between 2007 and 2010. Household wealth changes are hence largely related to financial portfolios whose changes in value can be better assessed than those of real estate. Although responses may be biased, this does not invalidate our interpretation of the variable. Our interpretation is supported to the extent that responses are influenced by the subjective perception of the crisis.

Economic theory predicts that household suffering is to some extent related to their earlier risk taking behavior. The suddenness and severity of market declines suggest that households were hit unexpectedly by wealth losses. We address possible endogeneity concerns by controlling for several variables potentially captured. For example, we control for the household's share of risky assets prior to the crisis and job-related consequences of the crisis (changes in background risk).

We find that the total change in wealth from end-2007 to end-2009 is unrelated to the change in risk attitude and planned risk taking. In contrast, our results show that households that report having generated wealth losses since the beginning of the crisis decreased their financial risk tolerance from 2007 to 2010 by almost one half point of the 10-point Likert scale used to measure risk attitudes. These households are 19 percentage points (ppts) more likely to plan to decrease their share of risky assets in the long run. A higher wealth loss attributed to the crisis (relative to

financial wealth) implies a larger decrease in the willingness to take risks. Our study is the first that shows that the crisis affects risk taking of the general population (Campbell 2006). Previous studies are based on client data from banks.

Wealth losses attributed to the crisis also affect subjective expectations. The experience seems to reveal information on how risks and returns will develop; respondents are less likely to be unable to provide an assessment. Wealth losses attributed to the crisis imply increased optimism with respect to future returns and pessimism with respect to future risks. Kuhnen and Knutson (2011) find that news that contradicts prior choices is not fully incorporated when updating beliefs about risky investments. Respondents who suffer sudden wealth losses may hope for increased future returns to avoid the pain of accepting losses as final.

We interpret our finding that self-assessed wealth losses attributed to the economic downturn influence the willingness to take risks as evidence for an emotional reaction. The idea that emotions play a role is by far not new in economics. For instance, Keynes (1936) emphasizes the importance of "animal spirits" which he defines as "a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities." We add to the literature by showing that emotions influence risk taking directly (by influencing behavior) and indirectly (by influencing attitudes and expectations). The analysis shows that changes in risk attitude and to some extent changes in subjective expectations are related to changes in future risk taking.

The analysis does not allow a direct assessment of whether the results also apply to Luxembourg. The Luxembourg Household Finance and Consumption Survey (LU-HFCS) does not include the information required to investigate this topic (see Mathä et al. 2012). Several similarities exist between Germany and Luxembourg which suggest that the results should extend to apply to Luxembourg households. Stock market participation is on a similarly low level as in Germany (24% including mutual funds). One sixth of households surveyed in the LU-HFCS reply that they would not anymore invest in assets they owned prior to the crisis (BCL 2013). Reluctance to invest in stocks or mutual funds is reported by 47% of these households. Stock market participation is important for higher returns in the long-run (e.g., Cocco et al. 2005). The crisis might have lasting consequences in both countries.

We find that inability to assess future risks seems to prevent households from making plans about their future risk taking. Previous literature analyzes why people fail to plan for retirement (e.g., Lusardi and Mitchell 2011a). Our results contribute to the understanding of the reasons. Uncertainty regarding future developments seems to provide one explanation for a lack of planning in saving decisions. Un-

derstanding why households lack a strategy is important. Lusardi and Mitchell (2007a,b) show that planning is a predictor of savings and investment success.

The paper is organized as follows. Section 2 contains a review of related literature. In section 3, the approach and results from our empirical analysis are described. Section 4 contains a discussion of the findings, and section 5 concludes.

2 Previous literature

Microeconomic theory predicts that investors who suffer wealth losses increase their risk aversion (e.g., Gollier 2001). However, the empirical evidence is ambiguous. Guiso et al. (2013) find that the observed increase in self-reported risk aversion from 2007 to 2009 cannot be explained by wealth changes. Using data from the U.S. Panel Study of Income Dynamics, Brunnermeier and Nagel (2008) find that changes in liquid wealth do not explain changes in household investments in risky assets. Their study shows that portfolio allocations seem to be determined by inertia, i.e., households adjusting their portfolio only slowly. Using responses to a hypothetical gamble in the U.S. Health and Retirement Study, Sahm (2012) finds no significant relationship between changes in wealth or income and changes in relative risk aversion. Guiso and Paiella (2008) use a measure of absolute risk aversion derived from a hypothetical gamble in the Bank of Italy Survey of Household Income and Wealth. They find that absolute risk aversion is a concave function of wealth.

Apart from variance with wealth changes, risk attitudes are traditionally considered constant at least during adulthood (Roberts and DelVecchio 2000). However, recent literature shows that the willingness to take risk varies with several factors (e.g., Dohmen et al. 2011). An increasing number of studies show that emotions or traumatic events play a role. Malmendier and Nagel (2011) find that birth-cohorts that experienced periods of high stock market returns report higher willingness to bear risk in financial matters and invest a higher fraction of their liquid assets in stocks even after several decades. Kuhnen and Knutson (2011) show experimentally that evoking negative emotions induces people to take less risks. Guiso et al. (2013) find that watching a horror movie produces a change in risk attitudes similar to the one observed from 2007 to 2009 among Italian bank clients. Since "conventional approaches" cannot explain the change in bank clients' risk attitudes, the authors conclude that the change is caused by an emotional reaction to the crisis. The experiment by Cohn et al. (2012) shows that financial professionals become more risk averse when they are primed with a financial crash rather than a boom.

Normative expected utility theory and risk-return models explain differences

in risk taking only by differences in risk attitudes (e.g. Sarin and Weber 1993). The focus on risk attitudes has been criticized. Psychophysical risk-return models assume also different risk and return expectations (e.g., Weber 2010). Empirical literature confirms that household stock market expectations are heterogeneous (e.g., Dominitz and Manski 2011; Kezdi and Willis 2008; Hudomiet et al. 2011; Hurd et al. 2011). Evidence from psychology suggests that cross-situational differences in risk expectations, but not in attitudes, can explain differences in risk taking (Weber and Milliman 1997). Kezdi and Willis (2008) claim that subjective expectations can even solve the "stockholding puzzle", i.e., the low stock market participation observed despite high stock performance. Previous studies of risk taking during the financial crisis also emphasize the need to take into account subjective expectations. Hoffmann et al. (2013) and Weber et al. (2013) find that the observed variation in subjective expectations explains the variation in risk taking. Only Hoffmann et al. (2013) find that risk attitudes are relevant for investors' portfolio choices.

Expectation updating is usually related to the overall stock market performance (e.g., Kezdi and Willis 2008; Hurd et al. 2011; Dominitz and Manski 2011). Three possible types of expectation formation are considered. A random-walk type believes that returns are iid and therefore uses long run historical returns to predict future returns. A persistence type uses recent realizations to update beliefs on the assumption that recent performance will persist. A mean reversion type expects stock market performance to be reversed. However, a relationship between an individual's own past portfolio returns and his expectations has also been established. Vissing-Jorgensen (2003) finds that positive own returns lead to higher expected market returns, while negative own returns also have a positive but small effect.

Subjective expectations may also be affected by the experience of a dramatic event. Barberis et al. (1998) show that in making forecasts investors overreact to information of high strength and low statistical weight. (Weber 2010) reports that subjective expectations are influenced by excitement. Kuhnen and Knutson (2011) find that emotions influence updating of beliefs about risky investments. Individuals seem to incompletely incorporate news that contradicts prior choices to avoid a negative emotional state.

3 Empirical analysis

3.1 Empirical approach

We focus on two possible causes for changes in risk taking after the crisis: economic effects (wealth changes in terms of material endowment) and psychological effects

(the shock of sudden wealth changes). The analysis is based on the representative German SAVE study. The household panel contains detailed information on the financial and socio-economic situation of household members. The survey started in 2001 and is conducted annually from spring until early summer. The data are imputed using an iterative multiple imputation procedure (Schunk 2008; Ziegelmeyer 2013). The analysis is based on information from 2007 (the year prior to the crisis) to 2010 (the last conducted regular survey).[1] The surveys conducted in these years provide a unique possibility to disentangle economic and psychological effects.

The 2010 survey contained a section on households' experience with the crisis. Respondents were asked whether they experienced wealth losses or gains between the beginning of the economic and financial crisis end-2007 and end-2009 and if so, to quantify them. While 14.1% attribute losses to that period (average 1.410 euros; weighted and unconditional, i.e., based on all households), 2.1% report gains (average 309 euros).[2] Households lost on average 3.9% of their financial wealth.

The SAVE study contains annual information on household wealth.[3] Since there was no housing or mortgage crisis in Germany between 2007 and 2010, household wealth losses should be largely related to the composition of their financial portfolios. We calculate the change in financial wealth from end-2007 to end-2009. We are thus able to differentiate wealth changes attributed to the crisis from total wealth changes. According to standard microeconomic theory, wealth changes due to a dramatic event should not have a different effect than other changes in wealth. We assume that - when it is controlled for the total change in wealth - an effect of wealth changes attributed to the crisis is consistent with the notion that changes in households' willingness to take risks are due to a psychological reaction to the event.

Our approach requires a thorough understanding of what motivates responses to the question on wealth changes generated since the beginning of the crisis. A simulation study by Börsch-Supan et al. (2010) shows that subjective losses reported in the SAVE survey largely correspond to simulated losses. SAVE participants in 2009 were also asked whether they attribute losses to the crisis, gains were not requested.[4]

[1] The panel dimension is exploited to measure changes from 2007/2008 to 2010. Table 1 shows the year(s) from which a variable is generated.

[2] Descriptive statistics are based on observed data and calculated using the 2010 weighting scheme. Weighting establishes the sample's representativeness of the German population. Income and age classes are adjusted to the German Mikrozensus (see Börsch-Supan et al. 2009).

[3] Wealth can be measured using administrative information from banks (e.g., Guiso et al. 2013) or survey responses (e.g., Brunnermeier and Nagel 2008). Company records are highly accurate but do not necessarily represent the total wealth of customers and the population. Surveys offer the advantage that they aim to be representative for the entire population. However, wealth is only reported at aggregate levels. The reliability of the information depends on the respondents' willingness to report accurately (Campbell 2006).

[4] Respondents were asked about the total wealth loss generated due to the crisis in 2008. Bucher-

The correlation between losses reported in 2009 and 2010 is 0.6, suggesting reliability of responses. We analyze the relationship between wealth changes attributed to the crisis and total changes in financial wealth from end-2007 to end-2009 (in absolute terms) using Spearman's rank correlation coefficient. The correlation is 0.24 (significant at 1%-level).[5] Changes in financial wealth can be caused by several factors. The imperfect correlation can be explained, e.g., by households changing their level of saving based on consumption and income changes or inheritance.

Nonetheless, it has to be considered that the amount of wealth losses attributable to the crisis is difficult to assess and to some extent subjective. The question is a one-shot recall question. Recollections have been shown to be more biased than responses from disaggregate designs with several categories (Hurd et al. 1998). At least quantitative responses to the question appear to be biased. A bias is suggested by the existence of focal responses, e.g., rounded-off numbers. To the question on wealth changes since the beginning of the crisis, 81% of non-zero-responses are given in multiples of 1.000 euros, 22% even in multiples of 10.000 euros.

The variable should not be interpreted as continuous. Our main measure are two binary variables which are set to unity if the respondent reports gains or losses, respectively. We also create a set of four dummy variables measuring the quartile of losses relative to the financial wealth prior to the crisis. The set is included together with a dummy measuring whether the household attributes gains.

While wealth changes attributed to the crisis may be (at least) partially misreported, the existence of a bias does not contradict our interpretation of the variable. On the contrary, our notion that the variable measures the emotional experience is supported to the extent that responses are influenced by the perception of the crisis.

3.2 Measuring changes in the willingness to take risks

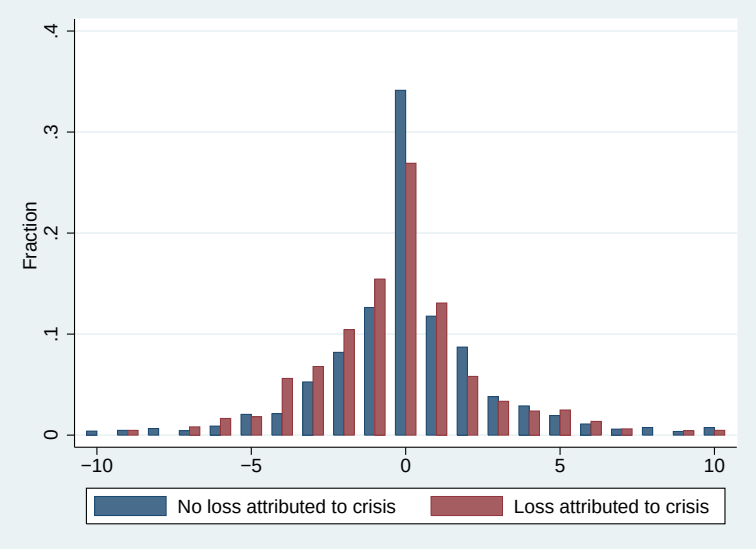
Modern finance theory suggests three different channels by which these factors may have affected risk taking: risk attitudes, risk expectations and return expectations.

Measuring changes in risk attitude Risk attitudes can be quantified by inference from actual choices, elicitation in experiments, or via survey questions. The SAVE survey contains respondents' self-reported financial risk attitude measured on a scale from 0 to 10 on an annual basis (exact wording reported in appendix A). Kapteyn and Teppa (2011) show that such "a-theoretical" risk aversion measures have higher explanatory power than sophisticated measures based on economic

Koenen and Ziegelmeyer (2013) employ this question to analyze who realized losses.

[5] The average change in financial wealth from end-2007 to end-2009 is a loss of 350 euros. Conditional on attributing wealth changes to the crisis. The unconditional correlation is 0.09.

Figure 1: Change in financial risk attitude 2007-2010



Note: A positive value implies an increase in risk tolerance, a negative value implies a decrease, zero implies no change.

theory. To validate the reliability of a single measure, approaches often compare measures across approaches (e.g., Anderson and Mellor 2009; Reynaud and Couture 2012; Dohmen et al. 2011). Coppola (2013) investigates the internal consistency and behavioral validity of the different risk attitude questions in SAVE. She concludes that the self-assessed risk attitude in a specific domain is more informative about actual behavior than lottery questions. We employ the change of self-reported risk attitude with respect to financial matters from 2007 to 2010 in our analysis.

Figure 1 shows the distribution of changes in financial risk attitude from 2007 to 2010 according to losses attributed to the crisis. A Kolmogorov-Smirnov test for equality of distributions indicates that the distribution of changes is significantly different between households with and without wealth losses. While 45% of those who attribute wealth losses to the crisis increase their risk aversion, this only applies to 33% of the other respondents. Only 26% that attribute wealth losses to the crisis do not change their initial willingness to take risks. This applies to 35% of households who do not report losses. The Spearman correlation between the change in risk attitude and losses/gains attributed to the crisis is 0.06 (absolute amount or relative to financial wealth in 2007; significant at the 1% level).

Measuring changes in subjective expectations Households' subjective expectations can be measured using probability formats or discrete-response alternatives such as "very likely, likely, somewhat unlikely." Both types of measures have advantages and disadvantages (e.g., Manski 2004). Discrete responses express little of the

richness of the uncertainty. While probability questions provide well-defined numerical scales for responses, many papers find inconsistent answers which are 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 and economic crisis (wording of questions reported in section A). We employ responses to the two questions to measure changes in subjective expectations.

Figure 2: Expected change of long run returns

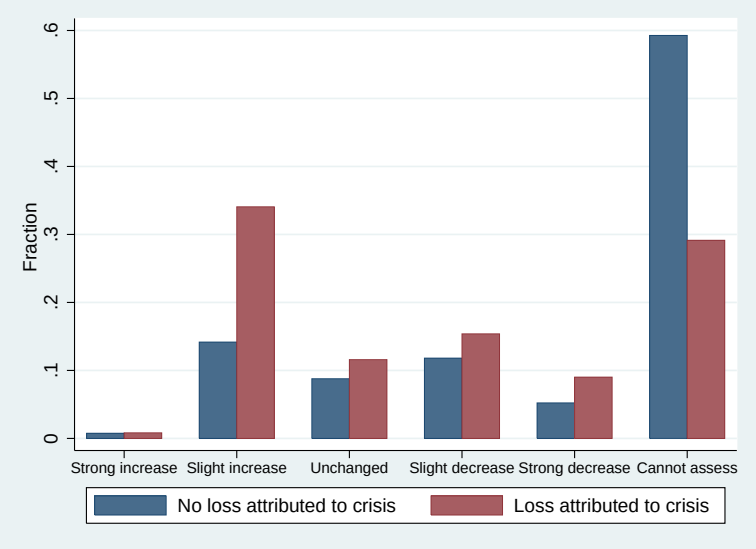
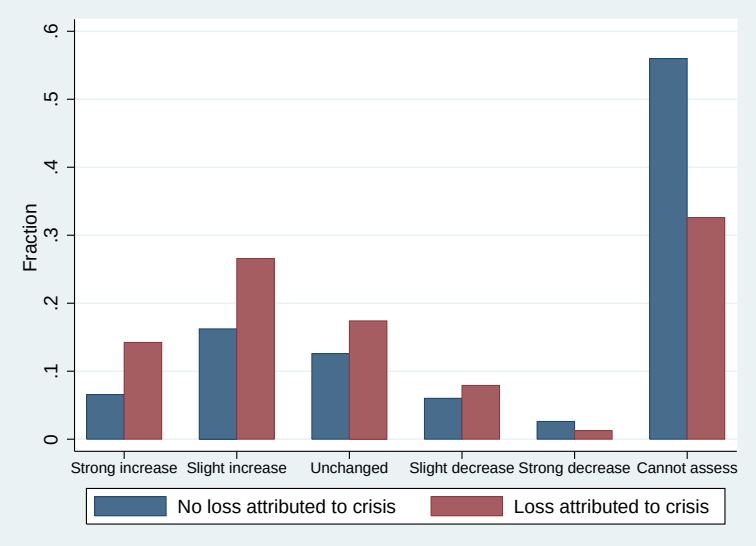


Figure 3: Expected change of long run risks



Figures 2 and 3 show that there is high uncertainty with respect to the development of long run risks and returns. Inability to assess the change of long run returns

(risks) due to the financial crisis is reported by 58% (56%) of households without a wealth loss. Only 29% (33%) of those who report losses tick that option. The fraction of respondents that cannot provide an answer is usually high in surveys.[6] Inquiring about long run changes may have further increased uncertainty. The sample contains different expectation types, as shown in figure 2. A large fraction (35%) of respondents reporting wealth losses expect that returns will increase strongly or slightly. A similar picture emerges for risk expectations.[7] Kolmogorov-Smirnov tests for equality of distributions show that the distribution differs between households who report wealth losses attributed to the crisis and other households.

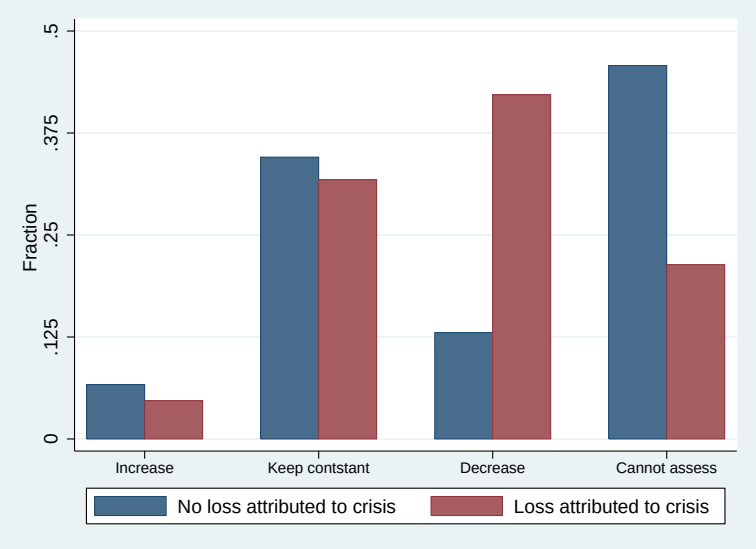
Measuring changes in risk taking Risk taking is frequently measured by observing actual choices. However, if agents do not instantaneously readjust their portfolio (given transaction costs), a significant drop in stock prices will be followed by a drop in the portfolio share invested in risky assets. Relationships between wealth changes and changes in risk aversion may then reflect a spurious correlation rather than changed behavior (Guiso et al. 2013). The results by Brunnermeier and Nagel (2008) and Hoffmann et al. (2013) suggest that inertia does influence portfolio allocations. This might be why Weber et al. (2013) - using a hypothetical measure - find changes in risk taking behavior in the course of the financial crisis but Hoffmann et al. (2013) do not. In the 2010 SAVE questionnaire, household members were asked to report how they plan to adjust their share of risky assets (wording of question reported in appendix A). This variable allows us to avoid inertia effects on the portfolio allocation. Sixty-nine percent respond that they do not invest in risky assets. This fraction is plausible. Stocks were held by only 28.5% of SAVE households in 2010. We drop these observations from the analysis.

Figure 4 shows households' planned long run risk taking behavior according to wealth changes attributed to the crisis. A Kolmogorov-Smirnov test shows that the distributions are statistically different. Households are reluctant to increase their investment in risky assets in the long run. A decrease is planned by 13% of households not reporting wealth changes. However, the fraction among those attributing wealth losses to the crisis is 42%. The figure reveals large uncertainty of households how to adjust their share of risky assets. Fifty percent of those reporting no wealth changes state that they cannot assess their plans. Such uncertainty is only

[6] Hurd et al. (2011) report that the fraction of "don't know"-responses is 13-21.1% if asked 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).

[7] However, 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."

Figure 4: Planned change of portfolio share in risky assets



expressed by 24% of those reporting no wealth changes.

3.3 Specification

The empirical analysis employs the variables described in sections 3.1 and 3.2 to analyze the relationship between wealth changes and changes in the willingness to take risks. All five multiply imputed data sets are used. The results are derived using Rubin's method (Rubin 1987, 1996).[8] We follow Deaton (1997, p. 70) who points out that "when the sectors [sub populations] are homogeneous, OLS is more efficient, and when they are not, both [weighted and unweighted] estimators are inconsistent. In neither case is there an argument for weighting." However, average marginal effects calculated from non-linear regressions are weighted to consider that the effect varies with the evaluation point (Cameron and Trivedi 2005, p. 821).

The first dependent variable is the change of risk attitude from 2007 to 2010. It is regressed on variables measuring the wealth change attributed to the crisis (Δ wealth crisis), the total relative change in financial wealth from end-2007 to end-2009 (Δ financial wealth), and a set of controls (denoted X). The model, shown in equation 1, is estimated using ordinary least squares (OLS).[9]

[8] The estimate of β is $\bar{\beta}_M = \frac{1}{5}\sum_{i=1}^{5}\hat{\beta}_i$. The variance-covariance matrix of $\bar{\beta}_M$ is $T = \bar{U} + (1+\frac{1}{5})B$ where $\bar{U} = \sum_{i=1}^{5}\frac{\hat{U}_i}{5}$ is the within-imputation variance-covariance matrix and $B = \sum_{i=1}^{5}\frac{(\beta_i-\bar{\beta}_M)(\beta_i-\bar{\beta}_M)'}{5-1}$ is the between-imputation variance-covariance matrix. Results are largely unchanged when only observed data is used. Available upon request.

[9] An alternative is to regress the level of risk attitude in the years 2007-2010 on the explanatory variables using fixed-effects estimation. However, the panel dimension cannot be exploited in a similar way with respect to the other dependent variables. To maintain comparability of the

$$\Delta \text{ risk attitude} = \beta_0 + \beta_1 \Delta \text{ wealth crisis} + \beta_2 \Delta \text{ financial wealth} + \beta_3 X + \epsilon \qquad (1)$$

We estimate three different variants of the model. For this purpose, three different sets of control variables X are defined which are included one after another. The baseline set includes controls for socio-demographic characteristics (gender, age, family status, education) and initial economic resources (financial wealth and household income reported for 2007). We control for financial literacy in 2007 (how many of three quiz-like questions were correctly answered) and whether the respondent is the financial decision-maker of the household.[10] With these variables we intend to capture how precisely a household can assess wealth changes due to the crisis.

The second set of controls includes variables that capture job-related changes. The literature discusses 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; Guiso and Paiella 2008). Guiso et al. (2013) find that government employees or retired individuals, i.e., groups that did not experience a change in background risk due to the crisis, do not show a different change in risk attitudes between 2007 and 2009. Whether their finding can be generalized to other employment relationships remains an open question. In the 2010 SAVE study, participants were asked to report whether they had experienced losses in income or became unemployed, whether they had to work short time or felt an increased job uncertainty as a consequence of the crisis. We include four binary variables indicating positive answers regarding the respondent or his partner. In addition, we control for changes in household income and whether the respondent became unemployed from 2007 to 2010.

A potential problem of our strategy is that wealth changes may capture past risk taking. Those who are more risk tolerant may invest a higher share in risky assets. They may have generated higher losses during the crisis. Omitting risk taking prior to the financial crisis may bias the effect of wealth changes. Thus the third set of controls is the household share of financial wealth invested in stocks, real estate funds, or other securities at the end of 2007. Adding the variable in an extra step allows us to check whether its inclusion affects the other relationships.

The second and third dependent variables are long run expectations. As described in section 3.2, responses to the questions are partly ordered. However, the

framework across specifications, we focus on the approach described in the text. It should be noted that fixed-effects regressions yield very similar effects. Results available upon request.

[10] A set of three quiz-like questions was developed by Lusardi and Mitchell (2011b). A detailed description of the variable used here can be found in Bucher-Koenen and Ziegelmeyer (2013).

unordered alternative (cannot assess) also contains valuable information. Thus ordered probit/logit estimation is unfeasible. Williams (2006) and Greene and Hensher (2009) caution against using multinomial probit/logit. Both require strong assumptions, e.g., independence of irrelevant alternatives, whose validity cannot be tested. In addition, interpretation of results is not straightforward. Another approach is to create four binary variables, which are set to unity when the respective alternative (m=increase, constant, decrease, cannot assess) was chosen, and estimate the models using binary probits.[11] While this comes at the cost of ignoring possible correlation of errors across alternatives, it allows a straightforward interpretation of the results. We estimate four binary choice models, as shown in equation 2.

$$P(\Delta\text{expectation}: \ m=1) = \phi(\beta_0' + \beta_1'\Delta \text{ wealth crisis} + \beta_2'\Delta \text{ financial wealth} + \beta_3' X) \tag{2}$$

We basically use the same three sets of controls as described above and add them step by step in the model. However, due to the forward-looking nature of the dependent variable, initial economic resources (financial wealth and household income) are from 2010. Risk-return models postulate that an individual's risk attitude determines the trade-off between risks and returns. We include the level of financial risk attitude in 2010 in all models to take this into account.

The fourth dependent variable are responses to the question on how households plan to adjust their risk behavior in the long run. The response possibilities are also partly ordered. We proceed as described above and create four binary variables which are set to unity if the respective alternative (n=increase, constant, decrease, cannot assess) was chosen, zero otherwise. The models, shown in equation 3, are estimated using binary probit.

$$\begin{aligned} P(\Delta \text{ risk behavior}) = \phi(\beta_0'' + \beta_1''\Delta \text{ wealth crisis} + \beta_2''\Delta \text{ financial wealth} + \beta_3'' X \\ + \beta_4''\Delta \text{ risk attitude} + \beta_5''\Delta \text{ expectations}) \end{aligned} \tag{3}$$

We include all three sets of controls.[12] As suggested by modern finance theory, we add the expected change in returns and risks and the change in risk attitude in a second step. Changes in risk and return expectations are included as a set of dummies (increase, constant, decrease, cannot assess). Those who expect risks to increase (decrease) should be less (more) likely to plan to increase their share of

[11] Due to a low fraction of respondents expecting "strong" changes, the responses "strong" and "slight" are combined in the empirical analysis.

[12] Results only including the first or second set of controls are unchanged - available upon request.

risky assets. Those who expect returns to increase (decrease) should be more (less) likely to plan to increase their share of risky assets. The change in financial risk tolerance is the difference between the levels reported in 2007 and 2010. A positive (negative) value implies an increase (a decrease) in risk tolerance. This should be positively related to the planned change in long run risk behavior. A description of all variables is provided in table 8. Table 9 contains summary statistics.

3.4 Results: Changes in risk attitude 2007-2010

Table 1 reports the results of estimating equation (1). The first three columns contain the results from regressions including two binary variables measuring whether the household reports having generated wealth losses or wealth gains since the beginning of the crisis. The reference group are households attributing no wealth change to the crisis. The three different sets of controls are added step by step. A positive coefficient implies an increase in risk tolerance from 2007 to 2010.

We observe that the total change in financial wealth from end-2007 to end-2009 is unrelated to the change in risk tolerance which is in line with Guiso et al. (2013). In contrast, attributing wealth losses to the crisis significantly decreases risk tolerance from 2007 to 2010. The effect is 0.45 in the first and second model (significant at the 5%-level), i.e., roughly one half of the dependent variable's scale unit. The average financial risk attitude is 2.2 in 2010. Hence this is a remarkable effect. The coefficient is 0.42 in the third model which includes the household's share of risky assets prior to the crisis. This suggests that the coefficients in the first two models to some extent capture past risk taking behavior. While the coefficient on reporting wealth gains attributed to the crisis is also negative, it is always insignificant.

Table 1: Determinants of changes in risk attitudes 2007-2010

	(1) b/se	(2) b/se	(3) b/se	(4) b/se	(5) b/se
Loss attributed to crisis (yes)	-0.452**	-0.457**	-0.415**	-0.401**	
	(0.186)	(0.190)	(0.193)	(0.193)	
No wealth change attributed (yes)	(ref.)	(ref.)	(ref.)	(ref.)	
Gain attributed to crisis (yes)	-0.301	-0.294	-0.291	-0.274	
	(0.484)	(0.485)	(0.485)	(0.485)	
Change in fin. wealth (in %)	-0.022	-0.020	-0.021		-0.020
	(0.032)	(0.032)	(0.032)		(0.032)
Financial wealth 2007 (logarithm)	0.011	0.012	0.024		0.016
	(0.022)	(0.022)	(0.020)		(0.023)
Net income 2007 (logarithm)	-0.188	-0.206	-0.207	-0.181	-0.188
	(0.125)	(0.152)	(0.150)	(0.153)	(0.154)
Age	0.019***	0.020***	0.019***	0.020***	0.020***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Female	0.053	0.058	0.047	0.045	0.049
	(0.137)	(0.137)	(0.136)	(0.136)	(0.137)
Not Married	0.368*	0.360*	0.358*	0.355*	0.363*
	(0.213)	(0.215)	(0.214)	(0.214)	(0.214)
Basic education	-0.439	-0.442	-0.433	-0.436	-0.444*
	(0.268)	(0.269)	(0.269)	(0.269)	(0.270)
Higher education	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)
Undergraduate education	-0.444**	-0.441**	-0.446**	-0.439**	-0.448**
	(0.185)	(0.187)	(0.187)	(0.188)	(0.186)
Graduate education	-0.162	-0.153	-0.147	-0.139	-0.149
	(0.175)	(0.176)	(0.177)	(0.177)	(0.177)
Financial literacy: 0/1 correct	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)
Financial literacy: 2 correct	-0.425	-0.424	-0.419	-0.409	-0.419
	(0.274)	(0.275)	(0.277)	(0.275)	(0.266)
Financial literacy: 3 correct	-0.336	-0.335	-0.323	-0.319	-0.329
	(0.267)	(0.268)	(0.270)	(0.267)	(0.259)
Financial decision maker of HH	-0.281	-0.282	-0.278	-0.265	-0.276
	(0.209)	(0.211)	(0.210)	(0.211)	(0.213)
Transition into unemployment		0.304	0.313	0.269	0.327
		(0.342)	(0.341)	(0.343)	(0.345)
Change in net income (in %)		-0.039	-0.027	-0.037	-0.030
		(0.208)	(0.208)	(0.205)	(0.209)
Other cons.: income loss		0.010	0.014	0.024	0.017
		(0.192)	(0.191)	(0.194)	(0.192)
Other cons.: job loss		-0.101	-0.105	-0.095	-0.091
		(0.296)	(0.296)	(0.291)	(0.295)
Other cons.: short time work		0.025	0.028	0.032	0.032
		(0.235)	(0.234)	(0.235)	(0.237)
Other cons.: job uncertain		0.105	0.098	0.106	0.099
		(0.176)	(0.176)	(0.176)	(0.177)
Share of risky assets 2007			-0.279	-0.203	-0.281
			(0.244)	(0.236)	(0.249)
Change in total wealth (in %)				0.013	
				(0.017)	
Total wealth 2007 (logarithm)				0.011	
				(0.016)	
Loss attributed to crisis: 4th quartile					-0.616**
					(0.311)
Loss attributed to crisis: 3rd quartile					0.091
					(0.392)
Loss attributed to crisis: 2nd quartile					-0.551
					(0.380)
Loss attributed to crisis: 1st quartile					-0.311
					(0.333)
No wealth change attributed					(ref.)
Gains attributed to crisis					-0.270
					(0.485)
F	2.54	1.89	1.85	1.77	1.93
R2	0.02	0.02	0.02	0.02	0.03
N	2047	2047	2047	2047	2047

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 lowest statistic from individual imputations.

Interesting results on the other control variables are the following. Labor market consequences associated with the crisis (i.e., changes in background risk) are unrelated to the change in financial risk attitudes, as is also found by Guiso et al. (2013). It has to be considered that Germany has a strong social security system. In addition, the German government provided financial support to companies who used short time employment to avoid dismissing employees during the crisis. Both effects may mitigate the impact of increased job uncertainty. The share of risky assets prior to the crisis is not significantly related to the change in risk tolerance (column (3)). We find that changes in risk tolerance increase with age.

The change in financial wealth may incompletely measure the change in wealth experienced during the crisis. We analyze whether considering net total wealth (i.e., including old-age assets, net real assets and excluding outstanding debt) changes the result. The fourth column of table 1 reports results from a regression including the level of net total wealth in 2007 and the change of that variable from 2007 to 2010 instead of financial wealth. The results show that both variables are unrelated to the change in risk tolerance. The effect of wealth losses attributed to the crisis is unaffected. As expected, since Germany experienced no housing or mortgage crisis, considering net total instead of financial wealth does not change the results.

Column (5) of table 1 shows the results from a regression in which the binary variable signaling whether the household reports having experienced losses since the beginning of the crisis is replaced by a set of dummies measuring the magnitude of those wealth losses. Those with the largest reported exposure to the crisis seem to have adjusted their financial risk attitude most. Households that report the highest wealth losses (4th quartile) decrease their risk tolerance by 0.62 scale points (significant at the 5% level). A lower and insignificant effect is found for households reporting wealth losses in the 1st and 2nd quartile. Households in the 3rd quartile do not fit the pattern. However, the effect is also insignificant.

We create an ordinal variable with three categories indicating whether the respondent's risk attitude increased, was unchanged, or decreased from 2007 to 2010 and use this as the dependent variable. The model including all three sets of controls is estimated using ordered probit. Wealth losses attributed to the crisis (measured binary) increase the likelihood that respondents increased their risk aversion by 6ppts (weighted average marginal effect). If we include the set of dummies considering the magnitude of wealth losses, we find that those attributing the highest wealth losses to the crisis are 16.5ppts more likely to increase their risk aversion. No significant effect is found for those with lower wealth losses or gains. The total change in financial wealth is not associated (results reported in table 10). Thus

applying a different estimator does not change our results.

Our results may be influenced by loss aversion, i.e., a greater sensitivity with respect to losses than to gains. We replace the continuous variable measuring the change of financial wealth from end-2007 to end-2009 by two binary variables. The first dummy is set to unity if the household generated gains in financial wealth in that period, the second if losses were generated (reference: no change). The results point to the same conclusions. The marginal effect of the two variables is insignificant (reported in table 12). Attributing losses to the crisis decreases risk tolerance by 0.41 scale points, as found in previous regressions. The variable does not seem to capture a different reaction to losses than to gains.

3.5 Results: Changes in long run expectations

Tables 2 and 3 report weighted average marginal effects from regressions of the model shown in equation (2). Results including the first two sets of variables can be found in the upper two panels of table 2. Results including all sets of controls are shown in table 3. The results indicate that wealth changes attributed to the crisis have an information-revealing effect. They decrease the probability that the respondent cannot assess long run changes of returns by 13.2ppts (table 3). Respondents attributing losses to the crisis are 6.7ppts more likely to expect mean-reversion, i.e., an increase in long run returns. The probability that those respondents expect persistence, i.e., a decrease in returns, is 4.5ppts higher (only significant at the 10% level). Whether someone expects a decrease or increase should depend on his expectation type. The magnitude of the effect of attributing gains to the crisis is similar to the effect of losses. However, the effect is insignificant. The total change in financial wealth is also unrelated to expectations.

The same applies to labor market consequences attributed to the crisis. In contrast, a higher share of risky assets prior to crisis has a highly significant effect. The probability of expecting an increase in returns is raised by 2ppts by a one standard deviation increase of the share of risky assets in 2007. The probability that the respondent cannot assess developments is decreased by 3.6ppts. Our results show that respondents with high financial literacy (3 correct answers) are less likely to respond that they cannot assess future returns and more likely to expect that returns will increase (significant at the 5% level). The probability that someone expects returns to increase is raised by a higher level of financial wealth or self-reported willingness to take risks. These variables are negatively related to the probability that someone cannot assess developments. It is plausible that greater familiarity with financial markets increases the ability to assess future returns.

Table 2: Determinants of return expectations I

Baseline controls				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.084***	0.000	0.048**	-0.167***
	(0.019)	(0.019)	(0.023)	(0.028)
Gain attributed to crisis (yes)	0.069	0.020	-0.000	-0.137*
	(0.048)	(0.038)	(0.052)	(0.082)
Change in fin. wealth (in %)	-0.003	-0.001	-0.002	0.006
	(0.004)	(0.003)	(0.004)	(0.005)
Baseline controls	YES	YES	YES	YES
Job-related controls	NO	NO	NO	NO
Share of risky assets	NO	NO	NO	NO
Wald Chi 2	182.08	37.94	25.95	310.12
Pseudo R2	0.11	0.03	0.01	0.12
N	2047	2047	2047	2047
Baseline and job-related controls				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.080***	0.001	0.040*	-0.157***
	(0.020)	(0.019)	(0.023)	(0.029)
Gain attributed to crisis (yes)	0.070	0.018	-0.002	-0.135*
	(0.047)	(0.038)	(0.052)	(0.082)
Change in fin. wealth (in %)	-0.002	-0.001	-0.001	0.005
	(0.004)	(0.003)	(0.004)	(0.005)
Baseline controls	YES	YES	YES	YES
Job-related controls	YES	YES	YES	YES
Share of risky assets	NO	NO	NO	NO
Wald Chi 2	190.66	38.97	34.05	313.28
Pseudo R2	0.11	0.03	0.02	0.12
N	2047	2047	2047	2047
All controls	Results shown in table 3			
All controls incl. net total wealth				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.073***	-0.002	0.050**	-0.150***
	(0.021)	(0.020)	(0.023)	(0.029)
Gain attributed to crisis (yes)	0.070	0.020	0.003	-0.142*
	(0.045)	(0.038)	(0.052)	(0.079)
Change in total wealth (in %)	-0.001	0.000	-0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.003)
Other controls as shown in table 3	YES	YES	YES	YES
Wald Chi 2	198.14	40.05	32.37	314.88
Pseudo R2	0.11	0.03	0.02	0.12
N	2047	2047	2047	2047
All controls incl. magnitude of wealth shock				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis: 4th quartile	0.079*	-0.012	0.042	-0.134***
	(0.042)	(0.032)	(0.040)	(0.048)
Loss attributed to crisis: 3rd quartile	0.084*	-0.021	0.038	-0.129**
	(0.043)	(0.030)	(0.045)	(0.057)
Loss attributed to crisis: 2nd quartile	0.055	0.029	0.024	-0.158**
	(0.041)	(0.039)	(0.045)	(0.062)
Loss attributed to crisis: 1st quartile	0.073	-0.024	0.080	-0.129**
	(0.050)	(0.031)	(0.055)	(0.059)
No wealth change attributed	(ref.)	(ref.)	(ref.)	(ref.)
Gain attributed to crisis	0.071	0.017	-0.002	-0.132
	(0.055)	(0.043)	(0.051)	(0.082)
Change in fin. wealth (in %)	-0.001	0.000	-0.002	0.003
	(0.004)	(0.003)	(0.004)	(0.005)
Other controls as shown in table 3	YES	YES	YES	YES
Wald Chi 2	198.34	46.47	32.95	322.76
Pseudo R2	0.12	0.04	0.02	0.13
N	2047	2047	2047	2047

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2/Pseudo R2 refer to lowest statistic from individual imputations.

Table 3: Determinants of return expectations II

	Increase ME/SE	Constant ME/SE	Decrease ME/SE	Don't Know ME/SE
Loss attributed to crisis (yes)	0.067***	-0.008	0.045*	-0.132***
	(0.021)	(0.020)	(0.023)	(0.029)
No wealth change attributed (yes)	(ref.)	(ref.)	(ref.)	(ref.)
Gain attributed to crisis (yes)	0.065	0.015	-0.001	-0.128
	(0.045)	(0.038)	(0.052)	(0.080)
Change in fin. wealth (in %)	-0.001	-0.000	-0.002	0.003
	(0.004)	(0.003)	(0.004)	(0.005)
Financial wealth in 2010 (logarithm)	0.007**	0.005**	0.004	-0.014***
	(0.003)	(0.002)	(0.003)	(0.003)
Net income 2010 (logarithm)	0.042	0.008	0.017	-0.075**
	(0.029)	(0.020)	(0.029)	(0.034)
Risk attitude level	0.007**	0.001	0.001	-0.012***
	(0.003)	(0.003)	(0.004)	(0.004)
Age	-0.001	-0.001**	-0.000	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Female	-0.066***	-0.044***	0.001	0.110***
	(0.018)	(0.015)	(0.020)	(0.024)
Not Married	0.012	0.005	-0.007	-0.013
	(0.026)	(0.023)	(0.029)	(0.035)
Basic education	-0.013	-0.008	-0.044	0.037
	(0.047)	(0.035)	(0.050)	(0.056)
Higher education	(ref.)	(ref.)	(ref.)	(ref.)
Undergraduate education	0.017	0.016	-0.018	-0.022
	(0.021)	(0.017)	(0.025)	(0.030)
Graduate education	0.031	0.003	-0.028	-0.020
	(0.024)	(0.017)	(0.027)	(0.031)
Financial literacy: 0/1 correct	(ref.)	(ref.)	(ref.)	(ref.)
Financial literacy: 2 correct	-0.011	-0.007	-0.039	0.062
	(0.031)	(0.028)	(0.037)	(0.045)
Financial literacy: 3 correct	0.086**	0.006	0.012	-0.099**
	(0.034)	(0.027)	(0.037)	(0.046)
Financial decision maker of HH	-0.014	0.004	0.025	-0.020
	(0.024)	(0.020)	(0.026)	(0.033)
Transition into unemployment	-0.021	-0.031	-0.002	0.044
	(0.074)	(0.059)	(0.101)	(0.122)
Change in net income (in %)	-0.027	-0.010	-0.024	0.061
	(0.036)	(0.022)	(0.033)	(0.041)
Other cons.: income loss	0.033	-0.008	0.033	-0.056*
	(0.023)	(0.019)	(0.023)	(0.030)
Other cons.: job loss	-0.048	0.033	0.069	-0.066
	(0.048)	(0.038)	(0.054)	(0.064)
Other cons.: short time work	-0.025	-0.052	0.042	0.028
	(0.037)	(0.036)	(0.043)	(0.056)
Other cons.: job uncertain	0.025	-0.017	-0.032	0.027
	(0.027)	(0.025)	(0.033)	(0.038)
Share of risky assets 2007	0.070***	0.044*	-0.022	-0.127***
	(0.026)	(0.025)	(0.036)	(0.041)
Wald Chi 2	197.10	44.39	34.18	322.47
Pseudo R2	0.12	0.04	0.02	0.13
N	2047	2047	2047	2047

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2/Pseudo R2 refer to lowest statistic from individual imputations.

The results are robust to using the level and change of net total instead of financial wealth, as shown in the middle panel of table 2. The bottom panel of the table reports the results from a regression including dummies capturing the magnitude of wealth losses attributed to the crisis. The effect slightly varies with the reported magnitude, the probability to expect an increase in returns is raised by 6-8ppts. However, only a wealth loss in the 3rd or 4th quartile is significant at the 10% level. The decrease in the likelihood that someone "cannot assess" developments varies between 13-16ppts (significant at 1 or 5% level). As found with

respect to the change in risk attitude, attributing a greater wealth loss to the crisis tends to have a stronger and more significant effect on return expectations.

Tables 4 and 5 report results using the expected change in long run risks as the dependent variables. Results of regressions including the first two sets of controls are reported in table 4, those including all three sets in table 5. Wealth losses attributed to the crisis seem to reveal information also about future risks. Table 5 shows that the probability that those respondents cannot assess future risks is decreased by 7.7ppts. The probability that risks are expected to increase in the long run is 8.9ppts higher in the model only including baseline controls, and 7.1ppts when all controls are included. There is no significant impact on households that expect a decrease of risks - as observed for returns. In line with previous results, only a negative experience associated with the crisis affects expectations. The total change in financial wealth is unrelated also to the expected change of risks.

We find that labor market consequences associated with the crisis have a significant effect on risk expectations. Those who report a loss of income (a loss of job) are 5ppts (10ppts) more likely to expect an increase in risk and are 5ppts (10ppts) less likely to be unable to assess developments. Changes in background risk may influence risk taking indirectly by their effect on expectations. In regard to the other control variables, results are similar to those for expected returns. High financial literacy increases the likelihood that a respondent expects increased or constant risks. A higher level of risk tolerance and financial wealth increase the likelihood that risks are expected to increase. An increase in all three variables decreases the likelihood that a respondent cannot assess developments. A higher share of risky assets in 2007 has an effect on the likelihood that a respondent cannot assess risks or that risks are expected to remain unchanged (significant at 1% and 10% level).

Our conclusions are unaffected when the regressions are estimated using multinomial probit (average marginal effects shown in table 11). We check whether our results are changed when the continuous variable measuring the change in financial wealth is replaced by two binary variables, one for gains and one for losses in financial wealth from end-2007 to end-2009. Taking into account loss aversion also does not change the results with respect to expectations (results reported in table 12).

3.6 Results: Changes in long run risk taking behavior

Tables 6 and 7 report weighted average marginal effects of probit regressions explaining the four responses on the question regarding household plans for risky assets in their portfolio. Attributing wealth losses to the crisis has a strong effect on

Table 4: Determinants of risk expectations I

Baseline controls				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.089***	0.007	-0.004	-0.111***
	(0.026)	(0.020)	(0.018)	(0.029)
Gain attributed to crisis (yes)	-0.014	0.061	-0.021	-0.066
	(0.061)	(0.044)	(0.046)	(0.072)
Change in fin. wealth (in %)	-0.006	0.003	-0.002	0.005
	(0.005)	(0.003)	(0.003)	(0.005)
Baseline controls	YES	YES	YES	YES
Job-related controls	NO	NO	NO	NO
Share of risky assets	NO	NO	NO	NO
Wald Chi 2	149.73	90.42	14.75	293.86
Pseudo R2	0.07	0.07	0.02	0.11
N	2047	2047	2047	2047
Baseline and job-related controls				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.076***	0.008	-0.003	-0.099***
	(0.026)	(0.021)	(0.019)	(0.029)
Gain attributed to crisis (yes)	-0.012	0.061	-0.023	-0.066
	(0.060)	(0.044)	(0.045)	(0.071)
Change in fin. wealth (in %)	-0.006	0.003	-0.002	0.005
	(0.004)	(0.003)	(0.003)	(0.005)
Baseline controls	YES	YES	YES	YES
Job-related controls	YES	YES	YES	YES
Share of risky assets	NO	NO	NO	NO
Wald Chi 2	158.92	95.64	18.89	299.10
Pseudo R2	0.07	0.07	0.02	0.12
N	2047	2047	2047	2047
All controls	Results shown in table 5			
All controls incl. net total wealth				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.087***	-0.003	-0.004	-0.094***
	(0.027)	(0.021)	(0.019)	(0.030)
Gain attributed to crisis (yes)	-0.001	0.054	-0.022	-0.072
	(0.060)	(0.043)	(0.046)	(0.072)
Change in total wealth (in %)	0.001	-0.001	-0.002	0.001
	(0.002)	(0.002)	(0.001)	(0.002)
Other controls as shown in table 5	YES	YES	YES	YES
Wald Chi 2	151.10	102.33	19.94	299.35
Pseudo R2	0.07	0.08	0.02	0.11
N	2047	2047	2047	2047
All controls incl. magnitude of wealth loss				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis: 4th quartile	0.122**	0.025	-0.025	-0.151***
	(0.053)	(0.039)	(0.029)	(0.054)
Loss attributed to crisis: 3rd quartile	0.023	-0.000	0.014	-0.040
	(0.052)	(0.035)	(0.034)	(0.060)
Loss attributed to crisis: 2nd quartile	0.080	-0.020	0.004	-0.085
	(0.056)	(0.036)	(0.034)	(0.064)
Loss attributed to crisis: 1st quartile	0.077	-0.013	-0.013	-0.047
	(0.056)	(0.037)	(0.036)	(0.058)
No wealth change attributed	(ref.)	(ref.)	(ref.)	(ref.)
Gain attributed to crisis	-0.014	0.066	-0.022	-0.061
	(0.057)	(0.056)	(0.037)	(0.072)
Change in fin. wealth (in %)	-0.005	0.005	-0.002	0.002
	(0.005)	(0.003)	(0.003)	(0.005)
Other controls as shown in table 5	YES	YES	YES	YES
Wald Chi 2	163.91	102.97	19.53	318.66
Pseudo R2	0.07	0.07	0.02	0.12
N	2047	2047	2047	2047

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2/Pseudo R2 refer to lowest statistic from individual imputations.

Table 5: Determinants of risk expectations II

	Increase ME/SE	Constant ME/SE	Decrease ME/SE	Don't Know ME/SE
Loss attributed to crisis (yes)	0.071***	-0.002	-0.006	-0.077**
	(0.027)	(0.021)	(0.019)	(0.030)
No wealth change attributed (yes)	(ref.)	(ref.)	(ref.)	(ref.)
Gain attributed to crisis (yes)	-0.014	0.057	-0.024	-0.059
	(0.060)	(0.044)	(0.045)	(0.071)
Change in fin. wealth (in %)	-0.005	0.004	-0.002	0.003
	(0.005)	(0.003)	(0.003)	(0.005)
Financial wealth in 2010 (logarithm)	0.010***	0.003	0.003	-0.015***
	(0.003)	(0.002)	(0.002)	(0.003)
Net income in 2010 (logarithm)	0.014	0.045**	-0.004	-0.061**
	(0.022)	(0.018)	(0.016)	(0.025)
Risk attitude level	0.008**	0.003	0.001	-0.014***
	(0.004)	(0.003)	(0.002)	(0.004)
Age	-0.001	-0.002***	-0.000	0.003***
	(0.001)	(0.001)	(0.000)	(0.001)
Female	-0.070***	-0.049***	-0.005	0.123***
	(0.020)	(0.015)	(0.013)	(0.021)
Not Married	0.038	0.008	-0.046**	-0.000
	(0.030)	(0.022)	(0.021)	(0.033)
Basic education	-0.082*	0.029	-0.030	0.056
	(0.044)	(0.033)	(0.026)	(0.043)
Undergraduate education	0.014	0.001	-0.002	-0.016
	(0.026)	(0.021)	(0.017)	(0.028)
Graduate education	0.048*	0.025	-0.046**	-0.046
	(0.025)	(0.019)	(0.020)	(0.029)
Financial literacy: 0/1 correct	(ref.)	(ref.)	(ref.)	(ref.)
Financial literacy: 2 correct	0.001	0.012	-0.014	0.012
	(0.033)	(0.024)	(0.024)	(0.038)
Financial literacy: 3 correct	0.097***	0.089***	-0.027	-0.143***
	(0.034)	(0.023)	(0.023)	(0.039)
Financial decisionmaker of HH	-0.024	0.026	0.034*	-0.043
	(0.029)	(0.021)	(0.019)	(0.031)
Transition into unemployment	0.022	-0.006	-0.035	0.008
	(0.067)	(0.054)	(0.052)	(0.071)
Change in net income (in %)	-0.012	-0.020	-0.011	0.043
	(0.025)	(0.021)	(0.016)	(0.027)
Other cons.: income loss	0.054**	0.000	-0.003	-0.052*
	(0.025)	(0.020)	(0.018)	(0.028)
Other cons.: job loss	0.098**	-0.029	0.021	-0.096**
	(0.039)	(0.038)	(0.028)	(0.045)
Other cons.: short time work	-0.002	-0.024	-0.012	0.038
	(0.037)	(0.029)	(0.026)	(0.042)
Other cons.: job uncertain	0.029	0.004	-0.020	-0.009
	(0.029)	(0.022)	(0.021)	(0.032)
Share of risky assets 2007	0.026	0.053*	0.013	-0.110***
	(0.037)	(0.028)	(0.024)	(0.040)
Wald Chi 2	159.52	102.29	18.89	308.39
Pseudo R2	0.07	0.07	0.02	0.12
N	2047	2047	2047	2047

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2/Pseudo R2 refer to lowest statistic from individual imputations.

planned future risk taking. Table 6 shows that households who attribute losses to the crisis are 19.1ppts more likely to plan a decrease of their share of risky assets. The probability that they plan keeping it constant is 11.6ppts lower. Again an information-revealing effect is observed. The probability that the respondent reports not being able to assess how the household will adjust the share of risky assets is 10.5ppts lower. Like in previous regressions, gains attributed to the crisis and the total change in financial wealth are not related to the responses.

The results from regressions including the change in risk attitude and the change

in expectations are reported in table 7. The effects of wealth changes - total and those attributed to the crisis - are largely unchanged. We find evidence for the theory's prediction that the change in risk attitude is related to the change in risk taking. A one standard deviation increase in financial risk tolerance increases the likelihood that the share of risky assets is planned to increase (keep constant) by 2ppts (4ppts); the effects are significant at the 5% level. An increase of the same magnitude makes it 6ppts less likely that the household has no plans. However, a relationship to the probability that the household plans to decrease the share of risky assets cannot be established. It has to be considered that the change is calculated from 2007 to 2010, while reported risk taking refers to the future. It is possible that portfolio adjustments took place between 2007 and 2010, thus lowering the link.

To some extent changes in expectations are also related to planned changes in risk taking behavior. The reference group are those who cannot assess future risks or returns (i.e., the largest group). Compared to this group, the probability to plan to increase the household share of risky assets is 10.4ppts higher among those who expect returns to increase (significant at the 5% level). The probability that the household plans a constant share of their risky assets is 15ppts lower if risks are expected to increase or remain constant (both effects significant at 10% level). The hypothesis that households expecting an increase in risk are more likely to plan to decrease the share of risky assets is not significant. The unordered response alternative to the expectation questions makes it difficult to establish a clear-cut "linear" relationship. Nonetheless, the findings are plausible.

Respondents that cannot assess the change in long run risk are more likely than those that have an opinion to report that they also cannot assess plans for their share of risky assets. Inability to assess future risks seems to be related to a lack of planning of future risk taking. A related literature analyzes why people fail to plan for retirement (e.g., Lusardi and Mitchell 2011a). While a causal interpretation of our result is difficult, it may be taken as an indication that uncertainty regarding future developments is one reason for a lack of planning in saving decisions.

We check whether our results hold when net total wealth replaces financial wealth (level and change). The results reported in the middle panel of table 6 show that the effects are largely unchanged. According to these results, households who attribute losses to the crisis are 21ppts more likely to plan to decrease their share of risky assets. The likelihood that these households are unable to plan future risk behavior is 15.8ppts lower. The change in net total wealth has no effect.

Table 6: Determinants of planned long run risk taking I

All controls				
	Increase	Constant	Decrease	Cannot Assess
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	-0.003	-0.116**	0.191***	-0.105***
	(0.029)	(0.046)	(0.036)	(0.041)
Gain attributed to crisis (yes)	0.010	0.030	-0.036	-0.018
	(0.044)	(0.088)	(0.087)	(0.088)
Change in fin. wealth (in %)	-0.001	-0.016	-0.003	0.015*
	(0.005)	(0.010)	(0.010)	(0.009)
Baseline/Job-related controls/Risky assets	YES	YES	YES	YES
Wald Chi 2	32.72	57.82	84.64	108.72
Pseudo R2	0.10	0.09	0.13	0.18
N	554	554	554	554
All controls incl. net total wealth				
	Increase	Constant	Decrease	Cannot Assess
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	-0.010	-0.075*	0.210***	-0.158***
	(0.028)	(0.044)	(0.035)	(0.040)
Gain attributed to crisis (yes)	0.002	0.080	0.000	-0.088
	(0.039)	(0.092)	(0.088)	(0.091)
%-change total wealth (logarithm)	0.002	-0.001	0.001	-0.004
	(0.002)	(0.005)	(0.004)	(0.005)
Control change in risk attitude	YES	YES	YES	YES
Controls return expectations	YES	YES	YES	YES
Controls risk expectations	YES	YES	YES	YES
Other controls as shown in table 7	YES	YES	YES	YES
Wald Chi 2	55.08	78.00	97.78	121.86
Pseudo R2	0.16	0.12	0.15	0.20
N	554	554	554	554
All controls incl. magnitude of wealth loss				
	Increase	Constant	Decrease	Cannot Assess
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis: above median	-0.007	-0.107**	0.237***	-0.148***
	(0.029)	(0.050)	(0.055)	(0.053)
Loss attributed to crisis: below median	-0.001	-0.091	0.189***	-0.096*
	(0.037)	(0.059)	(0.058)	(0.051)
No wealth change attributed	(ref.)	(ref.)	(ref.)	(ref.)
Gain attributed to crisis	0.007	0.035	-0.020	-0.040
	(0.044)	(0.095)	(0.066)	(0.093)
Change in fin. wealth (in %)	-0.002	-0.015	-0.003	0.012
	(0.005)	(0.011)	(0.009)	(0.010)
Control change in risk attitude	YES	YES	YES	YES
Controls return expectations	YES	YES	YES	YES
Controls risk expectations	YES	YES	YES	YES
Other controls as shown in table 7	YES	YES	YES	YES
Wald Chi 2	53.73	96.17	103.47	143.53
Pseudo R2	0.15	0.14	0.16	0.23
N	554	554	554	554

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2/Pseudo R2 refer to lowest statistics from individual imputations.

Table 7: Determinants of planned long run risk taking II

	Increase ME/SE	Constant ME/SE	Decrease ME/SE	Cannot Assess ME/SE
Loss attributed to crisis (yes)	-0.004	-0.101**	0.191***	-0.118***
	(0.029)	(0.044)	(0.036)	(0.040)
No wealth change attributed (yes)	(ref.)	(ref.)	(ref.)	(ref.)
Gain attributed to crisis (yes)	0.007	0.034	-0.028	-0.035
	(0.041)	(0.090)	(0.086)	(0.088)
Change in fin. wealth (in %)	-0.002	-0.014	-0.004	0.013
	(0.005)	(0.010)	(0.009)	(0.010)
Risk attitude change	0.007**	0.015**	0.001	-0.021***
	(0.004)	(0.007)	(0.006)	(0.007)
Returns cannot assess	(ref.)	(ref.)	(ref.)	(ref.)
Returns increase	0.104**	0.089	-0.098	-0.050
	(0.051)	(0.082)	(0.076)	(0.073)
Returns unchanged	0.082	0.092	-0.083	-0.058
	(0.054)	(0.092)	(0.086)	(0.083)
Returns decrease	0.073	-0.111	0.073	0.000
	(0.056)	(0.086)	(0.075)	(0.079)
Risks cannot assess	(ref.)	(ref.)	(ref.)	(ref.)
Risks increase	-0.017	0.157*	0.030	-0.189***
	(0.045)	(0.080)	(0.073)	(0.071)
Risks unchanged	-0.049	0.153*	0.064	-0.174**
	(0.047)	(0.086)	(0.078)	(0.076)
Risks decrease	0.005	0.089	0.057	-0.176**
	(0.053)	(0.099)	(0.086)	(0.088)
Financial wealth in 2010 (logarithm)	-0.001	0.038***	0.017**	-0.031***
	(0.005)	(0.008)	(0.008)	(0.006)
Net income in 2010 (logarithm)	0.016	-0.003	0.004	-0.016
	(0.018)	(0.045)	(0.040)	(0.045)
Age	-0.002***	0.000	0.004***	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Female	-0.018	0.112***	-0.044	-0.033
	(0.023)	(0.043)	(0.038)	(0.039)
Not Married	-0.016	-0.077	0.030	0.068
	(0.026)	(0.056)	(0.052)	(0.053)
Basic education	0.084	-0.358**	0.011	0.096
	(0.056)	(0.149)	(0.112)	(0.115)
Higher education	(ref.)	(ref.)	(ref.)	(ref.)
Undergraduate education	0.025	0.041	-0.048	-0.011
	(0.029)	(0.053)	(0.045)	(0.049)
Graduate education	0.020	0.012	-0.021	-0.010
	(0.025)	(0.048)	(0.045)	(0.047)
Financial literacy: 0/1 correct	(ref.)	(ref.)	(ref.)	(ref.)
Financial literacy: 2 correct	-0.048	-0.003	0.111*	-0.067
	(0.056)	(0.116)	(0.059)	(0.104)
Financial literacy: 3 correct	-0.007	-0.073	0.206***	-0.135
	(0.058)	(0.113)	(0.056)	(0.107)
Financial decision maker of HH	0.063**	0.044	-0.016	-0.098**
	(0.026)	(0.051)	(0.047)	(0.049)
Transition into unemployment	-	-0.163	0.012	0.154
	-	(0.175)	(0.128)	(0.106)
Change in net income (in %)	-0.015	0.024	0.026	-0.018
	(0.028)	(0.056)	(0.048)	(0.055)
Other consequences	-0.020	0.047	0.000	-0.018
	(0.021)	(0.040)	(0.038)	(0.041)
Share of risky assets 2007	0.017	0.100*	-0.056	-0.051
	(0.032)	(0.058)	(0.053)	(0.056)
Wald Chi 2	54.73	95.46	102.38	142.71
Pseudo R2	0.16	0.14	0.16	0.22
N	554	554	554	554

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2/Pseudo R2 refer to lowest statistics from individual imputations.

The bottom panel of table 6 reports results from a regression controlling for the reported magnitude of losses attributed to the crisis. Due to the lower number of observations, it is only distinguished between high (above median) and low (below median) losses. A large wealth loss increases the likelihood that households plan to decrease their share of risky assets by 23.7ppts. In contrast, a low wealth loss increases the likelihood by 18.9ppts. Both effects are significant at the 1% level. A higher exposure leads to a stronger adjustment of future risk taking. We check also whether taking into account loss aversion changes the results with respect to risk taking. This is not the case (results reported in table 12).

The results suggests that wealth changes attributed to the crisis have, in particular, a direct effect on reported risk taking behavior. The results reported in sections 3.4 and 3.5 show that wealth losses attributed to the crisis also influence risk attitudes and expectations. However, including these variables in the regressions does not change the link between wealth changes and planned risk taking.

4 Discussion

Economists are increasingly interested in the consequences of emotions and traumatic events for the willingness to take risk. The crisis in 2008/2009 is unprecedented in the post-World-War II-era. Households, as other investors, lost a substantial amount of their wealth. The event was a shock. Our analysis shows that the change in wealth from end-2007 to end-2009 is unrelated to the change in risk tolerance and in planned risk taking. The result is in line with several other empirical studies questioning the assumption that risk aversion decreases in wealth. In contrast, households that attribute wealth losses to the event show a different change in risk tolerance and in planned risk taking. According to standard economic theory, wealth changes due to a dramatic event should have the same effect as changes in wealth. We interpret our finding that wealth changes attributed to the crisis have an effect as evidence for an emotional reaction to the developments. The reaction implies a substantial reduction in households' willingness to take risks.

Wealth losses attributed to the crisis also affect expectations. On the one hand, we find an information-revealing effect. More interesting is that those losses imply increased optimism with respect to future returns and pessimism with respect to future risks. The two results are consistent. Although the relationship is scientifically disputed (e.g., Guo and Whitelaw 2006), a common rule of thumb claims that higher risks are related to higher expected returns. The result that wealth losses attributed to the crisis increase return expectations is in line with research by Kuh-

nen and Knutson (2011). The authors report that information that contradict prior choices are not fully incorporated when updating beliefs to avoid a negative emotional state. Respondents who suffer sudden losses may hope for increased future returns to avoid the pain of accepting the losses as final.

Quantifying the impact of emotions on risk taking is a challenge. Neuroscientific studies use brain activation to show that the parts of the brain that generate emotional states are important for the processing of information about risk. Activation in the anterior insula (nucleus accumbens) is associated with switching to riskless (risky) assets.[13] The evidence does not establish whether emotions caused by real-world events can influence risk taking. In incentivized laboratory experiments (e.g., Guiso et al. 2013; Cohn et al. 2012; Kuhnen and Knutson 2011) differences in behavior are explained by emotional states manipulated by subjects' exposure to stimuli. The extent to which the findings can be generalized to real-life situations remains open. Observational studies (e.g., Cameron and Shah 2012; Malmendier and Nagel 2011) analyze the impact of events such as natural disasters or economic crises comparing individuals that (potentially) experienced the event (and the associated emotions) with individuals that did not. Their reliability depends on a credible strategy isolating the effect of the traumatic experience from other influences.

Our analysis is an observational study. An advantage of our approach is that our information reveals whether a household considers itself affected by the event. We control for several factors which influenced whether a household experienced losses, e.g., financial literacy and past involvement in the financial market. Other factors which are potentially captured by the variable, e.g., the change in wealth and changes in background risk, are also included in the regression. However, this does not prove that the effect is due to emotions. A challenge of observational studies is the possibly inherent selection bias. We argue that selectivity is unlikely due to the suddenness and scope of wealth losses during the crisis which suggest that those were unexpected. While we think that we are thus able to isolate the psychological from other effects, one might still argue that an omitted variable affects the result.

Our results do not seem to be caused by loss aversion. Camerer (2005) discusses whether loss aversion is a judgment error, a genuine component of preferences, or an emotional reaction. He concludes that "loss aversion is often an exaggerated emotional reaction of fear, an adapted response to the prospect of genuine, damaging, survival-threatening loss" (p. 132). Hence the distinction may not be crucial.

[13] For instance, Pessiglione et al. (2006) show that activation of the anterior insula increases when the outcome is worse than expected. Knutson et al. (2008) find that exogenously increasing the nucleus accumbens activation by presenting positive stimuli before a financial decision causes the subjects to shift to a high-risk option.

5 Conclusion

The financial crisis presented a shock not only for institutional actors but also for private households. We analyze two important reasons why the developments could have changed risk taking: changes to the level of wealth and the shock of experiencing the wealth changes. Modern finance theory suggests three different channels by which these factors may have affected the willingness to take risk: risk attitudes, risk expectations and return expectations. We find no evidence that the willingness to take risk decreases in wealth. In contrast, attributing wealth losses to the crisis decreases risk tolerance from 2007 to 2010 and planned long run risk taking. Households attributing wealth losses to the crisis are more likely to expect an increase in risk and returns. We interpret our findings as evidence for an emotional reaction to the crisis. We add to literature by showing that subjectively perceived consequences of a dramatic event influence preferences as well as beliefs. Our study is the first to show that risk taking in the general population is affected by the crisis.

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A Exact wording of survey questions

1. *Wealth changes attributed to 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."

2. *Financial risk attitude*
   "To what extent do the following statements apply to you? Please answer on a scale from 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 financial matters."

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. *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?"

B Variable description and summary statistics

Table 8: Variable description

Variable	Survey wave	Description
Change long run risk taking	2010	Set of binary variables (increase, keep constant, decrease, cannot assess), exact wording of question reported in section A
Change long run return expectation	2010	Set of binary variables (increase, unchanged, decrease, cannot assess), exact wording of question reported in section A
Change long run risk expectation	2010	Set of binary variables (increase, unchanged, decrease, cannot assess), exact wording of question reported in section A
Change and level of financial risk attitude	2007/2010	Scale from 0-10, exact wording of question reported in section A, change calculated as difference of levels in 2007 to 2010, a positive value implies an increase in risk tolerance, a negative value a decrease, zero implies no change
Wealth change attributed to crisis	2010	Set of binary variables (loss/gain), exact wording of question reported in section A
Magnitude of wealth change attributed to crisis	2010	Set of binary variables (magnitude of loss/gain), exact wording of question reported in section A
Change and level of financial wealth	2008/2010	Financial wealth (deposits in savings accounts, building saving contracts, fixed income securities, stock holdings and real estate funds, other financial assets) in logarithm at the end of 2007/2009; change calculated as difference between levels at the end of 2007 and the end of 2009.
Change and level of total net wealth	2008/2010	Financial wealth plus old-age assets plus net real assets minus outstanding debt in logarithm at the end of 2007/2009; change calculated as difference between levels at the end of 2007 and the end of 2009.
Other consequences from crisis (background risk)	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; collapsed to one binary variable in risk taking regressions
Change and level of net HH income	2007/2010	Monthly net household income, change is from 2007 to 2010
Transition into unemployment	2007/2010	Binary variable that is one if respondent reports not to be unemployed in 2007 but in 2010
Share of risky assets on financial wealth 2007	2008	Ownership of "equity funds and real estate funds" (e.g., reverse convertible, exchange traded funds, mixed funds) or "other securities" (e.g., discount certificates, hedge fonds, money market fonds, and other finance innovations), in relation to financial wealth in 2007
Financial literacy 2007	2007	Set of binary variables measuring how many of three questions designed to measure financial skills are correctly answered
Financial decision maker of HH	2010	One if respondent is mainly responsible for financial decisions of HH, zero otherwise
Basic education	2010	One if respondent has 9/10 years of education, zero otherwise
Higher education (reference)	2010	One if respondent has 13/14 years of education, zero otherwise
Undergraduate education	2010	One if respondent has 16/17 years of education, zero otherwise
Graduate education	2010	One if respondent has 18/19 years of education, zero otherwise
Age	2010	Age of the respondent
Female	2010	One if respondent is female, zero otherwise
Not married	2010	One if respondent is not married, zero otherwise

Table 9: Summary statistics

Variable	Mean	Std.	Min	Max
Change risk taking: increased	0.0196	0.1387	0	1
Change risk taking: constant	0.0835	0.2766	0	1
Change risk taking: decreased	0.0542	0.2265	0	1
Change risk taking: cannot assess	0.1059	0.3077	0	1
Change risk taking: not applicable	0.7368	0.4404	0	1
Change return expectation: increase	0.1784	0.3828	0	1
Change return expectation: constant	0.0916	0.2885	0	1
Change return expectation: decrease	0.1799	0.3842	0	1
Change return expectation: cannot assess	0.5501	0.4975	0	1
Change risk expectation: increase	0.2503	0.4332	0	1
Change risk expectation: constant	0.1333	0.3399	0	1
Change risk expectation: decrease	0.0854	0.2795	0	1
Change risk expectation: cannot assess	0.5311	0.4991	0	1
Change financial risk attitude	0.0385	2.8015	-10	10
Level financial risk attitude 2010	2.1805	2.5084	0	10
Wealth loss attributed to crisis	0.1409	0.3479	0	1
Magnitude of wealth loss: Zero	0.8376	0.3688	0	1
Magnitude of wealth loss: 1st quartile	0.0379	0.1909	0	1
Magnitude of wealth loss: 2nd quartile	0.0344	0.1822	0	1
Magnitude of wealth loss: 3rd quartile	0.0358	0.1859	0	1
Magnitude of wealth loss: 4th quartile	0.0328	0.1782	0	1
Wealth gain attributed to crisis	0.0215	0.1449	0	1
Change of fin. wealth from 2007-10 (in %)	0.8110	2.5035	-0.8727	12.8858
Level of financial wealth 2007 (logarithm)	6.6489	4.5416	0	14.8277
Change of total net wealth from 2007-10 (in %)	0.2659	6.4360	-25.0583	26.6195
Level of total net wealth in 2007 (logarithm)	7.7536	7.0162	-13.1250	15.7857
Transition into unemployment	0.0311	0.1736	0	1
Net monthly HH income (logarithms)	7.7668	0.6928	3.6509	10.2507
Change of net monthly HH income (in %)	-4.3243	0.4917	-7.5032	-0.7492
Other consequences: income loss	0.1771	0.3818	0	1
Other consequences: job loss	0.0765	0.2658	0	1
Other consequences: work short time	0.0953	0.2937	0	1
Other consequences: income uncertainty	0.1702	0.3758	0	1
Share of risky assets on financial wealth	0.1263	0.2693	0	1
Financial literacy: 0/1 correct	0.1298	0.3161	0	1
Financial literacy: 2 correct	0.3352	0.4721	0	1
Financial literacy: 3 correct	0.5350	0.4988	0	1
Financial decision maker of HH	0.4486	0.4974	0	1
Basic education	0.0948	0.2929	0	1
Undergraduate education	0.5766	0.4941	0	1
Graduate education	0.1600	0.3666	0	1
Age	50.9517	16.1781	22	97
Female	0.5413	0.4983	0	1
Not married	0.4225	0.4940	0	1

Summary statistics calculated from five fully imputed data sets and weighted.

C Additional results

Table 10: Determinants of change in risk attitude - ordered probit

All controls			
	Decrease	Constant	Increase
	b/se	b/se	b/se
Loss attributed to crisis (yes)	0.062**	-0.002	-0.060**
	(0.029)	(0.002)	(0.028)
No wealth change attributed (yes)	(ref.)	(ref.)	(ref.)
Gain attributed to crisis (yes)	-0.044	0.002	0.042
	(0.075)	(0.003)	(0.072)
Change in fin. wealth (in %)	0.002	-0.000	-0.002
	(0.005)	(0.000)	(0.005)
Controls as in table 3, column (3)	YES	YES	YES
Wald Chi 2	46.86	46.86	46.86
Pseudo R2	0.01	0.01	0.01
N	2047	2047	2047
All controls incl. magnitude of wealth loss			
	Decrease	Constant	Increase
	b/se	b/se	b/se
Loss attributed to crisis: 4th quartile	0.165***	-0.029	-0.136***
	(0.057)	(0.018)	(0.040)
Loss attributed to crisis: 3rd quartile	-0.001	-0.000	0.001
	(0.050)	(0.001)	(0.049)
Loss attributed to crisis: 2nd quartile	0.060	-0.005	-0.055
	(0.054)	(0.008)	(0.046)
Loss attributed to crisis: 1st quartile	0.035	-0.002	-0.033
	(0.057)	(0.005)	(0.052)
No wealth change attributed	(ref.)	(ref.)	(ref.)
Gain attributed to crisis	-0.044	-0.002	0.045
	(0.075)	(0.007)	(0.082)
Change in fin. wealth (in %)	0.001	-0.000	-0.001
	(0.006)	(0.000)	(0.006)
Controls as in table 3, column (5)	YES	YES	YES
Wald Chi 2	52.20	52.20	52.20
Pseudo R2	0.01	0.01	0.01
N	2021	2021	2021

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2/Pseudo R2 refer to lowest statistics from individual imputations.

Table 11: Determinants of risk and return expectations - multinomial probit

Return expectations, incl. all controls				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.072***	0.001	0.058**	-0.130***
	(0.021)	(0.019)	(0.023)	(0.029)
Gain attributed to crisis (yes)	0.077*	0.025	0.019	-0.121
	(0.046)	(0.038)	(0.054)	(0.081)
Change in fin. wealth (in %)	-0.001	0.000	-0.002	0.003
	(0.004)	(0.003)	(0.004)	(0.005)
Controls as shown in table 5	YES	YES	YES	YES
Wald Chi 2	381.39	381.39	381.39	381.39
N	2047	2047	2047	2047
Risk expectations, incl. all controls				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.074***	0.004	-0.001	-0.077***
	(0.026)	(0.021)	(0.019)	(0.030)
Gain attributed to crisis (yes)	0.008	0.061	-0.014	-0.055
	(0.063)	(0.044)	(0.046)	(0.080)
Change in fin. wealth (in %)	-0.005	0.004	-0.002	0.003
	(0.005)	(0.003)	(0.003)	(0.005)
Controls as shown in table 7	YES	YES	YES	YES
Wald Chi 2	371.49	371.49	371.49	371.49
N	2047	2047	2047	2047

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. Multinomial probit estimates, reported are weighted average marginal effects. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. Chi2 refer to lowest statistics from individual imputations.

Table 12: Taking into account loss aversion

Change risk attitude 2007-2010 (controls as shown in column (3), table 1)				
				b/se
Loss attributed to crisis (yes)				-0.411**
				(0.193)
Gain attributed to crisis (yes)				-0.275
				(0.488)
Loss fin. wealth (yes)				-0.231
				(0.281)
Gain fin. wealth (yes)				-0.292
				(0.237)
F				1.82
R2				0.02
N				2047
Return expectations (controls as shown in table 3)				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.067***	-0.009	0.045*	-0.131***
	(0.021)	(0.020)	(0.023)	(0.030)
Gain attributed to crisis (yes)	0.062	0.010	0.004	-0.125
	(0.045)	(0.038)	(0.053)	(0.079)
Loss fin. wealth (yes)	-0.051	-0.050	0.034	0.063
	(0.040)	(0.035)	(0.040)	(0.044)
Gain fin. wealth (yes)	-0.034	-0.036	0.008	0.056
	(0.043)	(0.037)	(0.040)	(0.047)
Wald Chi 2	197.10	44.39	34.18	322.47
Pseudo R2	0.12	0.04	0.02	0.13
N	2047	2047	2047	2047
Risk expectations (controls as shown in table 5)				
	Increase	Constant	Decrease	Don't Know
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	0.070**	-0.002	-0.003	-0.078***
	(0.027)	(0.021)	(0.019)	(0.030)
Gain attributed to crisis (yes)	-0.007	0.050	-0.023	-0.059
	(0.060)	(0.044)	(0.046)	(0.070)
Loss fin. wealth (yes)	-0.002	-0.025	0.021	0.009
	(0.037)	(0.031)	(0.021)	(0.037)
Gain fin. wealth (yes)	-0.046	0.015	0.033	0.005
	(0.040)	(0.035)	(0.023)	(0.042)
Wald Chi 2	159.52	102.29	18.89	308.39
Pseudo R2	0.07	0.07	0.02	0.12
N	2047	2047	2047	2047
Long run risk behavior (controls as shown in table 7)				
	Increase	Constant	Decrease	Cannot Assess
	ME/SE	ME/SE	ME/SE	ME/SE
Loss attributed to crisis (yes)	-0.003	-0.095**	0.192***	-0.127***
	(0.028)	(0.044)	(0.036)	(0.040)
Gain attributed to crisis (yes)	0.008	0.041	-0.025	-0.042
	(0.041)	(0.091)	(0.085)	(0.089)
Loss fin. wealth (yes)	-0.092	0.040	0.058	0.047
	(0.120)	(0.124)	(0.111)	(0.092)
Gain fin. wealth (yes)	-0.092	0.026	0.054	0.050
	(0.126)	(0.116)	(0.114)	(0.094)
Wald Chi 2	54.73	95.46	102.38	142.71
Pseudo R2	0.16	0.14	0.16	0.22
N	554	554	554	554

SAVE 2007-2010, all 5 imputations are used, results combined using Rubin's rule. OLS coefficients in first panel, weighted average marginal effects from probit regressions in other panels. Hypothesis tests based on robust standard errors. Significance levels : $*$: 10% $**$: 5% $***$: 1%. F/R2/Chi2/Pseudo R2 refer to lowest statistics from individual imputations.

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